Appendix A

Ground Water Quality Assessment

Assessment of the Potential Impact on Water Resources of the Proposed O'oma Beachside Village in North Kona, Hawaii

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Introduction

This report presents an assessment of the potential impact on water resources of the proposed O'oma Beachside Village to be located on TMKs 7-3-09:4 and 22 in North Kona, Hawaii (its location is shown on Figure 1. The project site is approximately 303 acres. The inland 228 acres of the site would be developed for 950 to 1200 single and multi-family residential units and related uses. The remaining 75 acres along the shoreline would be a coastal preserve (57 acres) and a shoreline park (18 acres).

Specifics of the Proposed Development

Exhibits 1 through 8 in the Appendix to this report provide specific details of the land use plan, development areas, water supply requirements, wastewater generation and treatment, and stormwater collection and disposal as prepared by the project's planning and civil engineering consultants. Approximate water use and wastewater generation amounts by development area are tallied below and are briefly described in the paragraphs following.

Projected Average Water Use and Wastewater Generation by the O'oma Beachside Village*

Development Area	Potable Supply (MGD)	Irrigation Supply (MGD)	Wastewater Generation (MGD)
A	0.212	0.123	0.132
B	0.280	0.078	0.219
C	0.201	0.168	0.128
Other	--	0.036	--
Cumulative Total	0.693	0.405	0.479

* Refer to Exhibits 4, 5, and 6 in the Appendix for details on these projected quantities.

<u>Potable and Irrigation Water Supply</u>. Two quite different alternatives for potable and irrigation supply have been considered. One of these is to develop, individually or as a joint venture, a well or wells which would tap high level groundwater above Mamalahoa Highway. For this alternative, the well (or wells) would be connected to the Department of Water Supply's (DWS') North Kona System. Costs, timing, and other considerations for this alternative have directed the project to the second alternative. This second and preferred alternative would consist of the desalinization of saltwater to produce the necessary potable and irrigation supply. The two possible sources of feedwater supply being considered for the desalinization are the NELHA deep (cold) or shallow (warm) systems and onsite deepwells which would tap saline groundwater at depth beneath the brackish lens.

For the purposes of the analyses of the impact on water resources herein, it has been assumed that the second alternative, onsite reverse osmosis (RO) desalting, would be the source of potable and irrigation supply. For water from NELHA or onsite wells, the product recovery rate would be on the order of 40 to 45 percent of the feedwater supply. The remaining 55 to 60 percent would be a brine "concentrate" that would be disposed of in onsite deep wells.

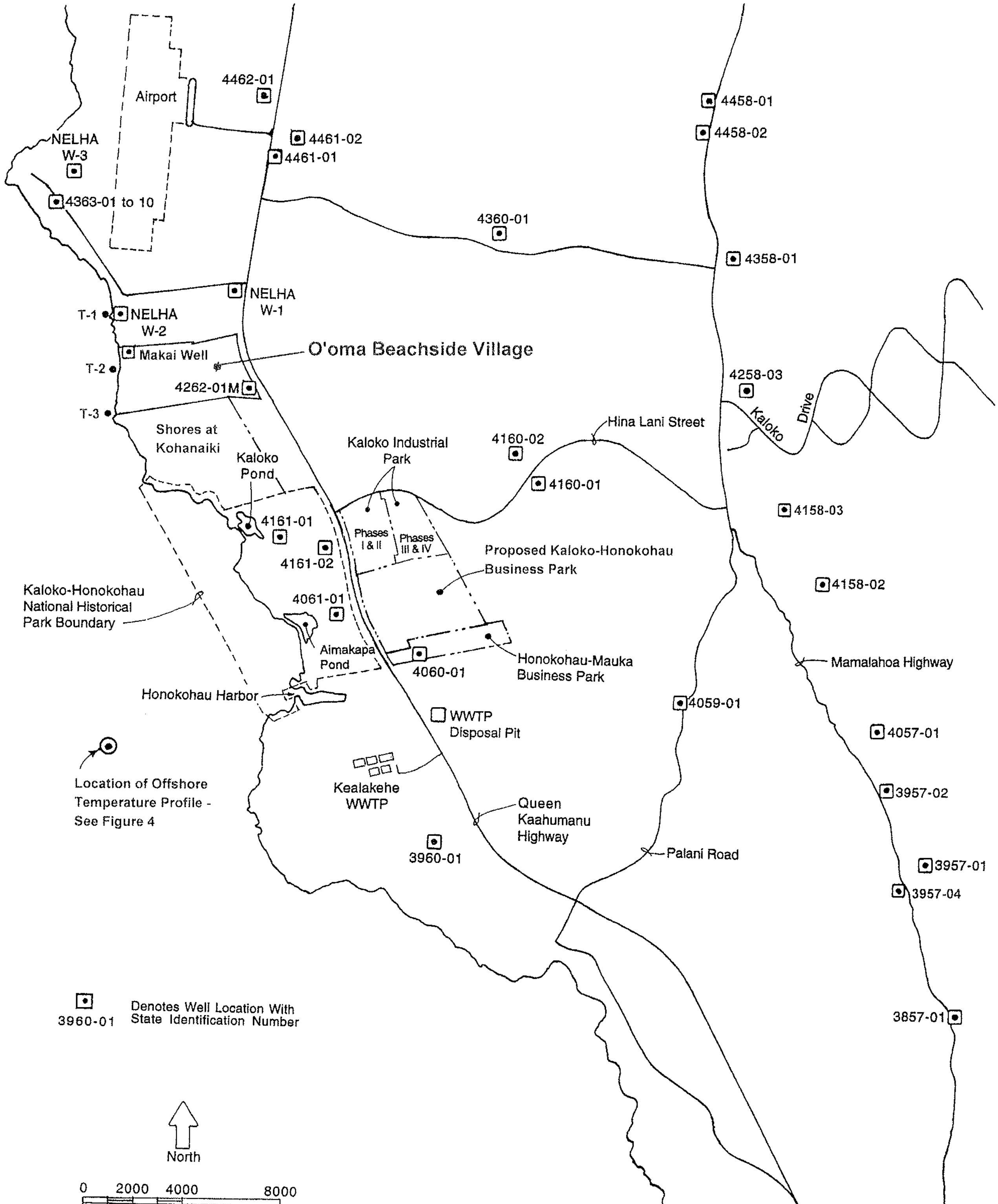

Figure 1
Location of the Proposed
O'oma Beachside Village

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Wastewater Generation, Treatment, and Reuse. The project's private wastewater treatment plant (WWTP) will be located along its northern (NELHA) boundary and near the makai end of the residential development. Wastewater will be delivered to the WWTP via 6- and 8-inch lines. The WWTP will utilize a membrane bioreactor (MBR) system that will provide treatment to R-1 (tertiary) standards. The intention is to reuse the R-1 effluent for non-potable irrigation. Experience with developments such as proposed for O'oma has shown that actual wastewater generation as computed in Exhibit 6 and summarized in the tally above is not likely to provide all of the non-potable irrigation requirement. There are three reasons for this. First, the amount of wastewater generated will increase gradually over time as the project is built out and occupied whereas the non-potable irrigation amount is required at the outset. Second, the projections in Exhibit 6 are based on year-round full occupancy which is only likely to occur during selected seasonal periods. Third, actual wastewater generation is typically less than design standards.

The three aspects noted above mean that a supplemental source of non-potable irrigation will be required at the outset and probably will also be needed to some extent (perhaps seasonally) in the long term. It also means that during peak occupancy periods after the project's full build-out, a backup to irrigation reuse will be needed for disposal of excess effluent. In this generally dry area, this excess can probably be handled with additional storage. Otherwise, a disposal well within the WWTP site would be required.

Stormwater Collection and Disposal. Except for a couple of unpaved, 4-wheel drive roads, the 303-acre site is completely undeveloped. Rainfall on the site does not move across it as surface runoff. It is either evaporated back to the atmosphere, transpired back to the atmosphere by vegetation, or becomes groundwater recharge. Once the development is completed, the ground surface will be converted to the land use types tallied below. It has been estimated that approximately 36 percent of the site would be impervious, about 38 percent would be landscaped and irrigated, and the remaining 26 percent would be undisturbed or restored to its natural condition (refer to Exhibit 3 in the Appendix).

Land Surface Changes Based on the Project's Concept Land Use Plan

Land Surface Type	Approximate Acres	Approximate Percent of Site
Impervious Surfaces		
- Buildings	83	
- Roadways and Parking	26	
- Total of Impervious Surfaces	109	36
Landscaped and Irrigated Areas		
- Single Family Lots	16	
- All Other Areas	99	
- Total Landscaped and Irrigated Areas	115	38
Undisturbed Areas	79	26
Total Project Site	303	100

The stormwater drainage system will consist of catch basins in roadways, drain lines, and "drywells" in selected catch basins for disposal. Numerous such drywells throughout the project site are planned (Exhibit 8 in the Appendix).

Description of Water Resources in the Keahole to Kailua Area

Overview. Due to high permeabilities of the natural ground surface across the project site and on the upslope lands, surface runoff does not occur even during the most intense rainfalls. As a result, no natural gulches or waterways have been created and there are no drainage culverts in the section of Queen Kaahumanu Highway in front of the project site. This being the case, the discussion of the area's water resources and the project's potential impact on these resources focuses exclusively on groundwater.

Knowledge of groundwater conditions comes primarily from the wells shown on Figure 1 and listed in Table 1. These depict two distinctly different modes of groundwater occurrence. From the shoreline inland to the near vicinity of Mamalahoa Highway, groundwater occurs in a thin and brackish basal lens which "floats" on saline groundwater beneath it and is in hydraulic contact with seawater at the shoreline. Somewhere in a generally linear alignment approximately coincident with Mamalahoa Highway, there is an abrupt change from basal to high level groundwater of exceptionally low salinity. High level groundwater is a relatively recent (1990) discovery in North Kona. The geologic feature which causes groundwater to be impounded to high levels behind it is not yet known. In addition to it creating a substantial reservoir of potable quality water, this subsurface feature also controls the location and manner of groundwater movement into the downgradient basal lens. While the hydraulic relationship between the two groundwater bodies is not yet understood, it is undoubtedly the reason for the anomalous characteristics of basal groundwater in the Keahole to Kailua area.

Description of Basal Groundwater Occurrence. Salinity, temperature, water level, and water quality data from basal wells in the area all indicate that the flow rate is low compared to areas to the north of Keahole Point and south of Kailua Bay, that saltwater circulation at depth exerts considerable influence on temperature in the basal lens, and that formation permeabilities are exceptionally high. These aspects are described below.

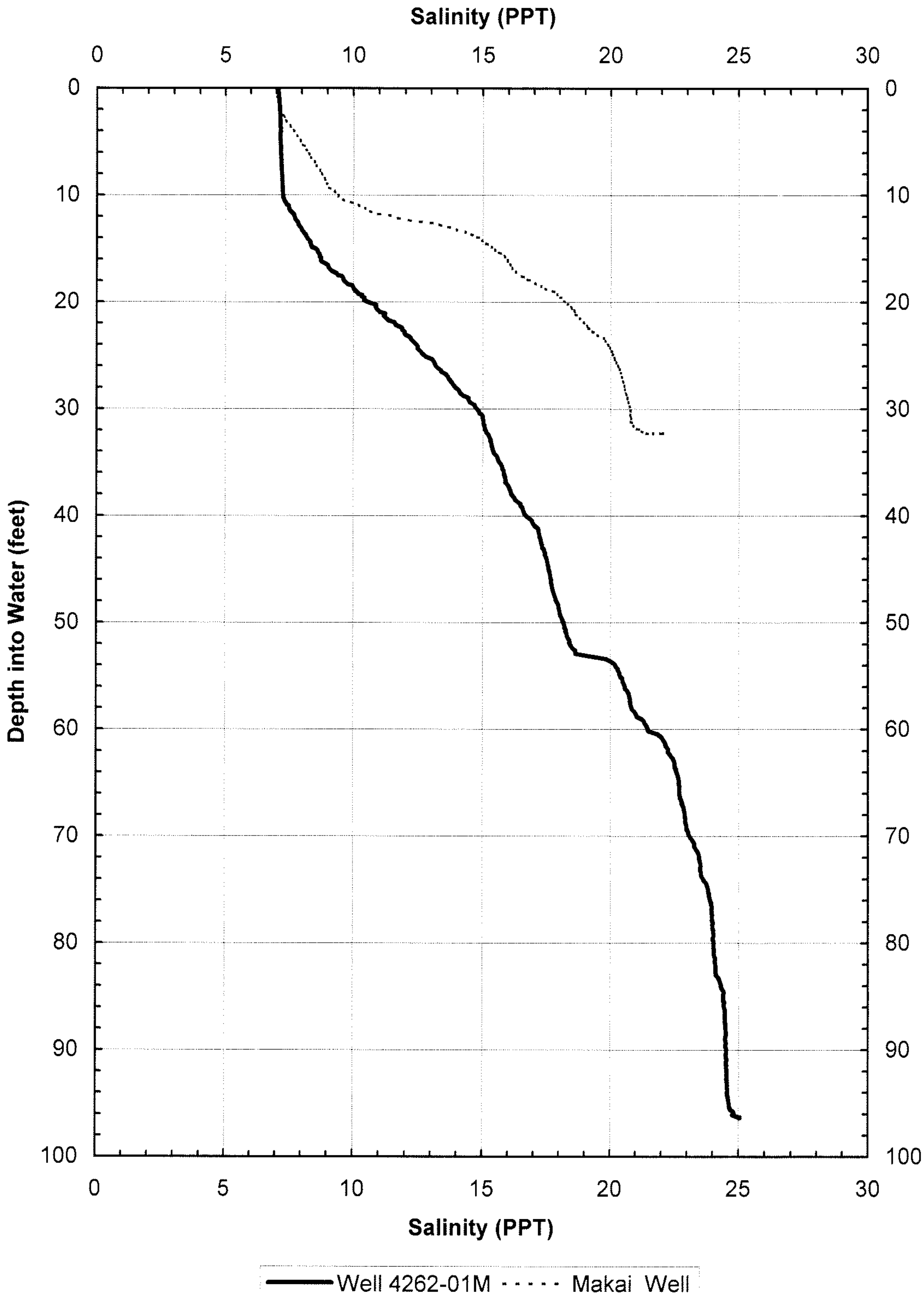
- The basal lens between the Old Kona Airport and Keahole Point is relatively saline, preventing it from being a significant source of irrigation supply unless it is extracted in small quantities from inland areas or it undergoes desalinization. There are two, small diameter monitor wells on the project site which provide information on basal groundwater beneath the site. At Well 4262-01M, which is located at the inland end of the property (refer to Figure 1), salinity in the upper 10 feet of the lens is 7.2 parts per thousand (PPT). This is about 20 percent of seawater salinity and equivalent to chlorides of about 4000 milligrams per liter (mg/l). This is too saline for irrigation except for seashore plants growing in well drained sand. Near the shoreline at the Makai monitor well, the lens is much thinner (refer to the comparative salinity profiles on Figure 2). Salinity, lens thickness, and the diffuse transition zone are all indicative of a modest groundwater flow. The best estimate of the mauka-to-makai rate of flow through the basal lens, made by the U.S. Geological Survey (Oki et al., 1999), is three (3) million gallons per day (MGD). Beneath the 0.5-mile wide project site, that would amount to a relatively modest 1.5 MGD.

Table 1

Available Data on Wells in the Keahole to Kailua Area

Well State No.	Well Name	Owner or Developer	Year Drilled	Ground Elevation (Ft. MSL)	Groundwater Level: Level (Ft. MSL)	Groundwater Level: Date Measured	Chloride Concentration: Value (MG/L)	Chloride Concentration: Date Sampled	Water Temp. (° F.)	Present Use
Basal Wells of Brackish Salinity										
3960-01	--	Queen Liliuokalani Trust	1982	40			3,400	1982		Irrigation
4059-01	Palani	DWS	1958	800	1.72	1958	3,475	1958	67.5	None
4060-01	Quarry			120			2,214	Nov. 1995	66.7	None
4061-01	KAHO-1	National Park Service	1996	38	1.20	May 2000			68.6	Monitoring
4160-01	Kaloko Irr. 1	TSA International	1985	566	2.59	3-31-93	940	7-16-85	64.3	None
4160-02	Kaloko Irr. 2	TSA International	1985	543	2.45	4-26-95	955	11-25-85	64.6	None
4161-01	KAHO-3	National Park Service	1996	24	1.37	May 2000			67.4	Monitoring
4161-02	KAHO-2	National Park Service	1996	57	2.37	May 2000			66.6	Monitoring
4262-01M	Ooma	Kahala Capital	1992	90	1.68	March 1996	2,500	1993	66.0	Monitoring
4360-01	Kalaoa	DLNR - DOWALD	1968	863	2.54	4-26-95	740	9-27-68	69.2	None
4363-01 to 10	--	Uwajima					15,000		68.0	Aquaculture
4461-01	--	Alika Cooper	1990	165			2,600		71.6	Irrigation
4461-02	--	HELCO	1993	210			5,900	6-24-93	69.5	Future Cooling Water Supply
4462-02	--	State DOT - Airports	1993				3,825	1-28-93		None
--	W-1	NELHA	1988	105	0.81	6-18-91				Monitoring
--	W-2	NELHA	1988	8	1.25	6-18-91				Monitoring
--	W-3	NELHA	1988	21	0.95	6-18-91				Monitoring
Basal Wells of Potable Quality										
4458-01	Kau 1	Nansay	1991	1799	10.10	4-26-95	17	5-30-90	72.0	None
4458-02	Kau 2	Nansay	1992	1799	10.50	4-26-95	15	7-15-91	78.0 (?)	None
Wells Tapping High Level Groundwater										
3857-01	Waiaha	DWS	1993	1542	62.00	1993				Pump stuck in well; to be Abandoned
3957-01	Keopu Mauka	HASEKO	1993	1674	47.00	1993	10	1-22-93	70.0	DWS Potable Use
3957-02	Komo Monitor	USGS / DWS	1991	1600	42.80	1-20-93				Monitoring
3957-04	Doutor Coffee	Doutor Coffee 1	2001	1445	43.30	9-14-00	10	9-14-00	71.1	Coffee Production
4057-01	QLT-1	Queen Liliuokalani Trust	1994	1720	189.00	1-19-94	5.6	5-26-00	69.4	DWS Potable Use
4158-02	Honokohau	DWS	1992	1675	98.20	4-26-95	6.7	5-26-00	72.3	DWS Potable Use
4158-03	Palani 1	Palani Ranch	2007	1671	77..3	8-24-07	<10	8-25-07	71.9	Not Yet in Service
4258-03	Hualalai	DLNR - DOWALD	1993	1681	288.60	4-26-95	5.0	10-12-93	69.8	DWS Potable Use
4358-01	North Kalaoa	DLNR - DOWALD	1991	1799	236.00	1991	6.5	5-26-00	73.8	DWS Potable Use

Figure 2. Salinity Profiles of the Two Onsite Monitor Wells Taken on May 24, 2007



- Basal wells further inland than the two monitor wells on the O'oma site have chlorides of 950 MG/L (Wells 4160-01 and 02) to 3475 MG/L (Well 4059-01). Relative to the distances of these wells from the shoreline, their chloride levels are substantially higher than found in wells at similar inland distances in the areas north of Keahole Point and south of the Old Kona Airport.

- Temperatures are anomalously cold and decrease progressively with depth into groundwater, a characteristic illustrated by the temperature profiles of the two O'oma monitor wells (Figure 3). Typical surface temperatures in basal groundwater in the Keahole to Kailua area are 64° to 68° F. This is 5° to 10° colder than the temperature of high level groundwater directly inland. This difference, along with the progressive decrease in temperature with depth, show that the source of the low temperature is the saline groundwater beneath the basal lens. However, equivalent temperatures in the ocean offshore can only be found at a depth of more than 700 feet (Figure 4). This means that cold seawater is drawn inland at depth and returns seaward at mid-depth, mixing with and cooling the basal groundwater enroute. Basal groundwater temperatures this low are unique along the West Hawaii coastline.

- Permeabilities of lavas in the nearshore area are very high, resulting in considerable tidal variation in wells at significant distances inland. Figure 5 illustrates the tidal response in the two O'oma monitor wells in comparison to the ocean tide as measured in Honokohau Harbor. At the Makai Well, which is only about 450 feet from the shoreline, the water level variation is about 75 percent of the ocean and is lagged by about a half an hour. At Well 4262-01M which is 5500 feet from the shoreline, the water level variation is about 45 percent of the ocean tide and lagged by about 1.4 hours.

- Table 2 is a compilation of water quality data from wells in the area, including the onsite monitor wells. The quality of the water in the high level wells listed at the top of the table is presumably inland of the influence of man's activities. The relatively high nitrogen and phosphorus levels in these wells appear to simply be a natural occurrence in the region. In comparison to the "background" levels in these inland wells, the nutrient levels in the downgradient brackish basal wells reflect inputs to groundwater as it moves toward the shoreline. This is illustrated by the mixing line presentation of nitrates on Figure 6 which is based on the well data in Table 2 and the offshore ocean water quality data in Table 3. The mixing line on the figure depicts what the nitrate levels in groundwater would be in the basal lens if the high level groundwater was simply diluted with seawater. For most of the basal wells, nitrate levels are above the mixing line. This is indicative of nitrate enrichment by intervening inputs, either from undisturbed or developed lands. Those well samples which plot below the mixing line are indicative of nitrate depletion as groundwater moves through the basal lens.

Figure 3. Temperature Profiles of the Two Onsite Monitor Wells Taken on May 24, 2007

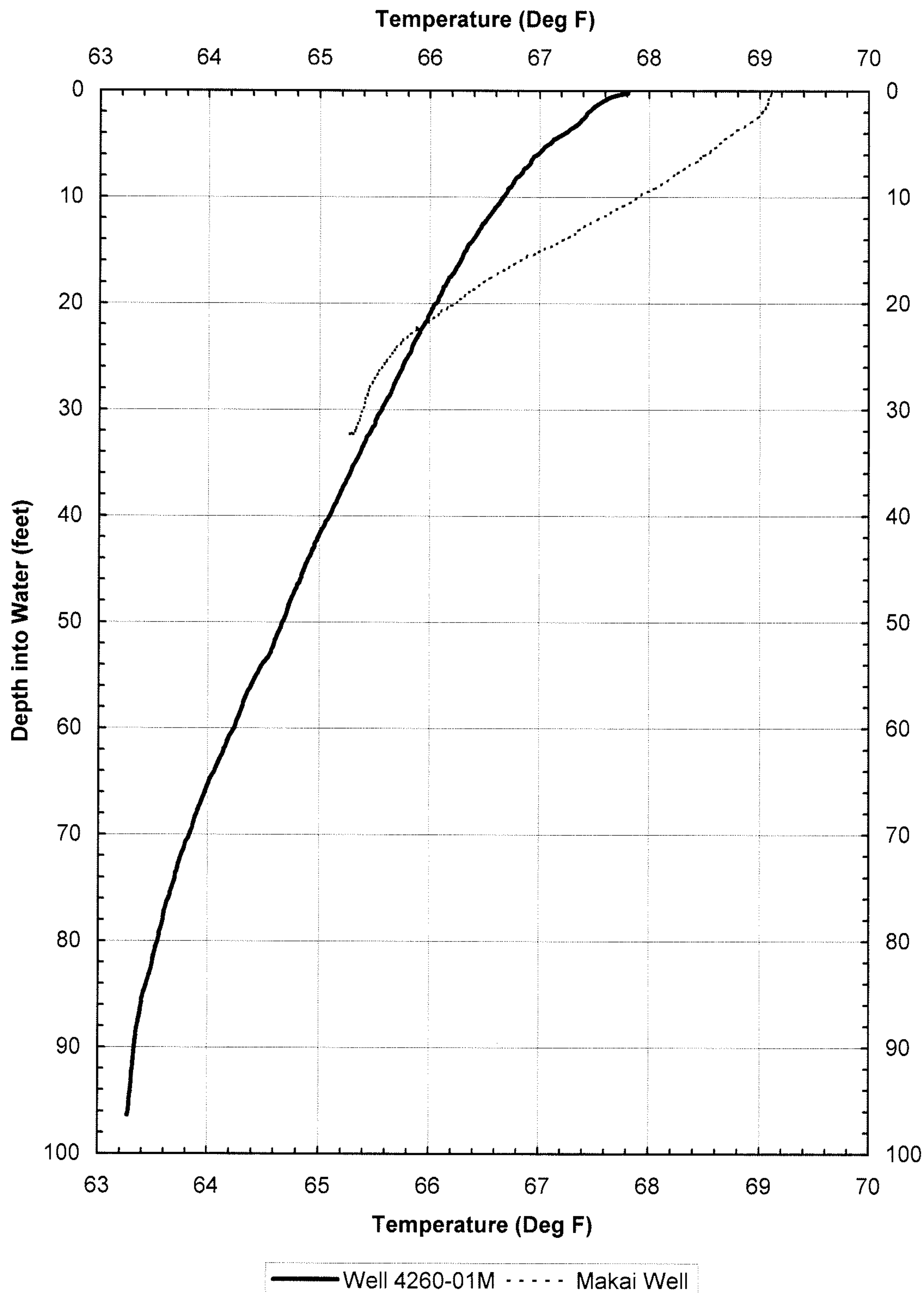


Figure 4
Comparative Ocean and Groundwater Temperature Profiles

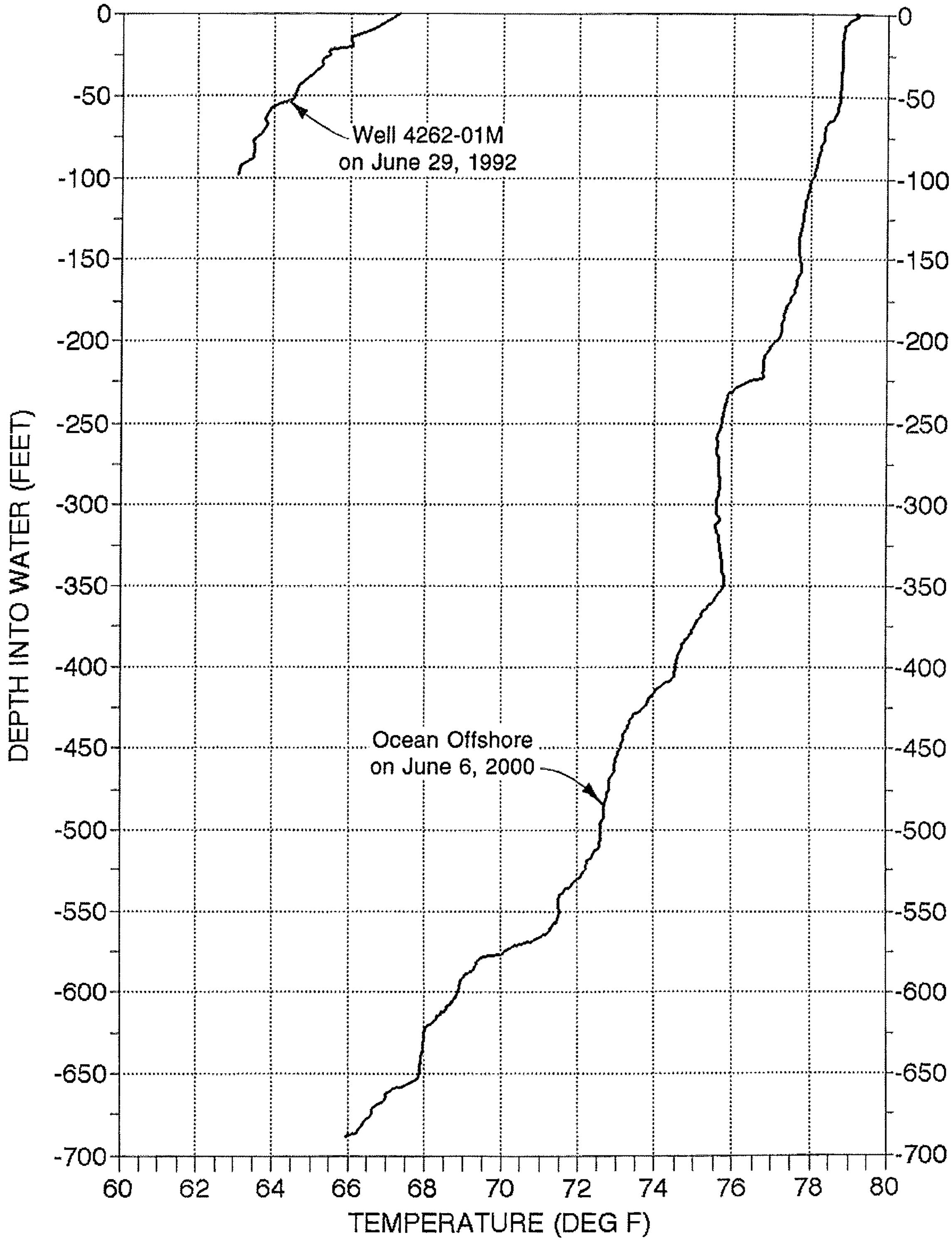


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Figure 5. Tidal Variation in Groundwater Beneath the O'oma Beachside Village Site

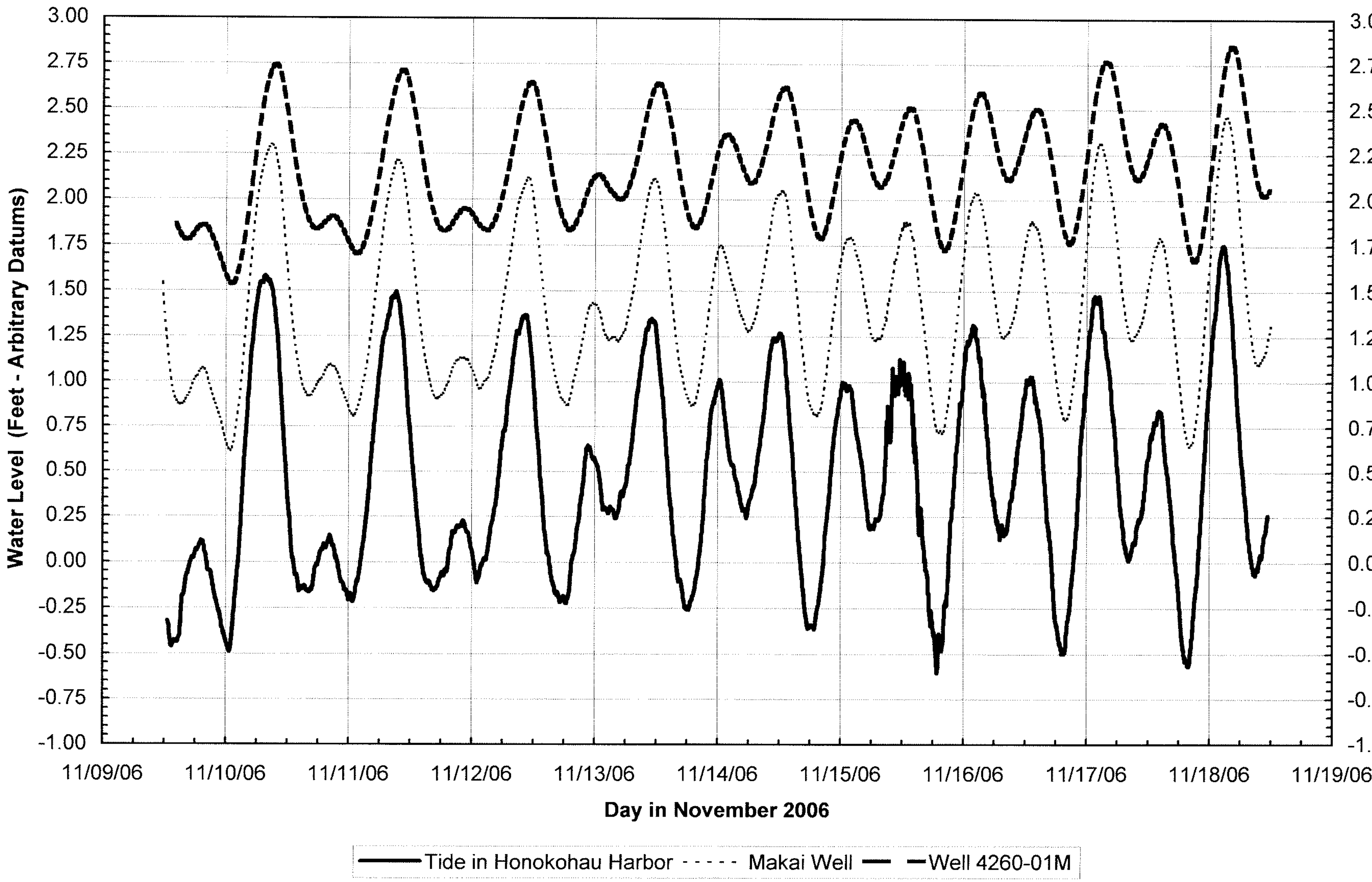

Table 2

Representative Groundwater Quality
From Wells in the Keahole to Kailua Area

Sampling Site	Date Sampled	Salinity (PPT)	Silica (µM)	Forms of Nitrogen (µM)				Forms of Phosphorus (µM)		
				NO_3	NH_4	TON	TN	PO_4	TOP	TP
High Level Potable Quality Wells										
4057-01	5-26-00	0.109	801	86.0	0.0	14.7	100.7	3.76	0.08	3.84
	7-20-01	0.079	776	85.1	0.0	35.1	120.2	3.83	3.16	6.99
4158-02	10-23-94	0.212	697	74.2	0.0	13.4	87.6	3.59	0.00	3.59
	5-26-00	0.144	844	80.1	0.0	14.5	94.6	3.64	0.20	3.84
	11-03-06	0.149	804	76.4	6.9	6.1	88.4	2.64	0.80	3.44
4258-03	6-02-00	0.165	833	70.2	1.2	19.4	90.8	3.85	0.50	4.35
4358-01	3-22-96	0.256	856	75.2	0.1	3.6	78.9	3.50	0.08	3.58
	5-26-00	0.182	908	71.8	0.0	11.9	83.7	3.40	0.24	3.64
	7-20-01	0.116	831	79.2	0.0	35.3	114.5	4.32	3.68	8.00
	11-03-06	0.172	805	66.9	7.6	6.6	81.1	3.84	0.56	4.40
Basal Wells of Brackish Quality										
4061-01 : Top	5-26-00	9.464	334	55.0	0.3	24.8	80.2	1.84	0.20	2.04
: Top	6-10-00	9.463	304	56.2	3.5	32.1	91.8	1.44	2.96	4.40
: Top	12-19-01	8.657	40	38.4	5.7	20.4	64.5	0.20	0.45	0.65
: Top	11-14-07	10.015	301	67.1	2.7	33.2	103.0	1.65	0.60	2.25
: Bottom	5-26-00	12.298	490	21.3	1.3	65.9	88.5	1.92	4.44	6.36
: Bottom	6-10-00	10.655	477	54.4	1.4	38.2	94.0	2.64	3.36	6.00
: Bottom	12-19-01	9.156	169	51.8	3.3	37.2	92.3	0.70	1.55	2.25
4161-01 : Top	5-26-00	6.259	672	75.0	0.2	14.8	90.0	4.36	0.04	4.40
: Top	6-10-00	6.325	701	76.9	1.6	43.2	121.7	4.64	2.64	7.28
: Top	12-19-01	6.305	652	79.4	4.2	0.1	83.7	4.35	0.07	4.42
: Top	11-14-07	6.854	666	76.7	1.4	27.2	105.3	3.70	0.50	4.20
: Bottom	5-26-00	6.548	694	77.3	0.3	16.0	93.6	4.52	0.08	4.60
: Bottom	6-10-00	6.601	709	76.4	1.5	31.4	109.3	5.28	2.24	7.52
: Bottom	12-19-01	6.413	629	76.3	1.8	5.4	83.5	4.05	0.20	4.25
4161-02 : Top	5-26-00	5.399	653	87.2	0.5	22.8	110.4	4.08	0.56	4.64
: Top	6-10-00	5.361	691	104.3	5.1	42.2	151.6	9.04	2.88	11.92
: Top	12-19-01	5.401	616	86.5	1.9	2.0	90.4	4.30	0.05	4.35
: Top	11-14-07	5.382	651	100.4	1.9	31.6	133.9	3.20	1.15	4.35
: Bottom	5-26-00	5.522	671	89.0	0.2	17.7	106.9	4.32	0.24	4.56
: Bottom	6-10-00	5.883	696	89.7	0.6	32.5	122.8	5.20	2.32	7.52
: Bottom	12-19-01	5.289	632	85.5	1.8	5.6	92.9	4.35	0.35	0.70
4160-02	5-15-94	1.734	670	68.6	0.3	2.9	71.8	5.89	0.03	5.92
	3-22-96	1.773	671	78.1	0.3	8.2	86.6	4.42	0.70	5.12
4262-01M : Top	3-15-96	7.962	661	81.8	0.2	15.8	97.8	3.08	0.16	3.24
: Top	6-02-00	7.783	672	89.7	1.5	26.6	117.8	5.30	0.75	6.05
: Top	6-10-00	7.850	741	91.4	1.0	35.8	128.2	3.60	0.72	4.32
: Top	11-03-06	7.293	640	81.2	3.5	24.8	109.5	2.32	1.28	3.60
: Bottom	6-02-00	16.224	547	55.4	3.2	27.9	86.4	2.25	1.00	3.25
O'oma Makai Well	11-03-06	9.945	577	67.0	2.5	22.8	99.2	2.64	1.04	3.68
4461-02	3-15-96	4.946	752	79.4	0.3	12.3	92.0	3.84	0.04	3.88
Basal Wells of Saline Quality										
3960-01	10-23-94	25.543	318	28.1	0.3	4.9	33.3	1.49	0.02	1.15
	6-02-00	25.698	356	30.5	1.6	22.5	54.6	1.40	0.70	2.10
4363-04	6-02-00	26.695	291	65.6	0.9	21.6	88.1	3.80	0.50	4.30
	6-10-00	26.836	287	72.3	1.4	32.8	106.5	4.08	0.56	4.64

Note: All samples collected by Tom Nance Water Resource Engineering and analyzed by Marine Analytical Specialists.

Figure 6. Nitrate Additions in Brackish Basal Groundwater in the Keahole to Kailua Area

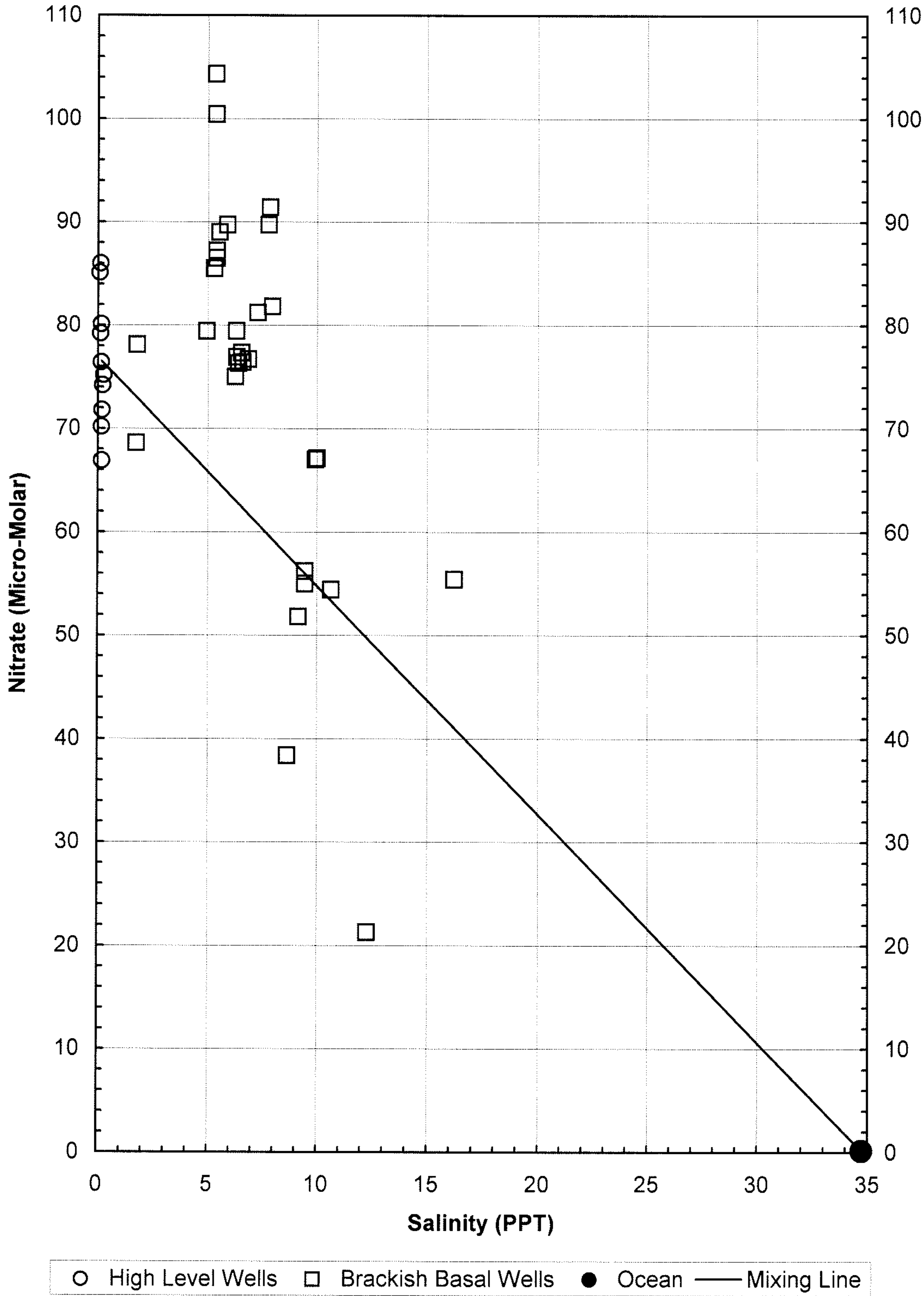

Table 3

Representative Shoreline Water Quality
in Front of the O'oma Beachside Village Project Site
(All Samples Taken on November 3, 2006)

Transect No.	Distance Offshore (Meters)	Salinity (PPT)	Silica (µM)	Forms of Nitrogen (µM)				Forms of Phosphorus (µM)		
				NO_3	NH_4	TON	TN	PO_4	TOP	TP
T-1	0	32.917	43.8	4.84	0.51	6.55	11.90	0.17	0.27	0.44
	1	31.482	74.9	8.95	0.34	7.95	17.20	0.50	0.38	0.88
	2	31.952	65.8	7.81	0.59	6.86	15.30	0.11	0.32	0.43
	5	31.987	64.4	7.48	0.40	6.73	14.61	0.27	0.27	0.54
	150 (Surface)	34.727	2.5	0.22	0.88	6.89	7.99	0.01	0.28	0.29
	150 (Bottom)	34.758	2.1	0.30	0.52	6.00	6.82	0.03	0.26	0.29
T-2	0	28.977	73.3	16.00	0.64	8.49	25.20	0.03	0.27	0.30
	1	33.123	30.6	1.92	0.54	6.99	9.50	0.03	0.30	0.33
	2	33.064	30.4	1.08	0.61	6.63	8.30	0.03	0.30	0.33
	5	33.205	30.5	1.82	0.43	7.49	9.74	0.03	0.29	0.32
	150 (Surface)	34.729	2.6	0.14	0.37	5.81	6.32	0.05	0.29	0.34
	150 (Bottom)	34.781	1.9	0.12	0.53	6.48	7.13	0.03	0.26	0.29
T-3	0	17.149	368.0	45.90	1.01	4.24	51.10	0.63	0.21	0.84
	1	28.751	109.0	11.40	1.24	10.50	23.10	0.04	0.32	0.36
	2	29.625	108.0	8.86	1.12	9.35	19.30	0.02	0.36	0.37
	5	29.642	101.0	8.35	0.71	7.58	16.60	0.03	0.30	0.33
	150 (Surface)	34.575	6.71	0.45	0.08	7.54	8.07	0.06	0.24	0.30
	150 (Bottom)	34.700	3.77	0.15	0.00	7.30	7.45	0.06	0.25	0.31
NELH Sources										
• Deep (Cold)		34.390	84.8	41.15	0.16	2.81	44.12	3.05	0.12	3.17
• Shallow (Warm)		34.690	2.9	0.24	0.26	4.57	5.07	0.13	0.22	0.35

Notes:
1. Refer to Figure 1 for the locations of Transects T-1, T-2, and T-3.
2. All samples from Transects T-1, T-2, and T-3 collected by Tom Nance Water Resource Engineering and/or Marine Research Consultants and analyzed by Marine Analytical Specialists.
3. NELH data are the averages of weekly samples by NELH from 1982 through 1999.

Attributes of High Level Groundwater in the Keahole to Kailua Area. Since the discovery of high level groundwater inland of Keauhou Bay in 1990, more than 20 wells have been completed above Mamalahoa Highway in North and South Kona. These wells encountered groundwater standing between 40 and 1280 feet above sea level (Oki et al., 1999:29 provides a good summary of water level data for most of these). Nine of these high level wells are within the area depicted on Figure 1 and three of these are nominally upgradient of the project site. Five of the nine have been outfitted with permanent pumps and are connected to DWS' North Kona system. A fifth well (No. 3957-04) provides water to Doutor Coffee. Attributes of high level groundwater inland of the project site, as demonstrated specifically by the three upgradient wells (Nos. 4158-03, 4258-03, and 4358-01 on Table 1), are as follows:

- Water levels range from about 70 to 290 feet above sea level, with no consistent pattern which might show a lateral direction of high level flow to the north or to the south.

- Chloride levels are typically less than 10 MG/L, essentially the same as found in high elevation rainwater.

- Compared to basal groundwater downgradient, temperatures are relatively warm, ranging from 69.8° to 73.8° F.

- Based on pump test results, permeabilities are less than found in the nearshore lavas but still sufficient to accommodate high capacity pumps of 350 to 1400 gallons per minute (GPM).

DWS' use of wells tapping high level groundwater in this area began in 1994 with the North Kalaoa Well (No. 4358-01). The Queen Liliuokalani Trust Well (No. 4057-01) was added in January 1997 and use of two others (Nos. 4158-02 and 4258-03) began in late 1998. Use of Well 3857-01 at Waiaha started in 2005. DWS' pumpage of these wells now averages more than 2.5 MGD. Groundwater responses when these wells are ultimately used to their full capacity may shed light on the unknown aspects of this groundwater occurrence, including the geologic feature which creates the high level water, the hydraulic relationships among the differing high level groundwater compartments, and where and how high level groundwater drains into the basal lens.

Analyses of the Project's Potential Impact on Water Resources

Based on the project's proposed water, wastewater, and stormwater systems described previously, there are a number of activities which will have an impact on groundwater resources. These activities are as follows:

- Use of saltwater from NELHA or onsite (deep) wells to produce potable and irrigation supply by RO filtration;

- Disposal of the RO concentrate in deep disposal wells;

- Percolation of excess applied irrigation water to the underlying basal lens;

- Possible periodic disposal of excess, R-1 quality WWTP effluent in a disposal well if this is not simply handled with additional storage; and

- Collection of stormwater runoff and disposal in onsite drywells.

Actual Water Use and Wastewater Generation. Projected potable and irrigation water use (Exhibit 4) and wastewater generation (Exhibit 6) are generally based on County design standards. In West Hawaii, these standards have not proven to accurately portray actual water use and wastewater generation. To take a conservative approach to the analyses herein, the following adjustments to these design projections have been made:

- The estimated average potable consumption of 0.693 MGD at full build out has already been adjusted above County design standard rates (footnotes on page 1 of Exhibit 4). As such, this projection is assumed to be a good approximation without further adjustment.

- The common area, non-potable irrigation projection of an average of 0.405 MGD (page 2 of Exhibit 4) is based on a year-round irrigation rate on the order of 6000 GPD/acre. This too is greater than the County design standard of 4000 GPD/acre and is a reasonable approximation without further adjustment.

- The projected year-round average wastewater generation at full buildout is 0.479 MGD. It is based on County design standards (340 GPD per residential unit, for example) and the assumption of year-round full occupancy. Experience in West Hawaii has shown that actual wastewater generation as a year-round average is substantially less than the design standards. For this reason, the analyses herein assume that actual wastewater generation will be 70 percent of the projection based on County standards. This means that total wastewater generation at full build-out would be approximately 0.33 MGD. Since this is less than the anticipated 0.405 MGD non-potable irrigation requirement, the balance would be provided from the potable system. There will be wet weather periods, however, when the irrigation requirement will be negligible and wastewater will continue to be generated. Treated effluent storage at the WWTP on the order of three to six million gallons should avoid the need for subsurface disposal of the excess effluent.

Feedwater Supply, RO Desalination, and Concentrate Disposal. Based on the foregoing set of assumptions, the year-round average RO product supply at full build-out would amount to approximately 0.77 MGD (0.693 MGD for potable use and 0.075 MGD for the portion of non-potable irrigation not provided by R-1 quality WWTP effluent). If RO product recovery rate is 40 to 45 percent, the average feedwater supply rate would be 1.7 to 1.9 MGD. Whether or not this feedwater supply is seawater from NELHA or onsite saltwater wells drawing water at depth below the basal lens, provision of this supply will have no impact on the basal groundwater as it moves across the project site and discharges at the shoreline.

The RO concentrate to be disposed of will amount to 55 to 60 percent of the feedwater supply or possibly as much as 1.1 MGD. This would be disposed of in onsite wells that would deliver the concentrate into the saltwater zone below the basal lens. The concentrate would be hypersaline, with a salinity on the order of 60 parts per thousand (PPT) as compared to 35 PPT for seawater and 33 to 35 PPT in saline groundwater. Being of far greater density than the receiving groundwater, together with the horizontal-to-vertical anisotropy in the subsurface lava flows, the brine will move toward and into the marine environment without rising into and impacting basal groundwater. Discharge into the marine environment would be offshore at substantial distance and depth.

Percolation of Excess Applied Irrigation. Total irrigation use is approximated as the 0.40 MGD for (non-potable) common area irrigation and the portion of the 0.69 MGD of projected potable use that will be used for irrigation. As computed of page 1 of Exhibit 4, this latter amount is approximately 0.18 MGD. The total of both is approximately 0.58 MGD. It is assumed that about 15 percent of this or 0.87 MGD is applied in excess of the consumptive use by landscaping and percolates downward to the underlying basal lens. About 57 percent of this (0.33 MGD of the total applied of 0.58 MGD) would have originated as R-1 WWTP effluent with assumed nitrogen and phosphorus concentrations of 300 and 100 μM, respectively. The remaining 43 percent would have originated as potable water produced by RO treatment of saltwater. It would have negligible nutrient levels.

The percolate from excess irrigation will be "enriched" by fertilizers which will be dissolved into the irrigation water moves through the soil layer. The following set of assumptions have been used to estimate the ultimate impact on groundwater:

- The total landscaped area will be 115 acres (Exhibit 3).
- Nitrogen and phosphorus in fertilizers will be applied at averages of 3 and 0.5 pound/year/1000 square feet, respectively.
- Ten (10) percent of the applied nitrogen and 2 percent of the applied phosphorus will be dissolved and carried in percolate below the root zone.
- As the percolate travels through the vadose (unsaturated) zone to underlying groundwater, removal rates of nitrogen and phosphorus will be 80 and 95 percent, respectively (TNWRE, 2002).

Stormwater Collection and Disposal. Stormwater over the 224 acres of the site to be developed will either percolate directly into the ground (in natural and landscaped areas) or will be collected in a system of catch basins and drain lines and disposed of in drywells located throughout the developed area. The area that will deliver runoff to the drywells will be approximately 168 acres. As a first order approximation, the following assumptions to estimate the potential impact have been made:

- Half of the 15 inches of annual rainfall reaches the underlying groundwater at present. The balance is evaporated or transpired to the atmosphere. Development of the project will not change this amount. It computes to a year-round average of 0.12 MGD.
- Data on the quality of runoff from developed areas are scarce, but that which are available (TNWRE, 2002) indicate that nitrogen and phosphorus levels are actually relatively low (lower

than the underlying groundwater, for example). Based on this, it is assumed that the nutrient levels in post-development runoff percolating to groundwater are increased by 20 µM and 2 µM for nitrogen and phosphorus, respectively.

- Removal rates in travel through the vadose zone are 80 and 95 percent for nitrogen and phosphorus.

Summary of the Project's Contributions to Basal Groundwater Discharging at the Shoreline. Compiled below is a summary of the project's potential contributions to the underlying basal lens which discharges into the marine environment along the shoreline. The totals indicate that the present relatively modest flow of 1.5 MGD beneath the half mile wide project site would be increased by about 0.09 MGD or six percent, that nitrogen in the groundwater would be increased by about six percent, and that phosphorus would be increased by about four percent.

Summary of Potential Nitrogen and Phosphorus Impacts by the O'oma Project to Underlying Basal Groundwater

Item	Flowrate (MGD)	Nitrogen (lbs/day)	Phosphorus (lbs/day)
Present (Ongoing) Groundwater Discharge	1.50	19.8	1.67
Excess Applied Irrigation			
• As RO Product Water	0.037	Negligible	Negligible
• As R-1 WWTP Effluent	0.050	0.33	0.062
• As Dissolved Fertilizer	In the Percolate	0.82	0.007
Percolating Stormwater	No Change	0.058	0.003
Post-Development Totals	1.587	21.088	1.742
% Increase Over Existing Conditions	5.8	6.1	4.3

The natural rate of groundwater flow beneath the half mile wide project site is estimated to be a modest 1.5 MGD. The project may increase this by about 0.087 MGD or six percent, an amount too small to be detect by water level monitoring. This amount will also have no significant impact to the use of groundwater by neighboring projects or the maintenance of anchialine pools and fishponds in the Kaloko-Honokohau National Park. Similarly, the contributions of nitrogen and phosphorus to the groundwater flowing beneath the project site will not impair present and foreseeable use of this resource. As documented by samples from the mauka onsite monitor well (Well 4262-01M on Table 2), the conservatively computed increases are well within the natural variability of concentrations of these nutrients in the underlying groundwater.

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Appendix


NELHA
Proposed Frontage Road
Existing Conservation District +/- 38 acres
Urban District Petition Area +/- 181 acres
Existing Urban +/- 83 acres (Mauka of State ROW)
MAUKA VILLAGE
MAKAI VILLAGE
RESIDENTIAL VILLAGE
THE SHORES AT KOHANAIKI
Conceptual Plan
`O`OMA BEACHSIDE VILLAGE
PBR HAWAII
& ASSOCIATES, INC.

Exhibit 1


LEGEND
Area A
Area B
Area C
Area A
Area B
Area C
Shoreline Park
Coastal Preserved / Open Space
12
11
3
2
4
AREA 9
10.23
AREA 10
9.80
AREA 8
PROJECT AREAS
`O`OMA BEACHSIDE VILLAGE
North Kona Village LLC
Island of Hawaii
NORTH
LINEAL SCALE (FEET)
200
0
200
600
PBR HAWAII

Exhibit 2

Summary of Ground Surface

Ground Surface Categories		Approx. Acreages
The Impervious Surface Area	±	**109**
Road & Parking	±	26
Building Footprint	±	83
Undisturbed Area	±	**79**
Landscape Irrigated Area	±	**115**
On Single Family Lots	±	16
Other Landscape Common Area	±	99
TOTAL:	±	**303**

Exhibit 3

Potable Water Consumption Estimate

Land Uses by Area	Total Approx. Acreage	Approx. Units Count	Potable Demand Area	Landscape / Common Area	Approx. Commercial Floor Area	Estimated Potable Water Demand Rate	Estimated Average Daily Potable Water Demand	Estimated Maximum Daily Potable Water Demand
	(acres)		(acres)	(acres)	(sq.ft.)		(gpd)	(gpd)
Area A								
Single Family Lot (9,000 - 15,000 sf)	22	70 - 85	22	0	-	900 GPD/DU*	76,500	114,750
Single Family Lot (5,000 - 6,000 sf)	12	90 - 100	12	0	-	550 GPD/DU**	55,000	82,500
Multi-Family Residential	5	45 - 60	3.5	1.5	-	400 GPD/DU	24,000	36,000
Makai Mixed-Use Village & Beachfront Restaurant	7		4	3	40,000	3,000 GPD/AC	12,000	18,000
Multi-Family & Mixed-Use Common Landscaping	(4.5)	-	4.5	-	-	3,000 GPD/AC	13,500	20,250
Residential Apartment on top of Commercial	-	35 - 60	-	-	-	400 GPD/DU	24,000	36,000
Ooma Canoe Club	2	-	1	1	10,000	3,000 GPD/AC	3,000	4,500
Road & Parking	26	-	-	13	-	-	–	-
Parks and Trails	6	-	-	6	-	-	–	-
Waste Water Treatment Plant	2	-	10 people	0	-	20 GPD/CAPITA	200	300
Mamalahoa Trail Undisturbed Zone / Setback Buffer	1	-	-	0.5	-	-	–	-
Community Pavilion	1	-	1	0.5	-	4,000 GPD / AC	4,000	6,000
Subtotal :	**84**	**240 – 305**	**48**	**25.5**	**50,000**		**212,200**	**318,300**
Area B								
Mauka Mixed-Use (Commercial below Residential)	14	-	12	2	135,000	3,000 GPD/AC	36,000	54,000
Mauka Mixed-Use (Residential Apartment on top of Commercial)	-	150 - 200	-	-	-	400 GPD/DU	80,000	120,000
Mauka Mixed-Use (Live-Work Units***)	4	50 - 70	2.8	1.2	-	400 GPD/DU	28,000	42,000
Multi-Family & Mixed-Use Common Landscaping	(9)	-	9	-	-	3,000 GPD/AC	27,000	40,500
Grocery Store	1	-	1	0	15,000	3,000 GPD/AC	3,000	4,500
Multi-Family Residential	19	195 - 250	13.2	5.8	-	400 GPD/DU	100,000	150,000
Charter School	3	-	1.5	1.5	-	4,000 GPD/AC	6,000	9,000
Road & Parking	10	-	-	5	-	-	-	-
Parks	3	-	-	3	-	-	-	-
Mamalahoa Highway Buffer	9	-	-	3.5	-	-	-	-
Subtotal :	**63**	**395 – 520**	**39.5**	**22.0**	**150,000**		**280,000**	**420,000**
Area C								
Single Family Lot (5,000 - 6,000 sf)	35	260 - 300	35	0	-	550 GPD/DU**	165,000	247,500
Multi-Family Residential	6	55 - 75	4	2	-	400 GPD/DU	30,000	45,000
Multi-Family Common Landscaping	(2)	-	2	-	-	3,000 GPD/AC	6,000	9,000
Community Park	7	-	-	7	-	-	-	-
Parks & Trails	7	-	-	7	-	-	-	-
Road & Parking	16	-	-	8	-	-	-	-
Mamalahoa Trail Undisturbed Zone / Setback Buffer	11	-	-	6	-	-	-	-
Subtotal :	**82**	**315 – 375**		**30.0**	**0**		**201,000**	**301,500**
Others								
Costal Preserved / Open Space	57	-		0	-	-	-	-
Shoreline Park (Excluding the Public Canoe Club)	17	-		6	-	-	-	-
Subtotal :	**74**	**0**		**6.0**	**0**			
TOTAL :	**303**	**950 - 1,200**		**84**	**200,000**		**693,200**	**1,039,800**

* Single Family Lot (9,000 - 15,000 sf) - assumes 30% of lot irrigated. 12,000sf x .30 = 3,600 / 43,560 = 0.083 acre x 6,000 gpd = 498 gpd + 400 gpd = 898 say 900 gpd/unit

** Single Family Lot (5,000 - 6,000 sf) - assumes 20% of lot irrigated. 5,500sf x .20 = 1,100 / 43,560 = 0.025 acre x 6,000 gpd = 150 gpd + 400 gpd = 550 gpd/unit

*** Live-Work units use multi-family standard (400 gpd/unit); No commercial areas included.

Nonpotable Water Consumption Estimate

Land Uses by Phase	Total Approx. Acreage	Approx. Units Count	Non-Potable Landscape/Common Area	Estimated Nonpotable Water Demand Rate	Estimated Average Daily Non potable Water Demand	Estimated Maximum Daily Nonpotable Water Demand
	(acres)		(acres)	(gpd/acre)	(gpd)	(gpd)
Area A						
Single Family Lot (9,000 - 15,000 sf)	22	70 - 85	0	-	-	-
Single Family Lot (5,000 - 6,000 sf)	12	90 - 100	0	-	-	-
Multi-Family Residential	5	45 - 60	1.5**	-	-	-
Makai Mixed-Use Village & Beachfront Restaurant	7	-	3**	-	-	-
Multi-Family & Mixed-Use Common Landscaping*	(4.5)	-	-	-	-	-
Residential Apartment on top of Commercial	-	35 - 60	-	-	-	-
Ooma Canoe Club	2	-	1	6,000	6,000	9,000
Road & Parking	26	-	13	6,000	78,000	117,000
Parks and Trails	6	-	6	6,000	36,000	54,000
Waste Water Treatment Plant	2	-	0	-	-	-
Mamalahoa Trail Undisturbed Zone / Setback Buffer	1	-	0.5	6,000	3,000	4,500
Community Pavilion	1	-	0.5***	-	-	-
Subtotal :	84	240 – 305	20.5		123,000	184,500
Area B						
Mauka Mixed-Use (Commercial below Residential)	14	-	2**	-	-	-
Mauka Mixed-Use (Residential Apartment on top of Commercial)	-	150 - 200	-	-	-	-
Mauka Mixed-Use (Live-Work Units)	4	50 - 70	1.2**	-	-	-
Multi-Family & Mixed-Use Common Landscaping*	(9)	-	-	-	-	-
Grocery Store	1	-	0	-	-	-
Multi-Family Residential	19	195 - 250	5.8**	-	-	-
Charter School	3	-	1.5	6,000	9,000	13,500
Road & Parking	10	-	5	6,000	30,000	45,000
Parks	3	-	3	6,000	18,000	27,000
Mamalahoa Highway Buffer	9	-	3.5	6,000	21,000	31,500
Subtotal :	63	395 – 520	13.0		78,000	117,000
Area C						
Single Family Lot (5,000 - 6,000 sf)	35	260 - 300	0	-	-	-
Multi-Family Residential	6	55 - 75	2**	-	-	-
Multi-Family Common Landscaping*	(2)	-	-	-	-	-
Community Park	7	-	7	6,000	42,000	63,000
Parks & Trails	7	-	7	6,000	42,000	63,000
Road & Parking	16	-	8	6,000	48,000	72,000
Mamalahoa Trail Undisturbed Zone / Setback Buffer	11	-	6	6,000	36,000	54,000
Subtotal :	82	315 – 375	28.0		168,000	252,000
Others						
Costal Preserved / Open Space	57	-	0	-	-	-
Shoreline Park (Excluding the Public Canoe Club)	17	-	6	6,000	36,000	54,000
Subtotal :	74	–	6.0		36,000	54,000
TOTAL :	303	950 - 1,200	68		405,000	607,500

* Multi-Family & Mixed Use common area landscaping separated into this line item. These areas will be irrigated with potable water.

** Landscape/Common Areas removed and reallocated into "Multi-Family & Mixed-Use Common Landscaping.

*** Community Pavilion to be irrigated with potable water.

'O'OMA BEACHSIDE VILLAGE

Water Demand Summary

SUMMARY:	AVERAGE DAILY DEMAND			MAXIMUM DAILY DEMAND		
AREA	**POTABLE (gpd)**	**NON-POTABLE (gpd)**	**TOTAL (gpd)**	**POTABLE (gpd)**	**NON-POTABLE (gpd)**	**TOTAL (gpd)**
Area A	212,200	123,000	335,200	318,300	184,500	502,800
Area B	280,000	78,000	358,000	420,000	117,000	537,000
Area C	201,000	168,000	369,000	301,500	252,000	553,500
Other	0	36,000	36,000	0	54,000	54,000
Sum Overall	**693,200**	**405,000**	**1,098,200**	**1,039,800**	**607,500**	**1,647,300**

Exhibit 5

'O'OMA BEACHSIDE VILLAGE

Wastewater Calculations

DESCRIPTION	Units	Area (acres)	Ave Flow (gpd)	Max Flow Factor	Dry I/I (gpd)	Design Ave (gpd)	Design Max (gpd)	Wet I/I (gpd)	Design Peak (gpd)	Reported Dsn. Peak (gpd)	Design Peak (cfs)
AREA A											
Single Family	185	34	59,200	5	3,700	**62,900**	299,700	42,500	342,200	343,000	0.53
Multi-Family	60	5	19,200	5	1,200	**20,400**	97,200	6,250	103,450	104,000	0.16
Mixed Use (R)	60	7	13,440	5	1,200	**14,640**	68,400	8,750	77,150	78,000	0.12
Mixed Use (C)	---	7	22,400	5	1,400	**23,800**	113,400	8,750	122,150	123,000	0.19
Commercial	---	3	9,600	5	600	**10,200**	48,600	3,750	52,350	53,000	0.08
TOTAL DEMAND (AREA A)						**131,940**	**627,300**			**701,000**	**1.08**
AREA B											
Single Family	0	0	0	5	0	**0**	0	0	0	0	0.00
Multi-Family	250	19	80,000	5	5,000	**85,000**	405,000	23,750	428,750	429,000	0.66
Mixed Use (R)	270	18	60,480	5	5,400	**65,880**	307,800	22,500	330,300	331,000	0.51
Mixed Use (C)	---	18	57,600	5	3,600	**61,200**	291,600	22,500	314,100	315,000	0.49
Commercial	---	1	3,200	5	200	**3,400**	16,200	1,250	17,450	18,000	0.03
School	---	3	3,000	5	600	**3,600**	15,600	3,750	19,350	20,000	0.03
TOTAL DEMAND (AREA B)						**219,080**	**1,036,200**			**1,113,000**	**1.72**
AREA C											
Single Family	300	35	96,000	5	6,000	**102,000**	486,000	43,750	529,750	530,000	0.82
Multi-Family	75	6	24,000	5	1,500	**25,500**	121,500	7,500	129,000	129,000	0.20
TOTAL DEMAND (AREA C)						**127,500**	**607,500**			**659,000**	**1.02**
OVERALL*											
Single Family	485	69	155,200	5	9,700	**164,900**	785,700	86,250	871,950	872,000	1.35
Multi-Family	385	30	123,200	5	7,700	**130,900**	623,700	37,500	661,200	662,000	1.02
Mixed Use (R)	330	25	73,920	5	6,600	**80,520**	376,200	31,250	407,450	408,000	0.63
Mixed Use (C)	---	25	80,000	5	5,000	**85,000**	405,000	31,250	436,250	437,000	0.68
Commercial	---	4	12,800	5	800	**13,600**	64,800	5,000	69,800	70,000	0.11
School	---	3	3,000	5	600	**3,600**	15,600	3,750	19,350	20,000	0.03
TOTAL DEMAND (OVERALL)						**478,520**	**2,271,000**			**2,469,000**	**3.82**

***NOTE:** The Overall sewer calculations are based upon the overall unit and area counts. These totals may differ from the sum of the three areas due to rounding.

Design Flows based on Average Daily Per Capita Flow

80 gallons per capita per day
4 persons per single family home
2.8 persons per apartment units (used for Mixed-Use)
4 persons per townhome/duplex unit
(assumption on townhomes/duplex based on larger size units)
40 persons per acre for commercial and business areas

Pipe Hydraulics will be based on peak flow.
Design peak flow is the sum of the design maximum flow and wet weather infiltratioı
Design maximum flow is the sum of the maximum flow and dry weather infiltration.
Maximum flow is based on the average flow multiplied by a flow factor.

Example Calculation: 185 single family units

Average Flow:	185 units * 4 persons/unit * 80 gal/capita/day
	59,200 gallons/day
Max flow factor:	5
Max flow:	296,000 gallons/day
Dry I/I:	185 units * 4 persons/unit * 5 gal/capita/day
	3,700 gallons/day
Design Ave:	62,900 gallons/day
Design Max:	299,700 gallons/day
Wet I/I:	34 acres * 1250 gallons/acre/day
	42,500 gallons/day
Design Peak:	342,200 gallons/day
say:	343,000 gallons/day
=	0.53 cfs

Exhibit 6

'O'OMA BEACHSIDE VILLAGE

Storm Drain Calculations

Sample Calculations for 10 year design storm (See Attached Tables)
PAVED AREA - Sample Area 1A

A = Q / CI

"C" based on Table 1 (County of Hawaii Storm Drainage Standards)

C = infiltration + relief + vegetal cover + development type

- infiltration is negligible: 0.2
- relief is flat: 0.00
- vegetal cover is none: 0.0
- development type is residential: 0.40

C = 0.6

I = rainfall intensity

- one hour rainfall from Plate 1 is ~1.9 inches
- inlet concentration is ~12 min from Plate 3

I = 3.75in/hr (from Plate 4)

Q = 6 cfs (based on average capacity of 6' deep drywell)

A = 2.67 acres / drywell

'O'OMA BEACHSIDE VILLAGE

Existing Drainage Calculations

C values:			
Infiltration	0.0	high	From Table 1
Relief	0.0	flat	From Table 1
Vegetal Cover	0.05	poor	From Table 1
Development	0.15	agricultural	From Table 1
TOTAL C:	**0.20**		

Area ID	Length (ft)	Slope (%)	Tc (min)	I (in/hr)	C	Planimeter (si)	Meas. Area (acres)	Q=CIA (cfs)
1	800	3.75	8.8	4.75	0.2	17.84	19.7	**18.8**
2	1,450	2.41	11.6	3.65	0.2	11.53	12.7	**9.3**
3	2,050	2.44	38	2.6	0.2	32.22	35.5	**18.5**
4a	2,000	1.875	17.25	---	---	---	---	**---**
4b	2,000	1.875	17.25	2.5	0.2	105.34	115.8	**57.9**
5	500	1	27.8	2.75	0.2	2.93	3.3	**1.9**
6	2,150	1.75	17.3	3.35	0.2	54.92	60.5	**40.6**
7	2,400	2.71	20.25	3.08	0.5	48.03	52.9	**81.5**
							TOTAL:	**228.5**

'O'OMA BEACHSIDE VILLAGE

Developed Drainage Calculations

Area ID	Area Name	Area (acres)	Length (feet)	Slope %	Tc (min)	I (in/hr)	C	Area/Inlet (acres)	Q (cfs)	# CB or drywells
1A	A	7.5	1,375	1.96%	12.5	3.75	0.6	2.67	16.9	3
1B	A	4.4	1,265	1.82%	12.5	3.75	0.6	2.67	9.9	2
2	A	7.1	660	3.79%	8.4	3.85	0.6	2.60	16.5	3
3	A	6.2	353	4.82%	6.75	4.5	0.6	2.22	16.8	3
4	A	5.3	202	2.48%	6	4.65	0.6	2.15	14.8	6
5	A	5.7	385	3.12%	7.3	4.45	0.6	2.25	15.3	4
6	A	11.4	820	2.20%	10.25	3.85	0.6	2.60	26.4	9
7	A	2.1	406	2.96%	7.5	4.4	0.6	2.27	5.6	0
8	A	4.8	220	2.27%	6	4.65	0.6	2.15	13.4	3
9	A	2.9	245	1.63%	6.8	4.5	0.6	2.22	7.9	2
10	B	1.6	355	2.54%	7.4	4.4	0.6	2.27	4.3	1
11	B	1.9	478	3.77%	7.75	4.35	0.6	2.30	5	2
12	B	3.0	100	5.00%	5	4.9	0.6	2.04	8.9	2
13	B	2.1	145	3.45%	5	4.9	0.6	2.04	6.2	2
14	B	2.8	318	2.83%	7.2	4.45	0.6	2.25	7.5	3
15	B	3.7	435	2.76%	6.5	4.55	0.6	2.20	10.2	3
16	B	0.9	141	7.09%	6	4.65	0.6	2.15	2.6	1
17	B	7.3	573	2.97%	8.5	3.85	0.6	2.60	16.9	3
18	B	1.6	116	4.31%	5	4.9	0.6	2.04	4.8	2
19	B	5.1	596	3.02%	8.5	3.85	0.6	2.60	11.8	5
20	B	1.8	455	0.88%	10.2	3.85	0.6	2.60	4.2	1
21	B	1.3	240	3.33%	6	4.65	0.6	2.15	3.7	1
22	B	0.9	218	1.83%	6.5	4.55	0.6	2.20	2.5	1
23	B	2.0	387	2.07%	7.7	4.35	0.6	2.30	5.3	1
24	B	1.1	170	2.94%	5.2	4.85	0.6	2.06	3.3	1
25	B	2.1	240	0.83%	7.8	4.35	0.6	2.30	5.5	1
26	B	1.3	170	4.71%	5	4.9	0.6	2.04	3.9	1
27	B	3.3	363	3.03%	7.2	4.45	0.6	2.25	8.9	3
28	C	14.9	930	1.51%	11.9	3.75	0.6	2.67	33.6	6
29	C	4.6	336	1.49%	8	4.25	0.6	2.35	11.8	2
30	C	8.3	942	1.17%	12.9	3.65	0.6	2.74	18.2	5
31	C	13.6	1,087	1.84%	15.1	3.5	0.6	2.86	28.6	6
32	C	13.6	655	1.83%	10	3.9	0.6	2.56	31.9	8
33	C	7.7	752	1.86%	10.4	3.8	0.6	2.63	17.6	4
34	C	4.2	474	2.74%	7.8	4.35	0.6	2.30	11	3
	TOTAL	**168.1**							**411.7**	**103**

SUMMARY	Area A	Area B	Area C	TOTAL
CB/Drywell by Area	0	0	0	0
Additional for Rdwy	7	11	0	18
TOTAL CB/Drywell	**7**	**11**	**0**	**18**

DRAINAGE SYSTEM OVERVIEW

SCALE: NOT TO SCALE

M&E Pacific, Inc.

METCALF & EDDY | AECOM

DAVIES PACIFIC CTR, STE 1900 · 841 BISHOP ST., HONOLULU, HAWAII 96813

Drainage System Overview

Infrastructure Report
'O'oma North Kona Villages
February 2008

Exhibit 8

Marine Environmental Assessment / Marine Water Quality Assessment

MARINE ENVIRONMENTAL ASSESSMENT
O'OMA BEACHSIDE VILLAGE
NORTH KONA, HAWAII

MARINE COMMUNITY STRUCTURE

Prepared for

O'oma Beachside Village LLC

Prepared by

Marine Research Consultants, Inc.
1039 Waakaua Pl.
Honolulu, HI 96822

May 2008

I. INTRODUCTION

The proposed O’oma Beachside Village is located on a 303-acre property in North Kona approximately one mile south of the Keahole Airport and seven miles north of Kailua- Kona. The property (project site) is bounded to the east by the Queen Kaahumanu Highway, on the west by the Pacific Ocean, and lies between the Natural Energy Laboratory of Hawaii Authority (NELHA) and Hawaii Ocean Science and Technology (HOST) Park to the north, and the Shores at Kohana’iki Development to the south (Figure 1).

O’oma Beachside Village will be a master-planned residential community with a full range of mixed uses including housing, mixed-use commercial, preserves, parks, trails, and shoreline access. In total, there will be 950 to 1,200 homes, which will include multi-family units, “live-work” or mixed-use homes, workforce, gap and affordable homes, and single-family home lots. With the exception of the shoreline park facilities, the entire O’oma Beachside Village community will be setback at least 1,100 feet from the shoreline. The proposed community will also include supporting infrastructure such as a wastewater treatment plant, water system, and power and communications systems.

While all planning and construction activities will place a high priority on maintaining the existing pristine nature of the marine environment, it is nevertheless important to address any potential impacts that may be associated with the planned community. None of the proposed land uses includes any direct alteration of the coastal areas or nearshore waters. In fact, the shoreline setback and coastal preserve area are specifically intended to preserve the coastal area as it exists at present. The potential exists, however, for the community to affect the composition and volume of groundwater that flows beneath the property, as well as surface runoff that may emanate from the community. As all groundwater that could be affected by the community subsequently reaches the ocean, it is recognized that there is potential for the community to affect the marine environment. This concern is especially critical owing to the close proximity of the NELHA and HOST Park facilities, where numerous mariculture operations rely on pristine ocean waters. In addition, the shoreline fronting the property is a recreational area and is utilized for surfing, swimming, and fishing. Therefore, evaluating the potential for alterations to water quality and marine life from material input from the community constitutes an important factor in the planning process.

In the interest of addressing these concerns and assuring maintenance of environmental quality, a marine water quality assessment and potential impact analysis of the nearshore areas off the O’oma Beachside Village property was conducted in November 2006. The rationale of this assessment was to determine the contribution of groundwater to the marine environments offshore of O’oma Beachside Village, and to evaluate the effects that this input has on water quality at the present time, prior to the commencement of any new construction activities. Combining this information with estimates of changes in groundwater and surface water flow rates and chemical composition that could result from the proposed community provides a basis to evaluate the potential future effects to the marine environment. Results of the combined evaluation have indicated that with respect to water quality, the O’oma Beachside Village will cause only small change from the present scenario, and that these changes would not result in conditions that are beyond the range of natural variability along the coast of West Hawaii.

However, regardless of the low potential for alteration of water quality, it has been deemed important to evaluate the existing condition of the nearshore marine biotic communities. Documentation of the existing conditions can provide an important baseline to evaluate future changes that may result from shoreline activities.

This report describes the results of the baseline survey of the nearshore marine communities. The survey is a continuation of previous work performed offshore of the O'oma property. In 1986, a "Baseline Assessment of the Marine Environment in the Vicinity of the O'oma II Resort Development" provided a detailed description of the physical and biological setting fronting the property. This baseline was repeated in 1990 and again in 2002. The strategy of the present report was to replicate as closely as possible the 1986, 1990 and 2002 surveys. Replicating surveys over an interval of approximate twenty-years, using the same techniques in the same locations, provides a descriptive and quantitative baseline of biotic communities off the proposed development that addresses change over time as well as space. Such a characterization of biotic assemblages can provide a basis for estimating alteration of community structure as a result of modifying land uses mauka of the shoreline. This baseline will also serve to identify any specific biotic communities that may be especially susceptible (or resistant), to the potential alterations that may result from the planned development. As this aspect of the survey will be repeating the investigations conducted in 1986 - 2006, it will provide information on the degree of natural variability in community structure.

An important part of this investigation is to provide an evaluation of the degree of natural stresses (sedimentation, wave scour, freshwater input, etc.) that influence the nearshore marine environment in the area that could be potentially influenced by the proposed project. Typically, water quality and the composition of nearshore marine communities are intimately associated with the magnitude and frequency of these stresses, and any impacts caused by the proposed project may either be mitigated in large part, or amplified, by natural environmental factors. Therefore, evaluating the range of natural stress is a prerequisite for assessing the potential for additional change to the marine environment owing to shoreline modification.

Marine community structure can be defined as the abundance, diversity, and distribution of stony and soft corals, motile benthos such as echinoderms, and pelagic species such as reef fish. In the context of time-series surveys, the most useful biological assemblages for direct evaluation of environmental impacts to the offshore marine environment are benthic (bottom-dwelling) communities. Because benthos are generally long-lived, immobile, and can be significantly affected by exogenous input of sediments and other potential pollutants, these organisms must either tolerate the surrounding conditions within the limits of adaptability or die.

As members of the benthos, stony corals are of particular importance in nearshore Hawaiian environments. Corals compose a large portion of the reef biomass and their skeletal structures are vital in providing a complex of habitat space, shelter, and food for other species. Since corals serve in such a keystone function, coral community structure is considered the most "relevant" group in the use of reef community structure as a means of evaluating past and potential impacts associated with land development. For this reason, and because alterations in coral communities are easy to identify, observable change in coral population parameters is a practical and direct method for obtaining the information for determining the effects of stress in the marine environment. In addition, because they comprise a very visible component of the nearshore environment, investigations of reef fish assemblages are presented.

II. METHODS

All fieldwork was carried out on December 26-27, 2006, and was conducted from a 22-foot boat. Biotic structure of benthic (bottom dwelling) communities inhabiting the reef environment was evaluated by establishing a descriptive and quantitative baseline between the shoreline and the 20 meter (m) (~60 foot) depth contour. Initial qualitative reconnaissance surveys were conducted that covered the area off the O'oma property from the shoreline out to the limits of coral reef formation. These reconnaissance surveys were useful in making relative comparisons between areas, identifying any unique or unusual biotic resources, and providing a general picture of the physiographic structure and benthic assemblages occurring throughout the region of study.

Following the preliminary survey, four quantitative transect sites were selected offshore of the development area at approximately the same sites as in the 1986-2002 surveys (see Figure 1). Station 1 was located at the northern property boundary, Stations II and III were located in the central area, and Station IV was located off Puhili Point, at the southern boundary of the property. At each station, three transect sites were selected, one in each of the dominant reef zones. Each transect was oriented parallel to depth contours so as to bisect a single reef zone at depths of approximately 6, 10 and 20 m. Care was taken to place transects in random locations that were not biased toward either peak or low coral cover. In total, twelve quantitative transects were conducted.

Quantitative benthic surveys were conducted by stretching a 50-m long surveying tape in a straight line over the reef surface. An aluminum quadrat frame, with dimensions of 1 m by 0.66 m, was sequentially placed over 10 random marks on the transect tape so that the tape bisected the long axis of the frame. At each quadrat location a digital color photograph recorded the segment of reef area enclosed by the quadrat frame. In addition, a diver knowledgeable in the taxonomy of resident species visually estimated the percent cover and occurrence of organisms and substratum type within the quadrat frame. No attempt was made to disturb substrata to observe organisms, and no attempt was made to identify and enumerate cryptic species dwelling within the reef framework. Only macrofaunal species greater than approximately 2 centimeters were noted.

Following the period of fieldwork, a grid divided into 100 equally sized units was overlain on each quadrat image, and units of bottom cover for each benthic faunal species and bottom type were recorded. Results of the photo-quadrats were combined with the in-situ cover estimates and community structure parameters (percent cover, species diversity) were calculated. The photo-quadrat transect method is a modification of the technique described in Kinzie and Snider (1978), and has been employed in numerous field studies of Hawaiian reef communities (e.g. Dollar 1979, Grigg and Maragos l974), and has proven to be particularly useful for quantifying coverage of attached benthos such as corals and large epifauna (e.g., sea urchins, sea cucumbers). This method provides for accurate estimates of abundance of organisms that cover a large percentage of the reef surface through photographic coverage, as well as occurrence of very small and/or rare organisms that are not visible in photographs. Few, if any other methods provide for such accurate characterization of both extremes of benthic community structure.

While this methodology is quantitative for the larger exposed fauna, many coral reef invertebrates are cryptic or nocturnal. Coupled with the generally small size of cryptic invertebrates, quantitative assessment of these groups requires methodologies that are beyond the scope of the present assessment.

Assessment of reef fish community structure was not conducted in 2002 and not repeated in 2006. As the transect tape was being laid along the bottom, all fish observed within a band approximately 2 meters wide along the transect path were identified by species name. Care was taken to conduct the fish surveys so that the minimum disturbance was created by divers, ensuring the least possible dispersal of fish. Only readily visible individuals were included in the census. No attempt was made to seek out cryptic species or individuals sheltered within coral. This transect method is an adaptation of techniques described in Hobson (1974).

III. RESULTS AND DISCUSSION

1. Physical Structure

The main structural feature of the approximately one-half mile of shoreline of the O'oma area is a basaltic ledge of pahoehoe lava with interspersed pockets of white calcareous sand. The intertidal platform, which is constantly subjected to the wash of waves, is flooded in places to form tidepools. None of these pools, however, appeared to be separated from the ocean on a permanent basis so they are not classified as "anchialine" (at least one true anchialine pond has been noted inland of the shoreline within a sinkhole, and surrounded by a grove of trees, and a single pond was observed at the bottom of a small sinkhole on a lava dome near the southern boundary of the O'oma Beachside Village property).

Rimming many of the shoreline pools formed in the basalt bench are dense bands of the intertidal seaweeds *Anhfeltia concinna* and *Ulva fasciata*. The submerged portions of the intertidal pools are lined with various forms of encrusting red algae, and contain numerous urchins of the species *Echinometra matheai, Echinostrephus aciculatus*, and *Colobocentrotus atratus*, as well as numerous juvenile reef fish. The seaward edge of the lava shoreline is composed of either basaltic boulder fields, or vertical sea cliffs 1 to 2 m in height. The one exception is a small area at the northern border of the property where a small sandy beach reaches the shoreline.

Beyond the shoreline, the structure of the offshore environment at O'oma generally conforms to the pattern that has been documented as characterizing much of the west coast of the Island of Hawaii (Dollar 1982). The zonation scheme consists of three predominant regions. Beginning at the shoreline and moving seaward, the shallowest zone beyond the shoreline is comprised of a seaward extension of the basaltic shoreline bench, along with scattered basaltic boulders that have entered the ocean after breaking off from the shoreline. *Pocillopora meandrina*, a sturdy hemispherical coral is the dominant colonizer of the nearshore area. This species is able to flourish in areas that are physically too harsh for most other species, particularly due to wave stress. The shallow transects conducted off O'oma all traversed the *Pocillopora meandrina*-boulder zone.

Seaward of the nearshore boulder zone, bottom structure is composed predominantly of a gently sloping reef bench composed of basalt, interspersed with lava extrusions and sand channels. In some areas, the bench is characterized by high relief in the form of undercut ledges and basaltic pinnacles. Fine-grained calcareous sediment also comprises a component of bottom cover. Water depth in this mid-reef zone ranges from about 6 to 15 m. As wave stress in this region is substantially less than in the shallower areas, and suitable hard substrata abound, the area provides an ideal locale for colonization by attached benthos, particularly reef corals, and generally the widest assortment of species and growth forms are encountered in this region. The intermediate depth transects at each survey station were located on the reef bench.

The seaward edge of the reef platform (at a depth of about 18 m) is marked by an increase in slope to an angle of approximately 20-30 degrees. In the deep slope zone, substratum changes from the solid continuation of the island mass to an aggregate of generally unconsolidated sand and rubble. The predominant coral cover in the slope zone is typically interconnected mats of *Porites compressa* or "finger coral", which grow laterally over unconsolidated substrata. Throughout the O'oma coastline, however, the growth of *P. compressa* has been greatly reduced by breakage from the concussive force of waves. Such breakage was especially evident at Transect Site 1, where cover of *P. compressa* on the 20 m transects was only about 3% of bottom cover. Moving down the reef slope, coral settlement and growth cease at a depth of approximately 25 m; beyond this depth the bottom consists mostly of sand, with occasional basaltic outcrops. The deep transects at each survey station were located on the upper portions of the reef slope.

2. Biotic Community Structure

A. Coral Communities

Table 1 shows abundance estimates of invertebrates observed throughout the region of study during the 2006 survey. The predominant taxon of macrobenthos (bottom-dwellers) throughout the reef zones off the O'oma property are Scleractinian (reef-building) corals. Results of quantitative line transects conducted within the three dominant reef zones provide a data base characterizing coral community structure. Table 2 shows the quantitative summary of coral community structure from the all four transect surveys (1986,1990, 2002 and 2006), while Appendices A-1 - A-4 show individual photo-quadrats for the 2006 data set.

During the 2006 survey, nine species of hermatypic, or reef-building "stony" corals, and one ahermatypic "soft coral" were encountered on transects, while the number of coral species on a single transect ranged from three to seven. The dominant species on all of the O'oma transects was *Porites lobata*, which accounted for about 66% of total coral cover, and 31% of bottom cover in 2006. The second and third most abundant species *Pocillopora meandrina* and *Porites compress* accounted for 15% and11% of coral cover. Thus, these three species comprised about 92% of living coral cover. In total, coral cover on transects accounted for 47% of bottom cover in 2006.

On the deep reef transects off O'oma surveyed in 2006, *P. compressa* accounted for relatively small percentages of bottom cover (range of 3.1% to 18.2%). In 2002, *P. compressa* cover was slightly lower (0.2% - 16.3%). With the exception of Station I-V in 1986 (31.2%) and 1990 (37.9%), cover of P. compressa has been consistently low on 20 m transects. Such low levels of *P. compressa* cover suggest relatively recent storm events that resulted in substantial damage to the mats of finger coral. With four benthic surveys spanning approximately a twenty-year period, it is possible to compare long-term changes to coral community structure. Figure 2 depicts coral community structure in histograms at each transect during each of the four surveys. Table 3 summarized coral community parameters from the 1986, 1990, 2002 and 2006 surveys, as well as the differences between the surveys. Differences in community structure parameters are in part an inevitable result of imprecision of relocation of transect locations. It is also apparent, however, that differences between years also is indicative of major processes that have influenced community structure.

In 1986, coral cover at all of the O'oma survey sites was noticeably reduced compared to other nearby areas. The decrease was attributed to the physical destruction of coral colonies brought on by a severe winter storm that occurred in February of 1986. The direction of wave propagation (from the northwest) was such that breaking waves estimated at 5-8 m in height directly impacted the O'oma site. It was apparent the greatest effects of the storm waves occurred at the deep reef zones, which are generally below the depth of destructive water motion.

Total coral cover in 1986 estimated from transects was approximately 20% of bottom cover. In 1990, total cover increased to 37%. Only one of the twelve transects (I-15') exhibited higher cover in 1986 compared to 1990. Of the eleven transects, where cover increased in 1990, the greatest increases occurred in the mid-reef zones, where total cover increased from between 14% to 43% during the years between surveys. The number of species remained unchanged on four transects, and increased in 1990 on seven transects. Species cover diversity increased on six transects.

When the 2002 data set is compared to the earlier data, it can be seen that the coral community is increased in cover compared to both the 1986 and 1990 data. Total pooled coral cover increased with each survey, from 20% of bottom cover in 1986, to 37% in 1990, to 45% in 2002. When coral cover on each transect was compared, cover increased on ten of the twelve transects between 1990 and 2002, and on eleven transects between 1986 and 2002. The largest and most consistent increase in cover occurred in the reef platform zone (10 m) where there was an increase between each survey on at all four sites (Figure 2, Table 3). Between 1986 and 2002, coral cover increased from between 26.7% of bottom cover (Site I) to 57% at Site 3 (Table 3). In the shallow boulder zone, there were also consistent increases with a single exception (1986-1990 Site I).

Between 2002 and 2006, total coral cover increased slightly from 45% to 47%. However, cover decreased on eight of the twelve transects, and increases on four transects. Changes were not consistent within zones. When the 1986 and 2006 data are compared coral cover more than doubled (20% to 47%) with a consistent increase in total cover in 2006 on eleven of the twelve transects (increases ranging from 10% to 57%). The only transect with higher cover in 1986 relative to 2006 was I-20 m, where cover during 2006 consisted of only 12% coral and the remainder primarily rubble.

A good indication of the relatively calm period without destructive storms between the surveys was the relatively high percentage of *Pocillopora eydouxi* on the reef platform in 2002 and 2006. This species occurs as a large hemispherical branching growth form that is easily broken by concussive force of breaking waves. In 2002, *P. eydouxi* occurred on all of the reef bench transects (6 and 10 m), while in 2006 it occurred on five of the eight reef bench transects. In contrast, in 1986 and 1990 this species was not encountered on any of the survey transects.

The consistent increase in coral cover with time is also evident on the three deep slope transects (20 m). At Sites II, III and IV there are increases in cover with time. However, at Site I, the lowest cover occurred during the most recent survey, and there was a substantial decrease from 72% to 19% cover between 1990 and 2002 (Table 2). These data indicate that recovery from storm stress does not occur at same rate in all reef zones, or even within the same zone in different areas. Recovery of the mats of *Porites compressa* on the deep slope zone has been substantially slower than the shallow reef bench zones. In addition, during the 2002 survey at Site 1 there was some evidence of physical alteration of the bottom from activities associated with installing a new pipeline for the Natural Energy Lab.

While number of species showed no consistent pattern of change through the entire transect set, coral cover diversity increased on ten of the twelve transects in 2002 compared to both 1986 and 1990 (Table 3). Thus, there is a consistent increase in both coral cover and coral cover diversity over the 1986-2002 interval. Between 2002 and 2006, coral cover diversity decreased or remained constant on all but one transect. Decreased diversity often occurs as a result of domination of coral cover by species with competitive superiority for occupying space. On Hawaiian reefs, coral diversity often decreases during community succession as species of Porites, (primarily *P. lobata*) dominate available substratum. As cover of *P. lobata* on the O'oma reefs increased by about 10% (in terms of coral cover) between 2002 and 2006, the competitively superiority of this species may be responsible for the decrease diversity throughout the reef community.

B. Benthic Macroinvertebrates

Other than corals, the dominant group of macroinvertebrates inhabiting the reef surface off O'oma are the sea urchins (Class Echinoidea). Table 1 summarizes the occurrence of sea urchins at all of the survey stations. The most common urchin is *Echinometra matheai*, which occurred in all reef zones. *E. matheai* are small urchins that are generally found within interstitial spaces bored into basaltic and limestone substrata. *E. matheai* were most abundant at the mid-reef transects where the number of individuals ranged from 4 to 56. This species was least abundant on the reef slope transects. *Echinostrephus aciculatus* is another small urchin with thin spines that is found in bored holes on the reef surface.

Tripneustes gratilla and *Heterocentrotus mammillatus* are other species of urchins that occurred on transects. Both of these urchins occur as larger individuals (compared with *E. matheai*) that are generally found on the reef surface, rather than within interstitial spaces.

Sea cucumbers (Holothurians) observed during the survey consisted of three species, *Holothuria atra*, *H. nobilis*, and *Actinopyga obesa*. Individuals of these species were distributed sporadically across the mid-reef and deep reef zones (Table 1). The most common starfish (Asteroidea) observed on the reef surface were *Linckia* spp. Several crown-of-thorns starfish (*Acanthaster planci*) were observed feeding on colonies of *Pocillopora meandrina*. Numerous sponges were also observed on the reef surface, often under ledges and in interstitial spaces. The green conical-shaped sponge *Iotrocha protea* was observed throughout the mid-depth reef zones.

While frondose benthic algae are conspicuously rare on the reefs of West Hawaii encrusting red calcareous algae (*Porolithon* spp., *Peysonellia rubra, Hydrolithon* spp.) were abundant throughout the reefs off O’oma. These algae were abundant on bared limestone surfaces, and on the nonliving parts of coral colonies. While very rare several species of frondose algae observed on the reef included *Valonia* sp., *Lyngbya majuscula* and *Galauxura* spp.

The design of the reef survey was such that no cryptic organisms or species living within interstitial spaces of the reef surface were enumerated. Since this is the habitat of the majority of mollusks and crustacea, detailed species counts were not included in the transecting scheme. No dominant communities of these classes of biota were observed during the reef surveys at any of the study stations.

C. Reef Fish Community Structure

Reef fish community structure was largely determined by the topography and composition of the benthos. Transect results are presented in Table 5. On individual transects, the numbers of species ranged from 14 to 40 in 2002.

The reef fish community off O’oma is typical of that found along most of the Kona Coast, as described by Hobson (1974), and Walsh (1984). Fish community structure can be divided into six general categories: juveniles, planktivorous damselfishes, herbivores, rubble-dwelling fish, swarming tetrodonts, and surge-zone fish.

Juvenile fish belonged mostly to the family Acanthuridae (surgeon fish), with representatives from the families Labridae (wrasses), Mullidae (goat fish) and Chaetodontidae (butterfly fish). Juveniles were most abundant on the deepest transects of the reef slope zone (60 feet) in areas dominated by finger coral (*P. compressa*), or basalt boulders. The complex habitat created by the spreading growth form of *P. compressa* provides shelter for small fish. Apparent storm damage to the mats of finger coral in the deep slope zone in many areas appeared to lower substantially the percentage of living finger coral. Because the coral framework was not completely flattened, habitat complexity was partially maintained in the aftermath of the storm event(s). It is apparent that fish abundance is not related directly to composition of intact living coral, but rather to the degree of shelter afforded by coralline structures, whether alive or dead.

Planktivorous damselfish, principally of the genus *Chromis* were abundant in all areas surveyed, and often comprised more than a quarter of the total number of individuals encountered along transects. Agile chromis (*Chromis agilis*) were very abundant along the outer edge of the shelf and in deeper water, whereas blackfin chromis (*C. vanderbilti*) was the primary shallow water species.

Herbivores, primarily the yellow tang (lau'i-pala, *Zebrasoma flavescens*) and goldring surgeonfish (kole, *Ctenochaetus strigosus*) were also abundant. On the shallower reef terrace, adult whitebar surgeonfish (maikoiko, *Acanthurus leucopareius*), orangeband surgeonfish (na'ena'e, *A. olivaceus*), brown surgeonfish (ma'i'i'i, *A. nigrofuscus*) and parrotfish (uhu, *Scarus* spp.) were also common. In areas where coral rubble was abundant, common fish included potters angelfish (*Centropyge potteri*), and several species of wrasses, notably fourline wrasse *(Psuedochilinus tetrataenia*), eightline wrasse (*P. octotaenia*), and yellowtail wrasse (aki-lolo, *Coris gaimard*).

The inner surge zone along the wave- swept basalt terraces supported a large number of fish, principally herbivores such as rudderfish (nenue, *Kyphosus bigibbus*), surgeonfish (*Acanthurus* spp.), and unicornfish (mostly umaumalei, *Naso lituratus*). Saddle wrasse (hinalea lau-wili, *Thalassoma duperrey*) were also abundant in the surge zone. Black durgon (humuhumu-ele'ele, *Melanichthys niger*) and pinktail durgon (humuhumu-hi'u-kole, *M. vidula*) were also observed congregating in the water column over the reef platform.

Several species of "food fish" (taken by subsistence and/or recreational fishermen) were observed during the survey. Schools of several hundred individuals of goatfish (weke, *Mulloidichthys flavolineatus*), and blue-lined snapper (taape, *Lutjanus kasmira*) were observed while diving. Numerous grand-eyed porgeys (mu, *Monotaxis grandoculis*) were observed. Rocky ledges and large coral heads sheltered fair numbers of squirrelfish (u'u, *Myripristes berndti*). Other food fishes included parrotfish (uhu, *Scarus spp.*), goatfish (moana kea and malu, *Parupaneus* spp.), jacks (papio, *Caranx melamphygus*), and grouper (roi, *Cephalopholus argus*). None of these species were particularly abundant. Orange-eyed surgeonfish (kole, *Ctenochaetus strigosus*), while abundant, were generally not large enough to be considered suitable as "food fish".

Overall, fish community structure at O'oma is fairly typical of the assemblages found in undisturbed Hawaiian reef environments. The lack of abundance of food fish indicates that the area has been subjected to moderate amounts of fishing pressure. The southern half of the property has been designated as an area where aquarium reef fish collection is prohibited. While not quantitatively assessed, it appeared that fish targeted by collectors were more abundant in the southern transects (Sites III, IV) than the northern transects (Sites I and II).

D. Anchialine Pond

Several anchialine ponds have been identified near the southern boundary of the property. By definition, anchialine ponds are areas of exposed groundwater with no surface connection to the ocean. In 2006, the single pond located on the O'oma property was observed the bottom of a small sinkhole on a lava dome with a floor elevation several meters lower than the surrounding lava fields. This pond was not identified in previous studies. The area of exposed water was on the order of one square meter. No sediment was present on the floor of the pond, and the water column was extremely clear. It is well known that nutrient concentrations within anchialine ponds vary considerable as a function of tidal oscillation with results in variable mixing of groundwater and marine waters. As a result, anchialine ponds are not nutrient limited, and thrive under a wide range of salinities and nutrient concentrations. The pond on the O'oma site was populated with numerous native herbivorous red shrimp or opae'ula (*Halocardina rubra*), and was devoid of exotic fishes, indicating that the pond is pristine in nature.

During the 1990-92 and 2002 surveys of the O'oma site, another anchialine pool was also identified in the same general area as the one observed in 2006. However, the reported description in these earlier surveys indicated that the anchialine pond was under a dense canopy of trees, and the pond was reportedly lined with sediment and plant detritus. The water column throughout the pond was extremely clear, with no apparent turbidity from suspended sediments or phytoplankton. Even with the thick sediment layer in the pond, red shrimp or opae'ula (*Halocardina rubra*) and glass shrimp (*Palaemon debilis*) were abundant in 2002. The three snails common to anchialine ponds (*Assiminea* sp. *Melania* sp. and *Theodoxus cariosa*) were also observed. As in 2006, alien fish species, which occur in many anchialine pools on West Hawaii, and are known to prey on native shrimp, were not observed in the pond in 2002.

Examination of the area in 2008 revealed marshy areas under the canopy of trees at the southern corner of the property, but no exposed water that could be considered a pond matching the description from 1990-92 and 2002. It was noted in 2002 that the pond appeared to be in a final stage of senescence, and would soon be entirely filled in. Documentation of the life history of anchialine ponds in Hawaii has shown that such infilling is part of the natural progression of these ponds. It is possible that in the four year interval, infilling of the senescent pond was complete, essentially eliminating this pond. Further examination of the area during varying stages of the tide will indicate if indeed the pond under the canopy of trees is still viable or if it has sedimented in.

E. Protected Marine Species

Several species of marine animals that occur in Hawaiian waters have been declared threatened or endangered by Federal jurisdiction. The threatened green sea turtle (*Chelonia mydas*) occurs commonly along the Kona Coast, and turtles are frequently observed on beaches throughout the area. The endangered hawksbill turtle (*Eretmochelys imbricata*) is known infrequently from waters off the Kona Coast. While turtles undoubtedly occur in the nearshore areas off O'oma, no individuals were observed during the course of the 2006 survey.

Populations of the endangered humpback whale (*Megaptera novaeangliae*) are known to winter in the Hawaiian Islands from December to April. The present survey was conducted in December, when whales are present in Hawaiian waters. However, the scope of the survey was limited to depth contours shallower than 20 m, which is not within the typical whale habitat.

The Hawaiian Monk Seal, (*Monachus schauinslandi)*, is an endangered earless seal that is endemic to the waters off of the Hawaiian Islands. Monk seals commonly haul out of the water onto sandy beaches to rest. Hence, while there is no greater potential for haul out to the beaches fronting the

O'oma Beachside Village than any other area, there is a probability that seals will haul out on these beaches. No individuals were observed on the beach or in the water during the course of the present survey. As there are no plans for any modification of the shoreline, and with established of the shoreline preservation area, there are no physical factors that will result in modification of seal behavior. The major factor that could affect seal behavior is interaction with humans. Typically when seals haul out, authorized Federal or State agencies may establish a safety zone by placement of temporary fencing and signs indicating proper treatment of the animals. At present, the O'oma area is heavily used for recreational purposes, which is not likely to change. Any additional activity by people using the beach area as a result of the Beachside Villages will not qualitatively change usage of the shoreline by humans. Hence, the best management protocol to ensure the absence of negative effects to seals is establishment of a protocol to notify the appropriate authorities as soon as possible to establish buffer zones with appropriate signage.

IV. CONCLUSIONS

Implementation of the proposed O’oma Beachside Village would involve grading, vegetation removal, new construction, and other land use changes. There are no plans, however, for alteration of the shoreline, or offshore environments in any manner. In fact, the shoreline area will be protected by a wide shoreline setback and coastal preserves area. Considerations of the changes to water chemistry as a result of alteration of groundwater flow and composition will not change the existing character of the marine environment to an extent that will alter biotic community structure (see Reports by Tom Nance Water Resources Engineering, and Marine Research Consultants). In summary, the proposed project does not appear to present the potential for alteration of the offshore environments. None of the proposed development activities has the potential to induce large changes in physico-chemical properties that could affect biotic community structure.

As described above, the reefs off O’oma are constantly exposed to natural stresses, primarily from storm waves that are the major forcing function determining the make-up of Hawaiian reef communities that occur on exposed shorelines. If some unexpected event related to shoreline development did occur, the resulting impact would likely be negligible in comparison to impacts caused by natural factors. The relatively flat grade of the property precludes any surface runoff from land to the ocean (S. Bowles, T. Nance, personal communication). Hence with proper BMPS, even expected changes associated with a temporary situation of increased sedimentation during the construction phase at O’oma will not result in sediment discharge to the ocean. As a result, there is essentially no potential for noticeable change to the nearshore community generated by the construction process. Observations of the response of marine ecosystems to shoreline development at Princeville on Kauai (Grigg and Dollar 1980, Dollar and Grigg 2004)), and Mauna Lani in South Kohala (Dollar and Grigg 2004) indicate that marine environments are not necessarily impacted by shoreline development.

It can be concluded that as long as reasonable steps are taken in construction practices, there should be no adverse impacts to the marine environment. If mandated, an ongoing monitoring program will assess if shoreline activities at O'oma are resulting in changes to nearshore water quality. Such changes in water quality would be indicative of potential changes to marine community structure. Thus, any changes in water quality owing to shoreline development would trigger mitigative action, hopefully at a level below that capable of inducing change in biotic structure.

V. SUMMARY

1. Assessment of the benthic and reef fish community structure off the proposed O'oma Beachside Village was conducted in December 2006. Twelve transects were evaluated at four stations located offshore of the property. Transect surveys were repeated at approximately the same locations as a previous survey of the same region conducted in 1986, 1990 and 2002, allowing for comparison of conditions over a twenty-year interval.

2. Physical structure of the nearshore region consists predominantly of narrow sand beaches that abut rocky basaltic shorelines that form the land-sea interface. The reef area is divided into three major zones; a shallow nearshore zone characterized by basaltic boulders and substantial water motion from breaking waves, a mid-reef zone which comprises the major "reef-building area", and a deep reef slope. Substrata on the shallow and mid-reef consist predominantly of solid limestone and basalt, while substrata on the deep reef slope are predominantly sand and coral rubble.

3. In general, the coral communities off O'oma are typical of the type that occurs throughout much of the west Hawaii coastline. In 2006, nine coral species were encountered on transects, and total coral cover was approximately 47% of bottom cover, which represents and increase of about 2% from 2002, and 27% from 1989. The dominant coral species at all sites was *Porites lobata*, which comprised approximately 60% of total coral cover in all four surveys.

4. Comparison of coral cover between 1986, 1990, 2002 and 2006 indicates a consistent increase in cover on the reef bench zones with time. The increase is likely a result of coral community recovery from a large storm event that occurred just prior to the 1986 survey. With no other significant storms occurring in the twenty years between studies, the coral community is recovering in terms of increasing bottom cover and species diversity. The pattern of change over time is less consistent on the reef slope, where much of the delicate finger coral was destroyed by the concussive force of waves in the 1986 storm. Recovery of coral cover in the deep slope zone is also apparent except at Site I, which may reflect damage to the reef from pipeline construction activities associated with NELHA.

5. Reef fish community structure at O'oma is fairly typical of the assemblages found in Hawaiian reef environments, and is characterized by six general categories: juveniles, plantivorous damselfishes, herbivores, rubble-dwellers, swarming tetrodonts, and surge-zone fishes. The presence of some food fishes indicates that the area has been subjected to low to moderate amounts of fishing pressure, both by aquarium fish collectors and fishermen. Fish were more abundant at the two transect sites (III and IV) located in the region which prohibits aquarium fish collecting.

6. It does not appear that the planned O'oma Beachside Village has the potential to cause adverse impacts to the marine environment. Stresses from natural forces (particularly storm waves) that are presently the dominant factors in influencing community structure are substantially greater than those

that could result from shoreline development. The absence of plans to modify the shoreline or nearshore environment eliminates the potential for direct alteration of ecosystems. Secondary impacts associated with changes to water quality from changes to groundwater chemistry associated with the development do not present the potential for changes based on estimates of changes to groundwater dynamics that will result from the project. The relatively low change in shoreline slope extending from the shoreline mauka precludes surface runoff from land to the ocean. In addition, similar existing projects that have been monitored for decades reveal no changes to marine environmental quality.

7. The O'oma Beachside Village does not have any likelihood of changing the present situation with respect to protected and endangered species, particularly turtles and Hawaiian Monk Seals. The complete lack of any shoreline modification, as well as establishment of a shoreline preserve area will ensure that the beach resources remain unchanged from present conditions. As a result, use of the beaches for haul-out areas by turtles or seals will not be altered from the present situation. The best mitigative measures to ensure that there are no effects to endangered or protected species by human interaction are appropriate signage and establishment of protective buffer zones established by trained personnel from State and/or Federal agencies.

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ASSESSMENT OF
MARINE WATER CHEMISTRY
O'OMA BEACHSIDE VILLAGE
NORTH KONA, HAWAII

Prepared for

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by

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I. INTRODUCTION AND PURPOSE

The proposed O'oma Beachside Village is located on a 303-acre property in North Kona approximately one mile south of the Keahole Airport and seven miles north of Kailua- Kona. The property (project site) is bounded to the east by the Queen Kaahumanu Highway, on the west by the Pacific ocean, and lies between the Natural Energy Laboratory of Hawaii Authority (NELHA) and Hawaii Ocean Science and Technology (HOST) Park to the north, and the Shores at Kohana'iki Development to the south (Figure 1).

O'oma Beachside Village will be a master-planned residential community with a full range of mixed uses including housing, mixed-use commercial, preserves, parks, trails, and shoreline access. In total, there will be 950 to 1,200 homes, which will include multi-family units, “live-work” or mixed-use homes, workforce, gap and affordable homes, and single-family home lots. With the exception of the shoreline park facilities, the entire O'oma Beachside Village community will be setback at least 1,100 feet from the shoreline. The proposed community will also include supporting infrastructure such as a wastewater treatment plant, water system, and power and communications systems.

While all planning and construction activities will place a high priority on maintaining the existing pristine nature of the marine environment, it is nevertheless important to address any potential impacts that may be associated with the planned community. None of the proposed land uses includes any direct alteration of the coastal areas or nearshore waters. In fact, the shoreline setback and coastal preserve area are specifically intended to preserve the coastal area as it exists at present. The potential exists, however, for the community to affect the composition and volume of groundwater that flows beneath the property, as well as surface runoff that may emanate from the community. As all groundwater that could be affected by the community subsequently reaches the ocean, it is recognized that there is potential for the community to affect the marine environment. This concern is especially critical owing to the close proximity of the NELHA and HOST Park facilities, where numerous mariculture operations rely on pristine ocean waters. In addition, the shoreline fronting the property is a recreational area and is utilized for surfing, swimming, and fishing. Therefore, evaluating the potential for alterations to water quality and marine life from material input from the community constitutes an important factor in the planning process.

In the interest of addressing these concerns and assuring maintenance of environmental quality, a marine water quality assessment and potential impact analysis of the nearshore areas off the O'oma Beachside Village property was conducted in November 2006. The rationale of this assessment was to determine the contribution of groundwater to the marine environments offshore of O'oma Beachside Village, and to evaluate the effects that this input has on water quality at the present time, prior to the commencement of any new construction activities. Combining this information with estimates of changes in groundwater and surface water flow rates and chemical composition that could result from the proposed community provides a basis to evaluate the potential future effects to the marine environment. Predicted changes in groundwater composition and flow rates have been supplied by Tom Nance Water Resource Engineering (TNWRE 2008). Results of the combined evaluation will indicate the degree of change to the marine environment that could occur as a result of O'oma Beachside Village.

The property is somewhat unique in that the O'oma Beachside Village represents at least the third iteration of proposed development on the property. During two separate earlier proposed scenarios in 1990-1992 and 2002 similar marine assessment programs were carried out by Marine Research Consultants. In 1990-92, four surveys were conducted between October 1990 and March 1992. Further consideration of these data in the present report will consist of the geometric means of these four surveys. Hence, by repeating similar sampling protocols in 2006, it is possible to evaluate not only the existing state of marine water quality at the site, but also to assess if any changes have occurred over the past fourteen years. The assessment program can also serve as a baseline if future permitting requirements include a repetitive monitoring program during the course of construction and operation of O'oma Beachside Village.

II. METHODS

Three transect survey sites were established in the vicinity of the O'oma property for the initial monitoring program in 1990. For the 1990-1992 program, Site 1 was located off the public bathhouse located to the north of the northern property boundary. During subsequent increments of monitoring, Sampling Site 1 was moved south to the northern boundary of the property. Site 2 is located off the approximate center of the property; and Site 3 is located near the southern boundary at Puhili Point (Figure 1). Sites 2 and 3 were in the same locations for all three surveys.

All fieldwork was conducted on November 3, 2006. Water quality was evaluated at each site on transects that were oriented perpendicular to the shoreline and depth contours. In 2006 water samples were collected at ten locations on each transect from just seaward of the shoreline to approximately 150 meters (m) offshore (0, 1, 2, 5, 10, 15, 20, 30, 50, 150 m). Such a sampling scheme was designed to span the greatest range of salinity with respect to potential freshwater efflux at the shoreline. Sampling was more concentrated in the nearshore zone because this area receives the majority of groundwater discharge, and hence is most important with respect to identifying the effects of shoreline modification. The sampling locations (in terms of distance from shore) were altered slightly in 2006 based on results of surveys from the 1992 and 2002 monitoring programs in order to best characterize the nearshore area which is affected by input from land. These changes in distances from shore where samples were collected does not affect to capability to compare water quality between the three survey periods.

Owing to the shallow depth of the near-shore shelf, at stations from the shoreline extending to 30 m from shore, a single sample was collected within 20 cm of the sea surface by swimmers working from shore. At stations 50 and 150 m from the shoreline samples were collected at two depths; a surface sample was collected within approximately 20 (cm) of the sea surface, and a bottom sample was collected within 1 m of the sea floor.

A sample was also collected from an anchialine pond located approximately 50 m behind the shoreline near the southern boundary of the property. In order to determine chemical concentrations in unaltered groundwater, samples were also collected from a variety of high level and brackish wells in the Keahole-Kailua corridor (see report by Tom Nance Water Resources Engineering for locations of wells and results of well water analyses).

Water quality parameters evaluated included the ten specific criteria designated for open coastal waters in Chapter 11-54, Section 06 (d)(Area-Specific criteria for the Kona (west) coast of Island of Hawaii). Open Coastal waters) of the State of Hawaii Department of Health (DOH) Water Quality Standards. These criteria include: total dissolved nitrogen (TDN), nitrate + nitrite nitrogen (NO_3^- + NO_2^-, hereafter referred to as NO_3^-), ammonium nitrogen (NH_4^+), total dissolved phosphorus (TDP), orthophosphate phosphorus (PO_4^{-3}), Chlorophyll a (Chl _a_), turbidity, temperature, pH and salinity. In addition, silica (Si) was also reported because these parameters are sensitive indicators of biological activity and the degree of groundwater mixing.

Surface water samples were collected by filling pre-rinsed, 1-liter polyethylene bottles. “Deep” water samples were collected using a Niskin-type oceanographic sampling bottle. The bottle is lowered to the desired sampling depth (approximately 1-2 off the bottom) with spring-loaded endcaps held open so water can pass freely through the bottle. At the desired sampling depth, a weighted messenger released from the surface triggers closure of the endcaps, isolating a volume of water.

Subsamples for nutrient analyses were immediately placed in 125-milliliter (ml) acid-washed, triple rinsed, polyethylene bottles and stored on ice. Analyses for Si, NH_4^+, PO_4^{3-}, and NO_3^- were performed of filtered subsamples with a Technicon Autoanalyzer using standard methods for seawater analysis (Strickland and Parsons 1968, Grasshoff 1983). TDN and TDP were analyzed in a similar fashion following digestion. Dissolved organic nitrogen (DON) and dissolved organic phosphorus (DOP) were calculated as the difference between TDN and dissolved inorganic N, and TDP and dissolved inorganic P, respectively.

Water for other analyses was subsampled from 1-liter polyethylene bottles and kept chilled until analysis. Chl *a* was measured by filtering 300 ml of water through glass-fiber filters; pigments on filters were extracted in 90% acetone in the dark at -20^o C for 12-24 hours. Fluorescence before and after acidification of the extract was measured with a Turner Designs fluorometer. Salinity was determined using an AGE Model 2100 laboratory salinometer with a readability of 0.0001‰ (ppt). Turbidity was determined using a 90-degree nephelometer, and reported in nephelometric turbidity units (NTU) (precision of 0.01 NTU).

In-situ field measurements included water temperature and pH using a field meter with a readability of 0.01°C and 0.01 pH units. Dissolved oxygen was measured with a Royce Model 91 field meter. Vertical profiles of salinity, temperature and depth were acquired using a RBR-620 CTD calibrated to factory standards.

All fieldwork was conducted by Dr. Steven Dollar. All laboratory analyses were conducted by Marine Analytical Specialists located in Honolulu, HI (Labcode: HI 00009). This analytical laboratory possesses acceptable ratings from EPA-compliant proficiency and quality control testing.

III. RESULTS

1. General Overview

Tables 1 and 2 show results of all water chemistry analyses for samples collected off the O'oma Beachside Village property in November 2006. Table 1 shows concentrations of dissolved nutrients in micromolar (µM) units; Table 2 shows concentrations in micrograms per liter (µg/L). Similar tables for surveys in 1992 and 2002 are shown in Appendix A.

Concentrations of eight dissolved nutrient constituents in surface and deep samples are plotted as functions of distance from the shoreline in Figure 2. Values of salinity, turbidity, Chl *a* and turbidity as functions of distance from shore are shown in Figure 3. Several patterns of distribution are evident in Tables 1 and 2 and Figures 2 and 3. It can be seen in Figure 2 that at all three transects, the dissolved nutrients Si, NO_3^- and TN display distinctly elevated concentrations in the samples collected within about 30 m from the shoreline at all three sites. Salinity displays the opposite trend, with sharply lower concentrations in the nearshore samples at all three sites (Figure 3). While these gradients are evident at all three sites, they are most pronounced at Site 3 and least pronounced at Site 2.

These patterns are a result of concentrated input of groundwater to the ocean near the shoreline. Low salinity groundwater, which typically contains high concentrations of Si and NO_3^-, percolates to the ocean at the shoreline, resulting in a nearshore zone of mixing. In many areas of the Hawaiian Islands, such groundwater percolation results in steep horizontal gradients of increasing salinity and decreasing nutrients moving seaward. PO_4^{3-} is also generally elevated in groundwater relative to ocean water. However, the patterns of horizontal gradients of concentrations of PO_4^{3-} do not show the same uniformly progressive decreases with distance from shore as Si and NO_3^-. Horizontal gradients of TDN and TDP reflect the patterns of NO_3^- and PO_4^{3-}, respectively.

At the open coastal sampling stations off O'oma, the zone of mixing is relatively small, and the gradients are less pronounced than at other areas of West Hawaii where semi-enclosed embayments occur.

Water chemistry parameters that are not associated with groundwater input (NH_4^+, DON, DOP) do not show a pattern of decreasing concentration with respect to distance from the shoreline. Rather, these constituents do not occur in any consistent pattern across the horizontal ranges of the sampling area.

Similar to the patterns of dissolved inorganic nutrients (Si and NO_3^-), the distribution of Chl *a* also displays peaks near the shoreline. Beyond 30 m from the shoreline, the concentration of Chl *a* in surface waters is essentially constant across the sampling scheme (Figure 3). Turbidity is slightly higher in the nearshore samples on all transects, with a peak value at the shoreline of Transect 2 (Figure 3). Temperature showed a distinct trend of increase with distance from shore at all three transects (Figure 3). The distinct cooling at the shoreline is likely a result of cool groundwater discharge.

It can be seen in Tables 1 and 2 that chemical concentrations at the most seaward sampling stations (150 m from shore) at all three sites are similar, and represent open coastal ocean waters with little influence from land.

2. Conservative Mixing Analysis

A useful treatment of water chemistry data for interpreting the extent of material input from land is application of a hydrographic mixing model. In the simplest form, such a model consists of plotting the concentration of a dissolved chemical species as a function of salinity. The concept of using such mixing models which scale nutrient concentrations to salinity is utilized by the State of Hawaii Department of Health for establishing a unique set of water quality standards for the West Coast of the Island of Hawaii [Hawaii Administrative Rules, §11-54-06 (d)].

Figure 4 shows plots of the concentrations of Si, NO_3^-, PO_4^{3-}, and NH_4^+ as functions of salinity for the samples collected at each transect site in November 2006. Each graph also shows a conservative mixing lines constructed by connecting the endmember concentrations of open ocean water collected at the same time as the other water samples, and groundwater from four high level potable well located upslope of the O'oma Beachside Village property (See Table 2 in TNWRE 2008).

Comparison of the curves produced by the distribution of data with conservative mixing lines provides an indication of the origin and fate of the material in question.

If the parameter in question displays purely conservative behavior (i.e., no input or removal from any process other than physical mixing), data points should fall on, or near, the conservative mixing line. If however, external material is added to the system through processes such as leaching of fertilizer nutrients to groundwater, data points will fall above the mixing line. If material is being removed from the system by processes such as biological uptake, data points will fall below the mixing line.

Dissolved Si represents a check on the method as this material is present in high concentrations in groundwater, low concentration in open coastal waters, and is not a major component of fertilizer or sewage effluent. In addition, Si is not utilized rapidly within the nearshore environment by biological processes. It can be seen in Figure 4 that with the exception of several data points at the lowest salinities, all other data points for all three transect sites fall in a linear array close to the conservative mixing line. Linear regression of the concentrations of Si as a function of salinity indicates that for all three transects, there is a highly significant R^2 (proportion of variation explained) of 0.97-0.99 indicating that the concentration of Si is dependant on salinity.

The Y-intercept of the regression of Si as a function of salinity can be interpreted as the predicted nutrient concentration at a salinity of zero. As groundwater has salinity close to zero, the Y-intercept can be used to evaluate the relationship between upslope groundwater and groundwater that is entering the ocean at the shoreline. When the average concentration of Si from the four potable wells upslope of O'oma and average concentration of open coastal water are plotted versus salinity, the Y-intercept is 815 µM. The upper and lower 95% confidence limits of the Y-intercepts of the regression lines of Si vs. salinity for the three transects are 762-808 µM (Transect 1); 378-484 µM (Transect 2) and 681-744 (Transect 3). Hence, if Si is a truly conservative tracer, it can be determined that there is a slight reduction of Si near the shoreline at all three transects. Even though regression statistics indicate slight depletion in Si concentrations in the ocean relative to upslope groundwater at two of the three transects, the extremely high R^2 supports the conclusion that Si is behaving as a conservative tracer and that well water sampled from the upslope wells is similar in composition to groundwater entering the ocean off the O'oma Beachside Village property.

The plots of NO_3^- versus salinity show a slightly different distribution than Si. All of the data points for Transect 1 fall slightly above the conservative mixing line, and all but one data point from each of Transects 2 and 3 fall below the mixing line. Linear regressions of these data indicate significant R^2s of 0.93 - 0.99 for each of the three transects indicating that the concentrations of NO_3^- are functions of salinity. The average concentration of NO_3^- in the four potable wells is 77 µM. The upper and lower confidence limits of the Y-intercepts of the concentrations of NO_3^- versus salinity for the three transects are 86-99 µM (Transect 1), 74-114 µM (Transect 2), and 76-98 µM (Transect 3). Hence, only on Transect 1 is there a subsidy of NO_3^- in the nearshore ocean relative to what would be predicted from mixing of natural groundwater and open coastal water.

While PO_4^{3-} is also generally found in groundwater in higher concentrations than open coastal water, it occurs in far lower concentrations compared to NO_3^-, owing in part to a high absorptive affinity of phosphorus in soils or rock. It can be seen in Figure 4 that when plotted as functions of salinity, concentrations of PO_4^{3-} do not prescribe linear patterns similar to Si and NO_3^-. Linear regression of PO_4^{3-} versus salinity is not statistically significant (P=0.05) for data from Transects 2 and 3 indicating that these concentrations are not functions of salinity. The mean value of the concentration of PO_4^{3-} in potable wells upslope of O'oma (3.6 µM) is within the range of the 95% confidence limits of the linear regression fitted through the data from Transect 1 (0.29-6.03 µM) indicating that the concentrations of PO_4^{3-} in the ocean are the result of mixing of groundwater and open ocean water endmembers.

Plots of concentrations of NH_4^+ versus salinity show different relationship than Si, NO_3^- and PO_4^{-3}. Plots of concentrations of NH_4^+ versus salinity exhibit no linear trends with respect to salinity (Figure 4). Data from Transects 1 and 2 do not result in statistically significant linear regression. In addition, the highest values of NH_4^+ on these two transects occurred at the highest salinities, suggesting that the source of most of the NH_4^+ in the nearshore ocean is not from the land but rather from biological processes occurring in the ocean. The situation is different at Transect site 3. If the single anomalous data point at the shoreline is omitted, the regression of the distribution of NH_4^+ data as a function of salinity is significant with a Y-intercept equal to the concentration in upslope well water.

3. Temporal Changes

As noted above, similar marine surveys have been conducted off the O'oma property in 1990-1992 and 2002. Comparison of the results of these surveys with the work in 2006 provides an indication of changes in nutrient characteristics over the fourteen year interval. Figure 5 shows mixing plots of Si, NO_3^-, PO_4^{3-}, and NH_4^+ as functions of salinity for the pooled samples from the three transects collected during each survey set. Comparison of the slopes of the mixing lines provides a valid indicator of changes between surveys with respect to input of nutrients to the coastal ocean.

Table 3 shows linear regression statistics for each nutrient as a function of salinity for each survey year. For Si, NO_3^- and PO_4^{3-} the upper confidence limits Y-intercept in 2006 are lower than in 1990-92. The upper confidence limit of the slope of NO_3^- is lower than in 1990-92. The regression for NH_4^+ and PO_4^{3-} in 2002 are non-significant, making any comparisons invalid. The overall results of the time-course comparison indicate that there have not been consistent increases or decreases in input of the nutrients to the ocean over the course of the three increments of monitoring.

4. Compliance with DOH Criteria

The West Coast of the Island of Hawaii has area specific water quality standards [Chapter §11-54-6(d)]. The major difference between these specific criteria and the general criteria for open coastal waters for the rest of the state is the consideration that high nutrient groundwater mixes with oceanic water within the nearshore zone. As a result, area specific criteria for nutrients that occur in high concentrations in groundwater relative to ocean water (NO_3^-, TDN, PO_4^+, and TDP) are evaluated by two criteria based on salinity. In areas where nearshore marine water salinity is greater than 32‰, specific criteria for geometric means apply. Geometric means are calculated at each sampling station from three values collected on three sampling dates, spaced within a 14-day period. For samples with salinity below 32‰, compliance with the DOH criteria is defined by the slope of the regression line of the nutrient concentration as a function of salinity. Slopes greater than the "not to exceed" values stated in the standards are deemed out of compliance. (Note that for the present assessment, three separate samplings within a 14-day period were not conducted).

It can be seen in Tables 1 and 2 that each transect had at least one sample with salinity less than 32‰. Hence, it can be interpreted that the relevant DOH compliance criteria are the regression statistics shown in §11-54-6(d)(1)(ii). Table 4 shows the slopes and upper and lower 95% confidence limits of linear regressions of NO_3^-, TDN, PO_4^{3-}, and TDP as functions of salinity from each of the three ocean transects. Also shown in Table 4 are the "compliance slopes" listed in the West Hawaii area specific water quality standards. As stated in the WQS, *"…the absolute value of the upper 95% confidence limit for the calculated sample regression coefficient (i.e., slope) shall not exceed the absolute value listed in the regulations."* When linear regression analyses are performed with data in units of µg/L , the absolute values of confidence limits of the slope of the regression line of NO_3^- vs. salinity exceeded the absolute values of the specific criteria slope (-31.92) only on Transect 1. None of the upper confidence limits for TDN, PO_4^{3-} or TDP on the three transects exceeded the respective specific criteria slopes (Table 4).

Considering dissolved nutrients with salinities greater than 32‰, only a single values of PO_4^{3-} and TDP exceeded the DOH geometric mean standard. However, many of the samples exceeded the geometric mean criteria for NO_3^- and TDN (Tables 1 and 2). As there is presently no development on the O'oma property, these "exceedances" can be considered a result of natural conditions. To illustrate this likelihood, it can also be seen in Figure 4 that concentrations of NO_3^- in samples with salinities above 32‰ fall in a linear array along the mixing lines. Hence, the "cut-off" of 32‰ to separate compliance evaluation by using mixing line regressions and geometric means does not appear to be a justifiable boundary to differentiate between methods of determining compliance. Samples with salinities of 32‰ are comprised of about 9% freshwater and 91% seawater. With such a mixture the geometric mean standard can be exceeded solely as a result of mixing of uncontaminated groundwater and ocean water.

The area specific DOH standards for West Hawaii also include three parameters (NH_4^+, Chl *a* and turbidity) that are not subjected to the conditions of salinity based on the 32‰ boundary. Rather, the specific geometric mean criteria apply to all values of these parameters regardless of salinity. It can be seen in Tables 1 and 2 that all values of NH_4^+ on Transects 1 and 2, and all on Transect 3 within 10 m of the shoreline exceed the geometric mean standard. Similarly, most of the values of turbidity and Chl *a* within the nearshore zone exceed standards. As stated above, with no development presently on the O'oma site, the offshore conditions represent essentially the natural setting of the area. It is apparent that the geometric mean values that are presently DOH compliance criteria do not fully take into account the natural setting of at least some nearshore areas in West Hawaii.

5. Anchialine Pond

Anchialine ponds have been identified on the O'oma property near the southern boundary. By definition, anchialine ponds are areas of exposed groundwater with no surface connection to the ocean. During fieldwork for the present report (2008), a single pond was observed at the bottom of a small sinkhole on a lava dome with a floor elevation several meters lower than the surrounding lava fields. This pond was not identified in previous studies. The area of exposed water was on the order of one square meter. No sediment was present on the floor of the pond, and the water column was extremely clear, as evidenced by the measure of turbidity of 0.12 ntu (Tables 1 and 2). Salinity of the pond was measured at 15‰, with a concentration of NO_3^- of 107 µM. It is well known that nutrient concentrations within anchialine ponds vary considerable as a function of tidal oscillation with results in variable mixing of groundwater and marine waters. As a result, anchialine ponds are not nutrient limited, and thrive under a wide range of salinities and nutrient concentrations. The pond on the O'oma site was populated with numerous native herbivorous red shrimp or opae'ula (*Halocardina rubra*), and was devoid of exotic fishes, indicating that the pond is pristine in nature.

During the 1990-92 and 2002 surveys of the O'oma property, another anchialine pool was also identified near the southern boundary. However, the reported description in these earlier surveys indicated that the anchialine pond was under a dense canopy of trees, and the pond was reportedly lined with sediment and plant detritus. The water column throughout the pond was extremely clear, with no apparent turbidity from suspended sediments or phytoplankton. Even with the thick sediment layer in the pond, red shrimp or opae'ula (*Halocardina rubra*) and glass shrimp (*Palaemon debilis*) were abundant in 2002. The three snails common to anchialine ponds (*Assiminea* sp. *Melania* sp. and *Theodoxus cariosa*) were also observed. As in 2008 alien fish species, which occur in many anchialine pools on

West Hawaii, and are known to prey on native shrimp, were not observed in the pond in 2002.

Examination of the area in 2008 revealed marshy areas under the canopy of trees at the southern corner of the property, but no exposed water that could be considered a pond matching the description from 1990-92 and 2002. It was noted in 2002 that the pond appeared to be in a final stage of senescence, and would soon be entirely filled in. Documentation of the life history of anchialine ponds in Hawaii has shown that such infilling is part of the natural progression of these ponds. It is possible that in the four year interval, infilling of the senescent pond was complete, essentially eliminating this pond. Further examination of the area during varying stages of the tide will indicate if indeed the pond under the canopy of trees is still viable or if it has sedimented in.

IV. DISCUSSION and CONCLUSIONS

The purpose of this assessment is to assemble the information to make valid evaluations of the potential for impact to the marine environments from the proposed O'oma Beachside Village community. The information collected in this study provides the basis to understand the processes that are operating in the nearshore ocean, so as to be able to address any concerns that might be raised in the planning process.

The proposed O'oma Beachside Village does not include any plans for any direct alteration of the shoreline or offshore areas. Rather, the shoreline area will be protected by a 1,000 foot shoreline setback and coastal preserves area. Therefore, potential impacts to the marine environment can only be considered from activities on land that may result in delivery of materials (primarily fresh water and nutrients) to the ocean through infiltration to groundwater on land with subsequent discharge to the ocean, and surface runoff. To evaluate the possible magnitude of these processes, a report has been prepared by Tom Nance Water Resource Engineering entitled "*Assessment of the Potential Impact on Water Resources of the Proposed O'oma Beachside Village in North Kona, Hawaii*" (TNWRE 2008). For the purposes of analyses of impact on water resources on the property, it was assumed that rather than utilize high level groundwater, irrigation and potable water would be supplied to the community by onsite reverse osmosis (RO) desalting. Recovery rate of the RO process is on the order of 40-45% of the saline feedwater supply, with the remaining 55-60% brine disposed of in deep onsite wells.

With respect to the potential impacts this process may have on the existing groundwater setting, TNWRE (2008) provides the following summary:

1) Whether or not the saline feedwater supply is seawater from NELHA or onsite saltwater wells drawing water at depth below the basal lens, such supply will have

no impact on the basal groundwater as it moves across the property and discharges at the shoreline.

2) The 55-60% of the initial feedwater that will become hypersaline RO concentrate will be disposed of in onsite wells that would deliver the concentrate into the saltwater zone below the basal lens. The concentrate, with a salinity on the order of 60‰ is substantially denser than either open coastal seawater (salinity of 35‰) or saline groundwater (salinity of 33-35‰). Owing to the greater density, as well as the horizontal-to-vertical anisotropy of the subsurface lava flows, the brine concentrate will flow seaward without rising into basal groundwater. Discharge into the marine environment would be at a substantial distance offshore.

3) Owing to the high permeability of the lavas comprising the entire property, surface stormwater runoff never reaches the ocean regardless of storm intensity. This condition will not change under the development scenario. At present, about half of the 15 inches of annual rainfall that occurs on the property percolates to the underlying groundwater. Development of the community will not result in any change to the stormwater percolation rate. Additional nutrient concentrations to percolating stormwater will be of a very small magnitude.

4) About 15% of the 0.58 MGD (million gallons per day) of total irrigation water is projected to be in excess of consumptive use by landscaping and will percolate downward to the underlying basal lens. Irrigation water would be comprised of a combination of R-1 WWTP effluent and potable RO water. Evaluation of the impacts of this percolate is based on total landscaped area of 115 acres and nitrogen and phosphorus fertilizer application rates of 3 and 0.5 lb. per year per 1,000 sq. feet, respectively. Based on past work in West Hawaii, it is assumed that 10% of applied nitrogen and 2% of applied phosphorus percolates past the root zone, and removal rates of nitrogen and phosphorus within the unsaturated vadose zone are 80% and 95%, respectively.

5) Using these estimates of changes in composition and inputs/withdrawals, TNWRE (2008) computed the total project-related changes to the underlying basal lens which discharges into the marine environment along the shoreline. At the present relatively modest flow of 1.5 MGD beneath the one-half mile wide property, total flowrate would increase about 6% (1.59 MGD). Such an increase is too small a magnitude to be detectable by water level monitoring. The additional groundwater flux would have no significant effect to the use of groundwater by neighboring projects or the functioning of anchialine pools or fishponds in the Kaloko Honokohau National Park.

6). On a weight basis, nitrogen and phosphorus are projected to increase in groundwater by about 6%, and 4%, respectively. TNWRE states that these contributions of nitrogen and phosphorus to groundwater flowing beneath the property will not impair present and foreseeable use of this resource.

Further evaluation of the potential changes to groundwater composition also indicate that there is little or no potential for alteration of the marine environment. Converted to a molar basis, the projected increases of 6% would result in a change of the average high level groundwater TN concentration from 83 to 88 µM (based on data in Table 2 of TNWRE 2008). Similarly, TP would increase in high level groundwater from 4.6 to 4.8 µM. Such changes would cause no impact to the marine environment for several reasons. First, the average TN concentration in existing basal wells of brackish quality in the Keahole to Kailua area (shown in Table 2 in TNWRE) is about 100 µM, which is 12 µM higher than the maximal potential increase in high level groundwater water resulting from the project. As groundwater from brackish water wells is diluted with ocean water with considerably lower nitrogen concentrations, it is apparent that the projected increases are well within the existing range of nutrient concentrations presently in groundwater discharging at the shoreline. Similarly the average concentration of TP in high level groundwater is about 4.6 µM. Increasing this concentration by the projected 4% as a result of the O'oma project results in a concentration of about 4.7 µM, which is nearly exactly the same as the concentration in brackish wells from Keahole to Kailua.

With respect to the additional nutrient concentration in marine waters, it can be seen in Figures 4 and 5 that with the exception of a two outliers with salinities of about 17‰ and 22‰, the lowest measured salinities at the shoreline are about 29‰. This salinity represents a dilution of groundwater with ocean water of about 83%. Hence, the 6% projected N increase to groundwater would result in only about a 1% increase at the shoreline. The shoreline fronting the entire property consists of a basaltic reef bench that is continually exposed to waves. As a result, physical processes rapidly mix seaward flowing groundwater with oceanic water, essentially diluting the groundwater to background ocean levels within meters of the shoreline. At a distance of 10 m (33 feet) from the shoreline, the average salinity on the three transects surveyed for this study was about 32‰, which represents a mixture of about 9% groundwater and 91% ocean water. Dilution of the projected 6% increase in nutrients by 91% results in nutrient increases of about 0.5% in the nearshore area beyond the basaltic bench where coral communities occur. In addition, these calculations do not take into account the increased groundwater flowrate (~6%) which would further dilute the projected increase in nutrient loading.

Such small changes are well within the natural variability of the groundwater-marine water mixing regimes on the coast of West Hawaii. In addition, these subsidies are small in comparison to other documented situation in West Hawaii where anthropogenic inputs have been quantified. For example, leaching of golf course nutrients resulted in an increase over natural flux of about 116% N and 22% P to a semi-enclosed embayment (Keauhou Bay). While these increases are orders of magnitude greater than predicted at O'oma, there was no measurable nutrient uptake within the Bay, and no alteration of biotic composition (Dollar and Atkinson 1992). Similarly, nutrients subsidies resulted in increased N and P flux to anchialine ponds at Waikoloa of about 229% and 400%, respectively. Even with such high nutrient subsidies to ponds that reflect substantial nutrient subsidies to groundwater, offshore sites at Waikoloa downgradient from these ponds on wave-exposed coastlines showed no input over natural sources (Dollar and Atkinson 1992). As the wave-exposed shorelines at Waikoloa are probably less turbulent than off the O'oma community, it can be expected that the small changes in groundwater nutrient concentrations will likewise have no effect to the marine environment.

In addition to consideration of effects from nutrient additions, it is also important to consider the potential effect of sedimentation that may occur as a result of construction activities. The property is presently comprised of extensive areas of exposed soil and rock, with relatively little vegetative groundcover. During the construction phases, it is likely that permit regulations will limit the area of excavation at any one time, and require dust control measures. In addition, the predominant direction of wind (land breezes) generated by thermal convection from solar heating of the land mass is inland, resulting in transport of dust inland, and not toward the ocean. As a result, it appears that there is little potential for significant input of sediment to the marine environment resulting from the proposed project.

All of these considerations indicate that the proposed O'oma Beachside Village community will not have any significant negative effect on water quality in the coastal ocean offshore of the property. Because of substantial buffers at the shoreline, lack of potential for surface runoff and sediment effects, small projected groundwater subsidies, and the wide variation in nutrient concentrations within the entirely of West Hawaii, as well as the strong mixing characteristics of the nearshore environment, changes to the marine environment as a result of O'oma Beachside Village will likely be undetectable, with no alteration from the present conditions.

V. SUMMARY

1. Evaluation of nearshore water chemistry off the proposed O'oma Beachside Village property was carried out in November 2006. Thirty-seven water samples were collected along three transects oriented perpendicular to shore, extending from the shoreline to a distance of approximately 150 m offshore. Samples were also collected in an anchialine pond near the southern boundary of the property. Analysis of fourteen water chemistry constituents included all specific constituents in DOH water quality standards. Sampling was similar to that conducted off the same site in 1992 and 2002.

2. Several dissolved nutrients (Si, NO_3^-, TDN) displayed distinct horizontal gradients with highest values closest to shore and lowest values at the most seaward sampling locations. Correspondingly, salinity was lowest closest to the shoreline. While these patterns were detectable at all three sampling sites, they were most pronounced at Site 3 located at the southern boundary of the property, and least pronounced at Site 2, located in the center of the property.

3. Water chemistry constituents that are not major components of groundwater (NH_4^+ , DON, DOP) did not display discernible gradients with respect to distance from the shoreline, or depth in the water column. Chl *a* and turbidity were generally elevated in nearshore samples with decreasing values moving seaward.

4. Application of a hydrographic mixing model to the water chemistry data was used to indicate if increased nutrient concentrations are the result of mixing of natural groundwater with oceanic water, or are the result of inputs from activities on land. The model indicates that during the 2006 survey there were external subsidies of NO_3^- nitrogen to the ocean only at one transect location (Transect 1). There was no input of PO_4^{-3} or NH_4^+ from activities on land that could subsidize groundwater nutrient concentrations. The overall lack of discernible nutrient subsidies in the nearshore groundwater-ocean water mixing zone indicates that there is presently no substantial input to the ocean from any sources of nutrients such as fertilizers or sewage effluent from upslope of the site.

5. Comparative results from the monitoring surveys conducted in 1990-92, 2002 and 2006 using mixing plots indicates that there has been no pattern of progressively increasing or decreasing input of materials to the nearshore ocean over the fourteen year interval.

6. Application of a linear regression model which is a component of DOH water quality standards specific for West Hawaii showed an exceedance for NO_3^- on Transect 1. Comparison of measurements of water chemistry with DOH criteria for samples with salinities below 32‰ reveal numerous exceedances of geometric mean standards. Such exceedances are likely the result of the natural influence of land on the coastal ocean, which is not accounted for the DOH standards.

7. With potable and irrigation water supplied by desalination of marine waters, there will be no adverse affect to groundwater resources in areas in the vicinity of the project. Evaluations of changes to groundwater flux and composition resulting from the project performed by Tom Nance Water Resources Engineering indicate that there will be a potential increase of groundwater flow of about 6% over present conditions in the one-half mile of coastline fronting the property. Accompanying the increase in flow rates are relatively small increases in nutrient loading of 6% for nitrogen and 4% for phosphorus. When these increases are applied to high level groundwater above the property, nutrient concentrations are lower than in brackish

wells along the Keahole-Kona corridor. In addition, dilution of groundwater at the shoreline and within the nearshore zone by turbulent mixing will result in little or no change to groundwater-marine water dynamics. Even if measured concentrations of nutrients are increased by the projected amounts with the development in place, nearshore waters are so well-mixed that there is little likelihood that concentrations will increase beyond the present ranges of conditions.

9. Overall, results of the water chemistry analysis indicate that there does not appear to be any potential for project-related negative to marine waters off the O'oma Beachside Village property. Changes of land use associated with the O'oma Beachside Village should not change water quality of the offshore area to any discernible extent.

10. The water quality study conducted for this report can serve as an initial baseline for any monitoring programs that may be required for the O'oma Beachside Village.

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FIGURE 1. Map of North Kona showing location of O'oma Beachside Village and three water quality monitoring transects located offshore of the property. Also shown are the locations of the Natural Energy Laboratory of Hawaii to the north of the O'oma site, and The Shores at Kahanaiki and the Kaloko-Honokohau National Park to the south.

TABLE 1. Water chemistry measurements from ocean samples collected along three transects off of the O'oma Beachside Village project site sampled on November 3, 2006. Nutrient concentrations are shown in micromolar units (μM). Abbreviations as follows: DFS=distance from shore; S=surface; D=deep; BDL=below detection limit. Also shown are the State of Hawaii, Department of Health (DOH) area-specific geometric mean criteria for the Kona (west) coast of the Island of Hawaii. Shaded and boxed values exceed geometric mean criteria for waters with salinity greater than 32‰. Red line separates samples with salinities of less the 32‰. For location of sampling transect sites, see Figure 1.

TRANSECT SITE	STA. NO.	DFS (m)	PO_4^{3-} (μM)	NO_3^- (μM)	NH_4^+ (μM)	Si (μM)	DOP (μM)	DON (μM)	TDP (μM)	TDN (μM)	TURB (NTU)	SAL (ppt)	CHL a (μg/L)	TEMP (deg.C)	O2 (%sat)	**pH**
OOMA 1	1S	0	0.17	4.84	0.51	43.80	0.27	6.55	0.44	11.90	0.20	32.917	0.69	26.64	106.4	8.25
	2S	1	0.50	8.95	0.34	74.91	0.38	7.95	0.88	17.24	0.29	31.482	0.74	26.76	105.3	8.27
	3S	2	0.11	7.81	0.59	65.84	0.32	6.86	0.43	15.26	0.21	31.952	0.56	26.89	107.0	8.27
	4S	5	0.27	7.48	0.40	64.42	0.27	6.73	0.54	14.61	0.13	31.987	0.91	26.99	107.5	8.27
	5S	10	0.09	6.76	0.36	63.76	0.41	8.20	0.50	15.32	0.20	32.048	0.94	27.00	106.4	8.26
	6S	15	0.04	5.74	0.25	51.65	0.29	7.09	0.33	13.08	0.14	32.655	0.71	27.01	104.3	8.25
	7S	20	0.03	5.59	0.36	47.12	0.28	6.25	0.31	12.20	0.12	32.839	0.63	27.06	104.8	8.24
	8S	30	0.03	4.00	0.44	38.82	0.35	6.60	0.38	11.04	0.14	33.147	0.39	27.09	103.5	8.22
	9S	50	0.03	0.58	0.64	7.09	0.27	5.72	0.30	6.94	0.10	34.548	0.20	27.10	108.1	8.16
	9D	50	0.02	BDL	0.90	2.94	0.27	5.86	0.29	6.76	0.08	34.721	0.17	27.23	107.2	8.15
	10S	150	0.01	0.22	0.88	2.49	0.28	6.89	0.29	7.99	0.07	34.727	0.15	27.25	105.1	8.15
	10D	150	0.03	0.30	0.52	2.11	0.26	6.00	0.29	6.82	0.10	34.758	0.14	27.24	105.2	8.16
OOMA 2	1S	0	0.03	16.04	0.64	73.34	0.27	8.49	0.30	25.17	0.78	28.977	1.22	26.89	105.2	8.07
	2S	1	0.03	1.92	0.54	30.63	0.30	6.99	0.33	9.45	0.18	33.123	0.40	27.01	105.8	8.26
	3S	2	0.03	1.08	0.61	30.38	0.30	6.63	0.33	8.32	0.18	33.064	0.87	27.01	104.6	8.33
	4S	5	0.03	1.82	0.43	30.54	0.29	7.49	0.32	9.74	0.14	33.205	0.28	27.04	106.3	8.24
	5S	10	0.03	0.54	0.62	14.28	0.28	6.37	0.31	7.53	0.11	34.081	0.34	27.10	104.5	8.23
	6S	15	0.03	0.41	0.77	11.55	0.28	5.97	0.31	7.15	0.10	34.233	0.73	27.13	105.5	8.22
	7S	20	0.02	0.18	0.75	8.85	0.26	6.50	0.28	7.43	0.08	34.408	0.28	27.19	106.4	8.21
	8S	30	0.02	0.21	0.77	7.31	0.28	7.14	0.30	8.12	0.09	34.521	0.34	27.20	101.2	8.18
	9S	50	0.02	0.19	0.52	5.99	0.27	6.90	0.29	7.61	0.08	34.605	0.38	27.23	104.5	8.18
	9D	50	0.03	0.15	0.59	2.91	0.27	5.33	0.30	6.07	0.07	34.720	0.13	27.33	102.2	8.16
	10S	150	0.05	0.14	0.37	2.62	0.29	5.81	0.34	6.32	0.08	34.729	0.12	27.24	105.5	8.16
	10D	150	0.03	0.12	0.53	1.94	0.26	6.48	0.29	7.13	0.06	34.781	0.14	27.22	104.3	8.16
OOMA 3	1S	0	0.63	45.87	1.01	368.06	0.21	4.24	0.84	51.12	0.13	17.149	0.44	26.54	107.4	8.18
	2S	1	0.04	11.36	1.24	108.57	0.32	10.54	0.36	23.14	0.15	28.751	0.27	26.99	105.5	8.28
	3S	2	0.02	8.86	1.12	107.60	0.35	9.35	0.37	19.33	0.22	29.265	2.00	27.01	104.8	8.31
	4S	5	0.03	8.35	0.71	100.98	0.30	7.58	0.33	16.64	0.15	29.642	0.64	27.21	106.3	8.32
	5S	10	0.06	8.43	0.65	102.21	0.25	8.33	0.31	17.41	0.13	29.618	0.46	27.14	105.3	8.32
	6S	15	0.04	5.55	0.14	78.99	0.28	9.17	0.32	14.86	0.13	30.853	0.46	27.15	108.4	8.34
	7S	20	0.06	1.84	0.06	32.97	0.28	7.28	0.34	9.18	0.10	33.332	0.39	27.21	103.1	8.29
	8S	30	0.09	1.50	0.22	24.85	0.27	6.43	0.36	8.15	0.09	33.777	0.45	27.22	104.3	8.26
	9S	50	0.37	0.34	0.07	6.59	0.02	7.50	0.39	7.91	0.09	34.595	0.22	27.27	108.8	8.19
	9D	50	0.09	0.22	0.11	4.22	0.21	7.00	0.30	7.33	0.07	34.720	0.13	27.26	107.6	8.17
	10S	150	0.06	0.45	0.08	6.71	0.24	7.54	0.30	8.07	0.07	34.575	0.13	27.25	105.8	8.14
	10D	150	0.06	0.15	BDL	3.77	0.25	7.30	0.31	7.45	0.08	34.700	0.15	27.24	105.7	8.15
W HI WQS (GEO MEAN)			0.16	0.32	0.18				0.40	7.14	0.10	*	0.30	**	***	****
ANCHIALINE POOL			6.64	106.56	0.64	1,002.48	0.32	41.60	6.96	148.80	0.12	15.02	0.27			7.74

* Salinity shall not vary more than ten percent form natural or seasonal changes considering hydrologic input and oceanographic conditions.
** Temperature shall not vary more than one degree Celsius from ambient conditions.
*** Dissolved oxygen shall not be less than 75% saturation.
****pH shall not deviate more than 0.5 units from a value of 8.1.

TABLE 2. Water chemistry measurements from ocean samples collected along three transects off of the O'oma Beachside Village project site sampled on November 3, 2006. Nutrient concentrations are shown in units of micrograms per liter (µg/L). Abbreviations as follows: DFS=distance from shore; S=surface; D=deep; BDL=below detection limit. Also shown are the State of Hawaii, Department of Health (DOH) area-specific geometric mean criteria for the Kona (west) coast of the Island of Hawaii. Shaded and boxed values exceed geometric mean criteria for waters with salinity greater than 32‰. Red line separates samples with salinities less than 32‰. For transect site locations, see Figure 1.

TRANSECT SITE	STA. NO.	DFS (m)	PO_4^{3-} (µg/L)	NO_3^- (µg/L)	NH_4^+ (µg/L)	Si (µg/L)	DOP (µg/L)	DON (µg/L)	TDP (µg/L)	TDN (µg/L)	TURB (NTU)	SAL (ppt)	CHL a (µg/L)	TEMP (deg.C)	O2 (%sat)	pH
OOMA 1	1S	0	5.27	67.76	7.14	1,231	8.37	91.70	13.64	166.60	0.20	32.917	0.69	26.64	106.4	8.25
	2S	1	15.50	125.30	4.76	2,105	11.78	111.30	27.28	241.36	0.29	31.482	0.74	26.76	105.3	8.27
	3S	2	3.41	109.34	8.26	1,850	9.92	96.04	13.33	213.64	0.21	31.952	0.56	26.89	107.0	8.27
	4S	5	8.37	104.72	5.60	1,810	8.37	94.22	16.74	204.54	0.13	31.987	0.91	26.99	107.5	8.27
	5S	10	2.79	94.64	5.04	1,792	12.71	114.80	15.50	214.48	0.20	32.048	0.94	27.00	106.4	8.26
	6S	15	1.24	80.36	3.50	1,451	8.99	99.26	10.23	183.12	0.14	32.655	0.71	27.01	104.3	8.25
	7S	20	0.93	78.26	5.04	1,324	8.68	87.50	9.61	170.80	0.12	32.839	0.63	27.06	104.8	8.24
	8S	30	0.93	56.00	6.16	1,091	10.85	92.40	11.78	154.56	0.14	33.147	0.39	27.09	103.5	8.22
	9S	50	0.93	8.12	8.96	199	8.37	80.08	9.30	97.16	0.10	34.548	0.20	27.10	108.1	8.16
	9D	50	0.62	BDL	12.60	83	8.37	82.04	8.99	94.64	0.08	34.721	0.17	27.23	107.2	8.15
	10S	150	0.31	3.08	12.32	70	8.68	96.46	8.99	111.86	0.07	34.727	0.15	27.25	105.1	8.15
	10D	150	0.93	4.20	7.28	59	8.06	84.00	8.99	95.48	0.10	34.758	0.14	27.24	105.2	8.16
OOMA 2	1S	0	0.93	224.56	8.96	2,061	8.37	118.86	9.30	352.38	0.78	28.977	1.22	26.89	105.2	8.07
	2S	1	0.93	26.88	7.56	861	9.30	97.86	10.23	132.30	0.18	33.123	0.40	27.01	105.8	8.26
	3S	2	0.93	15.12	8.54	854	9.30	92.82	10.23	116.48	0.18	33.064	0.87	27.01	104.6	8.33
	4S	5	0.93	25.48	6.02	858	8.99	104.86	9.92	136.36	0.14	33.205	0.28	27.04	106.3	8.24
	5S	10	0.93	7.56	8.68	401	8.68	89.18	9.61	105.42	0.11	34.081	0.34	27.10	104.5	8.23
	6S	15	0.93	5.74	10.78	325	8.68	83.58	9.61	100.10	0.10	34.233	0.73	27.13	105.5	8.22
	7S	20	0.62	2.52	10.50	249	8.06	91.00	8.68	104.02	0.08	34.408	0.28	27.19	106.4	8.21
	8S	30	0.62	2.94	10.78	205	8.68	99.96	9.30	113.68	0.09	34.521	0.34	27.20	101.2	8.18
	9S	50	0.62	2.66	7.28	168	8.37	96.60	8.99	106.54	0.08	34.605	0.38	27.23	104.5	8.18
	9D	50	0.93	2.10	8.26	82	8.37	74.62	9.30	84.98	0.07	34.720	0.13	27.33	102.2	8.16
	10S	150	1.55	1.96	5.18	74	8.99	81.34	10.54	88.48	0.08	34.729	0.12	27.24	105.5	8.16
	10D	150	0.93	1.68	7.42	55	8.06	90.72	8.99	99.82	0.06	34.781	0.14	27.22	104.3	8.16
OOMA 3	1S	0	19.53	642.18	14.14	10,342	6.51	59.36	26.04	715.68	0.13	17.149	0.44	26.54	107.4	8.18
	2S	1	1.24	159.04	17.36	3,051	9.92	147.56	11.16	323.96	0.15	28.751	0.27	26.99	105.5	8.28
	3S	2	0.62	124.04	15.68	3,024	10.85	130.90	11.47	270.62	0.22	29.265	2.00	27.01	104.8	8.31
	4S	5	0.93	116.90	9.94	2,838	9.30	106.12	10.23	232.96	0.15	29.642	0.64	27.21	106.3	8.32
	5S	10	1.86	118.02	9.10	2,872	7.75	116.62	9.61	243.74	0.13	29.618	0.46	27.14	105.3	8.32
	6S	15	1.24	77.70	1.96	2,220	8.68	128.38	9.92	208.04	0.13	30.853	0.46	27.15	108.4	8.34
	7S	20	1.86	25.76	0.84	926	8.68	101.92	10.54	128.52	0.10	33.332	0.39	27.21	103.1	8.29
	8S	30	2.79	21.00	3.08	698	8.37	90.02	11.16	114.10	0.09	33.777	0.45	27.22	104.3	8.26
	9S	50	11.47	4.76	0.98	185	0.62	105.00	12.09	110.74	0.09	34.595	0.22	27.27	108.8	8.19
	9D	50	2.79	3.08	1.54	119	6.51	98.00	9.30	102.62	0.07	34.720	0.13	27.26	107.6	8.17
	10S	150	1.86	6.30	1.12	189	7.44	105.56	9.30	112.98	0.07	34.575	0.13	27.25	105.8	8.14
	10D	150	1.86	2.10	BDL	106	7.75	102.20	9.61	104.30	0.08	34.700	0.15	27.24	105.7	8.15
W HI WQS (GEO MEAN)			5.00	4.50	2.50				12.50	100.00	0.10	*	0.30	**	***	****
ANCHIALINE POOL			205.84	1,492	8.96	28,170	9.92	582.40	215.76	2,083.20	0.12	15.02	0.27			7.74

* Salinity shall not vary more than ten percent form natural or seasonal changes considering hydrologic input and oceanographic conditions.
** Temperature shall not vary more than one degree Celsius from ambient conditions.
*** Dissolved oxygen shall not be less than 75% saturation.
****pH shall not deviate more than 0.5 units from a value of 8.1.

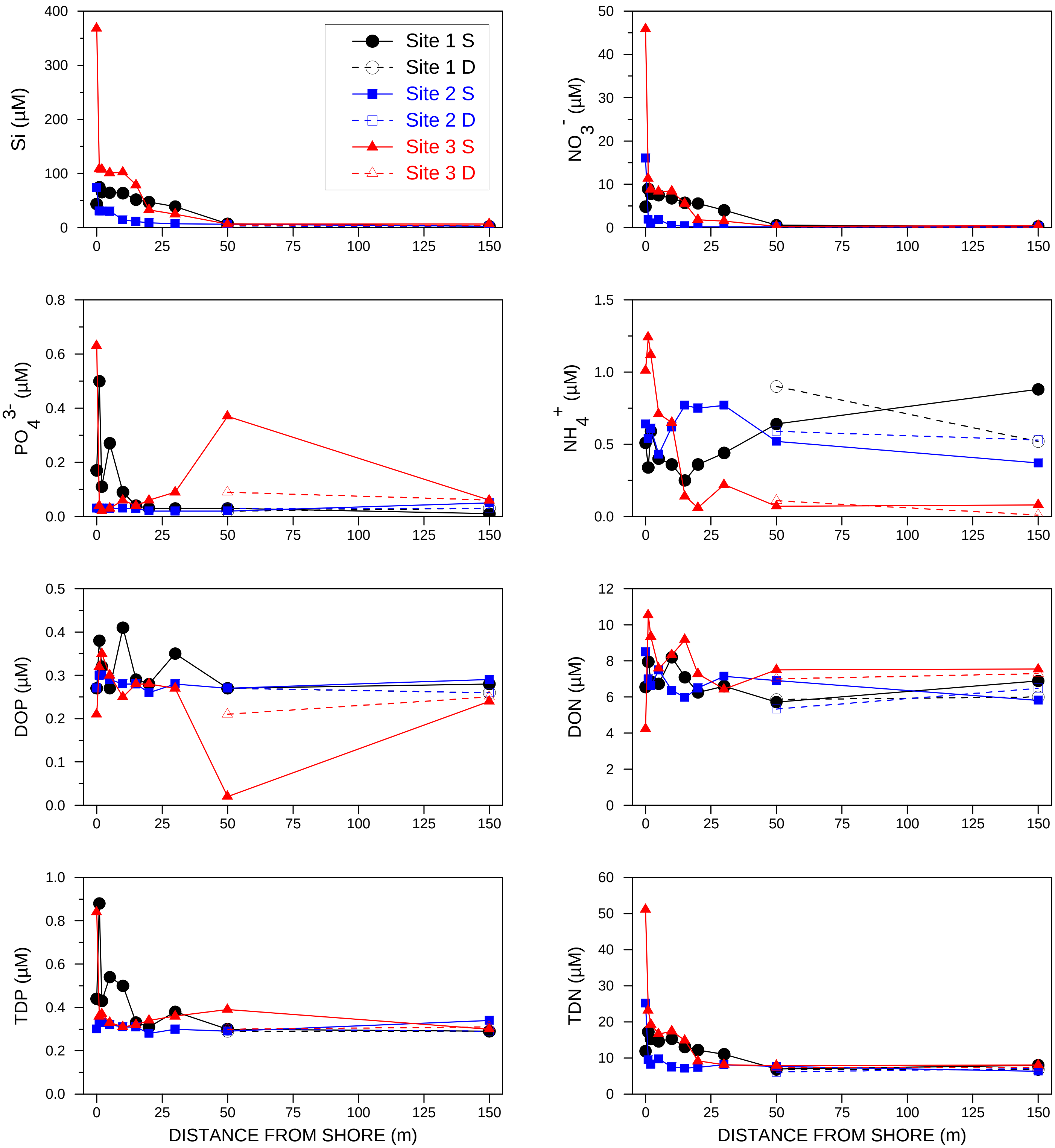

FIGURE 2. Plots of dissolved nutrients in surface (S) and deep (D) samples collected along transects offshore of the O`oma Beachside Village project on November 3, 2006 as a function of distance from the shoreline. For transect locations, see Figure 1.

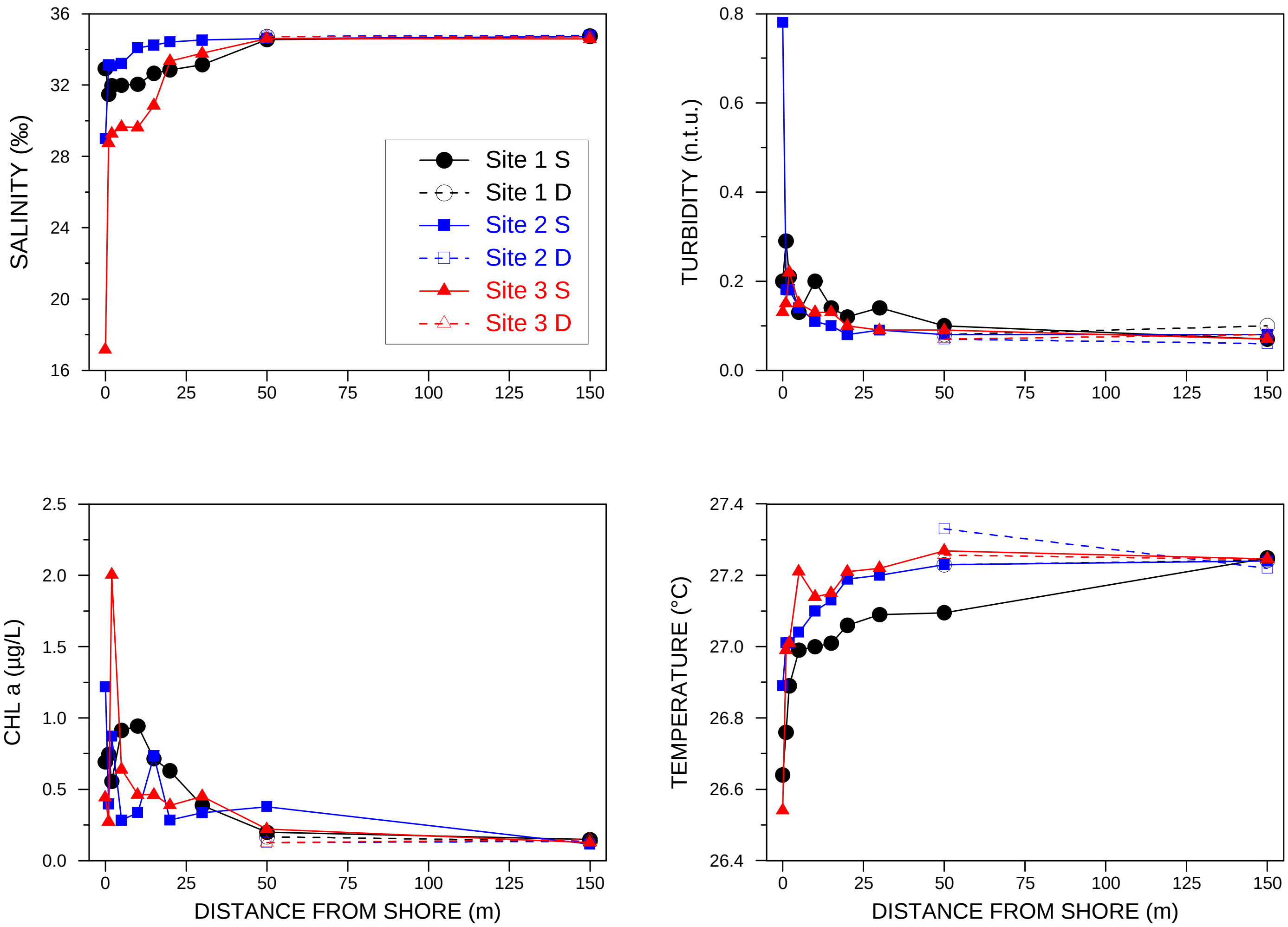

FIGURE 3. Plots of water chemistry constituents in surface (S) and deep (D) samples collected along three transects offshore of the O`oma Beachside Village project on November 3, 2006 as a function of distance from the shoreline. For transect locations, see Figure 1.

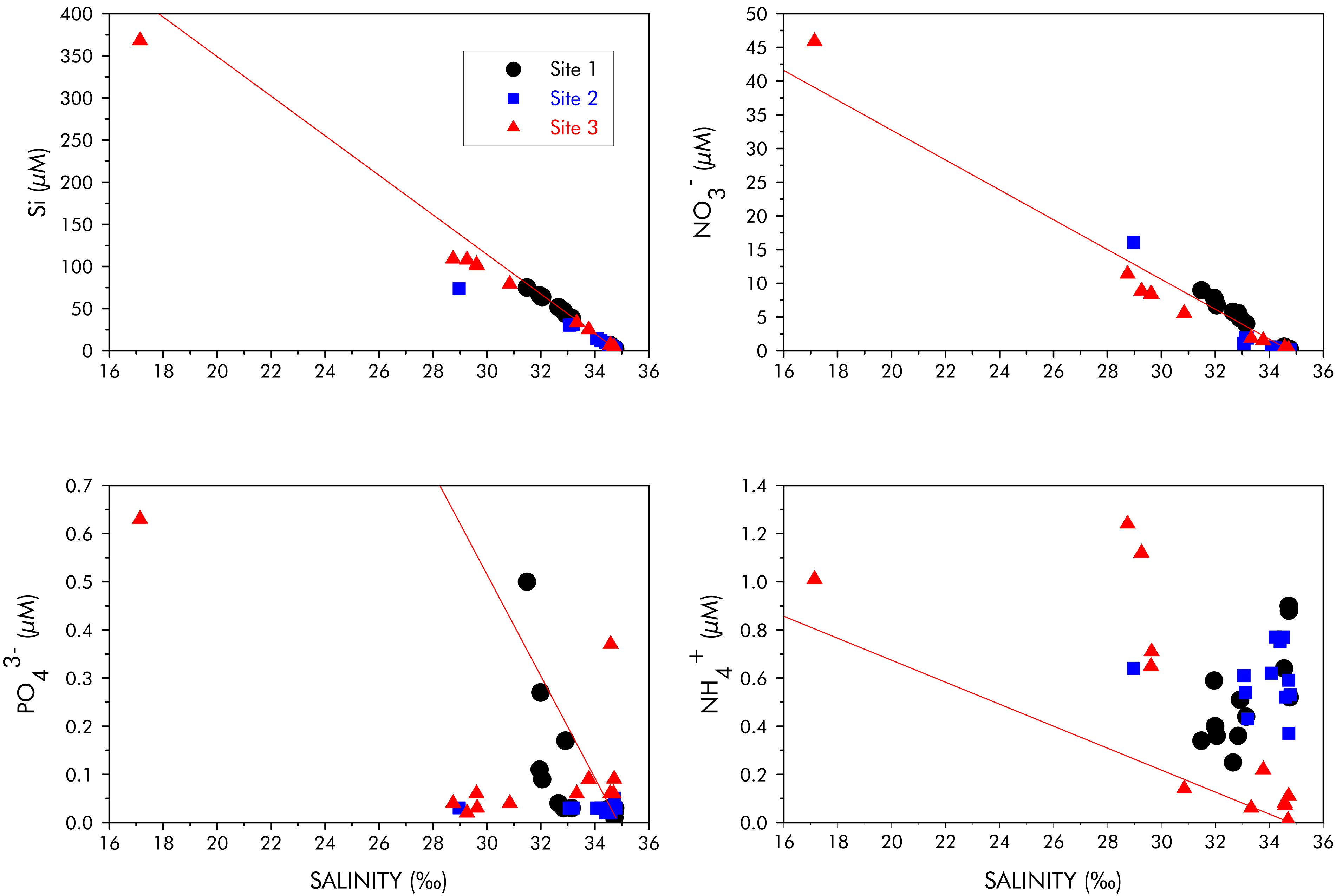

FIGURE 4. Mixing plots showing concentration of dissolved nutrients from samples collected along transects offshore of the O`oma Beachside Village project in November 2006 as functions of salinity. Straight line in each plot is the conservative mixing line constructed by connecting the concentrations in open ocean water with the averaged concentration measured in four high-level groundwater wells upslope of the sampling area (see TNWRE 2008). For transect locations, see Figure 1.

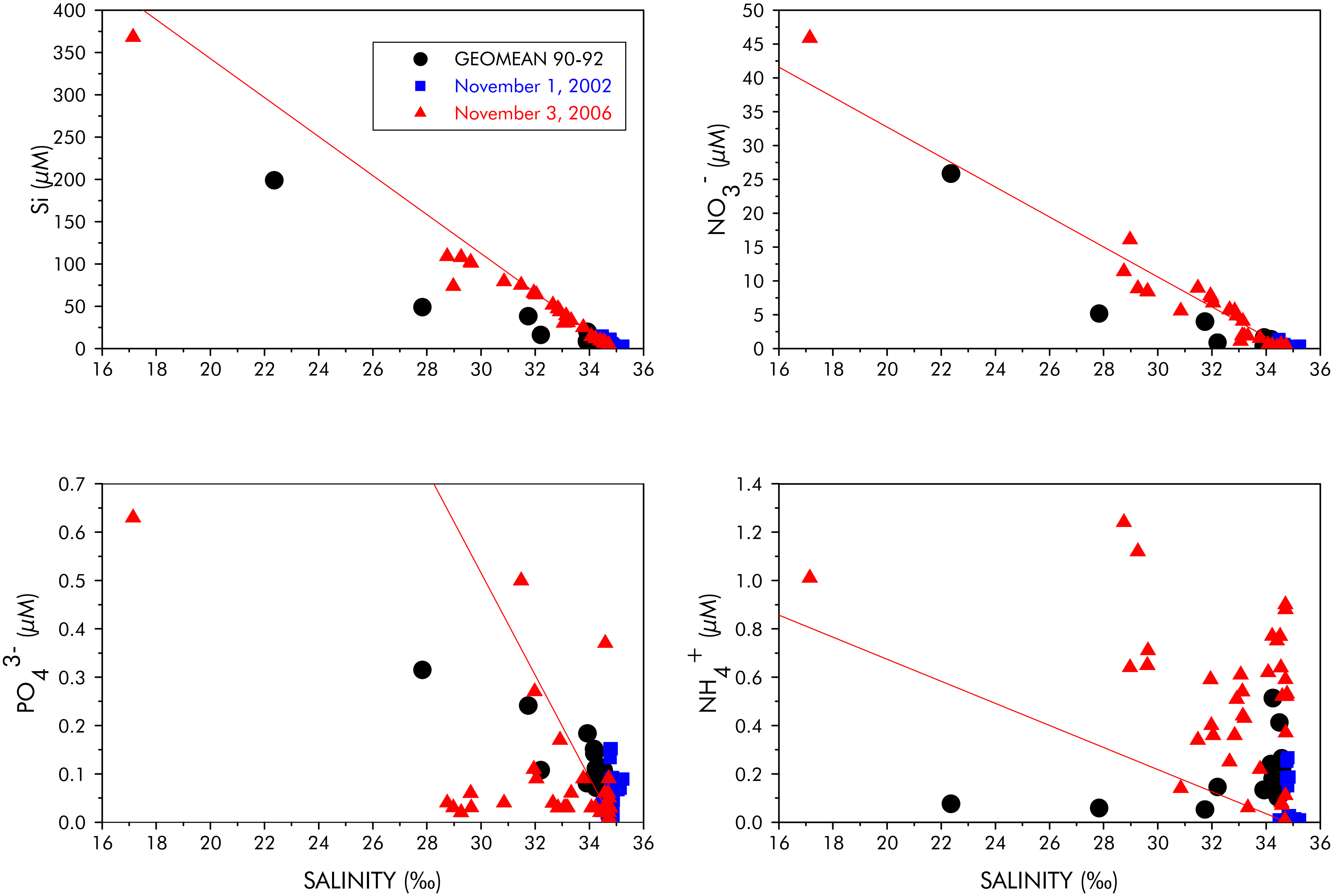

FIGURE 5. Mixing plots showing concentration of dissolved nutrients from all samples collected along three transects offshore of the O`oma Beachside Village project in 1990-1992, November 2002 and November 2006 as functions of salinity. Straight line in each plot is the conservative mixing line constructed by connecting the concentrations in open ocean water with the averaged concentration measured in four high-level groundwater wells located upslope of the sampling area (see TNWRE 2008). For transect locations, see Figure 1.

TABLE 3. Linear regression statistics for nutrient concentrations plotted as a function of salinity from pooled transect data off of the O'oma Beachside Village site in 1990-92, 2002 and 2006. "*" indicates non-significant F (P=0.05).

NUTRIENT	YEAR	R^2	Signif. F	SLOPE	LOWER 95% CI	UPPER 95% CI	Y-INTERCEPT	LOWER 95% CI	UPPER 95% CI
Si	1990-92	0.95	0.00	-20.1	-22.0	-18.3	694	634	754
	2002	0.60	0.00	-17.1	-21.9	-12.2	600	430	770
	2006	0.98	0.00	-19.9	-21.1	-18.8	695	659	731
NO_3^-	1990-92	0.93	0.00	-2.95	-3.31	-2.66	102.1	91.3	112.9
	2002	0.37	0.00	-1.17	-1.70	-0.64	41.0	22.6	59.4
	2006	0.95	0.00	-2.49	-2.70	-2.27	85.5	78.6	92.4
PO_4^{3-}	1990-92	0.94	0.00	-0.09	-0.10	-0.08	3.16	2.07	3.46
	2002	0.02	0.36*	0.04	-0.06	0.15	-1.51	-5.00	1.99
	2006	0.32	0.00	-0.03	-0.04	-0.01	0.91	0.45	1.36
NH_4^+	1990-92	0.16	0.02	0.01	0.00	0.01	-0.09	-0.33	0.15
	2002	0.03	0.29*	-0.11	-0.31	0.10	3.84	-3.30	10.99
	2006	0.19	0.01	-0.04	-0.07	-0.01	1.78	0.80	2.77

TABLE 4. Slopes of linear regressions of nutrient concentrations (in units of μg/L) as functions of salinity for surface samples on three transects offshore of the O'oma Beachside Village. Also shown are DOH compliance slopes. Underlined values indicate absolute value of upper confidence limit exceeding the DOH compliance slope.

NUTRIENT	DOH	TRANSECT 1			TRANSECT 2			TRANSECT 3		
	SLOPE	SLOPE	LOWER CI	UPPER CI	SLOPE	LOWER CI	UPPER CI	SLOPE	LOWER CI	UPPER CI
NO_3^-	-31.92	-37.48	-40.41	<u>-34.55</u>	-38.67	-47.06	-30.28	-36.31	-41.50	-31.12
TDN	-40.35	-41.64	-47.58	-35.70	-43.86	-53.11	-34.62	-35.25	-38.43	-32.06
PO_4^{3-}	-3.22	-2.87	-5.58	-0.16	-0.01	-0.14	0.12	-0.77	-1.54	-0.01
TDP	-2.86	-3.63	-6.50	-0.76	0.00	-0.28	0.29	-0.85	-1.23	-0.46

APPENDIX A

Tables of Water Quality Data 1990-2002
O'oma, North Kona Hawaii

TABLE A1. Geometric mean data from water chemistry measurements off the O'oma II property collected during four monitoring surveys in October 1990, May and November 1991 and March 1992. Nutrient concentrations shown in micromolar units (μM). Abbreviations as follows: DFS=distance from shore; S=surface; D=deep. Measurements below detection limit were not included in mean calculations. For sampling station locations, see Figure 1.

STATION NO.		DFS (m)	PO4 (μM)	NO3 (μM)	NH4 (μM)	Si (μM)	TOP (μM)	TON (μM)	TP (μM)	TN (μM)	TURB (ntu)	SALINITY (o/oo)	CHL a (μg/L)	TEMP (deg C)	pH
OOMA-1	1S	1	2.38	76.92	0.06	508.89	0.05	4.9	2.45	82.4	0.15	11.867	0.07	23.6	8.08
	2S	5	0.88	25.86	0.08	198.87	0.10	6.4	1.05	33.7	0.14	22.358	0.09	24.5	8.17
	3S	10	0.32	5.17	0.06	48.84	0.15	7.4	0.58	16.9	0.12	27.835	0.08	25.5	8.18
	3D	10	0.24	3.98	0.05	38.23	0.16	6.5	0.46	12.9	0.11	31.744	0.14	25.8	8.17
	4S	50	0.18	1.64	0.13	19.81	0.19	6.7	0.38	8.6	0.16	33.930	0.04	26.5	8.18
	4D	50	0.15	0.66	0.24	9.68	0.19	6.3	0.35	7.6	0.12	34.173	0.07	26.3	8.17
	5S	100	0.14	1.38	0.13	11.41	0.21	5.9	0.35	7.2	0.10	34.185	0.08	26.3	8.17
	5D	100	0.11	0.35	0.20	5.23	0.21	6.4	0.33	6.9	0.10	34.455	0.08	26.4	8.17
	6S	200	0.11	1.18	0.18	8.75	0.22	6.0	0.34	7.2	0.12	34.240	0.09	26.4	8.17
	6D	200	0.09	0.25	0.19	3.71	0.24	6.0	0.34	6.4	0.10	34.528	0.08	26.3	8.17
OOMA-2	1S	1	0.10	0.29	0.10	6.01	0.24	5.4	0.37	6.0	0.12	34.430	0.08	26.4	8.18
	2S	5	0.09	0.13	0.19	3.88	0.22	6.0	0.31	6.4	0.15	34.532	0.07	26.3	8.17
	3S	10	0.11	0.87	0.15	16.08	0.16	5.4	0.27	8.1	0.14	32.204	0.10	26.2	8.20
	3D	10	0.08	0.31	0.13	8.57	0.17	5.2	0.26	5.9	0.11	33.911	0.09	26.3	8.21
	4S	50	0.08	0.31	0.18	6.45	0.22	4.9	0.32	5.4	0.14	34.436	0.07	26.3	8.17
	4D	50	0.08	0.19	0.15	5.59	0.23	5.3	0.31	5.7	0.13	34.460	0.09	26.3	8.17
	5S	100	0.11	0.24	0.20	3.82	0.23	6.8	0.34	7.2	0.09	34.532	0.08	26.5	8.17
	5D	100	0.08	0.06	0.15	2.91	0.24	6.4	0.33	6.6	0.09	34.558	0.08	26.3	8.16
	6S	200	0.09	0.04	0.17	2.62	0.24	6.1	0.35	6.3	0.10	34.590	0.08	26.4	8.17
	6D	200	0.08	0.04	0.23	2.34	0.26	6.7	0.35	7.0	0.11	34.596	0.07	26.3	8.16
OOMA-3	1S	1	0.10	0.12	0.25	3.83	0.21	7.8	0.32	8.2	0.16	34.524	0.13	26.9	8.19
	2S	5	0.08	0.08	0.41	4.06	0.20	8.0	0.28	8.6	0.13	34.490	0.10	26.6	8.18
	3S	10	0.07	0.41	0.51	8.50	0.27	7.2	0.37	8.3	0.14	34.251	0.14	26.6	8.22
	3D	10	0.09	0.29	0.23	8.36	0.20	6.5	0.30	7.3	0.13	34.155	0.09	26.6	8.19
	4S	50	0.11	0.15	0.20	4.94	0.21	5.7	0.32	6.1	0.10	34.506	0.08	26.4	8.16
	4D	50	0.10	0.15	0.14	4.42	0.20	5.4	0.30	5.7	0.12	34.528	0.07	26.4	8.17
	5S	100	0.10	0.12	0.12	3.15	0.20	5.5	0.30	5.7	0.12	34.562	0.08	26.5	8.17
	5D	100	0.10	0.06	0.15	2.43	0.22	5.8	0.32	6.1	0.11	34.580	0.07	26.4	8.16
	6S	200	0.08	0.07	0.27	2.53	0.23	6.0	0.35	6.3	0.12	34.579	0.07	26.4	8.16
	6D	200	0.08	0.09	0.22	2.11	0.24	6.1	0.32	6.6	0.11	34.588	0.06	26.2	8.16
DOH GEOM. MEAN STDS.				0.25	0.14				0.52	7.86	0.20		0.15		

TABLE A2. Geometric mean data from water chemistry measurements off the O'oma II property collected during four monitoring surveys in October 1990, May and November 1991 and March 1992. Nutrient concentrations shown in units of micrograms per liter (μg/L). Abbreviations as follows: DFS=distance from shore; S=surface; D=deep. Measurements below detection limit were not included in mean calculations. For sampling station locations, see Figure 1.

STATION NO.		DFS (m)	PO4 (μM)	NO3 (μM)	NH4 (μM)	Si (μM)	TOP (μM)	TON (μM)	TP (μM)	TN (μM)	TURB (ntu)	SALINITY (o/oo)	CHL a (μg/L)	TEMP (deg C)	pH
OOMA-1	1S	1	73.78	1076.94	0.83	14299.72	1.58	68.2	76.07	1153.3	0.15	11.867	0.07	23.6	8.08
	2S	5	27.17	362.02	1.07	5588.24	3.16	89.6	32.44	472.3	0.14	22.358	0.09	24.5	8.17
	3S	10	9.77	72.38	0.82	1372.34	4.60	103.6	18.03	237.2	0.12	27.835	0.08	25.5	8.18
	3D	10	7.49	55.73	0.74	1074.33	4.81	91.6	14.14	181.1	0.11	31.744	0.14	25.8	8.17
	4S	50	5.71	22.92	1.86	556.65	5.88	93.3	11.84	119.8	0.16	33.930	0.04	26.5	8.18
	4D	50	4.70	9.20	3.37	272.10	5.91	88.6	10.76	106.8	0.12	34.173	0.07	26.3	8.17
	5S	100	4.42	19.26	1.88	320.60	6.42	82.9	10.88	100.7	0.10	34.185	0.08	26.3	8.17
	5D	100	3.52	4.87	2.75	147.07	6.63	89.1	10.28	96.2	0.10	34.455	0.08	26.4	8.17
	6S	200	3.45	16.58	2.53	245.76	6.96	84.2	10.49	100.9	0.12	34.240	0.09	26.4	8.17
	6D	200	2.73	3.46	2.72	104.38	7.59	83.7	10.45	89.0	0.10	34.528	0.08	26.3	8.17
OOMA-2	1S	1	3.25	4.02	1.45	168.79	7.47	75.4	11.48	84.7	0.12	34.430	0.08	26.4	8.18
	2S	5	2.64	1.86	2.62	108.94	6.67	84.4	9.56	89.7	0.15	34.532	0.07	26.3	8.17
	3S	10	3.34	12.16	2.04	451.79	4.83	75.9	8.25	112.8	0.14	32.204	0.10	26.2	8.20
	3D	10	2.50	4.30	1.88	240.76	5.34	72.7	7.96	82.7	0.11	33.911	0.09	26.3	8.21
	4S	50	2.57	4.31	2.50	181.26	6.80	68.0	9.92	75.7	0.14	34.436	0.07	26.3	8.17
	4D	50	2.33	2.62	2.07	157.02	7.16	74.5	9.74	80.1	0.13	34.460	0.09	26.3	8.17
	5S	100	3.34	3.42	2.80	107.25	7.25	95.4	10.68	100.5	0.09	34.532	0.08	26.5	8.17
	5D	100	2.60	0.87	2.04	81.72	7.49	89.0	10.31	92.7	0.09	34.558	0.08	26.3	8.16
	6S	200	2.78	0.54	2.34	73.56	7.46	84.8	10.94	87.8	0.10	34.590	0.08	26.4	8.17
	6D	200	2.39	0.63	3.21	65.73	7.93	93.5	10.74	97.5	0.11	34.596	0.07	26.3	8.16
OOMA-3	1S	1	3.23	1.70	3.46	107.64	6.61	108.8	9.95	115.2	0.16	34.524	0.13	26.9	8.19
	2S	5	2.34	1.18	5.78	114.17	6.22	111.4	8.63	120.5	0.13	34.490	0.10	26.6	8.18
	3S	10	2.21	5.75	7.19	238.88	8.45	100.4	11.41	115.9	0.14	34.251	0.14	26.6	8.22
	3D	10	2.87	4.01	3.22	234.84	6.30	90.8	9.36	102.6	0.13	34.155	0.09	26.6	8.19
	4S	50	3.27	2.06	2.84	138.87	6.45	79.5	9.80	85.5	0.10	34.506	0.08	26.4	8.16
	4D	50	3.05	2.08	1.99	124.25	6.15	75.7	9.26	79.8	0.12	34.528	0.07	26.4	8.17
	5S	100	2.99	1.63	1.66	88.63	6.24	76.5	9.24	79.7	0.12	34.562	0.08	26.5	8.17
	5D	100	3.04	0.87	2.16	68.36	6.71	81.5	9.93	84.8	0.11	34.580	0.07	26.4	8.16
	6S	200	2.59	0.94	3.71	71.20	7.23	83.3	10.85	88.3	0.12	34.579	0.07	26.4	8.16
	6D	200	2.33	1.26	3.08	59.21	7.30	85.6	9.96	92.7	0.11	34.588	0.06	26.2	8.16
DOH GEOM. MEAN STD			0.00	3.50	1.96	0	0	0	16.12	110.04	0.20		0.15		

TABLE A3. Water chemistry measurements from ocean water off of the O'oma II Development on November 1, 2002. Also shown are result a sample taken from an anchialine pond near the southern boundary of the project site. Nutrient concentrations are expressed as micromoles (μM). Abbreviations as follows: DFS=distance from shore; S=surface; D=deep; BDL=below detection limit; OO= open ocean.

TRANSECT SITE	STA. NO.	DFS (m)	PO_4^{3-} (μM)	NO_3^- (μM)	NH_4^+ (μM)	Si (μM)	TOP (μM)	TON (μM)	TP (μM)	TN (μM)	TURB (NTU)	SAL (ppt)	CHL a (μg/L)	TEMP (deg.C)	O2 (%sat)	pH
OOMA 1	0 S	0.1	0.13	0.31	0.25	9.96	0.25	15.51	0.38	16.07	0.28	34.77	0.45	27.40	100.00	8.28
	5 S	1	0.15	0.28	0.18	10.87	0.20	13.38	0.35	13.84	0.15	34.77	0.43	27.40	101.00	8.27
	10 S	1	0.04	1.31	BDL	14.53	0.35	13.93	0.39	15.24	0.06	34.48	0.18	26.60	97.00	8.16
	10 D	7	0.02	0.13	BDL	5.44	0.32	15.05	0.34	15.18	0.12	34.84	0.11	26.80	101.00	8.17
	25 S	1	0.02	0.58	BDL	9.55	0.29	14.90	0.31	15.48	0.09	34.66	0.13	26.70	94.00	8.16
	25 D	14	0.01	0.04	BDL	3.91	0.28	15.47	0.30	15.51	0.10	34.88	0.10	26.80	97.00	8.17
	50 S	1	0.01	0.43	BDL	8.77	0.31	13.65	0.32	14.08	0.07	34.70	0.12	26.80	98.00	8.16
	50 D	17	0.07	0.04	0.01	3.75	0.23	12.32	0.30	12.37	0.18	34.88	0.10	26.90	97.00	8.17
	100 S	1	0.02	0.37	BDL	8.91	0.29	12.53	0.31	12.90	0.17	34.69	0.13	26.80	98.00	8.17
	100 D	29	0.06	0.07	BDL	3.74	0.25	13.86	0.30	13.93	0.07	34.88	0.11	26.80	101.00	8.17
	500 S	1	0.07	0.04	BDL	3.29	0.28	15.22	0.35	15.26	0.09	34.89	0.10	26.70	98.00	8.09
	500 D	56	0.09	0.04	BDL	2.98	0.22	14.59	0.31	14.63	0.09	34.90	0.11	26.90	94.00	8.14
OOMA 2	0 S	0.1	0.06	0.07	0.19	4.42	0.22	14.05	0.28	14.31	0.26	34.85	0.16	27.70	99.00	8.19
	5 S	1	0.06	0.07	0.02	4.34	0.24	13.73	0.29	13.83	0.15	34.85	0.25	27.10	101.00	8.20
	10 S	1	0.06	0.10	0.03	4.34	0.21	13.43	0.28	13.56	0.21	34.84	0.11	26.60	89.00	8.08
	10 D	6	0.04	0.07	0.02	3.96	0.26	14.58	0.31	14.67	0.05	34.84	0.12	26.80	88.00	8.14
	25 S	1	0.09	0.23	0.18	5.84	0.22	14.25	0.31	14.66	0.04	34.78	0.12	26.70	88.00	8.14
	25 D	7	0.08	0.07	0.01	4.18	0.22	14.49	0.30	14.58	0.07	34.84	0.11	26.70	87.00	8.14
	50 S	1	0.08	0.11	0.02	4.48	0.25	14.14	0.33	14.26	0.05	34.83	0.13	26.30	86.00	8.16
	50 D	9	0.07	0.08	0.01	3.72	0.18	12.58	0.24	12.66	0.03	34.85	0.10	26.70	84.00	8.16
	100 S	1	0.07	0.05	BDL	3.94	0.23	11.58	0.30	11.63	0.35	34.85	0.11	26.60	87.00	8.17
	100 D	14	0.09	0.05	0.01	3.64	0.21	12.54	0.31	12.59	0.07	34.86	0.10	26.80	85.00	8.16
	500 S	1	0.07	0.05	0.01	2.96	0.21	14.53	0.28	14.58	0.07	34.89	0.09	26.70	84.00	8.16
	500 D	74	0.07	0.05	0.01	2.59	0.19	13.69	0.26	13.75	0.07	35.07	0.23	25.50	90.00	8.15
OOMA 3	0 S	0.1	0.15	0.14	0.27	5.96	0.16	15.60	0.31	16.00	0.80	34.82	0.29	27.90	91.00	8.23
	5 S	1	0.09	0.11	0.15	5.80	0.25	14.34	0.33	14.60	0.16	34.81	0.27	26.50	92.00	8.17
	10 S	1	0.02	0.08	0.02	4.68	0.29	12.87	0.31	12.97	0.07	34.82	0.14	26.60	87.00	8.15
	10 D	7	0.03	0.05	BDL	3.85	0.20	12.81	0.23	12.85	0.03	34.85	0.12	26.60	83.00	8.14
	25 S	1	0.03	0.05	0.02	3.78	0.26	13.72	0.29	13.79	0.05	34.85	0.14	26.80	83.00	8.16
	25 D	10	0.03	0.05	0.01	3.33	0.23	13.59	0.26	13.65	0.13	34.87	0.12	26.70	87.00	8.17
	50 S	1	0.02	0.05	BDL	3.70	0.24	13.65	0.26	13.70	0.24	34.86	0.11	26.40	91.00	8.15
	50 D	25	0.01	0.02	BDL	3.02	0.25	12.16	0.26	12.18	0.04	34.87	0.12	26.80	91.00	8.11
	100 S	1	0.08	0.02	0.03	3.32	0.21	11.39	0.28	11.44	0.17	34.87	0.10	26.70	95.00	8.10
	100 D	55	0.07	0.02	BDL	2.50	0.19	12.53	0.26	12.55	0.07	35.14	0.25	25.10	97.00	8.14
	500 S	1	0.04	0.02	BDL	2.43	0.22	12.24	0.26	12.26	0.06	34.89	0.10	26.30	98.00	8.16
	500 D	82	0.09	0.33	BDL	2.80	0.15	11.70	0.23	12.03	0.04	35.24	0.14	22.90	66.00	8.11
O.O	S	1	0.07	0.05	0.14	2.94	0.20	14.10	0.26	14.30	0.07	34.89	0.12	26.90	97.00	8.12
	D	95	0.01	0.02	BDL	2.94	0.24	12.76	0.26	12.79	0.05	34.88	0.10	22.70	64.00	8.15
POND			1.85	42.45	3.40	589.65	2.30	34.90	4.15	80.75		12.28				

TABLE A4. Water chemistry measurements from ocean water off of the O'oma II Development on November 1, 2002. Also shown are result a sample taken from an anchialine pond near the southern boundary of the project site. Nutrient concentrations are expressed as micrograms per liter (µg/L). Abbreviations as follows: DFS=distance from shore; S=surface; D=deep; BDL=below detection limit; OO= open ocean.

TRANSECT SITE	STA. NO.	DFS (m)	PO_4^{3-} (µM)	NO_3^- (µM)	NH_4^+ (µM)	Si (µM)	TOP (µM)	TON (µM)	TP (µM)	TN (µM)	TURB (NTU)	SAL (ppt)	CHL a (µg/L)	TEMP (deg.C)	O2 (%sat)	pH
OOMA 1	0 S	0.1	4.13	4.32	3.54	280.00	7.66	217.13	11.79	224.98	0.28	34.77	0.45	27.40	100.00	8.28
	5 S	1	4.70	3.90	2.53	305.56	6.05	187.38	10.76	193.81	0.15	34.77	0.43	27.40	101.00	8.27
	10 S	1	1.26	18.33	BDL	408.37	10.79	194.97	12.05	213.30	0.06	34.48	0.18	26.60	97.00	8.16
	10 D	7	0.57	1.79	BDL	152.78	9.92	210.66	10.50	212.45	0.12	34.84	0.11	26.80	101.00	8.17
	25 S	1	0.57	8.16	BDL	268.39	9.02	208.62	9.59	216.79	0.09	34.66	0.13	26.70	94.00	8.16
	25 D	14	0.46	0.53	BDL	109.74	8.75	216.60	9.21	217.13	0.10	34.88	0.10	26.80	97.00	8.17
	50 S	1	0.46	6.06	BDL	246.57	9.52	191.07	9.98	197.13	0.07	34.70	0.12	26.80	98.00	8.16
	50 D	17	2.18	0.55	0.11	105.34	7.03	172.48	9.21	173.13	0.18	34.88	0.10	26.90	97.00	8.17
	100 S	1	0.57	5.22	BDL	250.46	8.89	175.44	9.46	180.66	0.17	34.69	0.13	26.80	98.00	8.17
	100 D	29	1.72	0.99	BDL	105.21	7.61	193.98	9.34	194.97	0.07	34.88	0.11	26.80	101.00	8.17
	500 S	1	2.06	0.57	BDL	92.36	8.69	213.10	10.76	213.67	0.09	34.89	0.10	26.70	98.00	8.09
	500 D	56	2.75	0.57	BDL	83.79	6.84	204.26	9.59	204.83	0.09	34.90	0.11	26.90	94.00	8.14
OOMA 2	0 S	0.1	1.95	1.01	2.62	124.16	6.87	196.77	8.82	200.39	0.26	34.85	0.16	27.70	99.00	8.19
	5 S	1	1.72	1.01	0.30	121.96	7.36	192.24	9.08	193.55	0.15	34.85	0.25	27.10	101.00	8.20
	10 S	1	1.95	1.44	0.38	121.88	6.61	188.08	8.56	189.91	0.21	34.84	0.11	26.60	89.00	8.08
	10 D	6	1.38	1.03	0.26	111.19	8.09	204.13	9.46	205.41	0.05	34.84	0.12	26.80	88.00	8.14
	25 S	1	2.75	3.15	2.59	164.10	6.84	199.56	9.59	205.31	0.04	34.78	0.12	26.70	88.00	8.14
	25 D	7	2.41	1.04	0.11	117.40	6.93	202.90	9.34	204.05	0.07	34.84	0.11	26.70	87.00	8.14
	50 S	1	2.52	1.47	0.25	125.79	7.85	197.89	10.37	199.61	0.05	34.83	0.13	26.30	86.00	8.16
	50 D	9	2.06	1.05	0.07	104.57	5.46	176.09	7.53	177.21	0.03	34.85	0.10	26.70	84.00	8.16
	100 S	1	2.29	0.64	BDL	110.84	7.04	162.16	9.34	162.79	0.35	34.85	0.11	26.60	87.00	8.17
	100 D	14	2.87	0.64	0.08	102.34	6.60	175.58	9.46	176.31	0.07	34.86	0.10	26.80	85.00	8.16
	500 S	1	2.06	0.65	0.12	83.31	6.49	203.41	8.56	204.18	0.07	34.89	0.09	26.70	84.00	8.16
	500 D	74	2.06	0.66	0.20	72.74	5.85	191.70	7.91	192.56	0.07	35.07	0.23	25.50	90.00	8.15
OOMA 3	0 S	0.1	4.70	1.94	3.73	167.35	5.02	218.35	9.72	224.02	0.80	34.82	0.29	27.90	91.00	8.23
	5 S	1	2.64	1.52	2.09	163.03	7.60	200.81	10.24	204.42	0.16	34.81	0.27	26.50	92.00	8.17
	10 S	1	0.57	1.10	0.35	131.42	8.89	180.17	9.46	181.62	0.07	34.82	0.14	26.60	87.00	8.15
	10 D	7	1.03	0.68	BDL	108.25	6.11	179.28	7.14	179.97	0.03	34.85	0.12	26.60	83.00	8.14
	25 S	1	0.92	0.69	0.26	106.09	8.03	192.13	8.95	193.08	0.05	34.85	0.14	26.80	83.00	8.16
	25 D	10	1.03	0.70	0.08	93.46	7.01	190.25	8.04	191.03	0.13	34.87	0.12	26.70	87.00	8.17
	50 S	1	0.57	0.70	BDL	103.87	7.47	191.07	8.04	191.78	0.24	34.86	0.11	26.40	91.00	8.15
	50 D	25	0.46	0.29	BDL	85.00	7.71	170.29	8.17	170.57	0.04	34.87	0.12	26.80	91.00	8.11
	100 S	1	2.41	0.29	0.38	93.30	6.41	159.47	8.82	160.15	0.17	34.87	0.10	26.70	95.00	8.10
	100 D	55	2.18	0.30	BDL	70.30	5.86	175.35	8.04	175.65	0.07	35.14	0.25	25.10	97.00	8.14
	500 S	1	1.38	0.31	BDL	68.19	6.80	171.30	8.17	171.61	0.06	34.89	0.10	26.30	98.00	8.16
	500 D	82	2.75	4.56	BDL	78.56	4.51	163.80	7.27	168.36	0.04	35.24	0.14	22.90	66.00	8.11
OO	S	1	2.06	0.75	2.03	82.68	6.11	197.45	8.17	200.23	0.07	34.89	0.12	26.90	97.00	8.12
	D	95	0.46	0.33	BDL	82.64	7.45	178.70	7.91	179.03	0.05	34.88	0.10	22.70	64.00	8.15
POND			57.35	594.30	47.60	16,569.17	71.30	488.60	128.65	1,130.50		12.28				

Botanical Survey

Botanical Survey
TMKs 7-3-09:04 and 22
O`oma, North Kona, Island of Hawai‘i

By Ron Terry, Ph.D. and Patrick J. Hart, Ph.D.
Geometrician Associates, LLC
Prepared for PBR Hawaii
December 2006

Introduction

This report describes the results of a botanical survey of an approximately 300-acre property bordered by the sea, Queen Ka‘ahumanu Highway, Kohanaiki, and State property utilized by the Natural Energy Lab of Hawai‘i Authority (NELHA), just south of Kona International Airport on the Big Island of Hawai‘i (Fig. 1).

Purpose and Methodology

The objectives of the botanical survey were to 1) describe the vegetation; 2) list all species encountered; and 3) identify threatened or endangered plant species. The area was surveyed by Ron Terry and Patrick J. Hart in November 2006, with a repeat survey of the coastal area in December 2006 by Layne Yoshida and Graham Knopp. For purposes of survey and reporting, the area was divided into two regions: strand and upland. During the first survey, the botanists walked transects in upland areas spaced between 50 and 75 meters along GPS-guided UTM northings (i.e., east-west lines). Because of the very open and evenly sparse vegetation, plant visibility was excellent even over a range of 37.5 meters, but because each transect corridor was walked in a zigzag manner, coverage was actually much more intense than this spacing would indicate. In addition, botanists examined in detail rock outcrops, steep-sided depressions, lava tubes or other cave openings, and large fissures, where less common plants might be found.

As strand vegetation was much more dense, survey there consisted of near-100 percent coverage. Botanists walked along the beach road and ventured into patches of vegetation, walking or crawling under the canopy where necessary to examine ground herbs and grasses. In order to increase coverage, an additional survey was conducted on a separate day.

Species were identified in the field and, as necessary, collected and keyed out in the laboratory. Special attention was given to the possible presence of any federally (USFWS 2006) listed threatened or endangered plant species.

Limitations

No botanical survey of a large area can claim to have detected every species present. Some species are cryptic in juvenile or even mature stages of their life cycle. Dry conditions can render almost undetectable plants that extended rainfall may later invigorate and make obvious. Thick brush can obscure even large, healthy specimens. The findings of this survey must therefore be interpreted with proper caution; in particular, there is no warranty as to the absence of any particular species.

Vegetational Influences

The geologic substrate in this area is a 3-5,000-year old lava flow from Hualalai (Wolfe and Morris 1996). The surface is mainly *pahoehoe* (smooth or ropy lava) with scattered *'a'a* (clinkerly lava) inclusions. Elevation varies from sea level to about 120 feet above sea level. Annual rainfall in this area of Kona is about 20 inches. Almost no weathering has occurred on this substrate and little soil is present. The surface has been termed rough lava, 'a'a or pahoehoe in soil classifications (U.S. Soil Conservation Service 1973).

Based on the evidence of current rainfall, geology, and vegetation, the area probably supported a Coastal Dry Shrubland and Forest (per Gagne and Cuddihy 1990) prior to human disturbance. It was likely dominated in different places by naupaka (*Scaevola taccada*), ilima (*Sida fallax*) and pilo (*Capparis sandwichiana*), among other plants. Certain low-elevation areas of Kona that have avoided disturbance (often because of a rough 'a'a substrate) maintain semi-intact native vegetation. For example, a recent survey of relatively undisturbed land several miles north at somewhat higher elevations than the maximum found on this property (Hart 2003), found a *lama*-dominated forest with three endangered species: *halepepe* (*Pleomele hawaiiensis*), *uhiuhi* (*Caesalpinia kavaiensis*), and *'aiea* (*Nothocestrum breviflorum*), as well as several rare species: *'ohe makai* (*Reynoldsia sandwicensis*) and *maua* (*Xylosma hawaiiense*). Although elevation, rainfall and geology are not ideal for these on the subject property, some of these rare species may also have inhabited parts of it and were thus especially sought during the surveys.

This area seems to have avoided severe disturbance such as grading, although it has likely been intensely grazed by goats, and there is evidence of widespread small-scale trash dumping and some harvesting of rocks for rock walls. The margins of the property have been used for roads. The strand part of the property experiences intensive use for recreation, mainly picnicking.

Current Vegetation

There are two zones, strand and upland, neatly separated by the inland extent of wave-washed coral chunks and sand.

The vegetation of the upper portion has a simple and fairly uniform structure. The substrate is a mixture of pahoehoe and 'a'a, mostly the former. Vegetation cover varies from nearly continuous to sparse, and is most typically dominated by scattered bunch grasses, with low shrubs and herbs subdominant. There are a few very widely scattered trees. The most common grass is fountain grass (*Pennisetum setaceum*), with *pili* grass (*Heteropogon contortus*) locally abundant. Natal red-top grass (*Rhynchelytrum repens*) is also fairly common. The main herbs are *ilima* and *'uhaloa* (*Waltheria indica*), with various weedy composites, spurges, portulacas also common. The main shrub, surprisingly, is the regionally somewhat rare native *pilo*, with a fair amount of the aliens *noni* (*Morinda citrifolia*) and klu (*Acacia farnesiana*). The aliens *Pluchea symphitifolia* and *koa haole* (*Leucaena leucocephala*) are abundant in a few spots or widely scattered. The alien *Nephrolepis multiflora* fern is fairly common in cracks, with a native counterpart, *N. exaltata subsp. hawaiiensis* uncommon. Unusual natives scattered on the lava include the Polynesian-introduced herb *'auhuhu* (*Tephrosia purpurea*) and the native tree *naio* (*Myoporum sandwicense*). Cave underhangs support a few individuals of other natives species, including the fern *Doryopteris decora*, the fern ally *moa* (*Psilotum nudum*), and the herb *Plectranthus parviflorus*.

The strand area, enriched by sandy soil and groundwater, supports much higher species diversity and varies in cover from almost continuous blankets of herbs and grasses to low forests or parkland. It is dominated in biomass by the alien tree heliotrope (*Tournefortia argentea*), with the native *naupaka* and the aliens Christmas berry (*Schinus terebinthifolius*), *noni*, *kiawe* (*Prosopis pallida*), and *koa haole* also common. The herbs and shrubs mentioned in the upland description are also present below, but often more vigorous and common. There is also an abundance of other grasses, with Bermuda grass (*Cynodon dactylon*) very common. Coconuts (*Cocos nucifera*) and the native *kou* tree (*Cordia subcordata*) are also present. Vines include the natives *pa'u o hi'iaka* (*Jacquemontia ovalifolia*) and *pohuehue* (*Ipoemoea pes-caprae*) as well as the alien ivy gourd vine (*Coccinea grandis)*. A large number of native and alien herbs typical of the strand, including heliotropes, chenopodes, and other types are present.

A full list of plant species found on the site is contained in Table 1, below. **No listed or proposed threatened or endangered plant species were found**. *Pilo* (*Capparis sandwichiana*), although common on the property, is considered a species of concern by the U.S. Fish and Wildlife Service and is often listed among rare plants in Hawai'i. Although this status does not provide official legal protection, USFWS and the Hawai'i Department of Land and Natural Resources are keenly interested in its protection.

Impacts and Mitigation Measures

Landscaping should avoid invasive species and employ native species to the greatest degree consistent with project goals. Reputable Kona nurseries will supply lists of, and sources for, suitable native species. With the understanding that the strand vegetation and some of the area behind this will be preserved, the impacts of clearing the property will generally not be severe. We recommend that consideration be given to preserving some areas with fairly dense concentrations of *pilo* (e.g, as part of archaeological preserves, if these are present), as this is a somewhat unusual and valuable vegetation type that is also important in traditional Hawaiian medicine.

Figure 1
USGS Map of Subject Property

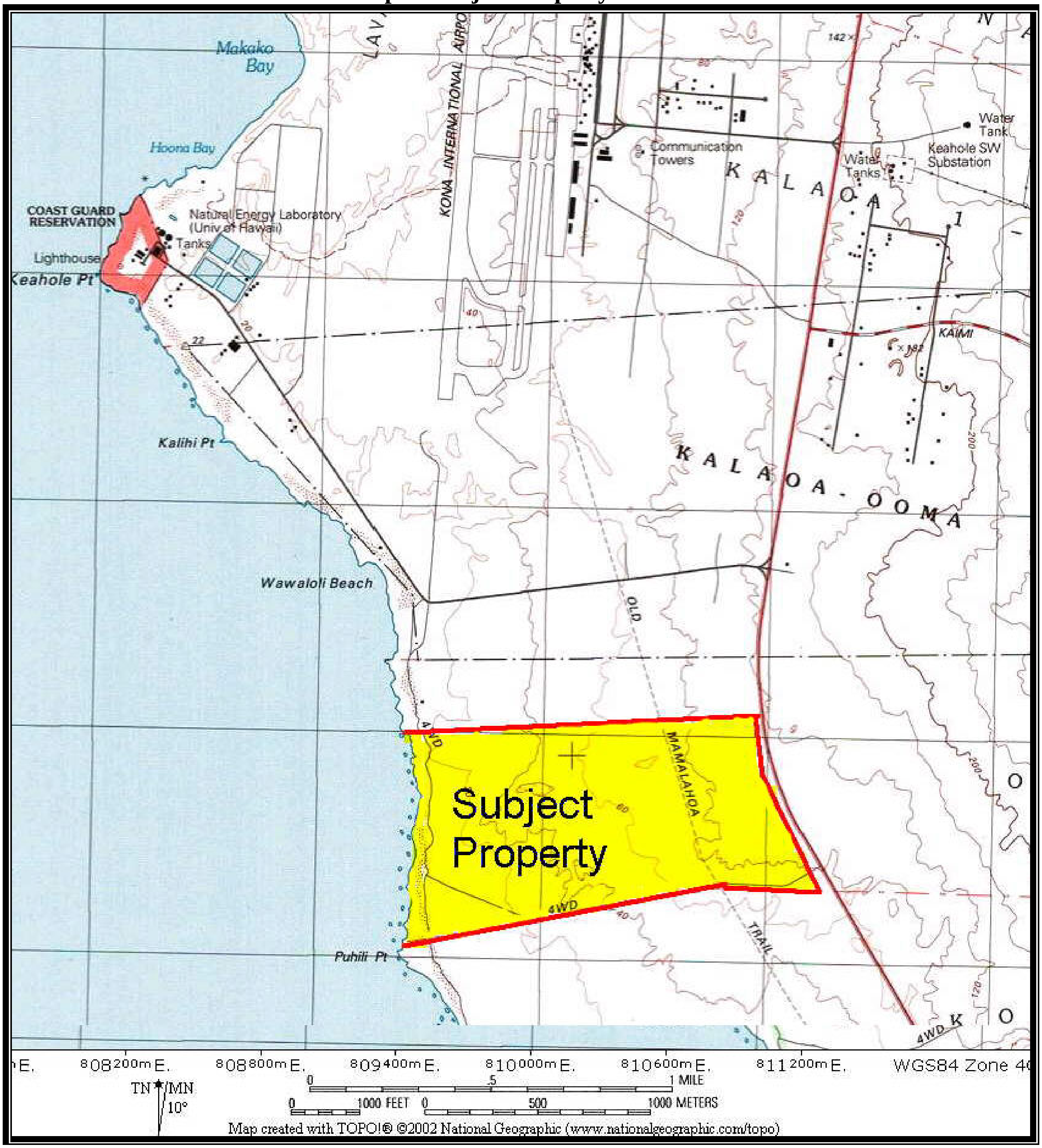

Table 1
Plants Observed on Property

Scientific Name	Family	Common Name	Life Form	Status*
Acacia farnesiana	Fabaceae	Klu	Shrub	A
Alternenthera pungens	Amaranthaceae	Khaki weed	Herb	A
Amaranthus sp.	Amaranthaceae	Amaranth	Herb	A
Argemone glauca	Papaveraceae	Pua kala	Herb	E
Bassia hyssopifolia	Chenopodaceae	None	Herb	A
Boerhavia coccinea	Nyctaginaceae	Boerhavia	Herb	A
Boerhavia acutifolia	Nyctaginaceae	Alena	Herb	I
Bougainvillea sp.	Nyctaginaceae	Bougainvillea	Shrub	A
Capparis sandwichiana	Capparaceae	Maiapilo	Shrub	E
Casuarina equisetifolia	Casuarinaceae	Ironwood	Tree	A
Catharanthus roseus	Apocynaceae	Madagascar periwinkle	Shrub	A
Chamaecrista nictitans	Fabaceae	Partridge Pea	Herb	A
Chamaesyce hirta	Euphorbiaceae	Garden Spruge	Herb	A
Chenopodium murale	Chenopodiaceae	‘Aheahea	Shrub	A
Chenopodium oahuense	Chenopodiaceae	‘Aheahea	Shrub	E
Coccinea grandis	Cucurbitaceae	Ivy gourd	Vine	A
Cocos nucifera	Arecaceae	Niu	Tree	A
Cordia subcordata	Boraginaceae	Kou	Tree	A
Cynodon dactylon	Poaceae	Bermuda grass	Grass	A
Dodonaea viscosa	Sapindaceae	‘A‘ali‘i	Shrub	I
Doryopteris decora	Pteridaceae	Doryopteris	Fern	E
Eleusine indica	Poaceae	Wire grass	Grass	A
Eragrotis variabilis	Poaceae	Lovegrass	Grass	E
Fimbristylis cymosa	Cyperaceae	Mau`u `aki`aki	Sedge	I
Fimbristylis hawaiiensis	Cyperaceae	Fimbristylis	Sedge	E
Heliotropium sp.	Boraginaceae	Heliotrope	Herb	I or A
Heliotropium curassavicum	Boraginaceae	Seaside Heliotrope	Vine	I
Heteropogon contortus	Poaceae	Pili grass	Grass	I
Indigofera suffruticosa	Fabaceae	Indigo	Shrub	A
Ipomoea pes-caprae	Convolvulaceae	Pohuehue	Vine	I
Jacquemontia ovalifolia	Convolvulaceae	Pa‘u o Hi‘iaka	Vine	I
Lantana camara	Verbenaceae	Lantana	Shrub	A
Leucaena leucocephala	Fabaceae	Haole koa	Tree	A
Morinda citrifolia	Rubiaceae	Noni	Shrub	A
Myoporum sandwicense	Myoporaceae	Naio	Tree	I
Nephrolepis exaltata subsp. hawaiiensis	Nephrolepidaceae	Ni‘ani‘au	Fern	E

Table 1, continued				
Scientific Name	**Family**	**Common Name**	**Life Form**	**Status***
Nephrolepis multiflora	Nephrolepidaceae	Sword Fern	Herb	A
Pennisetum setaceum	Poaceae	Fountain grass	Grass	A
Plectranthus parviflorus	Lamiaceae	‘Ala ‘ala wai nue	Herb	I
Pluchea symphytifolia	Asteraceae	Sourbush	Shrub	A
Portulaca oleracea	Portulacaceae	Pig weed	Herb	A
Portulaca pilosa	Portulacaceae	Portulaca	Herb	A
Prosopis pallida	Fabaceae	Kiawe	Tree	A
Psilotum nudum	Psilotaceae	Moa	Herb	I
Rhynchelytrum repens	Poaceae	Natal red-top	Grass	A
Scaevola taccada	Goodeniaceae	Naupaka	Shrub	I
Schinus terebinthifolius	Anacardiaceae	Christmas Berry	Shrub	A
Sesuvium portulacastrum	Aizoaceae	Akulikuli	Herb	I
Sida fallax	Malvaceae	‘Ilima	Shrub	I
Tephrosia purpurea	Fabaceae	‘Auhuhu	Shrub	A
Thespesia populnea	Malvaceae	Milo	Tree	I
Tournefourtia argentea	Boraginaceae	Tree heliotrope	Tree	A
Tribulus terrestris	Zygophyllaceae	Goat head	Herb	A
Tridax procumbens	Asteraceae	Coat buttons	Herb	A
Waltheria indica	Sterculiaceae	Uhaloa	Herb	I

A = alien, E = endemic, I = indigenous, End = Federal and State listed Endangered Species

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Avifaunal & Feral Mammal Survey

AVIFAUNAL AND FERAL MAMMAL SURVEY FOR THE

PROPOSED O'OMA, SEASIDE VILLAGE, O'OMA, NORTH KONA, HAWAII

TMKs: (3) 7-3-9:004 and 22

Report Prepared for:

North Kona Village, LLC
c/o Midland Pacific Homes

Survey and Report by:

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27 November 2006

INTRODUCTION

The purpose of this report is to provide the findings of a two day (18, 19 November 2006) field survey of an approximately 300 acre site (TMKs: (3)7-3-9:004 and 22) at Kona, Hawaii. The findings of an earlier survey (Bruner 2002) of a mauka portion of this site are also noted for comparison. The goals of the survey were:

1- To document the species of birds and mammals currently on the property.
2- To examine the entire site and nearby lands for the purpose of identifying important natural resources available to wildlife at this location.
3- To devote special attention to documenting the presence and possible use of this property by native and migratory species particularly those that are listed as threatened or endangered.

SITE DESCRIPTION

The mauka portions of the property were examined previously (Bruner 2002). The coastal habitat was the primary focus of this expanded and updated survey. The majority of the property is covered in grass with a few scattered bushes. The coastal strand is forested with native and alien (introduced) trees and brush. A very small, vegetation choked wetland occurs just mauka of the coastal forest. Human foot and vehicle traffic through the coastal section was constant and heavy during the period of this survey.

SURVEY PROTOCOL

The field survey was conducted on foot over two days to allow for early morning and late afternoon-evening observations. All birds seen or heard were noted. Observations of mammals were limited to visual sightings and evidence in the form of tracks. The evening of 18 November was used to search for the presence of the endangered Hoary Bat (*Lasiurus cinereus semotus*). A Pettersson Elektronik AB Ultrasound Detector D 100 was used to listen for echolocating bats at several locations on the property.

Weather during the survey was clear and relatively mild. The overall condition for detecting birds was excellent.

The scientific names used in this report follow Pyle (2002) and Honacki et al. (1982). These sources provide the current accepted names found in the scientific literature.

RESULTS AND DISCUSSION

Native Land Birds:

As on the earlier (Bruner 2002) survey no native land birds were recorded. The only possible native land birds that might on rare occasion forage in this area are the Hawaiian or Short-eared Owl (*Asio flammeus sandwichensis*), known as Pueo in Hawaiian and the Io or Hawaiian Hawk (*Buteo solitarius*). These species hunt in a variety of habitats including forests, agricultural lands and grasslands (Pratt et al. 1987, Hawaii Audubon Society 2005). Pueo are not listed as endangered or threatened on the Big Island, however, the State of Hawaii does list them as endangered on Oahu. The Io is an endangered species and is only found on the Big Island.

Seabirds:

No seabirds were seen on this 2006 survey. None would be expected to nest on this site due to the abundance of ground predators and human disturbance.

Migratory Birds:

All four of the common migratory shorebirds that breed in the arctic and "winter" in Hawaii were observed in the coastal portion of the property. The Pacific Golden-Plover or Kolea (*Pluvialis fulva*) were observed on the 2002 survey. Five Kolea were also tallied on this 2006 survey. This species has been extensively studied here in Hawaii and on its breeding grounds in western Alaska (Johnson et al. 1981, 1989, 1993, 2001a, 2001b). Four Wandering Tattler or Ulili (*Heteroscelus incanus*), three Ruddy Turnstone or Akekeke (*Arenaria interpres)* and one Sanderling or Hunakai (*Calidris alba*) were also tallied on this survey. These three species were not recorded on the 2002 survey which was in the mauka section of the site which does not contain suitable habitat for these migrants.

Alien (introduced) Birds:

Only one new alien species, the House Finch (*Carpodacus mexicanus*), was added to the list obtained in 2002 (Table 1). None of the alien birds are listed as threatened or endangered.

Mammals:

The Small Indian Mongoose (*Herpestes auropunctatus*) and feral cat (*Felis catus*) were the only mammals recorded. Seven Mongoose were observed along the coastal section. The tracks of cats were common along the coastal beach road. The endangered Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) was not recorded on the evening search using the ultrasound detector. This species was likewise not found on the 2002 survey. My most recent sighting of the Hawaiian Hoary Bat was on mauka lands above this property (Bruner 2006). Feral Goats (*Capra hircus*) were reported to occur on occasion along the coastal portions of O'oma and Kohanaiki (R.S.K. Mitchell pers. comm..)

EXECUTIVE SUMMARY

The emphasis of this field survey was to document the birds and mammals on the makai, coastal portion and to update data from the mauka grassland section of the property. There were no native birds or mammals found on the 2002 or this current 2006 survey. The Hawaiian Owl or Pueo, Hawaiian Hawk or Io and the Hawaiian Hoary Bat could forage on occasion at this site. I know of no data on their frequency of occurance in this general area of west Hawaii. All four common migratory shorebird species were seen in the coastal portion. The Pacific Golden-Plover or Kolea was also seen flying over the mauka grasslands. The vegetation choked wetland is too small and overgrown to be of use to waterbirds or migratory shorebirds. The only mammals seen were alien cats and the Small Indian Mongoose. The alien birds recorded on the 2002, 2006 surveys are those typically found in this region.

TABLE ONE

Alien (introduced) species of birds found on a two day (18, 19 November 2006) field Survey of TMKs:(3) 7-3-9:004 and 22 in North Kona, Hawaii. Data from 2002 are also shown (X=present, O=absent).

Common Name	Scientific Name	2002	2006
Gray Francolin	*Francolinus pondicerianus*	X	X
Ring-necked Pheasant	*Phasianus colchicus*	X	O
Spotted Dove	*Streptopelia chinensis*	X	X
Zebra Dove	*Geopelia striata*	X	X
Japanese White-eye	*Zosterops japonicus*	X	X
Common Myna	*Acridotheres tristis*	X	X
Northern Cardinal	*Cardinalis cardinalis*	X	X
Yellow-billed Cardinal	*Paroaria capitata*	X	X
House Finch	*Carpodacus mexicanus*	O	X
African Silverbill	*Lonchura cantan*	X	O
Nutmeg Mannikin	*Lonchura punctulata*	X	O
Java Sparrow	*Padda oryzivora*	X	O

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Archaeological Inventory Survey

RC-0445

Archaeological Inventory Survey Update for the ‘O‘oma Beachside Village Project Area

(TMK: 3-7-3-09:004 and 022)

‘O‘oma 2nd Ahupua‘a
North Kona District
Island of Hawai‘i

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ARCHAEOLOGICAL, CULTURAL, AND HISTORICAL STUDIES

RC-0445

Archaeological Inventory Survey Update for the ‘O‘oma Beachside Village Project Area
(TMK: 3-7-3-09:004 and 022)

‘O‘oma 2nd Ahupua‘a
North Kona District
Island of Hawai‘i

RECHTMAN CONSULTING

EXECUTIVE SUMMARY

At the request of PBR Hawaii & Associates Inc., on behalf of North Kona Village, LLC, Rechtman Consulting, LLC has prepared this update to earlier DLNR-SHPD approved archaeological inventory survey work of an approximately 300 acre project area in ʻOʻoma 2nd Ahupuaʻa, North Kona District, Island of Hawaiʻi (TMKs: 3-7-3-09:004 and 022) (Figures 1 and 2). Between 1985 and 2002, the current project area (in part and in whole) has been subject to intensive archaeological study, including inventory survey and data recovery. In September of 1998 DLNR-SHPD prepared an update on the historic preservation status of Parcel 004, and concluded that all historic preservation issues, except preservation planning, were completed. In October of 2002 DLNR-SHPD prepared another update on the historic preservation status of Parcel 022. This DLNR-SHPD correspondence likewise indicated that both survey work and data recovery had been acceptably completed and what remained to be done was preservation planning. However, given the sensitive nature of archaeological resources in the immediate project area and the recent inadvertent discoveries at neighboring Kohanaiki, the landowner/developer thought it prudent to reexamine the entire project area to assess the current condition of the known preservation sites and to identify any additional sites that may have gone undocumented during the earlier work. This approach was confirmed as valid with SHPD staff and with the SHPD administrator.

Rechtman Consulting, LLC completed an intensive resurvey of the study area; eight sites (SIHP Site 2, 1910, 1911, 1912, 1913, 10155, 18027, 18773) that had earlier been approved for preservation were investigated to verify current site conditions and site boundaries, and one site (SIHP Site 25932) was discovered that had not been previously documented. Site 25932 is a lava tube that contains three sets of human skeletal remains; this site is also recommended for preservation. A burial treatment plan should be prepared for Sites 18773 and 25932 and submitted to DLNR-SHPD and the Hawaii Island Burial Council, and an archaeological sites preservation plan should be prepared for the other seven sites and submitted to DLNR-SHPD for approval.

CONTENTS

FIGURES

TABLE

INTRODUCTION

At the request of PBR Hawaii & Associates Inc., on behalf of North Kona Village, LLC, Rechtman Consulting, LLC has prepared this update to earlier DLNR-SHPD approved archaeological inventory survey work (Barrera 1985; Cordy 1986; Donham 1987) of an approximately 300 acre project area in ʻOʻoma 2nd Ahupuaʻa, North Kona District, Island of Hawaiʻi (TMKs: 3-7-3-09:004 and 022) (Figures 1 and 2). Between 1985 and 2002, the current project area (in part and in whole) has been subject to intensive archaeological study, including inventory survey and data recovery (Barrera 1985, 1989, 1992; Cordy 1985, 1986; Donham 1987; Rechtman 2002). In September of 1998 DLNR-SHPD prepared an update on the historic preservation status of Parcel 004 (Appendix A), and concluded that all historic preservation issues, except preservation planning, were completed. In October of 2002 DLNR-SHPD prepared another update on the historic preservation status of Parcel 022 (see Appendix A). This DLNR-SHPD correspondence likewise indicated that both survey work and data recovery had been acceptably completed and what remained to be done was preservation planning. However, given the sensitive nature of archaeological resources in the immediate project area and the recent inadvertent discoveries at neighboring Kohanaiki, the landowner/developer thought it prudent to reexamine the entire project area to assess the current condition of the known preservation sites and to identify any additional sites that may have gone undocumented during the earlier work. This approach was confirmed as valid with SHPD staff and with the SHPD administrator. Rechtman Consulting, LLC completed an intensive resurvey of the study area, identified the known preservation sites, and found one additional site that had not been previously recorded.

The current report documents the findings of the resurvey of the study area and has been prepared as a companion document to a Cultural Impact Assessment (Rechtman 2007) in compliance with Chapter 343 HRS, as well as fulfilling the requirements of the County of Hawaiʻi Planning Department and the Department of Land and Natural Resources (DLNR) with respect to permit approvals for land-altering and development activities.

This report begins with a description of the general project area and the proposed development activities. This is followed by a presentation of the archaeological background for the specific study area. A discussion of the cultural and historical background for the ʻOʻoma *ahupuaʻa* and the Kekaha region was generated based on detailed archival research. It is a comprehension of this background information that facilitates a more complete understanding of the significance of the resources that exist within the study area. A description of the current condition of the eight archaeological sites that have already been slated for preservation is followed by a description, evaluation, and proposed treatment for one additional site that was newly discovered as a result of the current study.

PROJECT AREA DESCRIPTION AND PROPOSED DEVELOPMENT ACTIVITIES

The project area is roughly 300 acres in ʻOʻoma 2nd Ahupuaʻa, North Kona District, Island of Hawaiʻi and consists of two current Tax Map parcels (TMK:3-7-3-09:004 and 3-7-3-09:022) (Figure 2). Elevation across the project area ranges from sea level to 120 feet above sea level, and the terrain is characterized by weathered *pāhoehoe* and *ʻaʻā* flows that emanated from Hualālai between 3,000 and 5,000 years ago (Wolfe and Morris 1996). Situated within the Kekaha region, the principle environmental features are a hot, dry climate, and extensive lava fields with little to no soil accumulation. This region receives roughly 10 inches of rain per year and has a mean annual temperature of 70 to 76 degrees Fahrenheit (Donham 1987). With the exception of a narrow strip of coral beach deposit, no soil is present within the subject parcel. Coastal vegetation includes tree heliotrope (*Messerschmidia argentea*), *naupaka* (*Scaevola sericea*), Christmas-berry (*Schinus terebithifolius*), and beach morning glory (*Ipomea pescaprae*), along with occasional stands of *ʻilima* (*Sida fallax*), *noni* (*Morinda citrifolia*), and *maiapilo* (*Capparis sandwichiana*), with a blanket of fountain grass (*Pennisetum setaceum*) slightly further inland.

The development plans for the project area include a combination of mixed-use village, single-family and multi-family residential lots, with shoreline and inland park facilities. Aside from a proposed coastal public canoe club, no substantial development activities are planned to occur within greater than 1,000 feet of the shoreline (Figure 3).

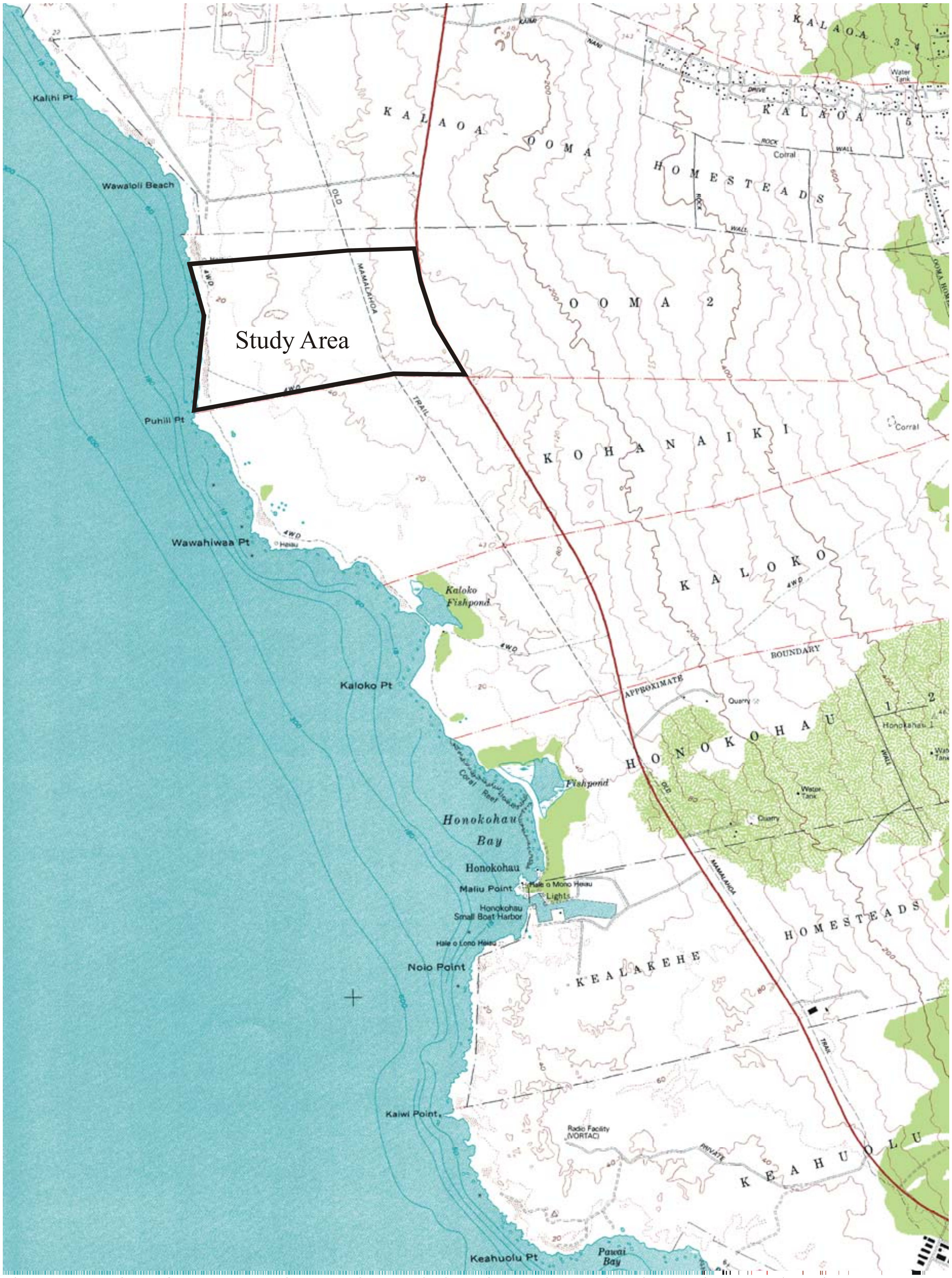

Figure 1. Portion of USGS 7.5 minute series Keahole Point, HI 1996 showing project area location.

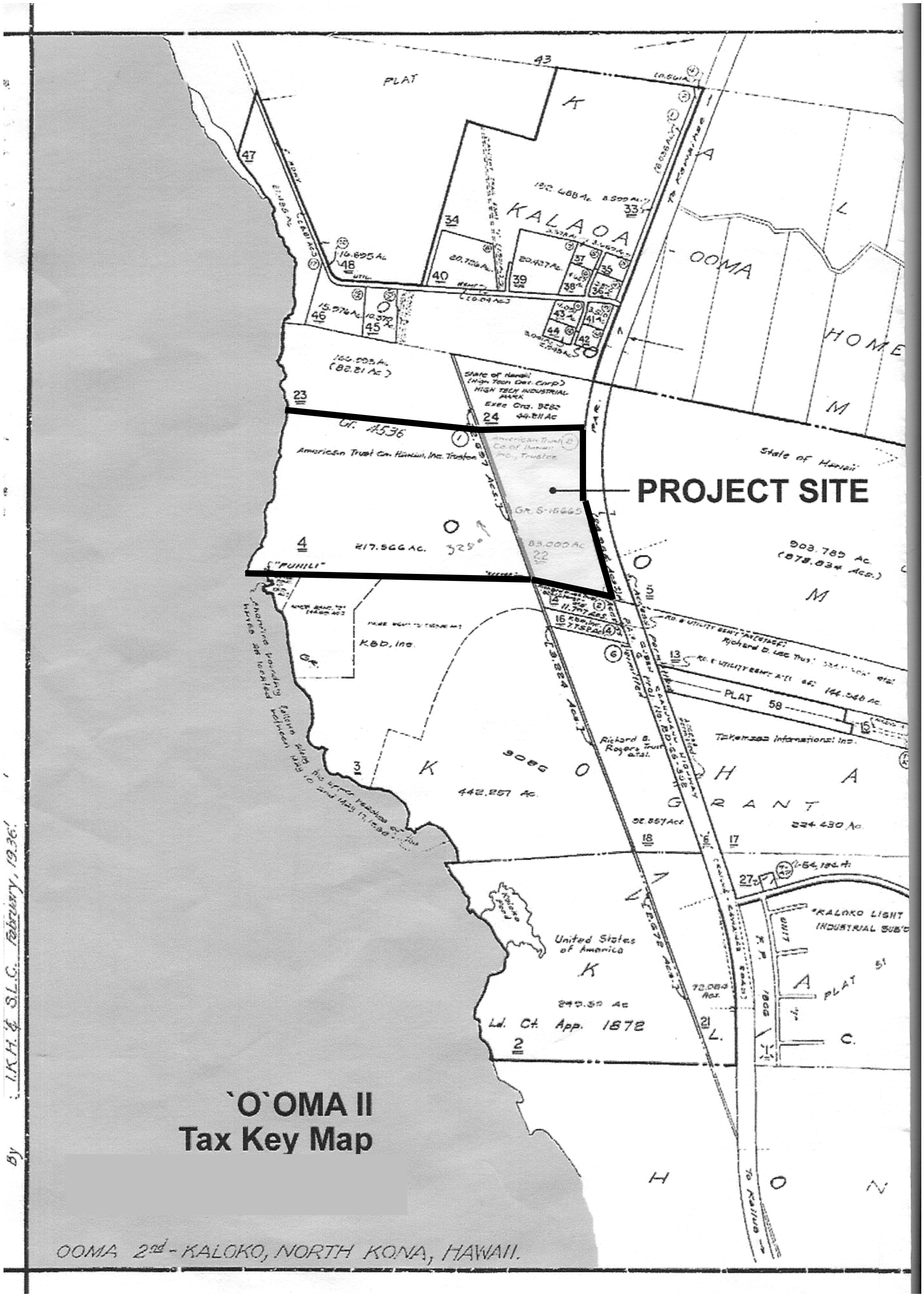

Figure 2. Portion of Tax Map Key 3-7-3 showing current project areas.

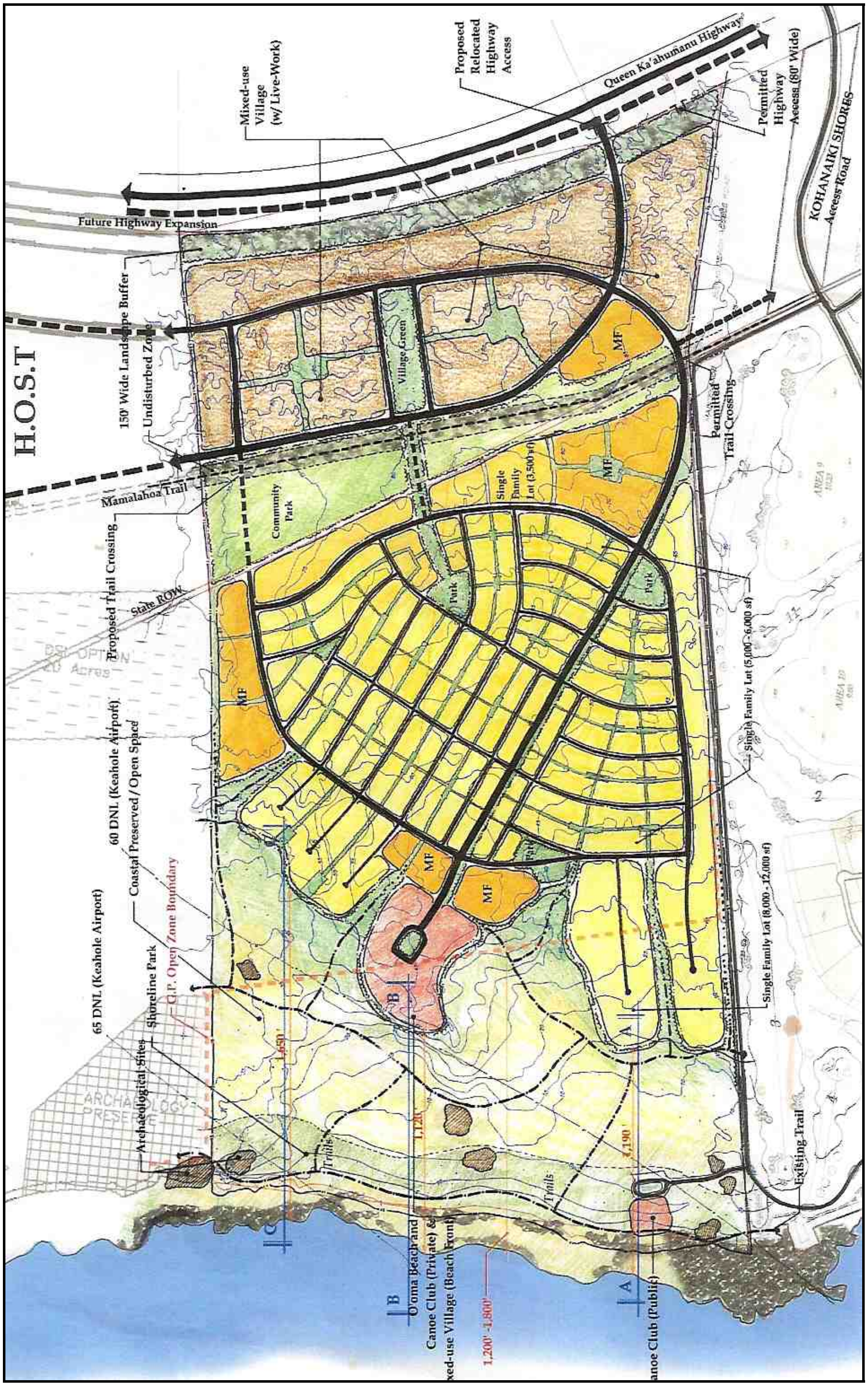

Figure 3. Proposed development plan.

Archaeological Background

Thrum (1908) compiled the earliest systematic report on archaeological features—*heiau* or ceremonial sites—on the island of Hawai'i. Thrum's work was the result of literature review and field visits spanning several decades. Unfortunately, Thrum's work did not take him into ʻOʻoma, and his documentation on *heiau* ends at Lanihau, south of the study area; and picks up to the north, in the Puʻu Anahulu vicinity. Likewise, the 1906-1907, J.F.G. Stokes detailed field survey of *heiau* on the island of Hawaiʻi for the B. P. Pauahi Bishop Museum (Stokes and Dye 1991) stopped short of doing comprehensive work in the Kekaha region, and no sites were recorded in ʻOʻoma.

In 1929-1930, the Bishop Museum contracted John Reinecke to conduct a survey of Hawaiian sites in West Hawaiʻi, including ʻOʻoma and the Kekaha region (Reinecke n.d.). A portion of Reinecke's survey fieldwork extended north from Kailua as far as Kalāhuipuaʻa. His work being the first attempt at a survey of sites of varying function, ranging from ceremonial to residency and resource collection.

During his study, Reinecke traveled along the shore of Kekaha, documenting near-shore sites. Where he could, he spoke with the few native residents he encountered. Among his general descriptions of the Kekaha region, Reinecke observed:

> This coast formerly was the seat of a large population. Only a few years ago Keawaiki, now the permanent residence of one couple, was inhabited by about thirty-five Hawaiians. Kawaihae and Puako were the seat of several thousands, and smaller places numbered their inhabitants by the hundreds. Now there are perhaps fifty permanent inhabitants between Kailua and Kawaihae–certainly not over seventy-five.
>
> When the economy of Hawaii was based on fishing this was a fairly desirable coast; the fishing is good; there is a fairly abundant water supply of brackish water, some of it nearly fresh and very pleasant to the taste; and while there was no opportunity for agriculture on the beach, the more energetic Hawaiians could do some cultivation at a considerable distance *mauka*.
>
> The scarcity of remains is therefore disappointing. This I attribute to four reasons: (1) those simply over looked, especially those a short distance mauka, must have been numerous; (2) a number must have been destroyed, as everywhere, by man and by cattle grazing; (3) the coast is for the most part low and storm-swept, so that the most desirable building locations, on the coral beaches, have been repeatedly swept over and covered with loose coral and lava fragments, which have obscured hundreds of platforms and no doubt destroyed hundreds more; (4) many of the dwellings must have been built directly on the sand, as are those of the family at Kaupulehu, and when the posts have been pulled up, leave no trace after a very few years.
>
> The remains on this strip of coast have some special characteristics differentiating them from the rest in Kona. First, there is an unusual number of petroglyphs and papamu, especially about Kailua and at Kapalaoa. Second, probably because of the strong winds, there are many walled sites, both of houses and especially of temporary shelters… (Reinecke n.d.:1-2)

The following site descriptions are quoted from Reinecke's manuscript of fieldwork conducted between Pūhili Point on the Kohanaiki-ʻOʻoma 2nd boundary, and into Kalaoa 5th (Figure 4). In the site descriptions below, Reinecke references the occurrence of at least six house sites; seven enclosures and pens (one of which is an "old cattle pen"); eleven terraces and platforms (one of which he felt was a "*heiau*"); two caves; two *ahu*; a stepping stone trail; three waterholes and a well; and eleven rock shelters. Apparently, no one was residing in the area at the time of his field survey.

Reinecke's site descriptions, south to north, across 'O'oma 2nd and 'O'oma 1st included:

> Site 66. Very doubtful dwelling site. Then a row of sand-covered platforms at the border of the sand and the beach lava, enough for 6-10 homes. Remains of an old, large pen.
>
> Site 67. Dry well on the crest of the beach.
>
> Site 68. Water hole, two small platforms, four or more shelters, pens with very small platform.
>
> Site 69. Large cattle pen. Doubtful old, rough platform at its north end. Remains of two old platforms by an ahu to the north.
>
> Site 70. Walled platform, S.E. corner terraced, badly broken down. Platform mauka. The walls of this and of Site 73 are built of thin pieces of pahoehoe surface lava, rather unusual in appearance. [Reinecke n.d.:15]
>
> Site 71. A knob partly walled on its slopes, with house site. Adjoining it on the south is a rough platform with three smooth boulders – heiau and kuula? Back of this a house platform and a platform about a fine shelter cave. Another platform and wall are about a slight natural depression filled with bones, including those of a whale.
>
> Site 72. Ruins of a pen.
>
> Site 73. Apparently a modern dwelling site of unusual construction; two terraces of pebbles, the upper 29x25x2 in front and 4-5' high elsewhere; the lower 19x10x25x3, with a three-

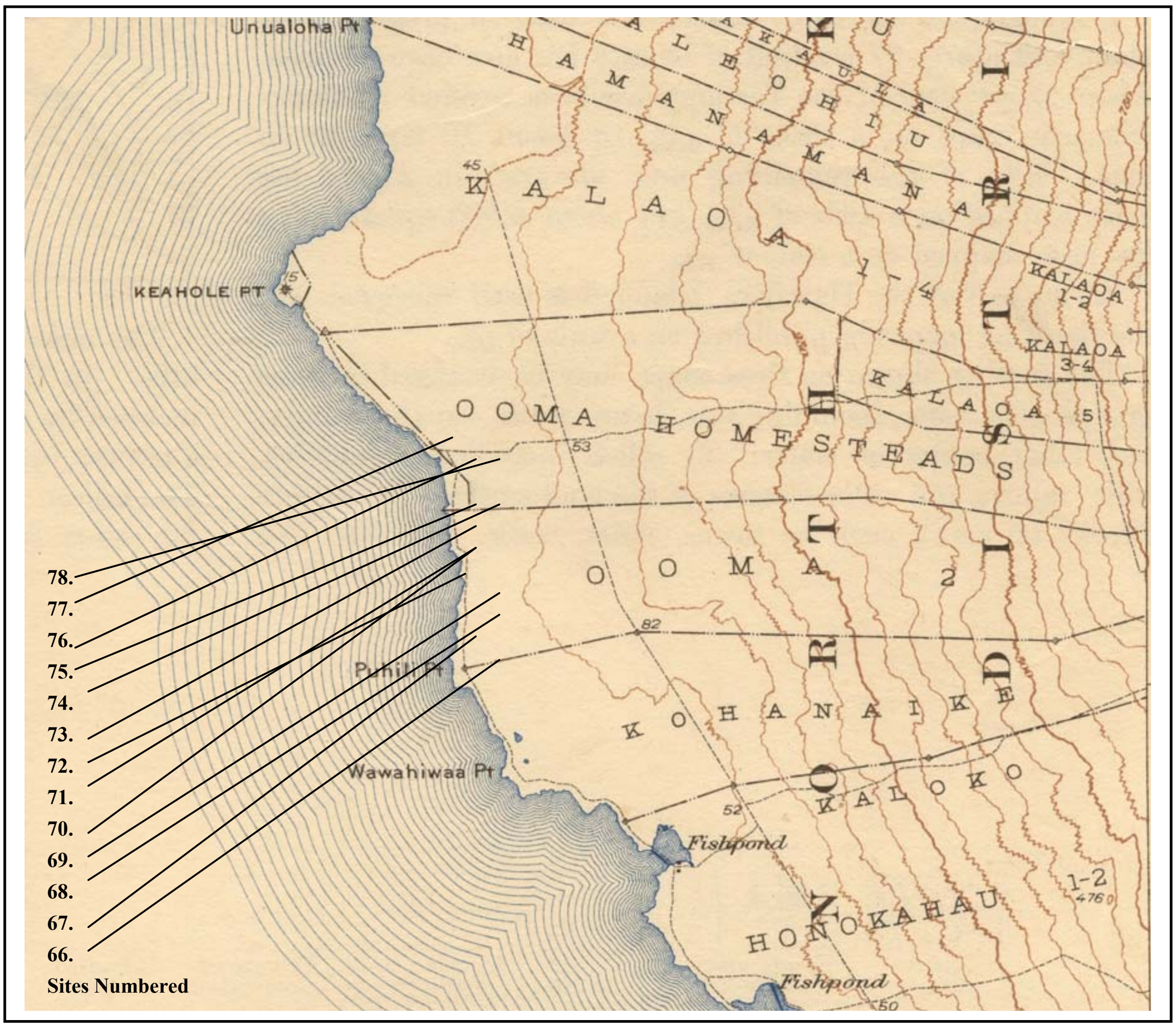

Figure 4. Approximate locations of sites described by Reinecke (n.d.:37) projected on USGS Keahole Quad, 1928.

> Site 74. A shelter about a shallow cave; remains of another shelter; an ahu.
>
> Site 75. Trace of site; house platform; enclosure on shore. There are many faint traces of sites on this strip of coast. Toward the north is an unmistakable small site.
>
> Site 76. Modern shelter pen; house or shelter site; shelter mauka by kiawe tree.
>
> Site 77. Platform; tiny pen; sites of some kind marked by stones in lines on the pahoehoe flow.
>
> Site 78. Slightly brackish springs and pools; house site, shelters, stepping stone path leading to the walled house site… [Reinecke n.d.:16]

Reneicke's Sites 66, 67, 68, 69, and 70 all fall at least partly within the current study area, and his description of the features, albeit limited, contains valuable information about site condition and provides a 70 plus year perspective on natural degradation along this coastline (c.f., Donham 1987:7). In 1971-72, DLNR started an inventory of known archaeological sites and visited the sites Reinecke recorded along the ʻOʻoma coastline. These sites were assigned State Inventory of Historic Places (SIHP) site numbers, site forms were completed, and sketch maps were made. Reneicke's sites were assigned SIHP Sites 1911–1915 and these were grouped as the ʻOʻoma II Site Complex and assigned SIHP Site 4165.

In 1975, Ross Cordy carried out an intensive survey and subsurface testing program along this portion of the coast. He assigned Bishop Museum site numbers to the sites recorded by Reneicke and documented by Martin, and synthesized the data he generated with those from seven other North Kona ahupuaʻa as part of his doctoral dissertation (Cordy 1981). Cordy (1985) further documented his work in an overview summary report for the ʻOʻoma and Kalaoa areas. Also in 1985, Barrera began a series of studies, survey and data recovery, which included the current project area (1985, 1989, 1992). This was followed by a DLNR-SHPD fieldcheck (Cordy 1986), the conclusion of which was that Barrera's work was "fairly accurate" (Cordy 1986:5). The subject property was surveyed for archaeological sites again as part of a larger study in 1986 by Donham (1987). That study was a comprehensive inventory of sites for an Environmental Impact Statement prepared in 1991. The overall survey area included the current project area and the adjoining NELHA land to the north. Donham (1987) documented eleven previously unrecorded sites within the current project area. The *mauka* portion (Parcel 22) of the current study area was surveyed yet again in 2002 (Rechtman 002). One additional site was found during that survey. Finally, Corbin (2000) carried out data recovery at several sites within and adjacent to the current study area.

As a result of these past studies a total of forty archaeological sites were recorded (cf., Corbin 2000). Collectively these sites document Precontact and Historic use of the project area for habitation, burial, and resource extraction activities. A prominent landscape feature that dates to the Historic Period is the *Alanui Aupuni* (Government Road), which runs a roughly north-south course through the *mauka* third of the project area. Archaeological inventory survey recording and data recovery has already been completed within the project area, mitigating impacts to all but eight of these sites, all of which are slated for preservation (Figure 5). Two of these sites extend into, and will become part of, the newly created 15-acre archaeological preserve on the NELHA parcel to the north (Rechtman and Clark 2006).

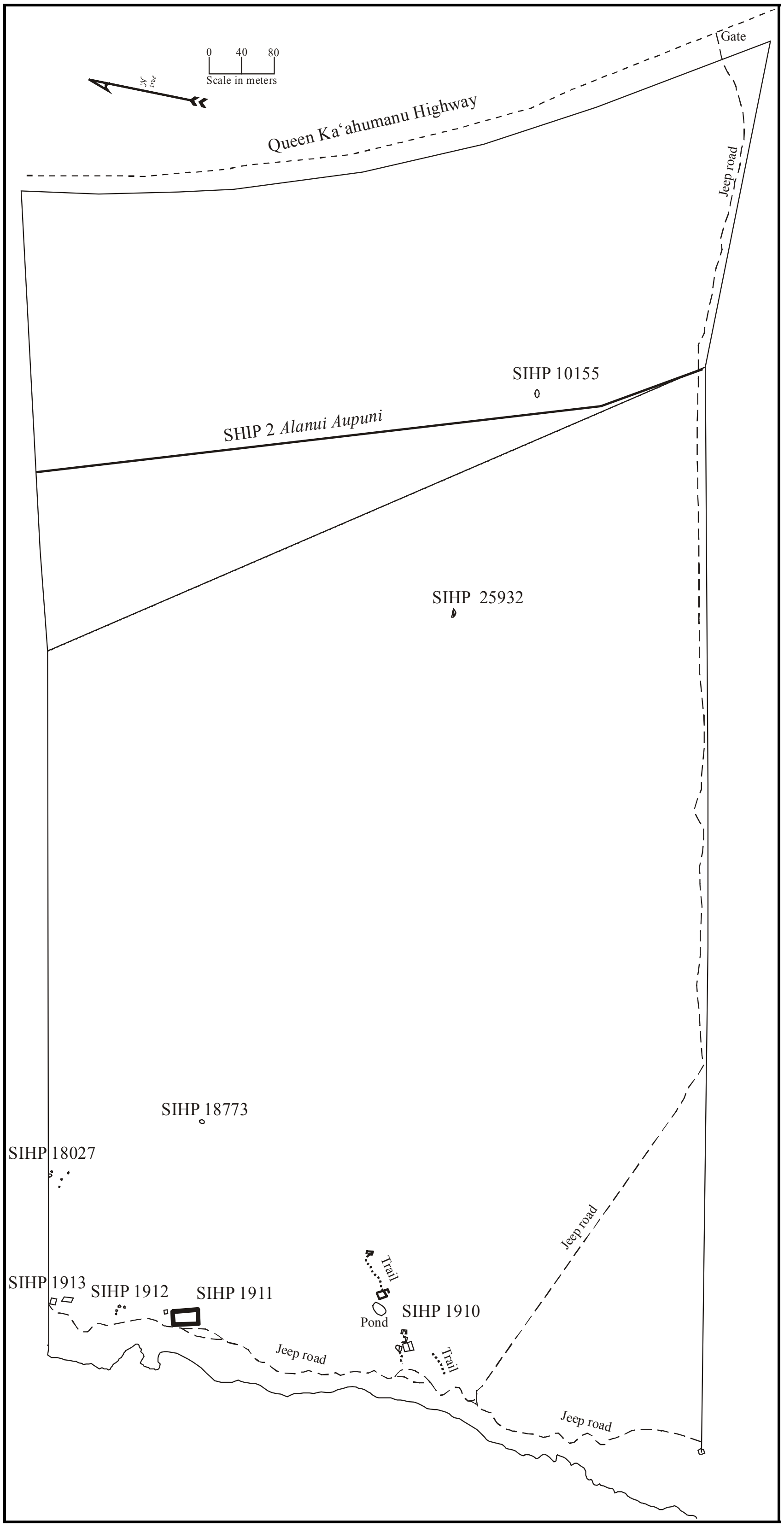

Figure 5. Distribution of archaeological preservation sites within the project area (includes the newly recorded Site 25932).

CULTURE-HISTORICAL BACKGROUND

One of the potential shortcomings of the earlier studies, given current regulatory standards and practices, was in not providing sufficiently detailed cultural and historical contexts. While the physical study area is limited to a portion of ʻOʻoma 2nd Ahupuaʻa identified as TMK:3-7-3-09:004 and 022, in an effort to provide a comprehensive and holistic understanding of the current project area, this section of the report examines the entire *ahupuaʻa* and its relationship to neighboring lands within the larger Kekaha region. Rechtman Consulting, LLC has recently prepared a Cultural Impact Assessment associated with the current proposed development (Rechtman 2007), which is based on an earlier such study for a portion (TMK:3-7-3-09:022) of the current project area (Rechtman and Maly 2003). Extensive research for that study was conducted by Kepā Maly of Kumu Pono Associates, and it included a review of archival-historical literature from both Hawaiian and English language sources, including an examination of Hawaiian Land Commission Award records from the *Māhele ʻĀina* (Land Division) of 1848; survey records of the Kingdom and Territory of Hawaiʻi; and historical texts authored or compiled by Malo (1951), Iʻi (1959), Kamakau (1961, 1964, 1976, and 1991), Ellis (1963), Fornander (1916-1919 and 1996), Thrum (1908), Stokes and Dye (1991), Beckwith (1970), Reinecke (n.d.); and Handy and Handy with Pukui (1972). That study also included several native accounts from Hawaiian language newspapers (compiled and translated from Hawaiian to English, by Kepā Maly), and historical narratives authored by eighteenth and nineteenth century visitors to the region. The information was presented within thematic categories and ordered chronologically by the date of publication.

The archival-historical resources were located in the collections of the Hawaiʻi State Archives (HSA), State Land Division (LD), State Survey Division (SD), and State Bureau of Conveyances (BoC); the Bishop Museum Archives (BPBM); Hawaiian Historical Society (HHS); University of Hawaiʻi-Hilo Moʻokini Library; private family collections; and in the collection of Kumu Pono Associates.

Over the last ten years, Kepā Maly of Kumu Pono Associates has researched and prepared several detailed studies—in the form of review and translation of accounts from Hawaiian language newspapers, historical accounts recorded by Hawaiian and non-Hawaiian residents, and government land use records—for lands in the Kekaha region of which ʻOʻoma is a part. Kepā Maly has also conducted a number of detailed oral history interviews with elder *kamaʻāina* documenting their knowledge of the Kekaha region (including ʻOʻoma), and he undertook new interviews and further consultation as a part of the 2003 study. All of the interview participants (both past and present) shared their personal knowledge of the land and practices of the families who lived in ʻOʻoma and vicinity. One additional oral-historical interview with Mrs. Elizabeth (Kahananui) Lee was also conducted for the current study.

As the information collected and presented by Rechtman and Maly (2003) is comprehensive, this report presents only a slightly modified version of the cultural and historical background for ʻOʻoma Ahupuaʻa and the Kekaha region than was already generated. It is a comprehension of this background information that facilitates a more complete understanding of the potential significance of the resources that exist within the current study area.

Natural and Cultural Resources in a Hawaiian Context

In Hawaiian society, natural and cultural resources are one and the same. Native traditions describe the formation (the literal birth) of the Hawaiian Islands and the presence of life on and around them in the context of genealogical accounts. All forms in the natural environment, from the skies and mountain peaks, to the watered valleys and lava plains, and to the shoreline and ocean depths were believed to be embodiments of Hawaiian deities. One Hawaiian genealogical account, records that Wākea (the expanse of the sky–father) and Papa-hānau-moku (Papa—Earth-mother who gave birth to the islands)—also called Haumea-nui-hānau-wā-wā (Great Haumea—Woman-earth born time and time again)—and various gods and creative forces of nature, gave birth to the islands. Hawaiʻi, the largest of the islands, was the first-born of these island children. As the Hawaiian genealogical account continues, we find that these same god-beings, or creative forces of nature who gave birth to the islands, were also the parents of the first man (Hāloa), and from this ancestor, all Hawaiian people are descended (cf. Beckwith 1970; Malo 1951:3; Pukui and Korn 1973). It was in this context of kinship, that the ancient Hawaiians addressed their environment and it is the basis of the Hawaiian system of land use.

An Overview of Hawaiian Settlement

Archaeologists and historians describe the inhabiting of these islands in the context of settlement that resulted from voyages taken across the open ocean. For many years, researchers have proposed that early Polynesian settlement voyages between Kahiki (the ancestral homelands of the Hawaiian gods and people) and Hawai‘i were underway by A.D. 300, with long distance voyages occurring fairly regularly through at least the thirteenth century. It has been generally reported that the sources of the early Hawaiian population—the Hawaiian Kahiki—were the Marquesas and Society Islands (Cordy 2000; Emory in Tatar 1982:16-18).

For generations following initial settlement, communities were clustered along the watered, windward (*ko‘olau*) shores of the Hawaiian Islands. Along the *ko‘olau* shores, streams flowed and rainfall was abundant, and agricultural production became established. The *ko‘olau* region also offered sheltered bays from which deep sea fisheries could be easily accessed, and near shore fisheries, enriched by nutrients carried in the fresh water, could be maintained in fishponds and coastal waters. It was around these bays that clusters of houses where families lived could be found (McEldowney 1979:15). In these early times, Hawai‘i's inhabitants were primarily engaged in subsistence level agriculture and fishing (Handy et al. 1972:287).

Over a period of several centuries, areas with the richest natural resources became populated and perhaps crowded, and by about A.D. 900 to 1100, the population began expanding to the *kona* (leeward side) and more remote regions of the island (Cordy 2000:130). In Kona, communities were initially established along sheltered bays with access to fresh water and rich marine resources. The primary "chiefly" centers were established at several locations—the Kailua (Kaiakeakua) vicinity, Kahalu‘u-Keauhou, Ka‘awaloa-Kealakekua, and Hōnaunau. The communities shared extended familial relations, and there was an occupational focus on the collection of marine resources. By the fourteenth century, inland elevations to around the 3,000-foot level were being turned into a complex and rich system of dryland agricultural fields (today referred to as the Kona Field System). By the fifteenth century, residency in the uplands was becoming permanent, and there was an increasing separation of the chiefly class from the common people. In the sixteenth century the population stabilized and the *ahupua‘a* land management system was established as a socioeconomic unit (see Ellis 1963; Handy et al. 1972; Kamakau 1961; Kelly 1983; and Tomonari-Tuggle 1985).

In Kona, where there were no regularly flowing streams to the coast, access to potable water (*wai*), was of great importance and played a role in determining the areas of settlement. The waters of Kona were found in springs and caves (found from shore to the mountain lands), or procured from rain catchments and dewfall. Traditional and historic narratives abound with descriptions and names of water sources, and also record that the forests were more extensive and extended much further seaward than they do today. These forests not only attracted rains from the clouds and provided shelter for cultivated crops, but also in dry times drew the *kēhau* and *kēwai* (mists and dew) from the upper mountain slopes to the low lands (see also traditional-historical narratives and oral history interviews in this study).

In the 1920s-1930s, Handy et al. (1972) conducted extensive research and field interviews with elder native Hawaiians. In lands of North and South Kona, they recorded native traditions describing agricultural practices and rituals associated with rains and water collection. Primary in these rituals and practices was the lore of Lono—a god of agriculture, fertility, and the rituals for inducing rainfall. Handy et al., observed:

> The sweet potato and gourd were suitable for cultivation in the drier areas of the islands. The cult of Lono was important in those areas, particularly in Kona on Hawai‘i . . . there were temples dedicated to Lono. The sweet potato was particularly the food of the common people. The festival in honor of Lono, preceding and during the rainy season, was essentially a festival for the whole people, in contrast to the war rite in honor of Ku which was a ritual identified with Ku as god of battle. (Handy et al. 1972:14)

Handy et al. (1972) noted that the worship of Lono was centered in Kona. Indeed, it was while Lono was dwelling at Keauhou, that he is said to have introduced taro, sweet potatoes, yams, sugarcane, bananas, and *‘awa* to Hawaiian farmers (Handy et al. 1972:14). The rituals of Lono "The father of waters" and the annual *Makahiki* festival, which honored Lono and which began before the coming of the *kona* (southerly) storms and lasted through the rainy season (the summer months), were of great importance to the native residents of this region (Handy et al. 1972: 523). The significance of rituals and ceremonial observances in cultivation and indeed in all aspects of life was of great importance to the well being of the ancient Hawaiians, and cannot be overemphasized, or overlooked when viewing traditional sites of the cultural landscape.

Hawaiian Land Use and Resource Management Practices

Over the generations, the ancient Hawaiians developed a sophisticated system of land and resources management. By the time ʻUmi-a-Līloa rose to rule the island of Hawaiʻi in ca. 1525, the island (*moku-puni*) was divided into six districts or *moku-o-loko* (cf. Fornander 1973–Vol. II:100-102). On Hawaiʻi, the district of Kona is one of six major *moku-o-loko* within the island. The district of Kona itself, extends from the shore across the entire volcanic mountain of Hualālai, and continues to the summit of Mauna Loa, where Kona is joined by the districts of Kaʻū, Hilo, and Hāmākua. One traditional reference to the northern and southern-most coastal boundaries of Kona tells us of the district's extent:

> *Mai Ke-ahu-a-Lono i ke ʻā o Kani-kū, a hōʻea i ka ʻūlei kolo o Manukā i Kaulanamauna e pili aku i Kaʻū!*—From Keahualono [the Kona-Kohala boundary] on the rocky flats of Kanikū, to Kaulanamauna next to the crawling (tangled growth of) ʻūlei bushes at Manukā, where Kona clings to Kaʻū! (*Kaʻao Hoʻoniua Puʻuwai no Ka-Miki in Ka Hōkū o Hawaiʻi*, September 13, 1917; Translated by Kepā Maly)

Kona, like other large districts on Hawaiʻi, was further divided into ʻokana or kalana (regions of land smaller than the *moku-o-loko*, yet comprising a number of smaller units of land). In the region now known as Kona ʻakau (North Kona), there are several ancient regions (*kalana*) as well. The southern portion of North Kona was known as "Kona kai ʻōpua" (interpretively translated as: Kona of the distant horizon clouds above the ocean), and included the area extending from Lanihau (the present-day vicinity of Kailua Town) to Puʻuohau (now known as Red Hill). The northern-most portion of North Kona was called "Kekaha" (descriptive of an arid coastal place). Native residents of the region affectionately referred to their home as *Kekaha-wai-ʻole o nā Kona* (Waterless Kekaha of the Kona District), or simply as the *āina kaha*. It is within this region of Kekaha, that the lands of ʻOʻoma are found.

The *ahupuaʻa* were also divided into smaller individual parcels of land (such as the *ʻili, kōʻele, māla*, and *kīhāpai*, etc.), generally oriented in a *mauka-makai* direction, and often marked by stone alignments (*kuaiwi*). In these smaller land parcels the native tenants tended fields and cultivated crops necessary to sustain their families, and the chiefly communities with which they were associated. As long as sufficient tribute was offered and *kapu* (restrictions) were observed, the common people, who lived in a given *ahupuaʻa* had access to most of the resources from mountain slopes to the ocean. These access rights were almost uniformly tied to residency on a particular land, and earned as a result of taking responsibility for stewardship of the natural environment, and supplying the needs of the *aliʻi* (see Kamakau 1961:372-377 and Malo 1951:63-67).

Entire *ahupuaʻa*, or portions of the land were generally under the jurisdiction of appointed *konohiki* or lesser chief-landlords, who answered to an *aliʻi-ʻai-ahupuaʻa* (chief who controlled the *ahupuaʻa* resources). The *aliʻi-ʻai-ahupuaʻa* in turn answered to an *aliʻi ʻai moku* (chief who claimed the abundance of the entire district). Thus, *ahupuaʻa* resources supported not only the *makaʻāinana* and *ʻohana* who lived on the land, but also contributed to the support of the royal community of regional and/or island kingdoms. This form of district subdividing was integral to Hawaiian life and was the product of strictly adhered to resources management planning. In this system, the land provided fruits and vegetables and some meat in the diet, and the ocean provided a wealth of protein resources. Also, in communities with long-term royal residents, divisions of labor (with specialists in various occupations on land and in procurement of marine resources) came to be strictly adhered to. It is in this cultural setting that we find ʻOʻoma and the present study area.

The *ahupuaʻa* of ʻOʻoma (historically, ʻOʻoma 1st and 2nd) are two of some twenty ancient *ahupuaʻa* within the *ʻokana* of Kekaha-wai-ʻole. The place name ʻOʻoma can be literally translated as concave. To date, no tradition explaining the source of the place name has been located, though it is possible that the name refers to the indentation of the shoreline fronting a portion of ʻOʻoma. A few place names within ʻOʻoma were discussed in traditional accounts, thus we have some indication of the histories associated with this land.

While there are only limited native accounts that have been recorded about ʻOʻoma, we do know that the land was so esteemed, that during the youth of Kauikeaouli (later known as Kamehameha III), the young prince—son of Kamehameha I and his sacred wife Keōpūolani—was taken to be raised near the shore of ʻOʻoma under the care of his stewards from infancy until he was five years old (Kamakau 1961:263-264). Again, this is a significant part of the history of this land, as great consideration went into all aspects of the young king's upbringing (see Iʻi 1959 and Kamakau 1961).

The Environmental Setting of ʻOʻoma

The *ahupuaʻa* of ʻOʻoma cross several environmental zones that are generally called *wao* in the Hawaiian language. These environmental zones include the near-shore fisheries and shoreline strand (*kahakai*) and the *kula kai/kula uka* (shoreward/inland plains). These regional zones were greatly desired as places of residence by the natives of the land.

While the *kula* region of ʻOʻoma and greater Kekaha is now likened to a volcanic desert, native and historic accounts describe or reference groves of native hardwood shrubs and trees such as *ʻūlei* (*Osteomeles anthyllidifolia*), *ēlama* (*Diospyros ferrea*), *uhiuhi* (*Caesalpina kavaiensis*), and *ohe* (*Reynoldsia sandwicensis*) extending across the land and growing some distance shoreward. The few rare and endangered plants found in the region, along with small remnant communities of native dryland forest (Char 1991) give an indication that there was a significant diversity of plants growing upon the *kula* lands prior to the introduction of ungulates.

The lower *kula* lands receive only about 20 inches of rainfall annually, and it is because of their dryness, the larger region of which ʻOʻoma is a part, is known as "Kekaha." While on the surface, there appears to be little or no potable water to be found, the very lava flows which cover the land contain many underground streams that are channeled through subterranean lava tubes which feed the springs, fishponds and anchialine ponds on the *kula kai* (coastal flats). Also in this region, on the flat lands, about a half-mile from the shore, is the famed *Alanui Aupuni* (Government Trail), built in 1847, at the order of Kamehameha III. This trail or government roadway, was built to meet the needs of changing transportation in the Hawaiian Kingdom, and in many places it overlays the older near shore *ala loa* (ancient foot trail that encircled the island).

Continuing into the *kula uka* (inland slopes), the environment changes as elevation increases. Based on historic surveys, it appears that ʻOʻoma ends at a survey station named Kuhiaka, 2,145 feet above sea level (cf. Register Map No. 1449). This zone is called the *wao kanaka* (region of man) and *wao nahele* (forest region). Rainfall increases to 30 or 40 inches annually, and taller forest growth occurred. This region provided native residents with shelter for residential and agricultural uses, and a wide range of natural resources that were of importance for religious, domestic, and economic purposes. In ʻOʻoma, this region is generally between the 1,200 to 2,200 foot elevation, and is crossed by the present-day Māmalahoa Highway. The highway is situated not far below the ancient *ala loa*, or foot trail, also known as Ke-alaʻehu, and was part of a regional trail system passing through Kona from Kaʻū and Kohala.

The ancient Hawaiians saw (as do many Hawaiians today) all things within their environment as being interrelated. That which was in the uplands shared a relationship with that which was in the lowlands, coastal region, and even in the sea. This relationship and identity with place worked in reverse as well, and the *ahupuaʻa* as a land unit was the thread that bound all things together in Hawaiian life. In an early account written by Kihe (in *Ka Hōkū o Hawaiʻi*, 1914-1917), with contributions by John Wise and Steven Desha Sr., the significance of the dry season in Kekaha and the custom of the people departing from the uplands for the coastal region is further described:

> *…ʻOia ka wā e neʻe ana ka lā iā Kona, hele a maloʻo ka ʻāina i ka ʻai kupakupa ʻia e ka lā, a o nā kānaka, nā liʻi o Kona, pūheʻe aku la a noho i kahakai kāhi o ka wai e ola ai nā kānaka* – It was during the season, when the sun moved over Kona, drying and devouring the land, that the chiefs and people fled from the uplands to dwell along the shore where water could be found to give life to the people. (*Ka Hōkū o Hawaiʻi*, April 5, 1917 translated

by Kepā Maly)

It appears that the practice of traveling between upland and coastal communities in the ʻOʻoma *ahupuaʻa* greatly decreased by the middle nineteenth century. Indeed, the only claimant for *kuleana* land in ʻOʻoma, during the *Māhele ʻĀina* of 1848—when native tenants were allowed to lay claim to lands on which they lived and cultivated—noted that he was the only resident in ʻOʻoma at the time (see *Helu* 9162 to Kahelekahi, in this study). This is perhaps explained by the fact that at time of the *Māhele* there was a significant decline in the Hawaiian population, and changes in Hawaiian land tenure led to the relocation of many individuals from various lands.

Native Traditions and Historical Accounts of ʻOʻoma and the Kekaha Region

This section of the study presents *moʻolelo*—native traditions and historical accounts (some translated from the original Hawaiian by Kepā Maly)—of the Kekaha region that span several centuries. There are very few accounts that have been found to date, that specifically mention ʻOʻoma. Thus, narratives that describe neighboring lands within the Kekaha region help provide an understanding of the history of ʻOʻoma, describing features and the use of resources that were encountered on the land.

It may be, that the reason there are so few accounts for ʻOʻoma, is that it may have been considered a marginal settlement area, occupied only after the better situated lands of Kekaha—those lands with the sheltered bays, and where fresh water could be easily obtained—were populated. As the island population grew, so too did the need to expand to more remote or marginal lands. This thought is found in some of the native traditions and early historic accounts below. However, as people populated the Kekaha lands, they came to value its fisheries—those of the deep sea, near shore, and inland fishponds.

The native account of Punia (also written Puniaiki – cf. Kamakau 1964), is perhaps among the earliest accounts of the Kekaha area, and in it is found a native explanation for the late settlement of Kekaha. The following narratives are paraphrased from Fornander's *Hawaiian Antiquities and Folklore* (Fornander 1959):

Punia: A Tale of Sharks and Ghosts of Kekaha

Punia was born in the district of Kohala, and was one of the children of Hina. One day, Punia desired to get lobster for his mother to eat, but she warned him of Kaiʻaleʻale and his hoards of sharks who guarded the caves in which lobster were found. These sharks were greatly feared by all who lived along, and fished the shores of Kohala for many people had been killed by the sharks. Heeding his mother's warning, Punia observed the habits of the sharks and devised a plan by which to kill each of the sharks. Setting his plan in motion, Punia brought about the deaths of all the subordinate sharks, leaving only Kaiʻaleʻale behind. Punia tricked Kaiʻaleʻale into swallowing him whole. Once inside Kaiʻaleʻale, Punia rubbed two sticks together to make a fire to cook the sweet potatoes he had brought with him. He also scraped the insides of Kaiʻaleʻale, causing great pain to the shark. In his weakened state, Kaiʻaleʻale swam along the coast of Kekaha, and finally beached himself at Alula, near the point of Maliu in the land of Kealakehe. The people of Alula, cut open the shark and Punia was released.

At that time Alula was the only place in all of Kekaha where people could live, for all the rest of the area was inhabited by ghosts. When Punia was released from the shark, he began walking along the trail, to return to Kohala. While on this walk, he saw several ghosts with nets all busy tying stones for sinkers to the bottom of the nets, and Punia called out in a chant trying to deceive the ghosts and save himself:

Auwe no hoi kuu makuakane o keia kaha e!	*Alas, O my father of these coasts!*
Elua wale no maua lawaia o keia wahi.	*We were the only two fishermen of this place (Kaha).*
Owau no o koʻu makuakane,	*Myself and my father,*
E hoowili aku ai maua i ka ia o ianei,	*Where we used to twist the fish up in the nets,*

O kala, o ka uhu, o ka palani, *The kala, the uhu, the palani,*
O ka ia ku o ua wahi nei la, *The transient fish of this place.*
Ua hele wale ia no e maua keia kai la! *We have traveled over all these seas,*
Pau na kuuna, na lua, na puka ia. *All the different place, the holes, the runs.*
Make ko'u makuakane, koe au. *Since you are dead, father, I am the only one left.*

Hearing Punia's wailing, the ghosts said among themselves, "Our nets will be of some use now, since here comes a man who is acquainted with this place and we will not be letting down our nets in the wrong place." They then called out to Punia, "Come here." When Punia went to the ghosts, he explained to them, the reason for his lamenting; "I am crying because of my father, this is the place where we used to fish. When I saw the lava rocks, I thought of him." Thinking to trick Punia and learn where all the kuʻuna (net fishing grounds) were, the ghosts told Punia that they would work under him. Punia went into the ocean, and one-by-one and two-by-two, he called the ghosts into the water with him, instructing them to dive below the surface. As each ghost dove into the water, Punia twisted the net entangling the ghosts. This was done until all but one of the ghosts had been killed. That ghost fled and Kekaha became safe for human habitation (Fornander 1959:9-17).

One of the earliest datable accounts that describes the importance of the Kekaha region fisheries comes from the mid-sixteenth century, following ʻUmi-a-Līloa's unification of the island of Hawaiʻi under his rule. Writing in the 1860s, native historian, Samuel Mānaiakalani Kamakau (1961) told readers about the reign of ʻUmi, and his visits to Kekaha:

> ʻUmi-a-Liloa did two things with his own hands, farming and fishing...and farming was done on all the lands. Much of this was done in Kona. He was noted for his skill in fishing and was called Puʻipuʻi a ka lawaiʻa (a stalwart fisherman). Aku fishing was his favorite occupation, and it often took him to the beaches (Ke-kaha) from Kalahuipuaʻa to Makaula[1]. He also fished for ʻahi and kala. He was accompanied by famed fishermen such as Pae, Kahuna, and all of the chiefs of his kingdom. He set apart fishing, farming and other practices… (Kamakau 1961:19-20)

In his accounts of events at the end of ʻUmi's life, Kamakau (1961) references Kekaha once again. He records that Koʻi, one of the faithful supporters and a foster son of ʻUmi, sailed to Kekaha, where he killed a man who resembled ʻUmi. Koʻi then took the body and sailed to Makaʻeo in the *ahupuaʻa* of Keahuolu. Landing at Makaʻeo in the night, Koʻi took the body to the cave where ʻUmi's body lay. Replacing ʻUmi's body with that of the other man, Koʻi then crossed the lava beds, returning to his canoe at Makaʻeo. From there, ʻUmi's body was taken to its' final resting place… (Kamakau 1961:32-33).

As a child in ca. 1812, Hawaiian historian John Papa Iʻi passed along the shores of Kekaha in a sailing ship, as a part of the procession by which Kamehameha I returned to Kailua-Kona from his residency on Oʻahu. In his narratives, Iʻi described the shiny lava flows and fishing canoe fleets of the "Kaha" (Kekaha) lands:

> The ship arrived outside of Kaelehuluhulu, where the fleet for aku fishing had been since the early morning hours. The sustenance of those lands was fish.
>
> When the sun was rather high, the boy [Iʻi] exclaimed, "How beautiful that flowing water is!" Those who recognized it, however, said, "That is not water, but pahoehoe. When the sun strikes it, it glistens, and you mistake it for water…"
>
> Soon the fishing canoes from Kawaihae, the Kaha lands, and Ooma drew close to the ship to trade for the paʻiʻai (hard poi) carried on board, and shortly a great quantity of aku lay

1 Kalāhuipuaʻa is situated in the district of Kohala, bounding the northern side of Puʻuanahulu in Kekaha. Makaʻula is situated a few *ahupuaʻa* north of ʻOʻoma.

silvery-hued on the deck. The fishes were cut into pieces and mashed; and all those aboard fell to and ate, the women by themselves.

The gentle Eka sea breeze of the land was blowing when the ship sailed past the lands of the Mahaiulas, Awalua, Haleohiu, Kalaoas, Hoona, on to Oomas, Kohanaiki, Kaloko, Honokohaus, and Kealakehe, then around the cape of Hiiakanoholae… (I'i 1959:109-110)

Ka-Lani-Kau-i-ke-Aouli (Kamehameha III)

In ca. 1813, Ka-lani Kau-i-ke-aouli, who grew up to become Kamehameha III, was born. S.M. Kamakau (1961) tells us that the baby appeared to be still-born, but that shortly after birth, he was revived. Upon the revival of the baby, he was given to the care of Ka-iki-o-ʻewa, who with Keawe-a-mahi and family, raised the child in seclusion at ʻOʻoma for the first five years of the young king's life. Kauikeaouli apparently held some interest in the land of ʻOʻoma 2nd through the *Māhele ʻĀina*, as he originally claimed ʻOʻoma 2nd as his personal property. Though he subsequently gave it up to the Kingdom (Government) later during the Division (see records of *Māhele ʻĀina* in this study).

Kamakau provides us with the following description of Kauikeaouli's birth and early life at ʻOʻoma:

> Ka-lani-kau-i-ke-aouli was the second son of Ke-opu-o-lani by Kamehameha, and she called him Kiwalaʻo after her own father. She was the daughter of Kiwalaʻo and Ke-kuʻi-apo-iwa Liliha, both children of Ka-Iola Pupuka-o-Hono-ka-wai-lani, and hence she [Ke-opu-o- lani] was a niʻaupiʻo and a naha chiefess, and the niʻaupiʻo rank descended to her children and could not be lost by them. While she was carrying the child [Kau-i-ke-aouli] several of the chiefs begged to have the bringing up of the child, but she refused until her kahu, Ka-lua-i-konahale, known as Kua-kini, came with the same request. She bade him be at her side when the child was born lest some one else get possession of it. He was living this side of Keauhou in North Kona, and Ke-opu-o-lani lived on the opposite side.
>
> On the night of the birth the chiefs gathered about the mother. Early in the morning the child was born but as it appeared to be stillborn Kua-kini did not want to take it. Then came Ka-iki-o-ʻewa from some miles away, close to Kuamoʻo, and brought with him his prophet who said, "The child will not die, he will live." This man, Ka-malo-ʻihi or Ka-pihe by name, came from the Napua line of kahunas descended from Makua-kau-mana whose god was Ka-ʻonohi-o-ka-la (similar to the child of God). The child was well cleaned and laid upon a consecrated place and the seer (kaula) took a fan (peʻahi), fanned the child, prayed, and sprinkled it with water, at the same time reciting a prayer addressed to the child of God, something like that used by the Roman Catholics—
>
> "He is standing up, he is taking a step, he walks" (*Kulia-la, kaʻina-la, hele ia la*).
>
> Or another—

Huila ka lani i ke Akua,	*The heavens lighten with the god,*
Lapalapa ka honua i ke keiki	*The earth burns with the child,*
E ke keiki e, hooua i ka punohu lani,	*O son, pour down the rain that brings the rainbow,*
Aia i ka lani ka Haku e,	*There in heaven is the Lord.*
O kuʻu ʻuhane e kahe mau,	*Life flows through my spirit,*
I laʻa i kou kanawai.	*Dedicated to your law.*

> The child began to move, then to make sounds, and at last it came to life. The seer gave the boy the name of "The red trail" (Ke-aweawe-ʻula) signifying the roadway by which the god descends from the heavens.
>
> Ka-iki-o-ʻewa became the boy's guardian and took him to rear in an out-of-the-way place at ʻOʻoma, Kekaha. Here Keawe-a-mahi, the lesser chiefs, the younger brothers and sisters of Ka-iki-o-ʻewa, and their friends were permitted to carry the child about and hold him on

> their laps (uha). Ka-pololu was the chief who attended him; Koʻi-pepeleleu and Ulu-nui's mother [were] the nurses who suckled him. Later Ka-ʻai-kane gave him her breast after she had given birth to Ke-kahu-puʻu. Here at ʻOʻoma he was brought up until his fifth year, chiefly occupied with his toy boats rigged like warships and with little brass cannon loaded with real powder mounted on [their] decks. The firing off of these cannon amused him immensely. He excelled in foot races. On one occasion when the bigger boys had joined in the sport, a [rascal] boy named Ka-hoa thought to play a practical joke by smearing with mud the stake set up to be grasped by the one who first reached the goal. He expected one of the larger boys to be the winner, but it was the little prince who first caught the stick and had his hands smeared. "You will be burnt alive for dirtying up the prince. We are going to tell Ka-pololu on you!" the boys threatened; but the prince objected, saying, "Anyone who tells on him shall never eat with me again or play with me and I will never give him anything again." Kau-i-ke-aouli was a splendid little fellow. He loved his playmates and never once did them any hurt, and he was kind and obedient to his teachers… [Kamakau 1961:264]

It is not until the early twentieth century, that we find a few detailed native accounts which tell of traditional features and residents of ʻOʻoma and vicinity. The writings of John Whalley Hermosa Isaac Kihe, a native son of Kekaha, in Hawaiian language newspapers (recently translated by Kepā Maly from the original Hawaiian texts), share the history of the land and sense the depth of attachment that native residents felt for ʻOʻoma and the larger Kekaha-wai-ʻole-o-nā-Kona.

> Kihe (who also wrote under the name of Ka-ʻohu-haʻaheo-i-nā-kuahiwi-ʻekolu) was born in 1853, his parents were native residents of Honokōhau and Kaloko (his grandfather, Kuapāhoa, was a famed kahuna of the Kekaha lands). During his life, Kihe taught at various schools in the Kekaha region; served as legal counsel to native residents applying for homestead lands in ʻOʻoma and vicinity; worked as a translator on the Hawaiian Antiquities collections of A. Fornander; and was a prolific writer himself. In the later years of his life, Kihe lived at Puʻu Anahulu and Kalaoa, and he is fondly remembered by elder kamaʻāina of the Kekaha region. Kihe, who died in 1929, was also one of the primary informants to Eliza Maguire, who translated some of the writings of Kihe, publishing them in abbreviated form in her book "Kona Legends" (1926).

Writers today have varying opinions and theories pertaining to the history of Kekaha, residency patterns, and practices of the people who called Kekaha-wai-ʻole-o-nā-Kona home. For the most part, our interpretations are limited by the fragmented nature of the physical remains and historical records, and by a lack of familiarity with the diverse qualities of the land. As a result, most of us only see the shadows of what once was, and it is difficult at times, to comprehend how anyone could have carried out a satisfactory existence in such a rugged land.

Kihe and his co-authors provide readers with several references to places and events in the history of ʻOʻoma and neighboring lands. Through the narratives, we learn of place name origins, areas of ceremonial significance, how resources were managed and accessed, and the practices of those native families who made this area their home.

One example of the rich materials recorded by native writers, is found in "*Kaʻao Hoʻoniua Puʻuwai no Ka-Miki*" (The Heart Stirring Story of Ka-Miki). This tradition is a long and complex account, that was published over a period of four years (1914-1917) in the weekly Hawaiian-language newspaper *Ka Hōkū o Hawaiʻi*. The narratives were primarily recorded for the paper by Hawaiian historians John Wise and J.W.H.I. Kihe.

While "*Ka-Miki*" is not an ancient account, the authors used a mixture of local stories, tales, and family traditions in association with place names to tie together fragments of site-specific histories that had been handed down over the generations. Also, while the personification of individuals and their associated place names may not be entirely "ancient," such place name-person accounts are common throughout Hawaiian (and Polynesian) traditions. The English translations below are a synopsis of the Hawaiian texts, with emphasis upon the main events and areas being discussed. Diacritical marks and hyphenation have been placed to help with pronunciation of certain words.

"Kaao Hooniua Puuwai no Ka-Miki" (The Heart stirring Story of Ka-Miki)

This *moʻolelo* (tradition) is set in the 1300s (by association with the chief Pili-a-Kaʻaiaea), and is an account of two supernatural brothers, Ka-Miki (The quick, or adept, one) and Ma-Kaʻiole (Rat [squinting] eyes). The narratives describe the birth of the brothers, their upbringing, and their journey around the island of Hawaiʻi along the ancient *ala loa* and *ala hele* (trails and paths) that encircled the island. During their journey, the brothers competed alongside the trails they traveled, and in famed *kahua* (contest fields) and royal courts, against *ʻōlohe* (experts skilled in fighting or in other competitions, such as running, fishing, debating, or solving riddles, that were practiced by the ancient Hawaiians). They also challenged priests whose dishonorable conduct offended the gods of ancient Hawaiʻi. Ka-Miki and Ma-Kaʻiole were empowered by their ancestress Ka-uluhe-nui-hihi-kolo-i-uka (The great entangled growth of uluhe fern which spreads across the uplands), who was one of the myriad of body forms of the goddess Haumea, the earth-mother, creative force of nature who was also called Papa or Hina. Among her many nature-form attributes were manifestations that caused her to be called upon as a goddess of priests and competitors (people, places named for them, and other place names are marked below with underlining):

> …Kūmua was the husband of Ka-uluhe-nui-hihi-kolo-i-uka. The place that is named for Kūmua is in the uplands of Kohanaiki, an elevated rise from where one can look towards the lowlands. The shore and deep sea are all clearly visible from this place. The reason that Kūmua dwelt there was so that he could see the children and grandchildren of he and his wife.
>
> Wailoa, a daughter, was the mother of Kapaʻihilani, also called Kapaʻihi. There is a place in the uplands of Kohanaiki, below Kūmua, to the northwest, a hidden water hole, that is called Kapaʻihi. Wailoa is a pond there on the shore of Kohanaiki. Because Wailoa married Kahunakalehu, a native of the area, she lived and worked there. Thus the name of that pond is Wailoa, and it remains so to this day.
>
> Pipipiʻapoʻo was another daughter of Kūmua and Ka-uluhe-nui-hihi-kolo-i-uka. She married Haleolono, one who cultivated sweet potatoes upon the ʻilima covered flat lands of Nānāwale, also called Nāhiʻahu (Nāwahʻiahu), as it has been called from before and up to the present time. Cultivating the land was the skill of this youth Haleolono, and because he was so good at it, he was able to marry the beauty, Pipipiʻapoʻo.
>
> Pipipiʻapoʻo's skill was that of weaving pandanus mats, and there are growing many pandanus trees there, even now. The grove of pandanus trees and a nearby cave, is called Pipipiʻapoʻo to this day, and you may ask the natives of Kohanaiki to point it out to you.
>
> Kapukalua was a son of Kūmua and Kaʻuluhe. He was an expert at aku lure fishing, and all other methods of fishing of those days gone by. He married Kauhiʻonohua a beauty with skin as soft as the blossoms of the hīnano, found in the pandanus grove of ʻOʻoma. This girl was pleasingly beautiful, and because of her fame, Kapukalua, the exceptionally skilled son of the sea spray of ʻApoʻula, secured her as his wife. Here, we shall stop speaking of the elders of Ka-Miki… [January 8, 1914]

The tradition continues, recounting the training of the brothers, and preparations of their *hālau aliʻi* (royal compound) at Kohanaiki. At the dedication ceremonies it was revealed that one of the *kahuna* of the Kaha lands, had taken up the habit of killing people, and that he had also thought to take the lives of Ka-Miki and Ma-Kaʻiole. We revisit the story here, and learn the name of a priest of ʻOʻoma and Kohanaiki—

> …The sun broke forth and the voices of the roosters and the ʻelepaio of the forests were heard resonating and rising upon the mountain slopes. The day became clear, with no clouds to be seen, it was calm. So too, the ocean was calm and the shore of Laʻi a ʻEhu (Kona) was calm. The flowers of the upland forest reddened and unfolded, and nodded gently in the kēhau breezes.

> The priests gathered together to discuss these events and prepared to apologize to the children of the chief, asking for their forgiveness. They selected ‘Elepaio, Pūhili, Kalua‘ōlapa, and Kalua-‘ōlapa-uwila to go before the brothers for this purpose.
>
> ‘Elepaio was the high priest of Honokōhau. The place where he dwelt bears the name ‘Elepaio [an ‘ili on the boundary of Honokōhau nui & iki]. It is in the great grove of *‘ulu (kaulu ‘ulu)* on the boundary between Honokōhau-nui and Honokōhau-iki… [April 23, 1914]
>
> Pūhili was the high priest of ‘O‘oma and Kohanaiki, the place where he lived is on the plain of Kohanaiki, at the shore, and bears his name to this day. It is on the boundary between Kohanaiki and ‘O‘oma.
>
> Kalua‘ōlapa was the high priest of Hale‘ōhi‘u and Kamāhoe, that is the waterless land of Kalaoa (Kalaoa wai ‘ole). The place where he lived was in the uplands of Maulukua on the plain covered with *‘ilima* growth. This place bears his name to this day.
> Kalua-‘ōlapa-uwila was the high priest of Kealakehe and Ke‘ohu‘olu (Keahuolu), and it was he who built the *heiau* named Kalua-‘ōlapa-uwila, which is there along the shore of Kealakehe, next to the road that goes to Kailua. The nature of this priest was that of a shark and a man. The shark form was named Kaiwi, and there is a stone form of the shark that can be seen near the *heiau* to this day.
>
> These priests all went to the door of the house and presented the offerings of the black pig, the red fish, the black *‘awa*, the white rooster, the *malo* (loin clothes), and all things that had been required of their class of priests. They also offered their prayers and asked forgiveness for their misspoken words. They then called for their prayers to be freed and the *kapu* ended… [April 30, 1914]

Through the 1920s, up to the time of his death in 1929, J.W.H.I. Kihe continued to submit traditional accounts and commentary on the changing times to the paper, *Ka Hōkū o Hawai‘i*. In 1923, Kihe penned a series of articles, some of which formed the basis of Eliza Maguire's *Kona Legend*s (1926). One of the accounts, "*Ka Punawai o Wawaloli*" (The Pond of Wawaloli), describes that the pond of Wawaloli, on the shore of ‘O‘oma, was named for a supernatural ocean being, who could take the form of the *loli* (sea cucumber) and of a handsome young man. Through this account it is learned that people regularly traveled between the uplands and shore of ‘O‘oma; the *kula* lands were covered with *‘ilima* growth; and that a variety of fish, seaweeds, and shellfish were harvested along the shore. Also, the main figures in the tradition are memorialized as places on the lands of ‘O‘oma, Kalaoa, and neighboring *ahupua‘a*. These individuals and places include Kalua‘ōlapa (a hill on the boundary of Hāmanamana and Haleohi‘u), Wawaloli (a bay between ‘O‘oma and Kalaoa), Ho‘ohila (on the boundary of Kaū and Pu‘ukala), Pāpa‘apo‘o (a cave site in Hāmanamana), Kamakaoiki and Malumaluiki (locations unknown). The following narratives were translated by Kepā Maly from the original Hawaiian texts published in *Ka Hōkū o Hawai‘i* (September 23rd, October 4th & 11th, 1923):

Ka Punawai o Wawaloli (The Pond of Wawaloli)

> The place of this pond (Wawaloli) is set there on the shore of ‘O‘oma near Kalaoa. It is a little pond, and is there to this day. It is very close to the sandy shore, and further towards the shore there is also a pond in which one can swim. There is a tradition of this pond that is held dearly in the hearts of the elders of this community.
>
> Wawaloli is the name of a loli (sea cucumber) that possessed dual body forms (kino pāpālua), that of a loli, and that of a man!
>
> Above there on the ‘ilima covered flat lands, there lived a man by the name of Kalua‘ōlapa and his wife, Kamakaoiki, and their beautiful daughter, Malumaluiki.
>
> One day the young maiden told her mother that she was going down to the shore to gather

limu (seaweeds), ʻōpihi (limpets), and pupu (shellfish). Her mother consented, and so the maiden traveled to the shore. Upon reaching the shore, Malumaluiki desired to drink some water, so she visited the pond and while she was drinking she saw a reflection in the rippling of the water, standing over her. She turned around and saw that there was a handsome young man there, with a smile upon his face. He said… [September 27, 1923] "…Pardon me for startling you here as we meet at this pond, in the afternoon heat which glistens off of the pāhoehoe."

She responded, "What is the mistake of our meeting, you are a stranger, and I am a stranger, and so we have met at this pond." The youth, filled with desire for the beautiful young maiden, answered "I am not a stranger here along this shore, indeed, I am very familiar with this place for this is my home. And when I saw you coming here, I came to meet you."

These two strangers, having thus met, then began to lay out their nets to catch kala, uhu, and pālani, the native fish of this land. And in this way, the beauty of the plains of Kalaoa was caught in the net of the young man who dwelt in the sea spray of ʻOʻoma.

These two strangers of the long day also fished for hīnālea, and then for kaweleʻā. It was during this time, that their lines became entangled like those of the fishermen of Wailua (a poetic reference to those who become entangled in a love affair).

The desire for the limu, ʻōpihi, and pūpū was completely forgotten, and the fishing poles bent as the lines were pulled back in the sea spray. The handsome youth was moistened in the rains that fell, striking the land and the beloved shore of the land. The sun drew near, entering the edge of the sea and was taken by Lehua Island. Only then did these two fishers of the long day take up their nets.

Before the young maiden began her return to the uplands, she told the youth, "Tell me your name." He answered her, "The name by which I am known is Wawa. But my name, when I go and dwell in the pond here, is Loli. And when you return, you may call to me with the chant:

E Loli nui kīkewekewe[2]	*Oh great Loli moving back and forth*
I ka hana ana kīkewekewe	*Doing your work moving back and forth*
I kuʻu piko kīkewekewe	*You are in my mind moving back and forth*
A ka makua kīkewekewe	*The parents moving back and forth*
I hana ai kīkewekewe	*Are at their work moving back and forth*
E piʻi mai ʻoe kīkewekewe	*Won't you arise moving back and forth*
Ka kaua puni kīkewekewe	*To that which we two desire moving back and forth*
Puni kauoha kīkewekewe	*Your command is desired moving back and forth*

Having finished their conversation, the maiden then went to the uplands. It was dark, and the kukui lamps had been lit in the house. Malumaluiki's parents asked her, "Where are your limu, ʻōpihi and pūpū?" She replied, "It is proper that you have asked me, for when I went to the shore it was filled with people who took all there was? Thus I was left with nothing, not even a fragment of limu or anything else. So I have returned up here."

Well, the family meal had been made ready, so they all sat to eat together. But after a short while the maiden stood up. Her parents inquired of this, and she said she was no longer hungry, and that her feet were sore from traveling the long path. So the maiden went to sleep. She did not sleep well though, and felt a heat in her bosom, as she was filled with desire, thus she had no sleep that night.

2 "Kīkewekewe" is translated by Eliza Maguire (1926) as "charmer." Kepā Maly was unfamiliar with this meaning of the word. It is most commonly used in the refrain of a song, and is here translated as "moving back and forth," as the word is used in the spoken language. Kewe also means concave, similar to the place name ʻOʻoma.

With the arrival of the first light of day, the Malumaluiki went once again down to the shore. Upon arriving at the place of the pond, she entered the water and called out as described above. Then, a loli appeared and turned into the handsome young man. They two then returned to their fishing for the kala, uhu and pālani, the native fish the land.

So it was that the two lovers met regularly there on the shore of ʻOʻoma. Now Malumaluiki's parents became suspicious because of the actions of the daughter, and her regular trips to the shore. So they determined that they should secretly follow her and spy on her.

One day, the father followed her to the shore, where he saw his daughter sit down by the side of the pond. He then heard her call out —

E Loli nui kīkewekewe	*Oh great Loli moving back and forth*
I ka hana ana kīkewekewe	*Doing your work moving back and forth*
I kuʻu piko kīkewekewe	*You are the center of my life moving back and forth*
Piko maikaʻi kīkewekewe	*It is good moving back and forth*
A ka makua kīkewekewe	*The parents moving back and forth*
I hana ai kīkewekewe	*Are at their work moving back and forth*
E piʻi mai ʻoe kīkewekewe	*Won't you arise moving back and forth*
Ka kaua puni kīkewekewe	To that which we two desire *moving back and forth*
Puni kauoha kīkewekewe	*Your command is desired moving back and forth*
[October 4, 1923]	

"O Loli, here is your desire, the one you command, Malumaluiki, who's eyes see nothing else."

Her father then saw a loli coming up from the pond, and when it was up, it turned into the youth. He watched the two for a while, unknown to them, and saw that his daughter and the youth of the two body forms (kino pāpālua), took their pleasure in one another.

The father returned to the uplands and told all of this to her mother, who upon hearing it, was filled with great anger, because of the deceitfulness of her daughter. But then she learned that the man with whom her daughter slept was of dual body forms. Kamakaoiki then told Kaluaʻōlapa that he should "Go down and capture the loli, and beat it to death," to which he agreed.

One day, Kaluaʻōlapa went down early, and hid, unseen by the two lovers. Malumaluiki arrived at the pond and called out, and he then memorized the lines spoken by his daughter. When she left, returning to the uplands, he then went to the pond and looked closely at it. He then saw a small circular opening near the top of the water in the pond. He then understood that that was where the loli came up from. He then slept that night and in the early morning, he went to the pond and set his net in the water. He then began to call out as his daughter had done with the above words.

When he finished the chant, the loli began to rise up through the hole, and was ensnared in the net. Kaluaʻōlapa then carried him up onto the kula, walking to the uplands. On his way, he saw his daughter coming down, and he hid until she passed him by.

When the daughter arrived at the pond, she called out in the chant as she always did. She called and called until the sun was overhead, but the loli did not appear in the pond, nor did he come forward in his human form. Thus, she thought that he had perhaps died, and she began to wail and mourn for the loss of her lover. Finally as evening came, the beautiful maiden stood, and ascended the kula to her home.

Now, let us look back to the Kalua‘ōlapa. He went up to his house and showed the loli to his wife. Seeing the loli, she told her husband, “Take it to the kahuna, Pāpa‘apo‘o who lives on the kula of Ho‘ohila.” So he went to the kahuna and explained everything that had occurred to him, and showed him the loli in his net. Seeing this and hearing of all that had happened, Pāpa‘apo‘o told the father to build an imu in which to kālua the great loli that moves back and forth (loli kīkewekewe). He said, “When the loli is killed, then your daughter will be well, so too will be the other daughters of the families of the land.” Thus, the imu was lit and the supernatural loli cooked.

When the daughter returned to her home, her eyes were all swollen from crying. Her mother asked her, “What is this, that your eyes are puffy from crying, my daughter?” She didn’t answer, she just kneeled down, giving no response. At that time, her father returned to the house and saw his daughter kneeling down, and he said “Your man, with whom you have been making love at the beach has been taken by the kahuna Pāpa‘apo‘o. He has been cooked in the imu that you may live, that all of the girls who this loli has loved may live.”

That pond is still there on the shore, and the place with the small round opening is still on the side of that pond to this day. It is something to remember those things of days gone by, something that should not be forgotten by those of today and in time to come. [October 11, 1923]

Ka Loko o Paaiea (The fishpond of Pā‘aiea)

The tradition of *Ka loko o Paaiea* (The fishpond of Pā‘aiea) was written by J.W.H.I. Kihe, and printed in *Ka Hōkū o Hawai‘i* in 1914 and 1924. The narratives describe traditional life and practices in various *ahupua‘a* of Kekaha, and specifically describes the ancient fishpond Pā‘aiea. The following excerpts from Kihe’s *mo‘olelo*, include references to Wawaloli, on the shore of ‘O‘oma and Kalaoa. Pā‘aiea, was destroyed by the Hualālai lava flows of 1801, reportedly as a result of the pond overseer’s refusal to give the goddess Pele—traveling in human form—any fish from the pond:

Pā‘aiea was a great fishpond, something like the ponds of Wainānāli‘i and Kīholo, in ancient times. At that time the high chiefs lived on the land, and these ponds were filled with fat awa, ‘anae, āhole, and all kinds of fish that swam inside. It is this pond that was filled by the lava flows and turned into pāhoehoe, that is written of here. At that time, at Ho‘onā. There was a Konohiki (overseer), Kepa‘alani, who was in charge of the houses (hale papa‘a) in which the valuables of the King [Kamehameha I] were kept. He was in charge of the King’s food supplies, the fish, the hālau (long houses) in which the fishing canoes were kept, the fishing nets and all things. It was from there that the King’s fishermen and the retainers were provisioned. The houses of the pond guardians and Konohiki were situated at Ka‘elehuluhulu and Ho‘onā.

In the correct and true story of this pond, we see that its boundaries extended from Ka‘elehuluhulu on the north, and on the south, to the place called Wawaloli (between ‘O‘oma and Kalaoa). The pond was more than three miles long and one and a half miles wide, and today, within these boundaries, one can still see many water holes.

While traveling in the form of an old woman, Pele visited the Kekaha region of Kona, bedecked in garlands of the *ko‘oko‘olau* (*Bidens* spp.). Upon reaching Pā‘aiea at Ho‘onā, Pele inquired if she might perhaps have an *‘ama‘ama*, young *āholehole*, or a few *‘ōpae* (shrimp) to take home with her. Kepa‘alani, refused, “they are *kapu*, for the King.” Pele then stood and walked along the *kuapā* (ocean side wall) of Pā’aiea till she reached Ka‘elehuluhulu. There, some fishermen had returned from aku fishing, and were carrying their canoes up onto the shore…

…Now because Kepa‘alani was stingy with the fishes of the pond Pā‘aiea, and refused to give any fish to Pele, the fishpond Pā‘aiea and the houses of the King were all destroyed by the lava flow. In ancient times, the canoe fleets would enter the pond and travel from

> Ka‘elehuluhulu to Ho‘onā, at Ua‘u‘ālohi, and then return to the sea and go to Kailua and the other places of Kona. Those who traveled in this manner would sail gently across the pond pushed forward by the ‘*Eka* wind, and thus avoid the strong currents which pushed out from the point of Keāhole
>
> It was at Ho‘onā that Kepa‘alani dwelt, that is where the houses in which the chiefs valuables (*hale papa‘a*) were kept. It was also one the canoe landings of the place. Today, it is where the light house of America is situated. Pelekāne (in Pu‘ukala) is where the houses of Kamehameha were located, near a stone mound that is partially covered by the *pāhoehoe* of Pele. If this fishpond had not been covered by the lava flows, it would surely be a thing of great wealth to the government today… [J.W.H.I. Kihe in *Ka Hoku o Hawaii*; compiled and translated by Kepā Maly, from the narratives written February 5-26, 1914 and May 1-15, 1924].

Na Ho‘omanao o ka Manawa (The Recollections of a Native Son)

Later in 1924, Kihe, described the changes which had occurred in the Kekaha region since his youth. In the following article, titled *Na Ho‘omanao o ka Manawa* (in *Ka Hōkū o Hawai‘i* June 5th & 12th 1924), Kihe wrote about the villages that were once inhabited throughout Kekaha, identifying families, practices, and schools of the historic period (ca. 1860-1924). In the two part series (translated by Kepā Maly), he also shared his personal feelings about the changes that had occurred, including the demise of the families and the abandonment of the coastal lands of Kekaha.

> There has arisen in the mind of the author, some questions and thoughts about the nature, condition, living, traveling, and various things that bring pleasure and joy. Thinking about the various families and the many homes with their children, going to play and strengthening their bodies.
>
> In the year 1870, when I was a young man at the age of 17 years old, I went to serve as the substitute teacher at the school of <u>Honokōhau</u>. I was teaching under William G. Kanaka‘ole who had suffered an illness (ma‘i-lolo, a stroke).
>
> In those days at the Hawaiian Government Schools, the teachers were all Hawaiian and taught in the Hawaiian language. In those days, the students were all Hawaiian as well, and the books were in Hawaiian. The students were all Hawaiian… There were many, many Hawaiian students in the schools, no Japanese, Portuguese, or people of other nationalities. Everyone was Hawaiian or part Hawaiian, and there were only a few part Hawaiians.
>
> The schools included the school house at <u>Kīholo</u> where Joseph W. Keala taught, and later J.K. Ka‘ailuwale taught there. At the school of <u>Makalawena</u>, J. Ka‘elemakule Sr., who now resides in Kailua, was the teacher. At the <u>Kalaoa</u> School, J.U. Keawe‘ake was the teacher. There were also others here, including myself for four years, J. Kainuku, and J.H. Olohia who was the last one to teach in the Hawaiian language. At <u>Kaloko</u>, Miss Ka‘aimahu‘i was the last teacher before the Kaloko school was combined as one with the Honokōhau school where W.G. Kanaka‘ole was the teacher. I taught there for two years as well... [Kihe includes additional descriptions on the schools of Kona]
>
> It was when they stopped teaching in Hawaiian, and began instructing in English, that significant changes took place among our children. Some of them became puffed up and stopped listening to their parents. The children spoke gibberish (English) and the parents couldn’t understand (*nā keiki namu*). Before that time, the Hawaiians weren’t marrying too many people of other races. The children and their parents dwelt together in peace with the children and parents speaking together… [June 5, 1924]

…Now perhaps there are some who will not agree with what I am saying, but these are my true thoughts. Things which I have seen with my own eyes, and know to be true…In the year 1870 when I was substitute teaching at Honokōhau for W.G. Kanakaʻole, I taught more than 80 students. There were both boys and girls, and this school had the highest enrollment of students studying in Hawaiian at that time [in Kekaha]. And the students then were all knowledgeable, all knew how to read and write.

Now the majority of those people are all dead. Of those things remembered and thought of by the people who yet remain from that time in 1870; those who are here 53 years later, we cannot forget the many families who lived in the various (*ʻāpana*) land sections of Kekaha.

From the lands of Honokōhau, Kaloko, Kohanaiki, the lands of ʻOʻoma, Kalaoa, Haleʻohiʻu, Makaʻula, Kaū, Puʻukala-ʻŌhiki, Awalua, the lands of Kaulana, Mahaiʻula, Makalawena, Awakeʻe, the lands of Kūkiʻo, Kaʻūpūlehu, Kīholo, Keawaiki, Kapalaoa, Puʻuanahulu, and Puʻuwaʻawaʻa. These many lands were filled with people in those days.

There were men, women, and children, the houses were filled with large families. Truly there were many people [in Kekaha]. I would travel around with the young men and women in those days, and we would stay together, travel together, eat together, and spend the nights in homes filled with aloha.

The lands of Honokōhau were filled with people in those days, there were many women and children with whom I traveled with joy in the days of my youth. Those families are all gone, and the land is quiet. There are no people, only the rocks remain, and a few scattered trees growing, and only occasionally does one meet with a man today [1924]. One man and his children are all that remain.

Kaloko was the same in those days, but now, it is a land without people. The men, the women, and the children are all gone, they have passed away. Only one man, J.W. Haʻau, remains. He is the only native child (keiki kupa) besides this author, who remains.

At Kohanaiki, there were many people on this land between 1870 and 1878. These were happy years with the families there. In those years Kaiakoili was the haku ʻāina (land overseer)...

Now the land is desolate, there are no people, the houses are quiet. Only the houses remain standing, places simply to be counted. I dwelt here with the families of these homes. Indeed it was here that I dwelt with my kahu hānai (guardian), the one who raised me. All these families were closely related to me by blood. On my fathers' side, I was tied to the families of Kaloko [J.W.H.I. Kihe's father was Kihe, his grandfather was Kuapāhoa, a noted kahuna of Kaloko]. I am a native of these lands.

The lands of ʻOʻoma, and Kalaoa, and all the way to Kaulana and Mahaiʻula were also places of many people in those days, but today there are no people. At Mahaiʻula is where the great fishermen of that day dwelt. Among the fishermen were Poʻokoʻai mā, Pāʻaoʻao senior, Kaʻao mā, Kaiʻa mā, Kaʻāʻīkaula mā, Pāhia mā, and John Kaʻelemakule Sr., who now dwells at Kailua.

Kaʻelemakule moved from this place [Mahaiʻula] to Kailua where he prospered, but his family is buried there along that beloved shore (kapakai aloha). He is the only one who remains alive today… At Makalawena, there were many people, men, women, and their children. It was here that some of the great fishermen of those days lived as well. There were many people, and now, they are all gone, lost for all time.

Those who have passed away are Kahaʻialiʻi mā, Mamaʻe mā, Kapehe mā, Kauaionuʻuanu mā, Hopulāʻau mā, Kaihemakawalu mā, Kaomi, Keoni Aihaole mā, and Pahukula mā. They are all gone, there only remains the son-in-law of Kauaionuʻuanu, J.H. Mahikō, and Jack Punihaole, along with their children, living in the place where Kauaionuʻuanu and Ahu once lived.

At Kūkiʻo, not one person remains alive on that land, all are gone, only the ʻaʻā remains. It is the same at Kaʻūpūlehu, the old people are all gone, and it is all quiet… [June 12, 1924]

Ko Keoni Kaelemakule Moolelo Ponoi – Kakau ponoi ia mai no e ia (The True Story of John Kaʻelemakule – Actually written by him[3])

In the period between 1928 and 1930, John Kaʻelemakule Sr., who was a native of Kekaha, living at Mahaiʻula, Kaulana and Kohanaiki, wrote a series of articles that were published in serial form in *Ka Hōkū o Hawaiʻi*. The story is a rich account of life in Kekaha between 1854 and 1900. Kaʻelemakule's texts introduce us to the native residents of Kekaha, and include descriptions of the practices and customs of the families who resided there. In the following excerpts from Kaʻelemakule's narratives (translated by Kepā Maly), we find reference once again to ʻOʻoma and neighboring lands, and the practices associated with procuring water in this region:

> *"Kekaha Wai Ole o na Kona"* (Waterless Kekaha of Kona)
>
> …We have seen the name "Kekaha wai ole o nā Kona" since the early part of my story in *Ka Hōkū o Hawaiʻi*, and we have also seen it in the beautiful tradition of Mākālei. An account of the boy who dwelt in the uplands of Kekaha wai ʻole, that was told by Ka-ʻohu-haʻaheo-i-nā-kuahiwi-ʻekolu [the penname used by J.W.H.I. Kihe]. I think that certain people may want to know the reason and meaning of this name. So it is perhaps a good thing for me to explain how it came about. The source of it is that in this land of Kekaha even in the uplands, between Kaulana in the north and ʻOʻoma in the south, there was no water found even in the ancient times. For a little while, I lived in the uplands of Kaulana, and I saw that this land of Kekaha was indeed waterless.
>
> The water for bathing, washing one's hands or feet, was the water of the banana stump (*wai pūmaʻia*). The *pūmaiʻa* was grated and squeezed into balls to get the juice. The problem with this water is that it makes one itchy, and one does not really get clean. There were not many water holes, and the water that accumulated from rain dried up quickly. Also there would be weeks in which no rain fell… The water which the people who lived in the uplands of Kekaha drank, was found in caves. There are many caves from which the people of the uplands got water… [September 17, 1929:3]
>
> …The *kūpuna* had very strict *kapu* (restrictions) on these water caves. A woman who had her menstrual cycle could not enter the caves. The ancient people kept this as a sacred *kapu* from past generations. If a woman did not know that her time was coming and she entered the water cave, the water would die, that is, it would dry up. The water would stop dripping. This was a sign that the *kapu* of Kāne-of-the-water-of-life (Kaneikawaiola) had been desecrated. Through this, we learn that the ancient people of Kekaha believed that Kāne was the one who made the water drip from within the earth, even the water that entered the sea from the caves. This is what the ancient people of Kekaha wai ʻole believed, and there were people who were *kiaʻi* (guardians) who watched over and cleaned the caves, the house of Kāne… [September 24, 1929:3]
>
> When the *kapu* of the water cave had been broken, the priest was called to perform a ceremony and make offerings. The offerings were a small black pig; a white fish, and *āholehole*; young taro leaves; and *awa*. When the offering was prepared, the priest would

[3] This account was published in serial form in the Hawaiian newspaper *Ka Hōkū o Hawaiʻi*, from May 29, 1928 to March 18, 1930. The translated excerpts in this section include narratives that describe Mahaiʻula and nearby lands in Kekaha with references to families, customs, practices, ceremonial observances, and sites identified in text. The larger narratives also include further detailed accounts of Kaʻelemakule's life, and business ventures. A portion of the narratives pertaining to fishing customs (November 13, 1928 to March 12, 1929), and canoeing practices (March 19 to May 21, 1929) were translated by M. Kawena Pukui, and may be viewed in the Bishop Museum-Hawaiian Ethnological Notes (BPBM Archives).

chant to Kane:

E Kane i uka, e Kane i kai,	*O Kane in the uplands, O Kāne at the shore,*
E Kane i ka wai, eia ka puaa,	*O Kane in the water, here is the pig,*
Eia ka awa, eia ka luau,	*Here is the ʻawa, here are the taro greens,*
Eia ka ia kea.	*Here is the white fish.*

Then all those people of the uplands and coast joined together in this offering, saying:

He mohai noi keia ia oe e Kane,	*This is a request offering to you o Kāne,*
E kala i ka hewa o ke kanaka i hana ai,	*Forgive the transgression done by man,*
A e hoomaemae i ka hale wai,	*Clean the water house (source),*
A e hoonui mai i ka wai o ka hale,	*Cause the water to increase in the house,*
I ola na kanaka,	*That the people may live,*
Na ohua o keia aina wai ole.	*Those who are dependent on this waterless land.*
Amama.	*It is finished…*

[October 1, 1929:3; Kepā Maly, translator]

It is not surprising today, when we hear of caves in which cultural materials are found. Along trails, near residences, and in once remote areas, a wide range of uses occurred. Caves in the Kekaha lands were used to store items, keep planting shoots cool and fresh for the next season, to hide or take shelter in, to catch water, and as burial sites.

Land Tenure in ʻOʻoma and Vicinity

Through the traditions and early historical accounts cited above, we see that there are descriptions of early residences and practices of the native families on the lands of ʻOʻoma and within greater Kekaha. Importantly, we find chiefly associations with the land of ʻOʻoma 2nd, as documented by the residency of the chiefs Kaikioʻewa, Keaweamahi, their families and retainers, while they were serving as the guardians of the young king, Kauikeaouli (Kamehameha III in ca. 1813-1818) (Kamakau 1961; Gov. Kapeau, 1847 correspondence reproduced in this study). Among the earliest government records documenting residency in ʻOʻoma and vicinity, are those of the *Māhele ʻĀina* (Land Division), Interior and Taxation Departments, Roads and Public Works, and the Government Survey Division.

This section of the study describes land tenure (residency and land use) and identifies families associated with ʻOʻoma and it's neighboring lands. The documentation is presented in chronologically within the following subsections, The *Māhele ʻĀina* (1848): Disposition of ʻOʻoma, Land Grants in ʻOʻoma and Vicinity (1855-1864), The Government Homesteading Program in Kekaha, Field Surveys of J.S. Emerson (1882-1889), and Trails and Roads of Kekaha (Governmental Communications).

A review of the records below reveals that none of the claims by native tenants made during the *Māhele*, or any of the applications for Royal Patent Grants, included lands that are a part of the current development area.

The *Māhele ʻĀina* (1848): Disposition of ʻOʻoma

In Precontact Hawaiʻi, all land, ocean, and natural resources were held in trust by the high chiefs (*aliʻi ʻai ahupuaʻa* or *aliʻi ʻai moku*). The use of land, fisheries and other resources were given to the *hoaʻāina* (native tenants) at the prerogative of the *aliʻi* and their representatives or land agents (*konohiki*), who were considered lesser chiefs. By 1845, the Hawaiian system of land tenure was being radically altered, and the foundation for implementing the *Māhele ʻĀina* was set in place, which led to the current system of fee-simple land ownership.

As the *Māhele* evolved, it defined the land interests of Kauikeaouli (King Kamehameha III), some 252 high-ranking *Aliʻi* and *Konohiki*, and the Government. As a result of the *Māhele*, all land in the Kingdom of Hawaiʻi came to be placed in one of three categories: (1) Crown Lands (for the occupant of the throne); (2) Government Lands; and (3) *Konohiki* Lands (cf. Indices of Awards 1929). The "Enabling" or "*Kuleana Act*" of the *Māhele* (December 21, 1849) further defined the frame work by which *hoa'āina* (native tenants) could apply for, and be granted fee-simple interest in "*Kuleana*" lands (cf. Kamakau in *Ke Au Okoa* July 8 & 15, 1869; 1961:403-403). The *Kuleana Act* also reconfirmed the rights of *hoa'āina* to access, subsistence and collection of resources necessary to their life upon the land in their given *ahupua'a* ("Enabling Act"[4], August 6, 1850 – HSA DLNR 2-4).

In the *Buke Kakau Paa no ka Mahele Aina* (Land Division Book), between Kamehameha III and his supporters, we learn that by the time of the *Māhele 'Āina*, 'O'oma was divided into two *ahupua'a*, 'O'oma 1st and 2nd. 'O'oma 1st was claimed by Moses Kekūāiwa (brother of Kamehameha IV and V, and Victoria Kamāmalu), one of the children of Kīna'u and M. Kekūanao'a, thus, a grandson of Kamehameha I. 'O'oma 2nd was held by Kamehameha III (*Buke Māhele*, January 27, 1848:13-14). On March 8, 1848, Kamehameha III assigned his interest in 'O'oma 2nd to the Government land inventory (*Buke Māhele*, 1848:183).

Moses Kekūāiwa died on November 24, 1848, and his father, Mataio Kekūanao'a, administrator of the estate, relinquished in commutation, his rights to 'O'oma 1st, giving the land over to the Government land inventory (Foreign Testimony Volume 3:408). Thus, both 'O'oma 1st and 2nd were assigned to the Government Land inventory (Government Lands - Indices of Awards 1929:10).

In 2000, Kumu Pono Associates digitized the entire collection of handwritten records from the *Māhele 'Āina*. Most of the records are in the Hawaiian language. An extensive review of all the records identifies only one native tenant who filed a claim of residency and land use in 'O'oma during the *Māhele*. The claim—*Helu* 9162, by Kahelekahi—was not awarded, and except for an entry in Native Register Volume 8 (Figure 6), there is no further record of the claim. Below, is a copy of the original Hawaiian text from the Native Register. The account is of particular interest as Kahelekahi reported that in 1848, he was the only resident in 'O'oma:

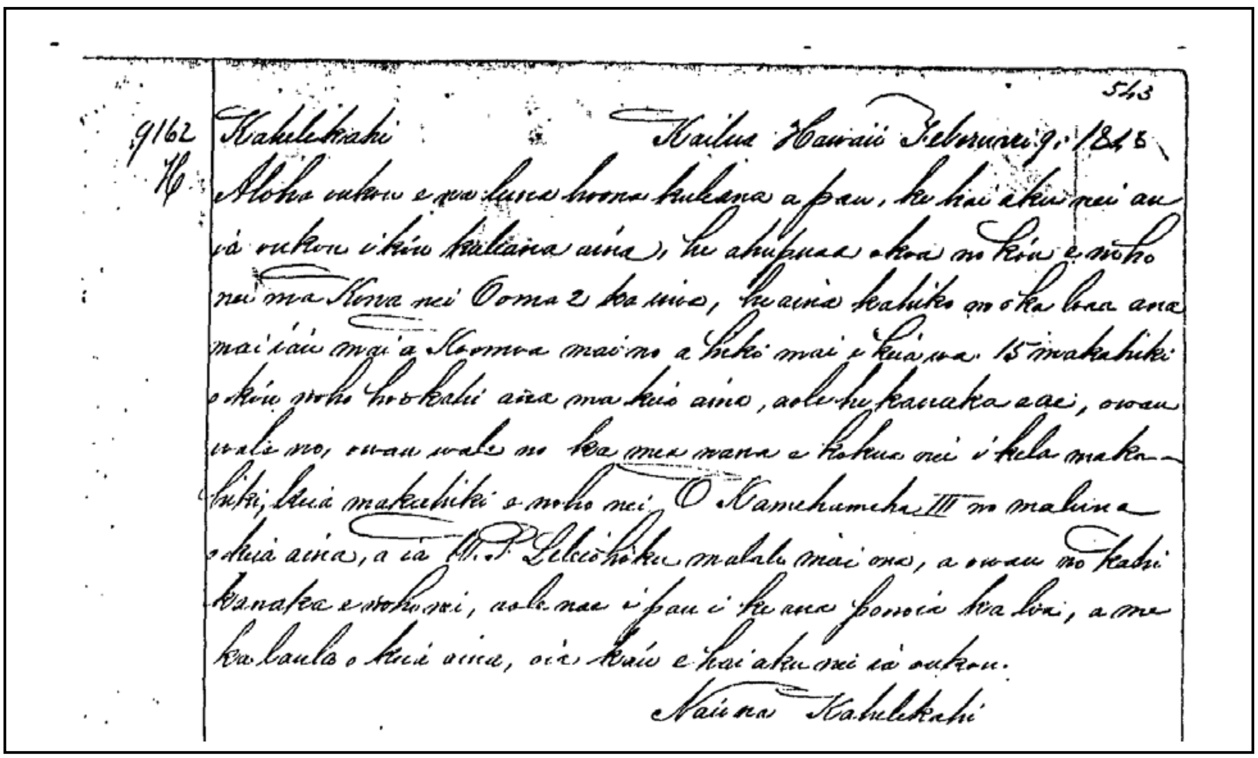
543
9162 H Kahelekahi Kailua Hawaii Feberuari 9, 1848
Aloha oukou e na luna hoona kuleana a pau, ke hai aku nei au ia oukou i ko'u kuleana aina, he ahupuaa koa no ko'u e noho nei ma Kona nei Ooma 2 ka inoa, he aina kahiko no o ka loaa ana mai ia'u mai a Moomoa mai no a hiki mai i keia wa. 15 makahiki o ko'u noho hookahi ana ma keia aina, aole he kanaka e ae, owau wale no, owau wale no ka mea nana e hoohua nei i kela makahiki, keia makahiki e noho nei. O Kamehameha III no maluna o keia aina, a ia M. P. Leleiohoku malalo mai ona, a owau no kahi kanaka e noho nei, aole nae i pau i ke ana ponoia ka loa, a me ka laula o keia aina, oia ko'u e hai aku nei ia oukou.
Na'u na Kahelekahi

Figure 6. Copy of Native Register Vol. 8:543 Helu 9162, claim of Kahelekahi for *kuleana* at 'O'oma.

4 See also *"Kanawai Hoopai Karaima no ko Hawaii Pae Aina"* (Penal Code) 1850.

Kahelekahi – Helu 9162
Kailua, Hawaii February 9, 1848
Greetings to all of you commissioner who quiet land titles, I hereby tell you of my claim for land. I have an entire ahupuaa situated there in Kona, it's name is Ooma 2. It is an old land gotten by me from Koomoa, and held to this time. For 15 years, I have been the only one residing on this land, there are no other people, only me. I am the only one, there is no one living here to help from one year to the next year. Kamehameha III is the one above, who has this land, and W.P. Leleiohoku is below him, and I am the one man dwelling there. The survey of the length and width of this land is not accurately completed. That is what I have to tell you.

Done by me, Kahelekahi
[Native Register Vol. 8:543; translated by Kepā Maly]

In 1849, S. Haanio, Tax Assessor of North Kona, submitted a report to the Board of Education regarding those individuals who were subject to the Tuesday Tax Laws (*Poalua*), to be worked as a part of the School Tax requirements of the time. At the time of Haanio's report, three individual families were identified as residents of ʻOʻoma. Residents in the neighboring lands of Kalaoa and Kohanaiki were also listed, they were:

Kalaoa: 1. Kila, 2. Piena, 3. Nakuala, 4. Kupono, 5. Loa, 6. Kaeha, 7. Keliipuipui, 8. Kapuolokai, 9. Kaainoa, 10. Paina, 11. Kalimaonaona, 12. Kaikeleaukai, 13. Kanahele, 14. Kukaani, 15. Kupuai, and 16. Helekahi[5]

Ooma: 1. Kalua, 2. Kamaka and 3. Mamali

Kohanaiki: 1. Hulikoa, 2. Kaoeno, 3. Honolii and 4. Awa [HSA – Series 262, Hawaii 1849].

Unfortunately, there is no indication of where Kalua, Kamaka, and Mamali were living in ʻOʻoma at the time. Based on traditional patterns of residency in the region, it is likely that they had primary residences in the uplands, near sheltered *māla ʻai* (agricultural fields), and kept near shore residences for seasonal fishing, collection of salt, and other resources of the coastal zone. Of the three names given for ʻOʻoma, descendants of the Kalua and Kamaka lines are known to still be residing in the Kekaha region.

Land Grants in ʻOʻoma and Vicinity (1855-1864)

In conjunction with the *Māhele*, the King also authorized the issuance of Royal Patent Grants to applicants for tracts of land, larger than those generally available through the Land Commission. The process for applications was set forth by the "Enabling Act" of August 6, 1850, which set aside portions of government lands for grants.

Section 4. Resolved that a certain portion of the Government lands in each Island shall be set apart, and placed in the hands of special agents to be disposed of in lots of from one to fifty acres in fee simple to such natives as may not be otherwise furnished with sufficient lands at a minimum price of fifty cents per acre. [HSA – "Enabling Act" Series DLNR 2-4]

The Kingdoms' policy of providing land grants to native tenants was further clarified in a communication from Interior Department Clerk, A. G. Thurston, on behalf of Keoni Ana (John Young), Minister of the Interior; to J. Fuller, Government Land Agent-Kona:

February 23, 1852
…His Highness the Minister of the Interior instructs me to inform you that he has and does hereby appoint you to be Land Agent for the District of Kona, Hawaii. You will entertain no application for the purchase of any lands, without first receiving some part, say a fourth or fifth of the price; then the terms of sale being agreed upon between yourself and the applicant you will survey the land, and send the survey, with your report upon the same to

[5] Helekahi or Kahelekahi – the one who made a claim for a *kuleana* in ʻOʻoma during the Māhele (Helu 9162).

this office, for the Approval of the Board of Finance, when your sales have been approved you will collect the balance due of the price; upon the receipt of which at this office, the Patent will be forwarded to you.

Natives who have no claims before the Land Commission have no Legal rights in the soil.

They are therefore to be allowed the first chance to purchase their homesteads. Those who neglect or refuse to do this, must remain dependant upon the mercy of whoever purchases the land: as those natives now are who having no kuleanas are living on lands already Patented, or belonging to Konohikis.

Where lands have been granted, but not yet Patented, the natives living on the land are to have the option of buying their homesteads, and then the grant be located, provided this can be done so as not to interfere with them.

No Fish Ponds are to be sold, neither any landing places.

As a general thing you will charge the natives but 50 cents pr. acre, not exceeding 50 acres to any one individual.

Whenever about to survey land adjoining that of private individuals, notice must be given them or their agents to be present and point out their boundaries… [Interior Department Letter Book 3:210-211]

Between 1855 and 1864, at least six applications were made for land in the *ahupua'a* of 'O'oma, and four of them were patented. The applications were made by:

Grant	Applicant	Land	Acreage	Book and Year
1590	Kauhini	Hamanamana, Kalaoa and Ooma 1	1,816	8:1855 (canceled)
1599	J. Hall	Ooma 2	101.33	8:1855 (canceled)
1600	Kaakau	Ooma 2	58.5	8:1855
2027	Kameheu	Ooma 2	101.33	11:1856 (same area as Grant 1599)
2031	Koanui	Ooma 1	24.5	11:1856
2972	Kaakau & Kama	Kalaoa 5 & Ooma 1	515	14:1864

["Index of all Grants Issued…Previous to March 31, 1886;" 1887]

The grants to Ka'akau and Kameheu in 'O'oma 2nd were patented by 1859, as recorded in the following letter:

April 8, 1859
S. Spencer, Interior Department Clerk;
to Lot Kamehameha, Minister of the Interior;
Lands in Puaa and Ooma 2 in Kona, Hawaii which were sold by the Government Agent:

Royal Patent 1600, Kaakau 58 50/100 acres in Ooma	$29.25
Royal Patent 2027, Kameheu, 101 33/100 acres in Ooma	$38.00

[HSA – Interior Department, Lands]

In the years following issuance of the first Royal Patents in 'O'oma and vicinity, native tenants and others continued to express interest in the lands of 'O'oma and neighboring *ahupua'a*. Applications were made to either lease or purchase portions of the remaining government lands. In 1865, Government Surveyor and Land

Agent, S.C. Wiltse, wrote to the Minister of the Interior, describing the condition and status of the lands remaining to the government.

September 5, 1865
S.C. Wiltse, Government Surveyor and Land Agent;
to F.W. Hutchinson, Minister of the Interior.
Kona Hawaii. Government Lands in this District not Sold;
also those Sold and Not Patented:

…"Kalaoa 5th"
Not in the Mahele book but believed to be Gov't. land. This land above the Govt. Road has been sold and Patented. Below the road I have surveyed 515 acres which was sold by Sheldon to "Kaakau" & "Kama" who payed him $165.00. As no valuation was made of this land per acre by Sheldon I afterwards valued it myself as follows, 300 Ac. at 50 cts. per acre, 215 at 25 cts. per Ac. The balance due according to this valuation including Patent was $42.75 which was payed to me in March 1864 and forwarded by me to your office. The survey of this land is in your office. If the payments made are satisfactory, these men would be very glad to get their Patent.

This is a piece of 3rd rate land, used only as goat pasture, no improvements on it. Makai of this survey is about 400 Ac. remaining to the Govt., but of very little value.

"Ooma 1st & 2nd"
The best part of these lands have been sold, there remains to the Govt. the forest part, 2 or 300 Ac., and the makai part some 1500 Ac., about 500 of which is 3rd rate land, the balance rocks.

"Kohanaiki"
The forest part of this land is all that remains to the Gov't., this is extensive, extending to the mauka side of the forest. It may contain 1500 to 2000 Ac.

The makai part of this land containing 220 Ac. has been sold both by Sheldon and myself. In April 1863 I was surveying in Kona when "Nahuina" (who lives on the adjoining land of "Kaloko") applied to me to survey the makai part of the Gov't. land Kohanaiki which he wished to purchase. I inquired whether he had applied to Sheldon for this lands (Sheldon was then in Honolulu) he told me that he had not, but would do so immediately, if it was necessary he would go to Honolulu for that purpose. I told him that I was then writing to Sheldon and I would make the application for him which I did, but never got an answer. I wrote several times to him about that time, for information about Gov't. lands, but he declined to answer my letters.

On the 30th of May following, I surveyed said piece of land for "Nahuina." When I was making this survey "Kapena" (who bought this land from Sheldon) was present, and afterwards went to Honolulu and payed Sheldon for this land.

"Nahuina" had the money then to pay for this land, and I told him to keep it until he knew who he was paying it to. I was perfectly satisfied then that Sheldon's transaction as Gov't. land Agt. was not honest. Mr. Sheldon had then been away from Kona nearly three months, he had previous to this resigned his office as Judge and taken up his residence permanently in Honolulu. Afterwards when requested by Mr. S. Spencer to act as land Agt. for Kona, "Nahuina" payed me for this land at 25 cents per Acre. Its only value is for a place for a residence on the beach.

I have been thus particular in giving you the history of this affair, so that you might be able to decide which of the parties were intitled to said land… [HSA – Interior Department, Lands]

Historical records document that the primary use of the *kula* – lowlands in the Kekaha region, was for goat ranching, with limited cattle ranching. Throughout the 1800s, most of the cattle ranching occurred on the *mauka* slopes nearer the old upper government road.

Summary of Land Tenure Described in Grant Records

Grant No.'s 1600 (for Kaakau) and 2031 (for Koanui) are situated on the *mauka* side of the Alanui Aupuni (the Upper Government Road, near present-day Māmalahoa Highway) in ʻOʻoma 2nd and 1st.

Grant No. 1599 (surveyed for Kauhini), was situated across the *kula* lands from Oʻoma 1st in the south, to Hāmanamana, in the north. Communications from the 1880s, indicate that the parcel was never patented, though Kauhini had lived in ʻOʻoma 1st, through the time of his death (before 1888). J.S. Emerson's Register Map No. 1449, identifies a Triangulation Station in ʻOʻoma 1st as "Kauhini." At almost the same time that Kauhini's grant was surveyed, other grants in Kalaoa and ʻOʻoma covering a portion of the area described under Kauhini's grant were patented to Kakau and Kama (Royal Patent Grant No. 2972). In 1888, this confusing situation was brought to the government's attention in a letter from more than 70 native residents of ʻOʻoma and the larger Kekaha region, when the Minister of the Interior was developing homestead lots for applicants (see communications below).

Grant No. 2027 (for Kameheu), situated in ʻOʻoma 2nd, extends from the *makai* edge of the Upper Government Road, to a short distance below the historic Homestead Road between Kaloko and Kalaoa, at about 900 feet above sea level (see Register Map No. 1449).

ʻOʻoma grantee Kaakau (Grant No. 1600), also held an interest in Grant No. 2972 in the land of Kalaoa 5th and ʻOʻoma 1st, which he shared with his relative, Kama. Historic survey records (in Register Maps and Survey Field Books) do identify "Kama's house" near the Wawaloli pond (Register Map No. 1449) in ʻOʻoma 2nd. The same house is later identified as "Keoki Mao's House" (Register Map No. 1280).

In 1888, government surveyor J.S. Emerson identified Kama as a resident in ʻOʻoma, near the *mauka* government road (see communication below). This Kama is identified in oral history interviews as being an elder of the Kamaka line, from whom the often-mentioned Palakiko Kamaka and others descend. A temporary beach shelter—in the vicinity of "Kama's House" marked near the shore of ʻOʻoma 2nd on Register Maps 1449 and 1280—remained in use by family members at least until the outbreak of World War II (based on interviews with Peter Kaikuaana Park, Geo. Kinoulu Kahananui, and Valentine K. Ako).

While no formal awards or grants of land appear to have been made for the near shore *kula* or beach lands, it is logical to assume that families living in the uplands of the ʻOʻoma and Kalaoa-Kohanaiki *ahupuaʻa*, made regular visits to the near shore lands. The practice of continued travel between upland residences and near-shore shelters, is also described by *kūpuna* Peter K. Park, and Elizabeth Lee, who was born and raised in the *mauka* section of ʻOʻoma, and by other *kupuna* from neighboring lands.

No records indicating that the above Royal Patent Grantees had applied for coastal parcels as a part of their original claims were found while conducting the present research. A further review of the *Māhele* records was also made to determine if any of the grant applicants had been *Māhele* claimants (as is sometimes the case). Their names did not appear in the Register or Testimony volumes for the area.

Ka ʻĀina Kaha–(A Native's Perspective)

In 1875, J.P Puuokupa, a native resident of Kalaoa wrote a letter to the editor of the Hawaiian newspaper, *Ku Okoa*, responding to a letter which had been previously published in the paper (written by a visitor to Kona). The first account apparently described the Kekaha region as a hard land that presented many difficulties to the residents. It was also reported that a drought on Hawaiʻi had significantly impacted crop production, and that a "famine" was occurring. Puuokupa, responded to the account and described the situation as he knew it, from living upon the land. His letter is important as it provides us with an explanation as to why people of the region—including ʻOʻoma—lived mostly in the uplands, for it was there that the rich soils enabled residents to cultivate the land and sustain themselves.

> *Mai Kailua a hiki i Kiholo*–(From Kailua to Kiholo)
> …The people who live in the area around Kailua are not bothered by the famine. They all have food. There are sweet potatoes and taro. These are the foods of these lands. There are at this time, breadfruit bearing fruit at Honokohau on the side of Kailua, and at Kaloko, Kohanaiki, Ooma and the Kalaoas where lives J.P. [the author]. All of these lands are cultivated. There is land on which coffee is cultivated, where taro and sweet potatoes are cultivated, and land livestock is raised. All of us living from Kailua to Kalaoa are not in a famine, there is nothing we lack for the well being of our bodies.
>
> Mokuola[6] is seen clearly upon the ocean, like the featherless back of the *ʻukeke* (shore bird). So it is in the uplands where one may wander gathering what is needed, as far as Kiholo which opens like the mouth of a long house into the wind. It is there that the bow of the boats may safely land upon the shore. The livelihood of the people there is fishing and the raising of livestock. The people in the uplands of Napuu are farmers, and as is the custom of those people of the backlands, they all eat in the morning and then go to work. So it is with all of the native people of these lands, they are a people that are well off.
>
> …As was said earlier, coffee is the plant of value on these lands, and so, is the raising of livestock. From the payments for those products, the people are well off, and they have built wooden houses. If you come here you shall see that it is true. Fish are also something which benefits the people. The people who make the *pai ai* on Maui bring it to Kona and trade it. Some people also trade their *poi* for the coffee of the natives here… (J.P. Puuokupa, in *Ku Okoa* November 27, 1875; translated by Kepā Maly)

The Government Homesteading Program in Kekaha

Following the *Māhele* and Grant programs of the middle 1800s, it was found that many native tenants still remained on lands for which they had no title. In 1884, the Hawaiian Kingdom initiated a program to create Homestead lots on Government lands—a primary goal being to get more Hawaiian tenants in possession of fee-simple property (Homestead Act of 1884). The Homestead Act allowed applicants to apply for lots of up to 20 acres in size, and required that they own no other land.

On Hawaiʻi, several lands in the Kekaha region of North Kona, were selected and a surveying program was authorized to subdivide the lands. Initially, those lands extended from Kohanaiki to Kūkiʻo. Because it was the intent of the Homestead Act to provide residents with land upon which they could cultivate crops or graze animals, most of the lots were situated near the *mauka* road (near the present-day Māmalahoa Highway) that ran between Kailua and ʻAkāhipuʻu.

Early in the process, native residents of Kekaha soon began writing letters to the Minister of the Interior, observing that 20 acre parcels were insufficient "to live on in every respect." They noted that because of the rocky nature of the land, goats were the only animals that they could raise, and thus, try to make their living (cf. State Archives–Land File, December 26, 1888, and Land Matters Document No. 255; and communications below).

During the first years of the Homestead Program, all of the remaining government lands in the Kekaha region, from Kohanaiki to Kūkiʻo 2nd, had been leased to King David Kalākaua for grazing purposes. The following lease was issued, with the notation that should portions of the land be desired for Homesteading purposes, the King would relinquish his lease:

6 *Moku-ola* — literally: Island of life — is a poetic reference to a small island in Hilo Bay which was known as a place of sanctuary, healing, and life. By poetic inference, the Kekaha region was described as a place of life and well-being.

August 2nd 1886
General Lease 364
Between His Majesty Kalakaua;
and Walter M. Gibson, Minister of the Interior
[Lease of unencumbered government lands between Kealakehe to Kukio 2nd]:

…Oma [Ooma] No. 1 & 2 – yearly rent Ten dollars…
Each and every of the above mentioned lands are let subject to the express condition that at any time during the term of this lease, the Minister of the Interior may at his discretion peaceably enter upon, take possession, and dispose of such piece or pieces of land included in the lands hereby demised, as may be required for the purposes of carrying out the terms and intent of the Homestead Laws now in force, or that may be hereafter be enacted during the term of this lease… [State Land Division Lease Files]

By 1889, the demand for homestead lots in ʻOʻoma and other Kekaha lands was so great that King Kalākaua gave up his interest in the lands:

January 22, 1889
J.W. Robertson, Acting Chamberlain;
to J.A. Hassinger, Chief Clerk, Interior Department
[Regarding termination of Lease No. 364 for lands from Kukio to Kohanaiki]:

…I have the honor to acknowledge the receipt of your communication, of the 17th, instant, informing me that you are directed, by His Excellency the Minister of the Interior, to say, that he desires to take possession of the lands, described in Government Lease No. 364, for Homestead purposes, and requests the surrender of the lease.

His Majesty the King, is willing, for the purpose of assisting in carrying out the Homestead Act, to accede to the terms of the lease, so far as to give up only such portions of the lands, as are suitable to be apportioned off for Homestead purposes.

It has come to the knowledge of His Majesty, that several of the applicants for portions of the above lands, are already in possession of lands elsewhere, and living in comfortable homes. They are not poor people, nor are they entitled to the privilege of obtaining lands under the Homestead Act, but are desirous of obtaining more of such property, for the purpose of selling or leasing to the Chinese, which class is beginning to outnumber the natives in nearly every district…

His Majesty is desirous of retaining the balance of lands, that may be left after the apportionment has been completed; and also desires to lease remnants of other Government lands in that section of the Island…

Reply attached – Dated January 22, 1889:
The lands of Kohanaiki and Kalaoa and Makaula have been divided up into Homestead lots, and taken up.

Lands marked * are in Emerson's List of lands to be sold. Emerson's List attached.

His Majesty has paid rent to Aug. 22, 1889. Another rent is due in adv. from this date…

* Kukio 2	* Maniniowali
* Mahaiula	* Kaulana
* Awalua	Puukala
+ Makaula	+ Kalaoa 1, 2, 3, 4 & 5
* Ooma 1 & 2	+ Kohanaiki

Lease cancelled by order – Minister of Int. August 2, 1889 [HSA – Interior Department, Lands]

One of the significant issues that arose with the development of homesteads in the Kekaha region, involved the lands of ‘O‘oma, Kalaoa and Hāmanamana, which had been surveyed for Kauhini in 1855, under Grant No. 1590. The grant was apparently never patented, and questions regarding the government’s authority to divide portions of the ‘O‘oma-Kalaoa-Hāmanamana lands into Homestead lots were raised. Adding to the confusion, in 1888, John A. Maguire was also making his move from Kohala to Kona, and in the process of establishing his Hu‘ehu‘e Ranch. One of the lands he reportedly purchased was covered under the unperfected Grant No. 1590. Thus, homestead applicants and program managers met with a wide range of challenges during the program’s history.

Homestead Communications

There are a number of letters between native residents (applicants for Homestead lands) and government agents, documenting the development of the homesteading program and residency in Kekaha. Tracts of land in Kohanaiki, ‘O‘oma, Kalaoa and neighboring *ahupua‘a* were let out to native residents, and eventually to non-native residents as well. Those lands which were not sold to native tenants were sold or leased to ranching interests—most of which came under John A. Maguire of Hu‘ehu‘e Ranch.

One requirement of the Homestead Program was that lots which were to be sold as homesteads to the applicants, needed to be surveyed. J.S. Emerson, one of the most knowledgeable and best-informed surveyors to work in Kona, began surveying the Kekaha region homestead lots in 1888. Emerson’s letters to Surveyor General, W. D. Alexander, provide valuable historical documentation about the community and land. Writing from ‘O‘oma in April 1888, Emerson spoke highly of the Hawaiian families living on the land; he also described land conditions and weather at the time. In the letter, we find that questions regarding the status of several lands in Kona had arisen, and that John A. Maguire was planning to “settle” in Kona (see communications in Part 4 of this section of the study). Emerson’s letters along with those below from the native tenants of the land, provide first hand accounts of the land development of the communities in Kekaha. The following communications are among those found in the collection of the Hawai‘i State Archives (HSA).

May 1888
J.W.H. Isaac Kihe, Jr., et al.; to L.A. Thurston, Minister of the Interior
[Petition with 71 signatures, regarding discrepancy in land grant to Kauhini in Kalaoa and Ooma; and desires that said land be divided into Homestead Lots for applicants]:

…We, the undersigned, subjects residing within the boundaries of Kekaha, from Kohanaiki to Makalawena, and Whereas, the land said to belong to Kauhini is within the boundaries above set forth; Whereas, some doubt and hesitancy has come into our minds concerning the things relating to said land of Kauhini, and that it is proper that a very careful investigation be made, because, we have never known said Kauhini to have lands in the Kalaoas and Ooma 1, and because of such doubt, the Government sold some pieces in said land of 687 acres to Kama, Kaakau and Hueu, and they have been living with all the rights for 20 years and over, on pieces that were acquired by them. Therefore, we leave this request before your Excellency, the honorable one, with the grounds of this request:

First: The said land of Kauhini is not a land that is clear in every way, so that it can be shown truthfully and clearly that it belongs to Kauhini and his heirs – said kuleana.

Second: The land said to belong to Kauhini was only surveyed, but the money was not paid, that is the price for the land, only the payment for the survey was paid. We are ready with witnesses to prove this ground, as well as other grounds.

Third: Because of Kama and Kaakau and Hueu’s knowing that Kauhini had no true interest in the land, therefore, they bought from the Government some acres of in the piece which Kauhini had surveyed, and the Government readily agreed to sell to them. This is real proof that said land was not conveyed to Kauhini, and the second is that Kauhini was living right there and he made no protest against the sale by the Government of those 687 acres to Kama (k), Kaakau (k) and Hueu (k), up to the time of his death, and only now has the question been raised through the plat of the survey, and thereby basing the claim that Kauhini had some land.

…We ask your honor that this matter be traced in the Government Departments, so as to find out the truth, there is much trouble and uncertainty about this land.
And our inquiry to be based upon these great questions. Does the land belong to Kauhini? Or to the Government?… [HSA – Interior Department, Lands]

May 16, 1888
Interior Department Clerk; to J.W.H. Isaac Kihe, Jr.:
…I have been directed by the Honorable Minister of the Interior, to say, that your request asking that Kauhini's interest in the lands of Kalaoa & Ooma 1 be investigated, and to let you know the you are wanted to send, or to bring here to Honolulu, 2 or 3 good witnesses, and all the papers found by you or them, concerning this land of Kauhini… [HSA Interior Department Lands]

May 16, 1888
J.F. Brown, Government Surveyor; to L.A. Thurston, Minister of the Interior
[Regarding disposition of Grant No. 1590, to Kauhini for Lands in Hamanamana, Kalaoa, and Ooma; Figure 7]:

…With reference to the letter of inquiry of numerous natives in N. Kona, Hawaii, I beg to report:

That as regards the land belonging to Kauhini, I find that Grant 1590 on record and signed in due form, assigned to Kauhini something over 1800 acres shown in sketch by yellow tinted boundary line. At the bottom of the page however and in different handwriting is the following remark "Memo – this to be cancelled" S.S. (Stephen Spencer)?

Later the grants shown in sketch by blue lines were issued to the parties indicated in the sketch, and this fact together with the memo attached to the Grant, and the statements and beliefs of the natives leads me to think that the Grant to Kauhini was actually cancelled, but of this I have not yet obtained further proof than I have here given… [HSA – Interior Department, Lands]

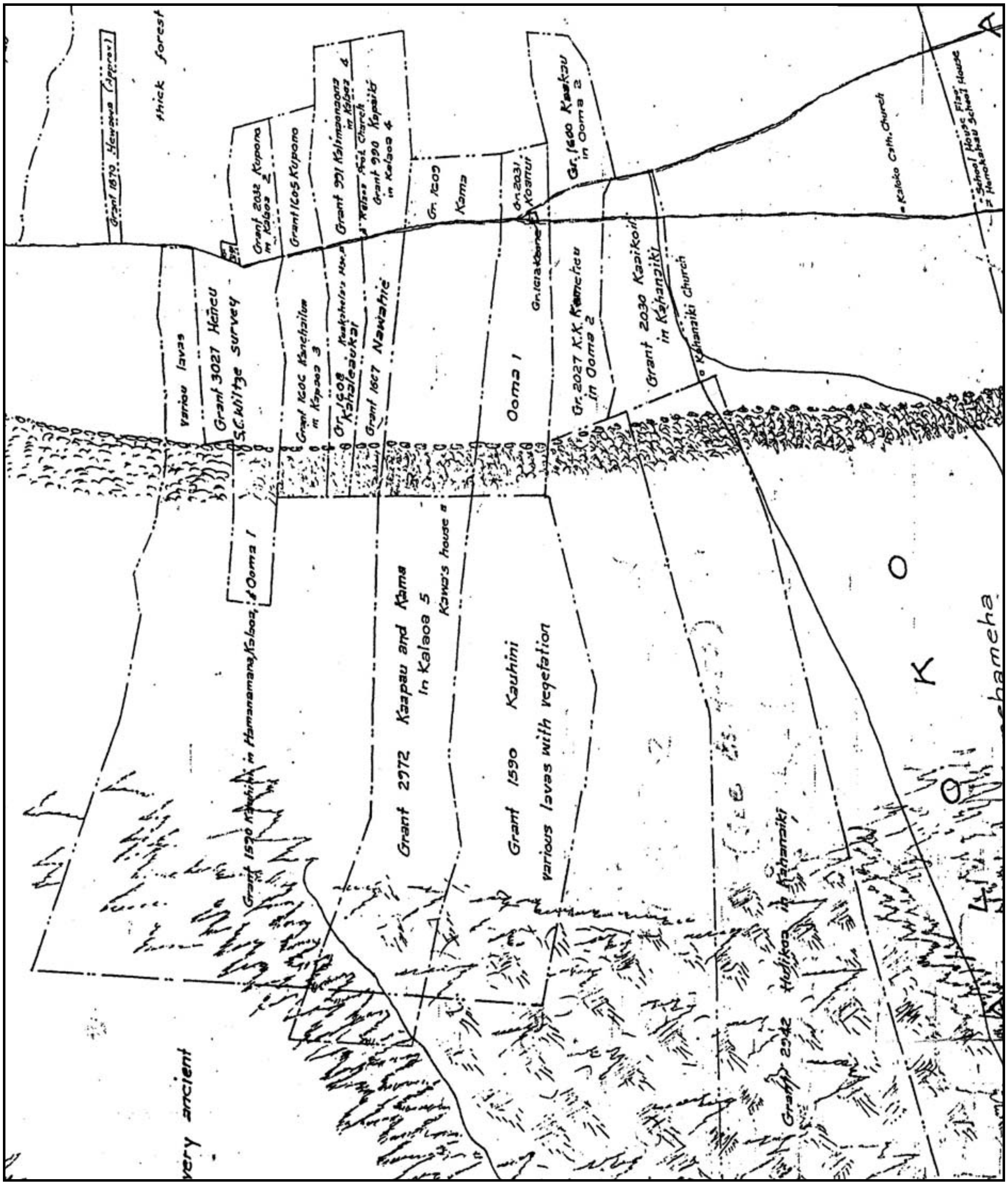

Figure 7. Portion of 1882 Register Map No. 1280 showing original boundaries of Grant No. 1590, to Kauhini.

May 1888 - J.W.H.I. Kihe, Jr.; to L.A. Thurston, Minister of the Interior:
…Oh honorable one, I am ready with the right witnesses to come when I receive the order, and if you agree, oh honorable one, to help with the fares for us on the vessel, and for our support while staying there and coming back.

Proofs are ample to prove that the land belongs to the Government, when I arrive with the witnesses, according to what you wish to be done… [HSA – Interior Department, Lands]

[Applying to purchase remnant lands from Makaula to Ooma 2nd, as a native Hui; and that land not be sold to outsiders.]

…We the undersigned, kamaaina (old residents) who reside from "Makaula" to "Ooma 2," joining "Kohanaiki," hereby petition and we also file this petition with you, and for you to consider and conferring with the Minister of the Interior, whether to consent or refuse the petition which we humbly file, and at the same time setting forth the nature of the land and the boundaries desired.

We ask that all be sold to us as a Hui, that the remnants of all the Government lands from "Hamanamana" to "Ooma 2 (two)," that is from the Government remnant of "Hamanamana, Kalaoa 1, 2, 3, 4, 5, Ooma 1 & 2" running until it meets the sea. Being the remnants remaining from the "Homesteads" lately, and remaining after the sale of the lands formerly sold by the Government, these are the remnants which we wish to buy as a "HUI." If you consent, and also the "Minister of the Interior," for these reasons:

1. The "remnants of Government lands" aforesaid, join our land kuleanas and were lately surveyed, and for that reason we believe it proper that they be sold to us.
2. The "kuleanas" that were surveyed for us are not sufficient to live on in every respect, they are too small, and are not in accordance with the law, that is one hundred acres, (Laws 1888).
3. Because of our belonging to, and being old residents of said places, is why we ask that consent be granted us for the sale to us and not to any one from other places, or we may be put to trouble in the future.

With these reasons, we leave this with you, and for you to approve, and we also adhere to our first offer per acre, and the explanations in regards to said offer.

FIRST: The price per acre to be 10 cents per acre.

SECOND: The nature of the land is rocky and lava stones in all from one and to the other, and there is only one kind of animal which can roam thereon, and it is goats, and that is the only thing to make anything out of, and to benefit us if we acquire it.

THIRD: If this land is acquired by others, they will probably cause us trouble, because the kuleanas which we have got are very small and not enough, not 20 acres of the land were acquired by us; very few of the lots reach 20 acres or more.

And because of these reasons and the explanations herein, we leave before your Excellency for the granting of the consent or not… [HSA – Interior Department, Lands]

ca. February 1889
Petition of J.W.H. Isaac Kihe, Jr. and 21 others;
to L.A. Thurston, Minister of the Interior
[Transmitting first payment for Homestead Land from Makaula to Kohanaiki]:

…We, the ones whose names are below, persons who but for the pieces of "Homestead" lands from Makaula to Kohanaiki, present to you documents of proof and money as first payment of ten ($10.00) dollars in the hands of J. Kaelemakule, the Agent appointed for the "Homestead" lands in North Kona, Hawaii.

We ask that the Agreements be sent up, with the Government for five years to J. Kaelemakule, the Agent here, in number the same as there are names below…

1. J.W.H. Isaac Kihe, Jr.	9. P. Nahulanui	17. Keawehawaii
2. S. Mahauluae	10. Kaukaliinea	18. D. Kaninau
3. D.P. Manuia	11. Kamahiai (w)	19. Mokuaikai
4. S.M. Kaawa	12. C.K. Kapa	20. Nuuanau
5. H.P. Ku	13. P.K. Kanuha	21. S. Kaimuloa
6. W.N. Kailiino	14. J. Haau	22. J. Kaloa
7. Z. Kawainui	15. G. Mao	
8. Kikane	16. J. Pule	

[HSA – Interior Department Document No. 227]

February 18, 1889
J. Kaelemakule, Land Agent; to L.A. Thurston, Minister of the Interior:
I am sending the correct report of the applicants for homestead lands here in North Kona, and their respective names, and the amount they have paid for their initial deposits in order that the agreements will be made correctly…

Pule $10.	Keoki Mao $10.	Mahuluae $10.	Haau $10.
Nuuanu $10.	Manuia $10.	Kaukaliinea $10.	Kamahiai (w) $10.
Kaawa $10.	Kaninau $10.	J. Kaelemakule $10.	Kawainui $10.
Mokuaikai $10.	Keawehawaii $10.	Nahulanui $10.	Kaloa $10.
Haiha $10.	Kapa $10.	Kaumuloa $10.	Isaac Kihe $10.
Kailiino $10.	Kanuha $10.	Ku $10.	Kikane $10.

[HSA – Interior Department, Lands]

October 7, 1889
J. Kaelemakule, Land Agent; to L.A. Thurston, Minister of the Interior:
…The applications of Kahinu and Lilinoe which were sent down during the month of August, please have the lots changed, because the map of Ooma has arrived with new numbers, as follows: Kahinu, Lot 51; Lilinoe, Lot 49, in Ooma 1st … [HSA – Interior Department, Lands]

October 10, 1889
J.W.H. Isaac Kihe, Secretary; to L.A. Thurston, Minister of the Interior:
…I leave some more names who make applications for homestead lands here in North Kona… The places wanted by those named are:

Pika Kaninau at Ooma 1
Kahinu at Ooma 2
Keaweiwi at Ooma 2… [HSA – Interior Department, Lands]

October 28, 1889
J. Kaelemakule, Land Agent; to L.A. Thurston, Minister of the Interior:
…The eight lots in Ooma have all been taken, none are left… These lots have been very quickly taken by the bidders, before the issuance of the notice from the Minister… Bear in mind the agreements for Kahinu and Lilinoe… [HSA – Interior Department, Lands]

December 31, 1890
J.W.H.I. Kihe, Jr.; to C.N. Spencer, Minister of the Interior:
We, the undersigned, who are without homes, and are destitute and have no place to live on, and whereas, the government has permitted all the people who have no lands, and that they receive homesteads, and for that reason, your humble servants make application that our

application may be speedily granted which we now place before Your Excellency, that the Government land which was divided and surveyed by Joseph S. Emerson, be immediately sub-divided , the same being portions of Kalaoa 5 and Ooma, on the mauka side of Kama (k), Koanui (k), to the junction with Ooma of Kaakau (k), containing an area of one hundred and fifteen acres (115), and it is those acres which your applicants are applying for before Your Excellency, and where as your applicants are native Hawaiians by birth, residing at Kalaoa, North Kona, Island of Hawaii. And the minds of your servants hope and desire to have a place to live on in the future, and to have a home for all time, and Your Excellency, your servants humbly place their petition with the hope that you will grant this application...

M.E. Kuluwaimaka (k)
H. Hanawahine (k)
D.W. Kanui (k)
Mr. Kahumoku (k)
[HSA – Interior Department, Lands]

July 30, 1890
Petition of Kaihemakawalu and 63 native residents of Kekaha;
to C.N. Spencer, Minister of the Interior
[Requesting that lands available for Homesteading be sub-divided and granted to applicants]:

…We, the undersigned, old-timers living from Kealakehe to Kapalaoa, who are subject to taxes, and who have the right to vote in the District of Kona, Hawaii, and ones who are really without lands, and who wish to place this application before Your Excellency, that all of these Government lands here in North Kona, be given to the native Hawaiians who are destitute and poor, being the lots which were sub-divided by the Government which are lying idle and for which no Agreements have been given out, and also the lots which were granted Agreements and issued in the time when Lorrin A. Thurston was Minister of the Interior, and also the lots which still remain undivided. All of these Government lands are what we are now again asking that the dividing and sub-dividing be continued in these remnants of Government lands, until all of the poor and needy ones are provided for.

Your Excellency, we ask that no consent whatever be given to permitting lands to be acquired by the rich through sale at auction, or by lease, and if there is to be any lease, then to be leased to the poor ones, if they are supplied with homes.

Your Excellency, we ask that you immediately send copies of all agreements of the Government lands which were cut up and sub-divided, which are remaining and have no documents for those lots. And we also ask that a surveyor be sent now to again survey and sub-divide the remaining Government lands, being the Government lands of Kaulana, Mahaiula, Kukio 1 & 2, mauka of the Government Road, and Kalaoa 5 & Ooma 1, mauka of the Government Road, joining Kama's and Koanui's.

And now, Your Excellency, we also ask that all of the pieces of Government land lying idle outside of these lands which have been sub-divided, and lands which are to be sub-divided, applied for above, to be allowed to be leased to use for five cents per acre, because, they are rocky and pahoehoe lands only left, and the number of acres being about three thousand and over, thereby giving the Government some income from these which have been lying idle and without any value… [HSA – Interior Department, Lands]

June 22, 1893
J. Kaelemakule, Land Agent; to J.A. King, Minister of the Interior:
…I am forwarding you with this, the copy of the agreement of Wm. Harbottle, and some applications as herein below set forth (Figure 8):

107, Kalua (w), for Lot # 59, Map 6, Ooma;
108, G.M. Paiwa, for Lot # 56, Map 6, Ooma;
109, Namakaokalani, for Lot # 58, Map 6, Ooma;
110, Pika Kaninau, for Lot # 57, Map 6, Ooma.

Lot # 57 above set forth, was formerly agreed with D. Kealoha Hoopii, but this applicant left altogether and lived a long time in Kohala, and has done nothing towards the land, and has never signed the agreement to this day. As two years have gone by, I thought it would be better to give the lands to the new applicant… [HSA – Interior Department, Lands]

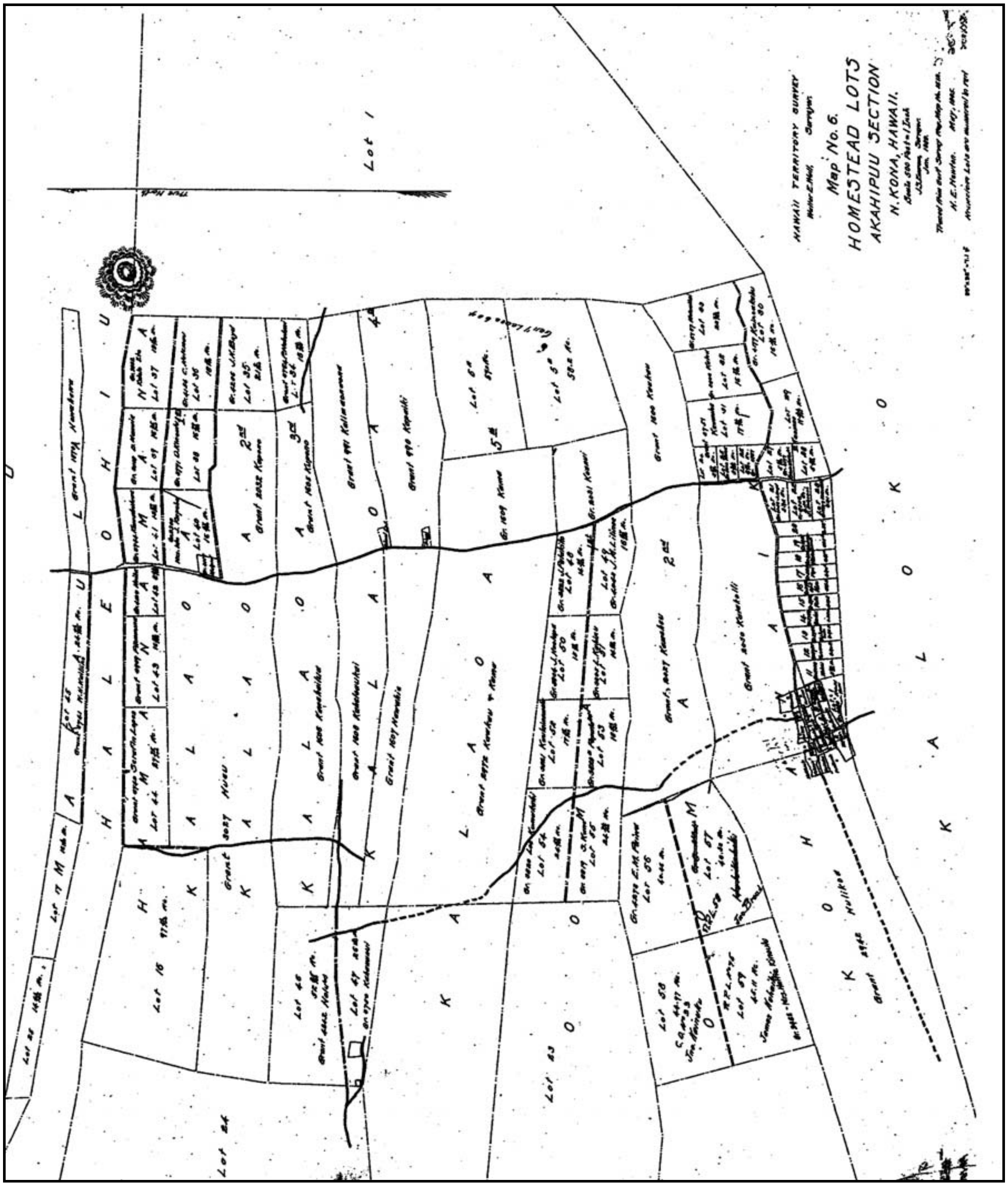

Figure 8. 1902 homestead map No. 6 showing Ooma-Kalaoa Homestead Lots (State Survey Division).

August 31, 1898
Statement of Leases of Public Lands
Under Control of the Commissioner of Public Lands…
…Ooma (mauka) 1160 acres – Coffee, wood lands & grazing
Lease No. 432 – Annual rent $60. – Expires August 1st, 1906…
Reservation in lease by which the Gov't. may take up portions suited to settlement. [HSA – F.O. & Ex, 1898 – Public Lands]

In May 1902, the Territorial Survey Office issued Register Map No. 2123, depicting a portion of the Kalaoa-Ooma Homesteads. ʻOʻoma 1st had been divided into 25 lots extending from near the shore (excluding the shore line) to the upper limits of the ahupuaʻa; also excluding the early Royal Patent Grant parcels previously sold to native tenants.

<u>Applicants for land in ʻOʻoma 1st</u> (from *maka*i to *mauka*) included:

- Kanealii – Right of Purchase Lease # 30; Lot 4-B (cancelled);
Kanealii's parcel was just mauka of the shore line exclusion.

- Wm. Keanaaina – Right of Purchase Lease #33; Lot 13
(Patented by Grant No. 5472);
The makai end of Wm. Nuuanu Keanaaina's Grant 5472, is situated at approximately 325 feet above sea level.

- J. Maiola – Right of Purchase Lease # 28; Lot 14 (cancelled);
J. Maiola's parcel was situated about 525 feet above sea level.

- K. Kama Jr. – Right of Purchase Lease #27; Lot 15
(Patented by Grant No. 5046).
The makai end of K. Kama's Grant No. 5046, is situated at approximately 725 feet above sea level.

Territorial Survey Map No. 6 (Homestead Lots, Akahipuu Section), surveyed by J.S. Emerson in 1889, depicts the eight original homestead lots sold to applicants. The lots are in the area extending from 1,022 feet above sea level to the old Māmalahoa Highway. The lots contained approximately 15 to 25 acres each, and were (*makai* to *mauka*) sold to:

- S. Kane – Grant No. 3819, Lot 55;
- Loe Kumukahi – Grant No. 3820, Lot 54;
- Papala (w) – Grant No. 3820 B, Lot 53;
- Kaulainamoku – Grant No. 3821, Lot 52
- L. Kahinu – Grant No. 3805, Lot 51
- J. Hoolapa – Grant No. 3804, Lot 50
- J.M. Lilinoe – Grant No. 4343, Lot 49
- J. Palakiko – Grant No. 3822, Lot 48

Except for the Homestead parcels and the two lots patented to Keanaaina and Kama (totaling ten parcels of the available 25 parcels), no other land in ʻOʻoma 1st was sold during this time. The land was retained by the government and portions leased out for grazing (see General Lease No.'s 590 and 604).

ʻOʻoma 2nd was also divided into homestead parcels, but only six lots were made in the subdivision (see Figure 8 and Figure 9). Between 700 and 1,100 feet elevation four Homestead lots were subdivided, containing 40.50 to 45 acres each. Applicants for the lots (*makai* to *mauka*) were:

James Kuhaiki – Right of Purchase Lease # 75, Lot 59
(Patented to Mrs. Hattie Kinoulu; current Parcel 09:007);

Jno. Kainuku – C.O. No. 33, Lot 58 (not granted by 1902; current Parcel 09:008);

Holokahiki – C.O. No. 11, Lot 57
(cancelled; R.P.L. # 59 to Jno. Broad; current Parcel 07:038); and

E.M. Paiwa – Grant No. 4273, Lot 56 (current Parcel 07:039).

Land use on these parcels associated with the Homestead Grants began in the early twentieth century and consisted of both livestock grazing and small-scale agriculture (primarily sweet potato cultivation).

The two *makai* lots consisted of approximately 1,333 acres—the first lot from above the shore to the 1847 *Alanui Aupuni*, containing approximately 302 acres, and the other lot running *mauka* from the same *Alanui Aupuni*, to about the 800 foot elevation (containing approximately 1,031 acres). In 1899, John A. Maguire, founder of Hu‘ehu‘e Ranch applied for a Patent Grant on both of the *makai* lots, but he only secured Grant No. 4536, for the lower parcel of 302 acres, in ‘O‘oma 2nd (coincident with the bulk of the current project area). Maguire's Hu‘ehu‘e Ranch did hold General Lease No.'s 1001 and 590 for grazing purposes on the remaining government lands—both below and above the *mauka* highway—in ‘O‘oma 2nd. The notes of survey from Maguire's Grant No. 4536 describes the near shore parcel in ‘O‘oma 2nd. Of particular interest, it also references one of the prominent cultural-historical features on the boundary between ‘O‘oma 2nd and Kohanaiki, an "old ‘Kahua hale' on white sand…" The "kahua hale" being an old house site. The notes of survey read (see Figure 9):

Grant No. 4536
To J.A. Maguire
Purchase Price $351.00
A Portion of Ooma 2nd, N. Kona, Hawaii Applied for by J.C. Lenhart, June 8, 1899.
Beginning at Puhili Gov't. trig. St. on the boundary between Kohanaiki and Ooma marked by a drill hole in stone 9 feet South of the South corner of an old "Kahua hale" on white sand at a point from which
Akahipuu Gov't. trig. Sta. is N 55º 27' 39" E true 32634.7 feet
Keahole Gov't. Trig. Sta. is N 21º 52' 36" W true 9310.5 ft.
Keahuolu Gov't Trig. Sta. is S 22º 24' 36" E true 20,141.8 ft., and running —
1. S. 79º 26' W. true 298.0 feet along Gr. 3086 Kapena, to a large [mark] on solid pahoehoe by the sea at Puhili Point, thence continuing the same line to the sea shore and along the sea shore to a point whose direct bearing and distance is:
2. N. 4º 54' W. true 4192.0 feet;
3. Due east true 2920.0 feet along Ooma 1st;
4. S. 31º 30' E. true 3920.0 feet along reservation for Gov't. Road 30 feet wide;
5. S 790º 45' W. true 4387.0 feet along Grant 3086 Kapena, to initial point and including an area of 302 acres.

J.S. Emerson, Surveyor
Oct. 10, 1901.

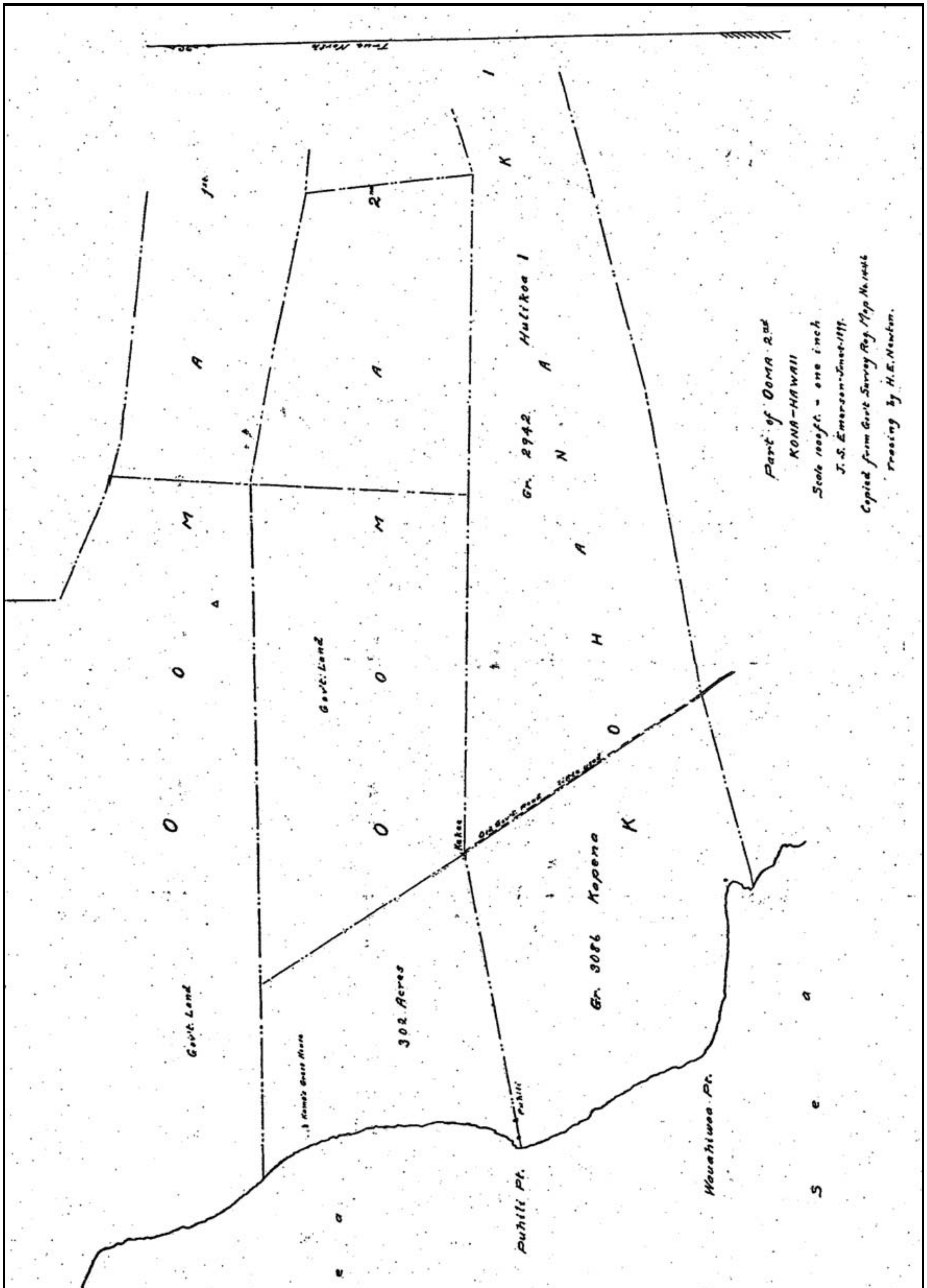

Figure 9. 1899 Grant Map No. 4536 showing *makai* portion of ‘O‘oma 2nd to John A. Maguire.

Field Surveys of J.S. Emerson (1882-1889)

Among the most interesting historic Government records of the study area—in the later nineteenth century—are the communications and field notebooks of Kingdom Surveyor, Joseph S. Emerson. Born on O‘ahu, J.S. Emerson (like his brother, Nathaniel Emerson, a compiler of Hawaiian history) had the ability to converse in Hawaiian, and he was greatly interested in Hawaiian beliefs, traditions, and customs. As a result of this interest, his letters and field notebooks record more than coordinates for developing maps. While in the field, Emerson also sought out knowledgeable native residents of the lands he surveyed, as guides. Thus, while he was in the field he also recorded their traditions of place names, residences, trails, and various features of the cultural and natural landscape (including the extent of the forest and areas impacted by grazing). Among the lands that Emerson worked in was the greater Kekaha region of North Kona, including the lands of ‘O‘oma and vicinity.

One of the unique facets of the Emerson field notebooks is that his assistant J. Perryman, was also a sketch artist. While in the field, Perryman prepared detailed sketches that help to bring the landscape of the period to life. In a letter to W.D. Alexander, Surveyor General, Emerson described his methods and wrote that he took readings off of:

> …every visible hill, cape, bay, or point of interest in the district, recording its local name, and the name of the *Ahupuaa* in which it is situated. Every item of local historical, mythological or geological interest has been carefully sought & noted. Perryman has embellished the pages of the field book with twenty four neatly executed views & sketches from the various trig stations we have occupied… [Emerson to Alexander, May 21, 1882; HSA – DAGS 6, Box 1]

Discussing the field books, Emerson also wrote to Alexander, reporting “I must compliment my comrade, Perryman, for his very artistic sketches in the field book of the grand mountain scenery…” (HSA – HGS DAGS 6, Box 1; Apr. 5, 1882). Later he noted, “Perryman is just laying himself out in the matter of topography. His sketches deserve the highest praise…” (ibid. May 5, 1882). Field book sketches and the Register Maps that resulted from the fieldwork provide a glimpse of the country side of more than 100 years ago.

Field Notebooks and Correspondence from the Kekaha Region

The following documentation is excerpted from the field notebooks and field communications of J. S. Emerson. Emerson undertook his original surveys of lands in the Kekaha region in 1882-1883 (producing Register Maps No. 1278 and 1280). Subsequently, in 1888-1889, Emerson returned to Kekaha to survey out the lots to be developed into Homesteads for native residents of ‘O‘oma and vicinity (see above, The Government Homesteading Program in Kekaha). Through Emerson’s letters and notes taken while surveying, we learn about the people who lived on the land—some of them identified in preceding parts of the study—and about places on the landscape. The numbered sites and place names cited from the field books coincide with sketches prepared by Perryman, which are shown as figures in the current study.

> *J.S. Emerson Field Notebook Vol. 111 Reg. No. 253*
> *West Hawaii Primary Triangulation, Kona District*
> *Akahipuu; May 27, 1882*
> (Figures 9 and 10)
>
> *Site # and Comment:*
>
> …6 – Koanui’s frame house. E.G. In Honokohau – nui.
>
> 7 – Aimakapaa Cape. Extremity. In Honokohau-nui.
>
> 11 – Beniamina’s house (frame). N.G. In Aiopio. In Honokohau-nui.
>
> 12 – Beniamina’s house No. 2. E.G. In Honokohau-nui.
>
> 18 – Lae o Palaha. Between Kaloko and Honokohau-nui.
>
> 19 – Awanuka Bay (Haven of rest) Retreat during storms in this dist.
>
> 20 – Kealiihelepo’s (frame house). N.G. In Kaloko.

21 – Lae Maneo. From the “Maneo” fish in Kaloko.

22 – Kohanaiki Bay. By sea wall of fish pond.

23 – Kaloko-nui fish pond. Tang. S. end by Nuuanu’s grass house.

24 – Wall between fish pond of Kaloko nui and iki.

25 – Kaloko iki fish pond. Tang. N. extremity.

Kaloko nui was originally a bay, shut off from the sea by a wall by Kamehameha 1st order.

26 – Kawaimaka’s frame house. In Kohanaiki.

27 – Lae o Wawahiwaa. Rock cape. In Kohanaiki.

28 – Keoki Mao’s grass house. In Ooma.

29 – Pahoehoe hill. Between Ooma and Kalaoa 5.

30 – Lae o Keahole. Extremity. In Kalaoa 5.

31 – Lae o Kukaenui. Resting place for boats.

32 – Makolea Bay.

33 – Lae o Unualoha.

34 – Pohaku Pelekane.

35 – Lae o Kahekaiao. Kahe-ka-iao – place of the “iao” which abound there. [Notebook 253:33,35]

…Keahole Bay.

Lae o Kalihi in Kalaoa 5.

Wawaloli Bay in Kalaoa 5.

Lae o Kekaaiki.

Limu Koko in Ooma 1.

Lae o Puhili in Kohanaiki.

Lae o Kealakehe in Kealakehe.

Hueu’s frame house in Kalaoa 4, makai side of Gov’t. Road.

Kuakahela’s frame house in Kalaoa 5.

Protestant Church Steeple in Kalaoa 5.

Kama’s frame house, N. gable in Ooma 1.

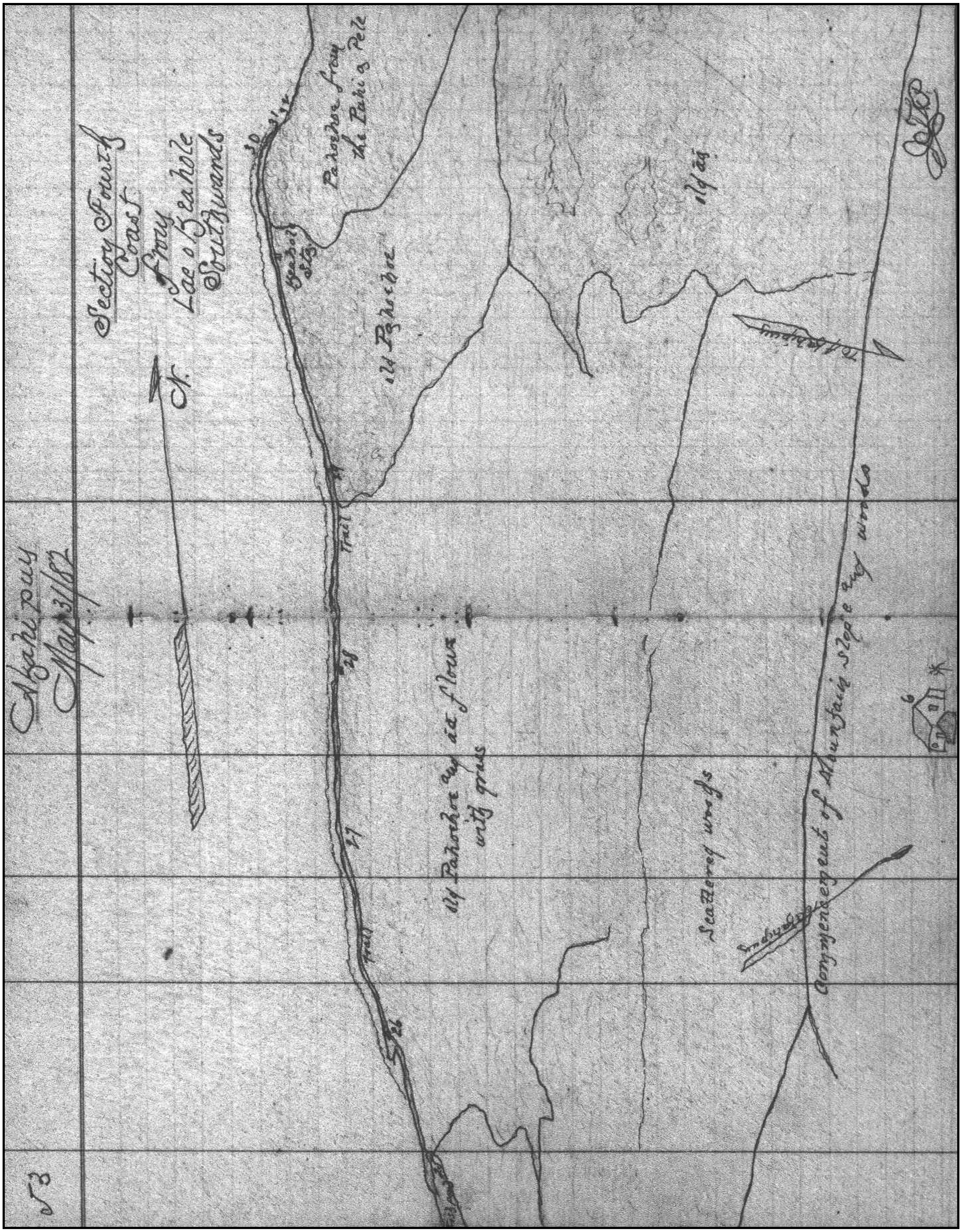

Figure 10. J. S. Emerson, field notebook map, Book 253:53 (State Survey Division).

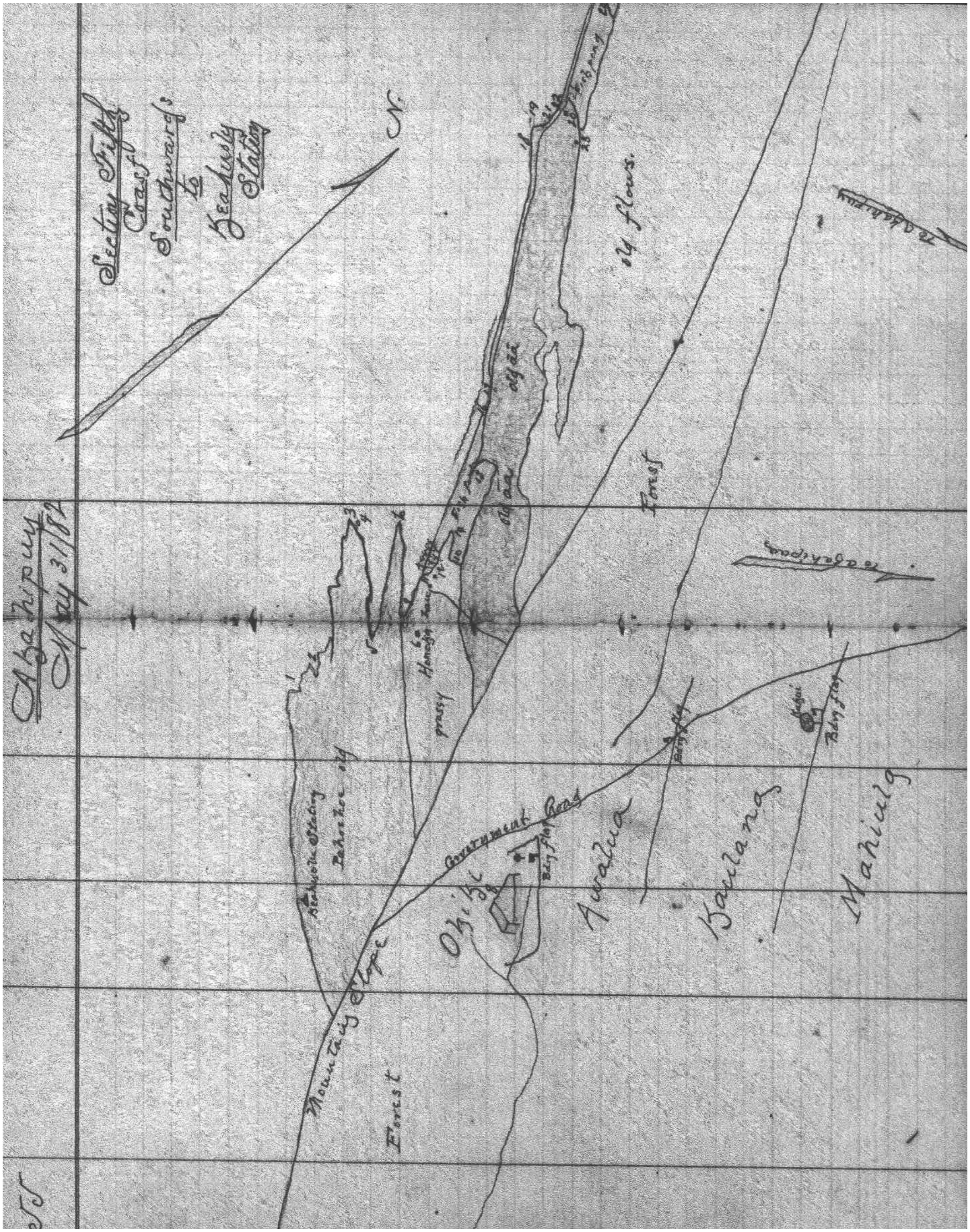

Figure 11. J. S. Emerson, field notebook map, Book 253:55 (State Survey Division).

While taking sightings from Keāhole, Perryman prepared additional sketches of the landscape. One sketch on page 69 of the field book (Figure 12) depicts the view up the slope of Hualālai. Dated June 4, 1882, the sketch is of importance as it also depicts Kalaoa Village and church; the upper Government road; Kohanaiki Village; and two trails to the coast, one trail to Honokōhau, and the other near the Kaloko-Kohanaiki boundary. Use of these trails continued through the 1950s.

The other sketch on page 73 of the field book (dated June 8, 1882) depicts the coastline south from Keāhole, to an area beyond Keauhou (Figure 13). Of interest, we see only the near-shore "Trail" in the foreground, with no trail on the *kula* lands. Then a short distance south, a house is depicted on the shore, in the ʻOʻoma vicinity (identified as the house of Kama or Keoki Mao on Emerson's Register Maps). And a little further beyond (south) the house, two trails are indicated—presumably the *Alanui Aupuni* on the *kula* lands to ʻOʻoma, and the near shore trail, seen coming in from Honokōhau.

While surveying the uplands on Hualālai in August 1882, Perryman drew a sketch of the Keāhole-Honokōhauiki coastal lands. This sketch (Figure 14) from field Book No. 254 shows the reverse view of Figure 13. Noting again, that the only trail given at that time, was the near shore trail, running out of Honokōhau-Kaloko, Kohanaiki, ʻOʻoma and on to Keāhole.

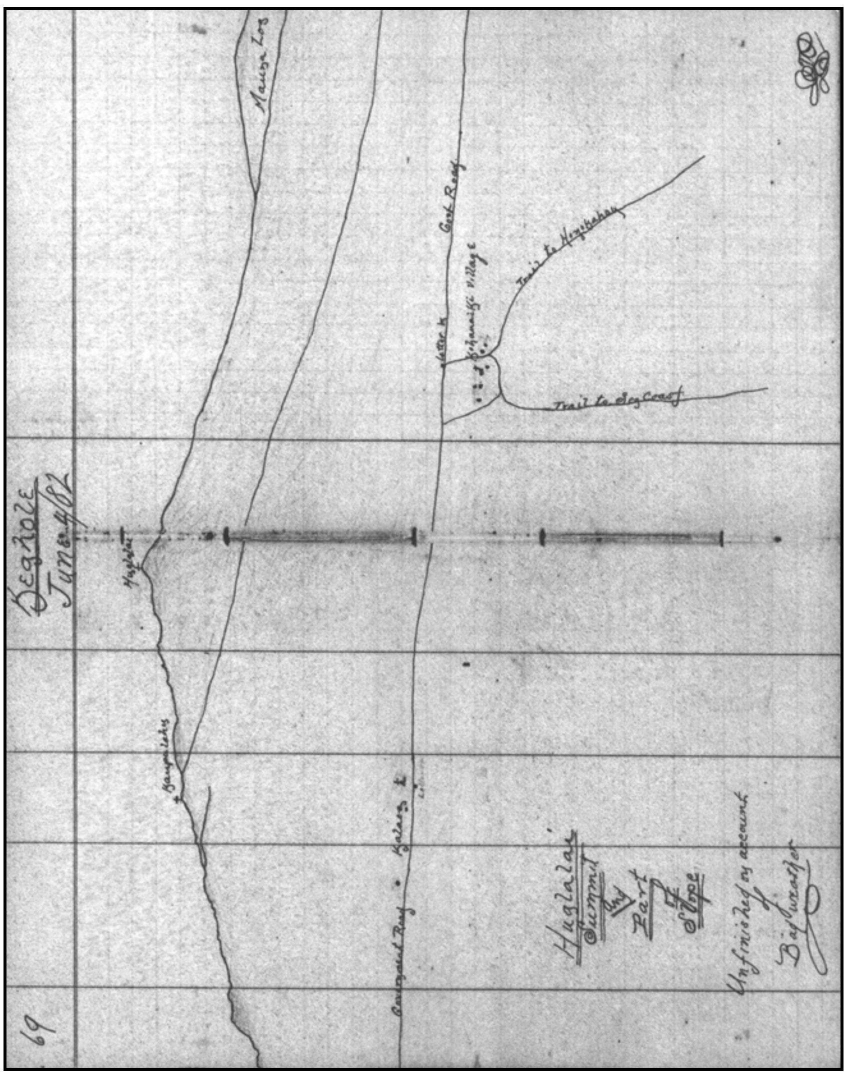

Figure 12. J. S. Emerson, field notebook map, Book 253:69 (State Survey Division).

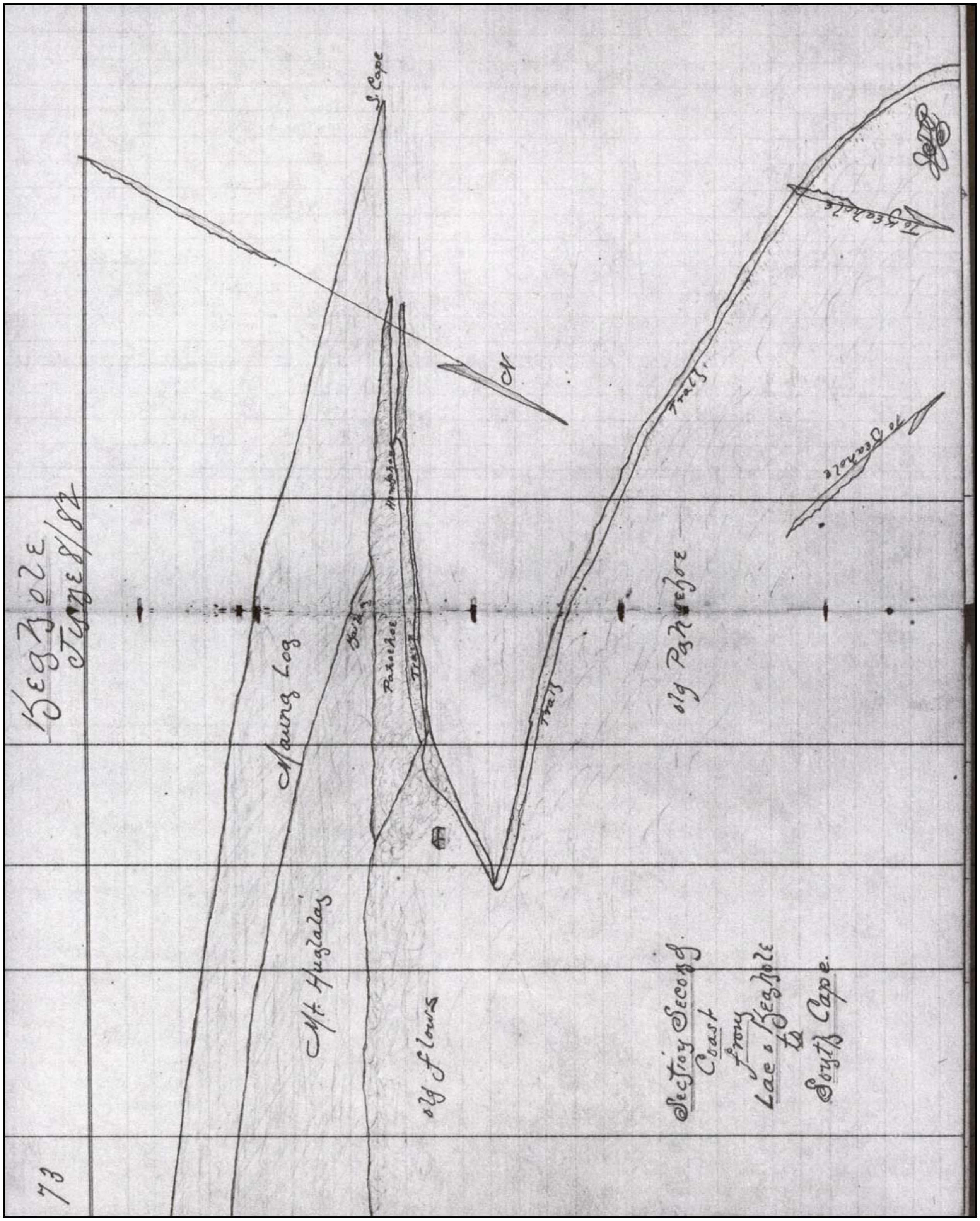

Figure 13. J. S. Emerson, field notebook map, Book 253:73 (State Survey Division).

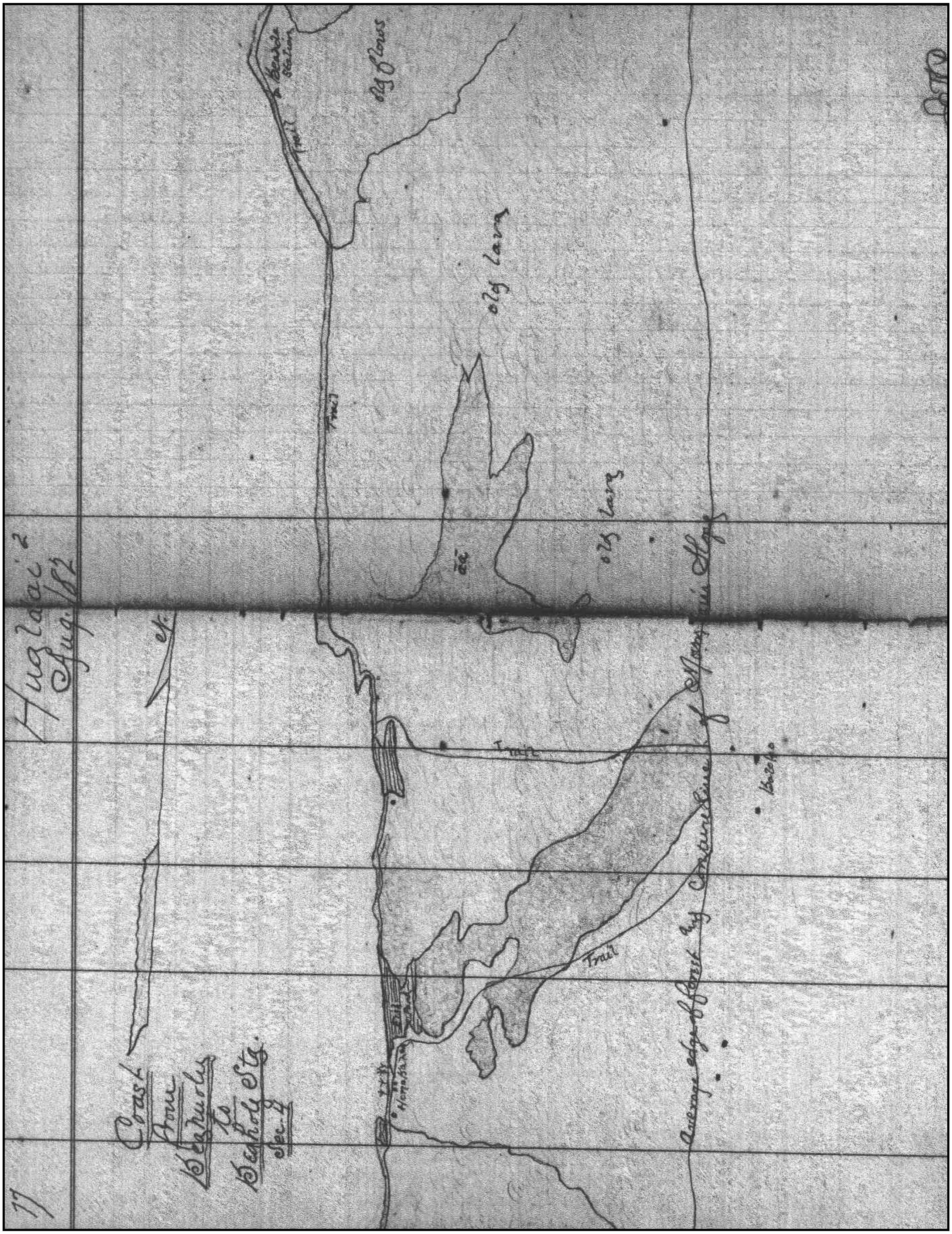

Figure 14. J. S. Emerson, field notebook map, Book 254:77 (State Survey Division).

While surveying the ‘O‘oma and vicinity homestead lots in 1888-1889, Emerson camped near Kama’s house in ‘O‘oma 1st. The following communications were sent by Emerson to W.D. Alexander, and tell us more about the people of the land, their beliefs, and commentary on then current events in the Kingdom. Of interest, we also find that J.W.H. Isaac Kihe, whose writing of traditions, and as a representative of the native families in the land application process—which have been cited extensively in this study—is also mentioned in Emerson’s narratives.

(Underlining, italics and brackets are inserted to draw attention to certain passages.)

> *April 8, 1888*
> …Our tent is pitched in Ooma on the *mauka* Govt. road at a convenient distance from Kama’s fine cistern which supplies us with the water we need. The pasturage is excellent and fire wood abundant. As I write 4:45 P.M. the thermometer is 71º, barometer 28.78. The entire sky is overcast with black storm clouds over the mountains. The rainy season comes late to Kona this year and has apparently just begun. We have had about three soaking rains with a good deal of cloud & drizzle. We are now having a gentle rain which gladdens the residents with water for their cisterns… We have set a large number of survey signals and identified many important corners of Gov’t. lands etc. from Puhiapele on the boundary of Kaupulehu to the boundary line of Kaloko. The natives welcome us and do a great deal to help the work along. Tomorrow I expect to go to Kuili station with a transit and make a few observations & reset the old signal... The Kamaainas tell me that Awakee belongs to the Gov’t. though I see it put down as LCA 10474 Namauu no Kekuanaoa.
>
> They also tell me that the heirs of Kanaina estate still receive rent for the Ahupuaa of Kaulana, though I have recorded as follows in my book, Kaulana ½ Gov’t. per civil Code 379, ½ J. Malo per Mahele Bk. Title not perfected; all Gov’t. Please examine into the facts about Kaulana and instruct me as to what I shall do about it. Kealoha Hopulaau rents it and if it is Gov’t. land the Gov’t. should receive the rent or sell it off as homesteads. It is a desirable piece of land, a part of it at least… [HSA – HGS DAGS 6, Box 2]
>
> *April 17, 1888*
> ...The work is being pushed rapidly and steadily forward. The natives render me most valuable assistance and find all the important corners for me as fast as I can locate them. It is hard getting around on account of the rocks & stones, to say nothing of trees etc., but there is a great deal of really fine land belonging to the Government, admirably adapted to coffee etc. The more I see of it the better it appears.
>
> As to Kaulana, if I hear nothing to the contrary from you, I will leave it all as Gov’t. land.
>
> Mr. McGuire [sic] of Kohala, the representative for that district, proposes to settle in Kona. He has bought Grant 1590, Kauhine, in Ooma, Kalaoa etc. and wants the Gov’t. to make good to him the amount taken from him by Grants 2972, Kaakau & Kama, and 3027, Hueu, which occupy portions of the same land granted to Kauhine. If his title is good, would it not be just to leave Kaakau & Kama as well as Hueu in possession of their lots where they have lived for over 20 years, and give McGuire an area in adjoining lands equal to that taken from him by these two grants.
>
> It is said that Chas. Achi has written to the natives that Grant 1590, Kauhine, has been cancelled. Will you learn the true state of the case and be so kind as to inform me… [HSA – HGS DAGS 6, box 2 Jan.-Apr. 1888]

In his field book notes, on May 1st, 1888, Emerson noted that he had placed the “Pulehu” station on the “ground by ahu, about 4 feet makai of Kama’s goat pen, on the iwi aina between Kalaoa 5 and Ooma 1…” (J.S. Emerson Field Book 291:83).

In the same field book on May 19th, 1888, while surveying the area near the boundary of ‘O‘oma 1st and 2nd, at the 325 foot elevation, Emerson cited off of a station named “Kahokukahi.” The point is “on the entrance of the cave, Kahokukahi… The above is the vertical entrance of a famous *ana kaua*, which extends for a long distance to the E. and to the W…” (J.S. Emerson Field Book 291:137). An “ana kaua” would be a place, where during times of war, people could hide and fortify themselves. Emerson’s description indicates that the cave runs some distance *mauka* and *makai* of “Kahokukahi.”

On May 23, 1888, Emerson surveyed Pūhili, the boundary between Kohanaiki and ‘O‘oma 2nd. He observed, “Large [mark] on solid pahoehoe, on bound. bet. Kohanaiki & Ooma, by the sea, near the end of a cape… Station mark, drill hole in stone, 9 ft. S. of the S. corner of an old “kahua hale” on white sand…” (J.S. Emerson Field Book 291:151).

Returning to his “old camp Ooma,” in August 1888, Emerson submitted the following letter to Alexander:

> *August 25th, 1888*
> …I have to report that the very intricate and irregular remainder of Gov’t. land situated in Kealakehe is cut up into homesteads, ready for the committee to estimate its values. The job has been made unusually long & tedious by the absurd arrangement of the old kuleanas scattered around at random. I have also run out the boundaries of Papaakoko, ready for fencing. Thursday P.M. I made my way through a heavy rain to this place and set up tent in the storm. It rained a good deal every day since and is raining now. In spite of the weather the work of cutting up Ooma 1st goes bravely on. I have a huge umbrella to camp under while it rains. I propose to finish up Ooma 1st & return to Honolulu by the next trip of the *Hall*.
>
> Kailua beach is the great rendezvous for men & asses from all parts of the country when the steamer arrives from Honolulu. It has in consequence become the natural place to tell and hear gossip & news. Here, the sand-lot orator, mounted on a packing box, can address the largest crowd. T.N. Simeona, who stole the church money, keeps the pound and takes care of the court house wanting to make a speech, repaired to the beach last Wednesday morning and is reported to have made a windy harangue to the effect that the King was hewa and that the Ministers were pono! Up to that time he had always been the contemptible too of the King’s party and was loud in his denunciation of the Government. I explain this change in his talk by his wish to retain his Gov’t. billets & his desire to avoid arrest as a rebel.
>
> A native man told me the other day (Wednesday) that the Cabinet was hewa in two things viz.
>
> 1st They taxed chickens, banana trees and many other things that had not been heretofore taxed.
>
> 2nd They arrested and sent to Molokai many who were not lepers. For these reasons many justified Wilcox for trying to out the ministers.
>
> There is a sturdy old native living at Kaloko named Kealiihelepo, whom I greatly respect. Said he to me “When King Kalakaua returned from his foreign trip he made a speech at Kailua and said that ‘in foreign lands the foreign God was losing his power. His former worshippers were deserting him. That the old Hawaiian Gods were still mana and them he would worship.’” But said Kealiihelepo “The King was mistaken. Our old Gods were once mighty, but the coming of the foreigner with his Gods has robbed them of their strength. Therefore the King has made the mistake to oppose the God who is now in power, and Jehovah is opposing him. Hence the King’s pilikia.”
>
> You are entirely justified in calling Kona “that heathen district.” [HSA – HGS DAGS 6, box 2 Jan.-Apr. 1888]

On October 14th 1888, Emerson wrote to Alexander, briefing him on conversations he was having with J.W.H. Isaac Kihe, his "encyclopedia," "the son of a famous sorcerer." Later, Emerson used many of the notes taken during his conversations with Kihe, to develop his paper on Hawaiian religion (Emerson 1892). J.W.H. Isaac Kihe, was the son of Kihe, who was the son of Kuapahoa, of Kaloko (notes of J.S. Emerson, September 25, 1915; in collection of the Hawaiian Historical Society). While at ʻOʻoma, Kihe described the various nature forms taken by the deceased, and their role in the spiritual practices. On October 14th Kihe named for him some of the gods called upon by those who practiced the Kahuna Kuni sorcery.

> *Ooma*
> *October 14, 1888*
> *J.S. Emerson; to W.D. Alexander:*
> …I have just been having a chat with a son of a famous sorcerer, with the following for a summary of what he said.
>
> There are four gods worshipped by murders and sorcerers viz:
>
> (1). Kui-a-Lua, the god of the Lua, Mokomoko, Haihai and other forms of violence.
>
> (2). Uli, the god of the Anaana, Kuni, Hoopiopio and Lawe Maunu.
>
> (3). Kalaipahoa, god of the Hoounauna, Hookomokomo and Hooleilei.
>
> (4). Hiiaka-i-ka-poli-o-Pele, the goddess of the Poi uhane, Apo leo, Pahiuhiu and Hoonoho uhane… [J.S. Emerson, in collection of the Hawaiian Historical Society]

Trails and Roads of Kekaha (Governmental Communications)

Alahele (trails and byways) and *alaloa* (regional thoroughfares) are an integral part of the cultural landscape of Hawaiʻi. The *alahele* provided access for local and regional travel, subsistence activities, cultural and religious purposes, and for communication between extended families and communities. Trails were, and still remain important features of the cultural landscape.

Traditional and historical accounts (cited in this study) describe at least two traditional trails that were of regional importance which pass through the lands of ʻOʻoma. One trail is the *alaloa*—parts of which were modified in the 1840s and later, into what is now called the *Alanui Aupuni* (Government Road) or Māmalahoa Trail or King's Highway—that crosses the *makai* (near shore) lands, linking royal centers, coastal communities, and resources together. The other major thoroughfare of this region is "*Kealaehu*" (The path of Ehu), which passes through the uplands, generally a little above the *mauka* Government Road or old Māmalahoa Highway, out to the ʻAkāhipuʻu vicinity, and then cuts down to Kīholo in Puʻu Waʻawaʻa. From Kīholo, the *makai alaloa* and Kealaehu join together as the *Alanui Aupuni,* and into Kohala, passing through Kawaihae and beyond. The *mauka* route provided travelers with a zone for cooler traveling, and access to inland communities and resources. It also allowed for more direct travel between the extremities of North and South Kona (cf. Malo 1951; Iʻi 1959; Kamakau 1961; Ellis 1963; and *Māhele* and Boundary Commission Testimonies).

In addition to the *alahele* and *alaloa*, running laterally with the shore, there are another set of trails that run from the shore to the uplands. By nature of traditional land use and residency practices, every *ahupuaʻa* also included one or more *mauka-makai* trail. In native terminology, these trails were generally known as—*ala piʻi uka* or *ala piʻi mauna* (trails that ascend to the uplands or mountain). Some of these trails are described in native accounts and oral history interviews cited in this study.

Along the trails of the Kekaha region of which ʻOʻoma is a part, are found a wide variety of cultural resources, including, but not limited to residences (both permanent and temporary), enclosures and exclosures, wall alignments, agricultural complexes, resting places, resource collection sites, ceremonial features, *ilina* (burial sites), petroglyphs, subsidiary trails, and other sites of significance to the families who once lived in the vicinity of the trails. The trails themselves also exhibit a variety of construction methods, generally determined by the environmental zone and natural topography of the land. "Ancient" trail construction methods included the making of worn paths on *pāhoehoe* or *'a'ā* lava surfaces, curbstone and coral-cobble lined trails, or cobble stepping stone pavements, and trails across sandy shores and dry rocky soils.

Following the early nineteenth century, western contact brought about changes in the methods of travel (horses and other hoofed animals were introduced). By the mid-nineteenth century, wheeled carts were also being used on some of the trails. In the Kona region portions of both near shore and upland *ala hele-ala loa* were realigned (straightened out), widened, and smoothed over, while other sections were simply abandoned for newer more direct routes. In establishing modified trail—and early road-systems—portions of the routes were moved far enough inland so as to make a straight route, thus, taking travel away from the shoreline.

It was not until 1847, that detailed communications regarding road construction on Hawai'i began to be written and preserved. It was also at that time that the ancient trail system began to be modified and the alignments became a part of a system of "roads" called the "*Alanui Aupuni*" or Government Roads. Work on the roads was funded in part by government appropriations, and through the labor or financial contributions of area residents and prisoners working off penalties (see communications below). Where the *Alanui Aupuni* crosses the lands of 'O'oma, the alignment includes several construction methods, such as being lined with curbstones; elevated; and with stone filled "bridges" in areas that level out the contour of the roadway.

The following letters provide readers with a historical overview of the *Alanui Aupuni*, and travel through 'O'oma and the Kekaha region. Of particular interest to the lands of 'O'oma, are those communications addressing the lower Government Road which passes through the proposed development area.

(Underlining, italics, and square brackets have been added.)

> *June 26, 1847*
> *George L. Kapeau to Keoni Ana*
> I have received your instructions, that I should explain to you about the *alaloa* (roadways), *alahaka* (bridges), lighthouses, markets, and animal pounds. I have not yet done all of these things. I have thought about where the *alanui heleloa* (highways) should be made, from Kailua to Kaawaloa and from Kailua to Ooma, where our King was cared for [7], and then afterwards around the island. It will be a thing of great value, for the roads to be completed. Please instruct me which is the proper thing for me to do about the *alaloa*, *alahaka*, and the laying out of the *alaloa*… [HSA – Interior Department Misc., Box 142; Kepā Maly, translator)
>
> *August 13, 1847*
> *Governor of Hawaii, George L. Kapeau; to*
> *Premier and Minister of Interior, Keoni Ana*
> *Aloha oe e ka mea Hanohano –*
> I have a few questions which I wish to ask you. Will the police officers be required to pay, when they do not attend the Tuesday (*Poalua*) labor days? How about parents who have several children? What about school teachers and school agents? Are they not required to work like all other people when there is Government work on the roads and highways?
>
> I believe that school agents, school teachers and parents who have several children, should only go and work on the weeks of the public, and not on the *konohiki* days…
>
> …The roads from Kailua and down the pali of Kealakekua, and from Kailua to Honokohau, Kaloko, Ooma, at the places that were told our King, and from thence to Kaelehuluhulu [at Kaulana in Kekaha], are now being surveyed. When I find a suitable day, I will go to

[7] For the first five years of his life (until ca. 1818), Kauikeaouli was raised at 'O'oma, by Ka-iki-o-'ewa and Keawe-a-mahi *mā* (see Kamakau 1960; and this study).

Napoopoo immediately, to confer with the old timers of that place, in order to decide upon the proper place to build the highway from Napoopoo to Honaunau, and Kauhako, and thence continue on to meet the road from Kau. The road is close to the shore of Kapalilua…

The width of the highways around Hawaii, is only one fathom, but, where it is suitable to widen where there is plenty of dirt, two fathoms and over would be all right… If the roads are put into proper condition, there are a lot of places for the strangers to visit when they come here. The Kilauea volcano, and the mountains of Maunaloa, Maunakea, Hualalai.

There is only one trouble to prevent the building of a highway all around, it is the steep gulches at Waipio and Pololu, but this place can be left to the very last… [HSA – Roads, Hawaii]

March 29, 1848
Governor Kapeau; to Minister of the Interior, Keoni Ana:
[Acknowledging receipt of communication and answering questions regarding construction methods used in building the roads.]

…I do not know just what amount of work has been done, but, I can only let you know what has come under my notice.

The highway has been laid from Kailua to Kaloko, and running to the North West, about four miles long, but it is not completely finished with dirt. The place laid with dirt and in good condition is only 310 fathoms.

The highway from Kealakekua to Honaunau has been laid, but is not all finished, and are only small sections… [HSA – Roads, Hawaii]

July 9, 1873
R.A. Lyman; to
E.O. Hall, Minister of the Interior.
Notifies Minister that *the road from Kiholo to Kailua needs repairing*. [HSA – Interior Department – Land Files]

August 14, 1873
R.A. Lyman; to
E.O. Hall, Minister of the Interior:
I have just reached here [Kawaihae] from Kona. I have seen most of the roads in N. Kona, and they are being improved near where the people live. If there is any money to be expended on the roads in N. Kona, I would say that the place where it is most needed is from Kiholo to Makalawena, or the Notch on Hualalai.

This is the main road around the island and is in very bad condition. Hardly anyone lives there, and there are several miles of road across the lava there, that can only be worked by hiring men to do it. There is also a road across a strip of Aa a mile & a half or 2 in length in the south end of S. Kohala next to the boundary of N. Kona, that needs working, and then the road from here [Kawaihae] to Kona will be quite passable… [HSA – Roads, Hawaii]

November 4, 1880
J.W. Smith, Road Supervisor, North Kona; to
A.P. Carter, Minister of the Interior:
…Heretofore I have been paying one dollar per day, but few natives will work for that, they want $1.50 per day. Thus far I have refused to pay more than $1.00 and have been getting men for that sum.

The most urgent repairs are needed on the main road from Kaupulehu to Kiholo, and north of Kiholo to the Kohala boundary, a distance of about 20 miles... [HSA – Roads, Hawaii]

Kailua Nov. 19th, 1880
Geo. McDougall; to
A.P. Carter, Minister of the Interior —
…I noticed among the appropriation passed by the last Legislature, an item of $5000 for Roads in North Kona Hawaii — as I am very much interested about roads in this neighbourhood, I take the liberty to express my opinions what is wanted to put the roads in good repair and give the most satisfaction to all concerned.

The Road from Kailua going north for about eight miles to where it joins the upper Road, has never been made, it is only a mule track winding through the lava. It could cost to make it a good cart road, fully two thousand dollars. And from Kailua to where it joins the South Kona road, about 12 miles was made by Gov. Adams, and is in pretty much the same state as he left it, only a little worse of the ware of 20 years or more, it could cost to make it in good repair about 15 hundred dollars. Then we could have 20 miles of good road… [HSA – Interior Department Letters]

March 21st, 1885
C.N. Arnold, Road Superintendent-in-Chief, Hawaii; to
Charles Gulick, Minister of Interior:
…In accordance with your instructions I beg to hand you the following list of names as being those I would select for Supervisors in the different Road Districts under my charge:

… Judge J.K. Hoapili, North Kona District…

Hoping these parties may meet with your approval… [HSA – Roads, Hawaii]

March 1886
Petition to Charles Gulick, Minister of the Interior:
[Signed by 53 residents of North Kona, asking that the appropriated funds be expended for the Kailua-Kohanaiki Road]:

We the people whose names are below, subjects of the King, residing in North Kona, Island of Hawaii:

The funds have been appropriated by the Legislature for the opening of the road from Kailua to Kohanaiki, therefore, we humbly request that the road be made there. The length of this road being thought of is about five miles more or less. The road that is there at the present time is not fit for either man nor beast.

Your people have confidence that as so explained, you will kindly grant our request, and end this trouble in our District…

[those signing included names of individuals known to have ties to the ‘O‘oma vicinity]: …J. Kamaka, Kuakahela, Kahulanui, & Palakiko… [HSA – Roads Hawaii; Maly, translator]

March 9th, 1887
C.N. Arnold, Road Superintendent-in-Chief, Hawaii; to
Chas. Gulick, Minister of the Interior:
[Arnold provides documentation of the early native trail from Kailua to the upper Kohanaiki region, and its’ ongoing use at the time. He also notes that McDougall (resident at Honokōhau) and others are presently in the business of dairy ranching]:

…The enclosed petition [cited above] has just come to hand from North Kona. The petitioners are mistaken when they say that any special appropriation has been made for this road as there has never been a Government road in this part of the District. There is however an old native trail which has always been used as a short cut, from the lower part of the district between Keahou [sic] and Kailua, by persons who were traveling to Kawaihae and Waimea. The opening of a good road here would be a great convenience to the traveling public and also a great accommodation to a great many people who live on, or nearly on the line of it. I may mention among the number, Messrs. McDougall and Clark who are engaged in dairy ranching near the head of the proposed line. I may also mention that I, with Mr. Smith, made a preliminary survey of it, at the request of His Majesty the King, who is also interested in the opening of this road, as itopens up all of His Kailua lands for settlement. I regard the road as necessary for the above reasons.

From the preliminary survey made, I estimate that a wagon road 12 feet wide will cost from Kailua to the *mauka* Govt. road at Kohanaiki $6000. The length of the road is 5 ¾ miles. The elevation of highest point (*mauka* Road) is 1600 feet above tide at Kailua. Mr. Smith Supt. of Public Works has all the notes of the survey, and can give you full information in regard to this matter… [HSA – Roads, Hawaii]

July 14th, 1887
C.N. Arnold, Road Superintendent-in-Chief, Hawaii; to
L.A. Thurston, Minister of the Interior:
…In obedience to your request I beg to hand you the following list of the District Supervisors under my jurisdiction:

…North Kona – Hon. J.K. Nahale; Native… [HSA – Roads Hawaii]

March 8, 1888
J. Kaelemkule; Supervisor, North Kona Road Board; to
L.A. Thurston, Minister of the Interior.
[Ka'elemakule provides Thurston with an overview of work on the roads of North Kona, and describes the Government roads (*Ala nui Aupuni* or *Ala loa*) which pass through the Kekaha region]:

The road that runs from Kailua to Kohanaiki, on the north of Kailua, perhaps 6 miles. It is covered with aa stone, and is perhaps one of the worst roads here. The Road Board of North Kona has appropriated $200 for work in the worst areas, and that work has been undertaken and the road improved. The work continues at this time. This is one of the important roads of this district, and it is one of the first roads that should be worked on.

The government road or ala loa from upland Kainaliu (that is the boundary between this district of South Kona) [Kealaehu], runs straight down to Kiholo and reaches the boundary of the district adjoining South Kohala, its length is 20 and 30 miles. With a troubled heart I explain to your Excellency that from the place called Kapalaoa next to South Kohala until Kiholo – this is a very bad section of about 8 miles; This place is always damaged by the animals of the people who travel along this road. The pahoehoe to the north of Kiholo called Ke A. hou, is a place that it is justified to work quickly without waiting. Schedule A, attached, will tell you what is proposed to care for these bad places…

Schedule A: [Appropriations needed]
The road from Kailua to Kohanaiki, and then joining with the inland Government Road – $500.

The upland Road from Kainaliu to the boundary adjoining S. Kohala – $1,500.00. [HSA – Roads Hawaii; Kepā Maly, translator]

September 30, 1889
Thos. Aiu, Secretary, North Kona Road Board (for J. Kaelemakule); to
L.A. Thurston, Minister of the Interior.
[Provides Thurston with an overview of work on the roads of North Kona, and identifies individuals who are responsible for road maintenance (cantoniers) in various portions of the district; several of the individuals named were also old residents and applicants for Homestead lots. Of interest, Kaelemakule's report indicates that maintenance of the Alanui Aupuni which crossed into the kula lands of ʻOʻoma, had not been assigned to anyone. (see report of Dec. 22, 1890)]:

1. In that section of the road which proceeds from Kailua near the shore to Kohanaiki, Mano is the cantonier.
2. That section of the road from Kukuiooohiwai to Keahuolono, Paiwa is the cantonier…
3. That section of road from Kailua to the shore of Honokohau, Keaweiwi is the cantonier …
4. That section of road from Kukuioohiwai to Lanihau along the upland road, Isaac Kihe is the caretaker…

The work done along these sections is the cutting of brush – guava, lantana and such – which trouble the road, and the removal of bothersome stones… [HSA – Roads Hawaii; Kepā Maly, translator]

December 22, 1890
J. Kaelemkule; Supervisor, North Kona Road Board; to
C.N. Spencer, Minister of the Interior
[Reports on the cantoniers assigned to road work in various sections of North Kona. As in 1889, apparently no one was assigned to the lower Alanui Aupuni through the ʻOʻoma kula lands. Though Kaelemakule did include the road section on the land, extending through Kalaoa, on his attached diagram]:

…I forward to you the list of names of the cantoniers who have been hired to work on the roads of this district, totaling 15 sections; showing the alignment of the road and the length of each of the sections. The monthly pay is $4.00 per month, at one day of work each week. The board wanted to increase it totwo days a week, but if that was done, there would not have been enough money as our road tax is only $700.00 for this district… You will receive here the diagram of the roads of North Kona. [HSA – Roads Hawaii; Kepā Maly, translator] (Figure 15)

Twentieth Century Travel in ʻOʻoma and Neighboring lands of Kekaha

Kamaʻāina who have participated in oral history interviews, describe on-going travel between the uplands and coastal lands of ʻOʻoma and other *ahupuaʻa* in Kekaha. The primary method of travel between 1900 and 1947, was by foot or on horse or donkey, and those who traveled the land, were generally residents of the ʻOʻoma, Kalaoa, Kohanaiki Homesteads and other lands in the immediate vicinity. After World War II, retired military vehicles became available to the public, after that time, the *Alanui Aupuni* (Figure 16) and some of the smaller trails along the shore were modified for vehicular traffic.

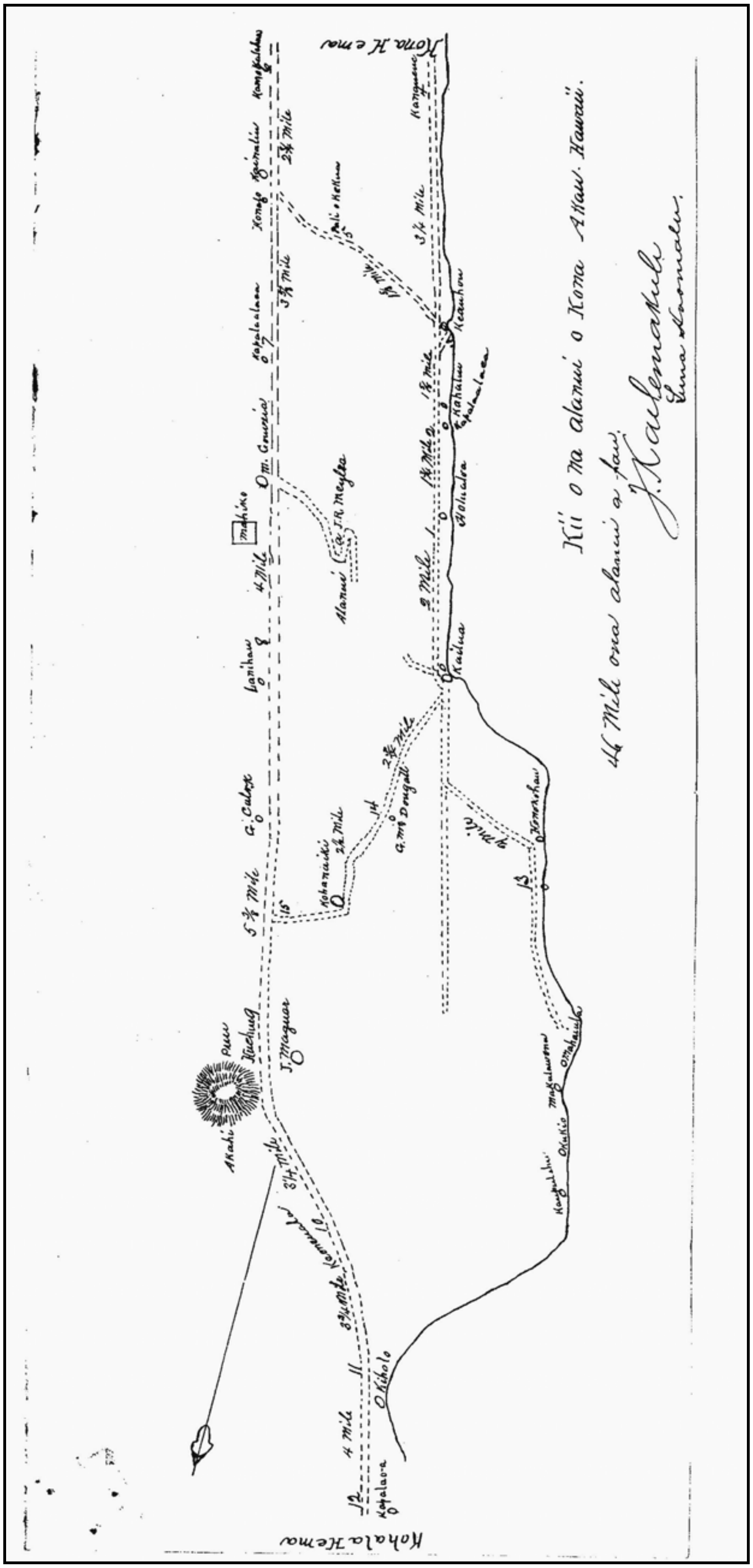

Figure 15. *Kii o na alanui o Kona Akau* (diagram of the roads of North Kona); J. Kaelemakule Sr., Road Supervisor (HAS—Roads, Hawaii; December 22, 1890).

Figure 16. Portion of the *Alanui Aupuni* (SIHP Site 2) crossing ‘O‘oma 2nd; view toward Kohanaiki.

The primary routes of travel through the 1960s, descended from upland Kohanaiki and Kaloko, or came out of Kailua. In the 1950s, Hu‘ehu‘e Ranch bulldozed a jeep road to the shore at Kaloko. The ranch, and some individuals who went to the shore either as a part of their ranch duties, or for leisure fishing along the coast, used this jeep road. The *Alanui Aupuni* was modified from Kailua, to at least as far as Honokōhau and Kaloko, and remained in use through the 1970s. It was not until the Queen Ka‘ahumanu Highway was opened (ca. 1973) that travel across the *kula kai* (shoreward plains) of ‘O‘oma was once again made possible for the general public.

ORAL-HISTORICAL INTERVIEWS

In support of both earlier research (Clark and Rechtman 2005; Rechtman 2006; Rechtman and Maly 2003), and the current proposed development (Rechtman 2007), oral-historical interviews were conducted specific to ‘O‘oma and the neighboring lands of Kekaha.

Interview Participants

All of the individuals that participated in the oral history interviews cited in this study are directly descended from traditional residents of ‘O‘oma and adjoining lands, and many of the personal recollections date back to the 1920s. The interviewees also benefited from the words of their own elders and extended family members, whose personal recollections dated back to the middle 1800s. Following is a summary of the interviewees.

Valentine K. Ako is of Hawaiian ancestry and was born at Hōlualoa in 1926. He currently resides on Kaua‘i. Interviewed in 1996, *kupuna* Ako visited families and fished at ‘O‘oma and neighboring lands of Kekaha (ca. 1930s-1940s). He is well known for his knowledge of Hawaiian fishing customs and fisheries, and is a member of several cultural committees.

George Kinoulu Kahananui Sr. is of Hawaiian ancestry and was born at Hōlualoa in 1925. Raised from infancy at ‘O‘oma 2nd, he continues to reside on old family land in ‘O‘oma. Uncle Kino regularly traveled the uplands and coastal lands of ‘O‘oma and Kekaha, learned of traditions and practices; and later managed the lands under Hu‘ehu‘e Ranch. He continues to fish on the coastal lands of ‘O‘oma and Kohanaiki. As a child he farmed the family lands that make up a portion of the current project area, a portion of which he retained ownership of until recently. Uncle Kino is well respected and known for his knowledge of the land, and is a valued resource on a number of cultural committees.

Elizabeth Maluihi Ako Lee is of Hawaiian ancestry and is the sister of Uncle Kino. Auntie Elizabeth was born in 1929 and was raised by her *hanai* family, Kahananui, in upland ‘O‘oma. As a child she walked the upland trails and cultivated sweet potatoes on her family land in ‘O‘oma 2nd Ahupua‘a, which are now part of the current project area. She is a well-respected *lauhala* weaver and retains valuable cultural knowledge.

Samuel Keanaaina is of Hawaiian ancestry and was born at Kolaoa in 1926, where he remains resident. Descendant of families with generational ties to various lands of the Kekaha region, including ‘O‘oma, *kupuna* Keanaaina regularly traveled the uplands and coastal lands of ‘O‘oma and Kekaha. He learned of traditions and practices of the families of the land, and was a fisherman in his youth.

Malaea Agnes Keanaaina-Tolentino (with daughter Cynthia Torres) is of Hawaiian ancestry and was born at Kolaoa in 1928. She currently resides in Kealakehe and is the Sister of Samuel Keanaaina, who shared in similar experiences as her brother. She was raised by her grandparents in Honokōhau Nui and as a youth she regularly traveled between the uplands and coastal lands of Honokōhau-Kaloko, Kalaoa-‘O‘oma and Kohanaiki. Kupuna Malaea has served on several cultural committees and is known for her knowledge of the land.

Ruby Keanaaina McDonald was born at Kalihi on O‘ahu in 1942 and moved to Kona when she was about six years old. *Kūpuna* Keanaaina and Malaea are her uncle and auntie. Ruby grew up with her aunties and uncles in Kona (*mauka* Kalaoa and Hōlualoa) and spent a lot of time with her *kūpuna* listening to their stories and later documenting the family genealogy. As a child her experiences on the land in ‘O‘oma included stopovers at the family’s *kula* house (Kamaka homestead) on the way to the shore to gather and process *lauhala*. She currently works as the Office of Hawaiian Affairs liaison for west Hawai‘i.

Peter Keka is of Hawaiian ancestry and was born at Waiki‘i in 1940. His family resided for years in the Kalaoa-Kohanaiki-Honokōhau vicinity, and he currently resides in Kohanaiki. Peter traveled the Kekaha region and fished at ‘O‘oma and neighboring lands. He has been employed by the National Park Service and was responsible for the restoration of the Kaloko-Honokōhau fishponds and other cultural sites in the park

Peter Keikua‘ana Park is of Hawaiian ancestry and was born at ‘O‘oma in 1918. He currently resides in Kalaoa 5th. Born and raised in the upland section of ‘O‘oma 2nd he regularly traveled with his grandparents (adoptive parents) to the coastal lands of ‘O‘oma. *Kupuna* Park described life on the lands and identified elder families of ‘O‘oma and neighboring lands. He also shared important documentation pertaining to traditions associated with fishing and cultivation of the land. Kupuna Park’s elders were noted *lauhala* weavers, a craft that was passed on to him and his sisters, and was an activity that sustained their family. They collected *lauhala* from ‘Ohikapua on the *kula* lands of Kalaoa 5th. Kupuna Park is a noted weaver and resource for several cultural programs.

Summary of Oral-Historical Information

Elder *kama‘āina* of the Kekaha region, tell much the same story as that described in the communications from the period of homestead development, and in the accounts given by J. Puuokupa in 1875 and J.W.H. Isaac Kihe in 1924. By the late 1800s, only a few permanent residence remained along the ‘O‘oma (and Kekaha) coastline. Primary residences were in the uplands, in the vicinity of the old Māmalahoa Highway. In that region, people were able to cultivate a wide range of crops—both native staples and new introductions—with which to sustain themselves, and in some case even as cash crops.

By the middle to late 1800s, the *kula* lands, from around the 900-foot elevation to shore, were primarily used for goat, cattle, and donkey pasturage. The families of the uplands regularly traveled to the coast via trails. This was usually done to go fishing, or to round up cattle, goats, or donkeys. During periods of extreme dry weather, when water resources dried up, the families relied on the brackish water ponds in the near-shore lands. In ‘O‘oma, near Wawaloli, the area marked on J.S. Emerson’s Register Maps 1280 (see Figure 7), as Kama’s or Keoki Mao’s house, families still took shelter, and drank the water from the spring, through the 1940s. Such was the case at various locations of the coast, between Kohanaiki, ‘O‘oma, Kalaoa, Ho‘onā, Kaulana, and lands further north to Kapalaoa.

Near the coastline several sites were described and, during field visits, pointed out by *kūpuna* Peter Kaikuaana Park and George Kinoulu Kahananui. These are also described by other elder *kamaʻāina*. The features included old goat and cattle corrals, old *kahua hale* (house sites), shelters, springs, burial sites, and fishery resources. Except for the old *mauka/makai* trail, the *Alanui Aupuni* (*makai* Government Road – "Old Māmalahoa Trail"), and walls, few other features were known by the interviewees on the lower *kula* lands (the area of the current proposed development). This is not surprising as the interviewees observed, when they were young, they were instructed not to wander around, and *mahaʻoi* (poke their noses) into caves and such. Their primary interest while traveling *makai* was to get to the fishing ground, and in reverse, to get back home. In the region of the lower homestead lots (the area of the current project) and above, interviewees have described the occurrence of caves, walls, and various features, including burials. Occasionally, when working the range, rounding up cattle, *huakaʻi pō* or night marchers have been heard, or even seen. The explanation being that the people of old, who once lived on the land, were traveling the trails in one direction or the other to attend to some ceremony or to venture out on fishing journeys, or other such activities. Both Auntie Elizabeth Maluihi Ako Lee and George Kinoulu Kahananui described their family's agricultural practices within portion of the current project area, and their father's use of the *mauka/makai* trails to access the shore for fishing.

When asked about proposed development on the ʻOʻoma lands and in other locations of Kekaha, the interviewees all speak with hesitancy. It is difficult for them to see the landscape that they have known all their lives, and for which traditions were handed down, change. None of the interviewees shared any specific knowledge about traditional cultural resources and associated practices within the boundaries of the current project area. All interviewees believe that *ilina* (burial sites) should be preserved in place; likewise, should any *heiau*, or other important sites be located, they should be protected. Whenever possible all sites, such as house sites, petroglyphs, walls, and other features should be protected.

ARCHAEOLOGICAL FIELDWORK

Fieldwork for the current project began on November 16, 2006 and was completed on January 11, 2007. Robert B. Rechtman, Ph.D. directed all fieldwork. Fieldworkers included Christopher S. Hand, B.A., Olivier M. Bautista, B.A., Johnny R. Dudoit, B.A., Sandy L. Ireland, B.A., and Robert L. Snibley.

During the intensive pedestrian survey of the study area, the entire parcel was subject to north/south transects with fieldworkers spaced at 10-meter intervals. When archaeological resources were encountered, they were compared to existing site location maps to determine if they had been previously recorded. If they had been recorded during the earlier studies, the sites were examined to see that the earlier sites descriptions were consistent with current observations. Previously recorded sites fell into three categories based on DLNR-SHPD approved treatments: no further work, data recovery, and preservation. Those sites approved for no further work and those sites that had already been subject to data recovery received only cursory investigation during the current fieldwork. Eight sites (SIHP Site 2, 1910, 1911, 1912, 1913, 10155, 18027, 18773) that had earlier been approved for preservation were investigated to verify current site conditions and site boundaries.

During the current survey fieldwork one site (SIHP Site 25932) was discovered that had not been previously documented, it was plotted on a map (see Figure 5) of the study parcel using Garmin 76s handheld GPS technology (with sub five-meter accuracy), and then mapped in detail using tape and compass, photographed, tagged with its temporary site number, and described using standardized site record forms. Only one newly discovered site was recorded.

Previously Identified Preservation Sites

As a result of the earlier studies conducted within the project area, eight sites were identified that DLNR-SHPD approved for preservation (see Figure 5). Each of these is described below and an assessment of its current condition is provided.

SIHP Site 50-10-27-2

This is the 1847 *makai* Government Road and has been variously referred to as the Māmalahoa Trail and the King's Highway. The site is visible across the landscape as a kerbstone alignment (see Figure 16) and forms a portion of the boundary between the two existing parcels that make up the current project area, and then alters its course to a slightly more *mauka* direction (see Figure 5). This site has been maintained (kerbstone replacement and vegetation removal) over the years as part of various community service projects. SIHP Site 2 is a linear trail feature that extends from Kailua Town to Kawaihae. Historical records indicate that the "Māmalahoa Trail" is more properly identified as the *alanui aupuni*, or government road, and was constructed through the ʻOʻoma area in 1847. This road is shown on the 1928 version of the USGS topographic map (Figure 17), and corresponds precisely to what can be seen on aerial photographs (Figure18) and what was observed on the ground during our study.

It was not until 1847 that detailed communications regarding road construction on Hawaiʻi began to be written and preserved. It was also at that time that the ancient trail system began to be modified and the alignments became a part of a system of "roads" called the "*Alanui Aupuni*" or Government Roads. Work on the roads was funded in part by government appropriations, and through the labor or financial contributions of area residents and prisoners working off penalties. Where the *Alanui Aupuni* crosses the lands of ʻOʻoma the alignment includes several construction methods: kerbing, elevating, and bridging. It should be noted that the alignment on the ground in this area does not match the alignment indicated on most early maps (and transposed to new maps). This deviation appears to be a result of early surveying errors. The actual alignment of the trail (labeled Māmalahoa Trail) was surveyed in 1986 as depicted on the Hawaiʻi State Survey Division's map C.S.F. No. 20499 (Figure 19). There is no physical evidence of a trail route on the ground matching the location of the "mapped" King's Trail.

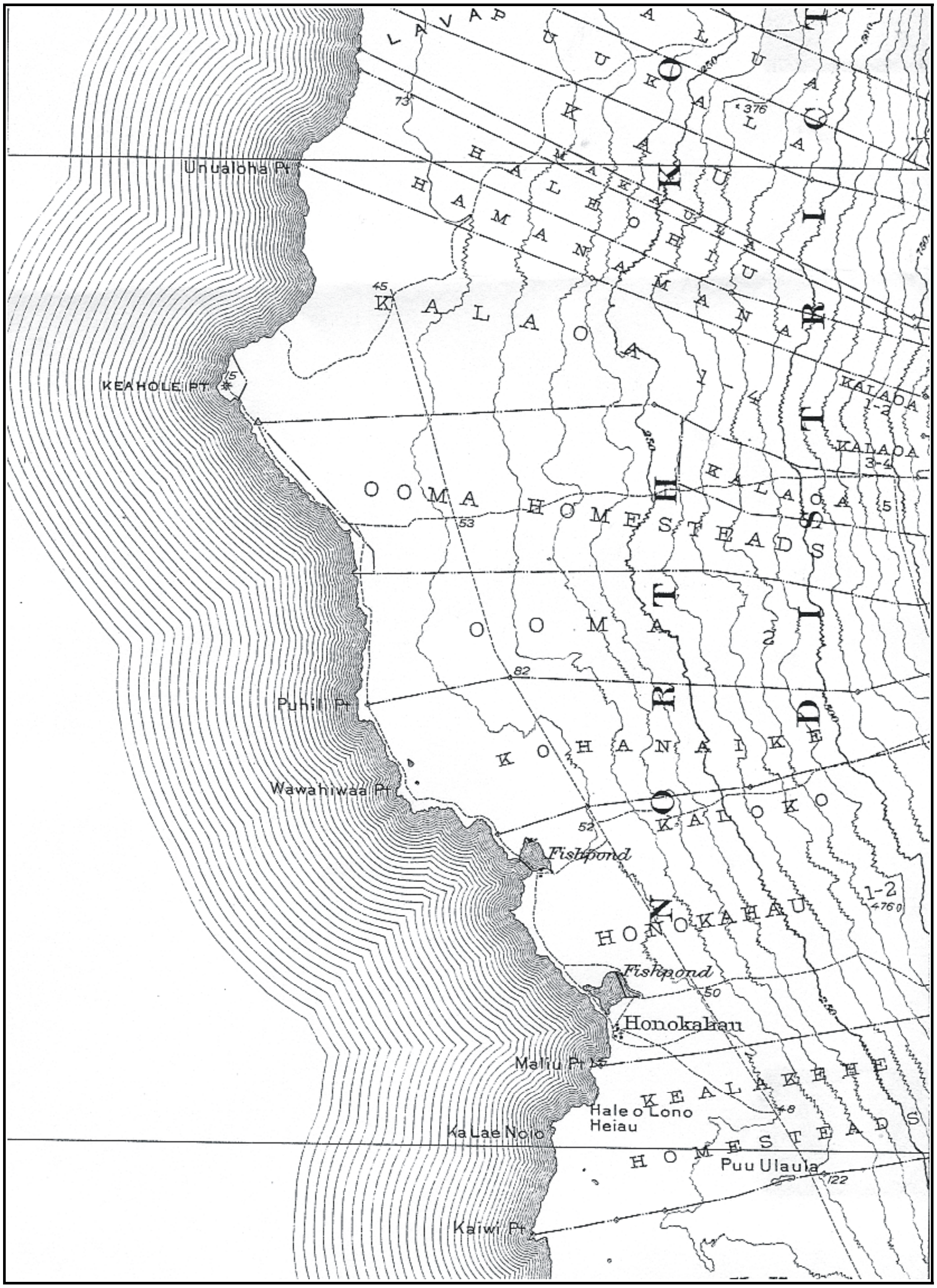

Figure 17. Portion of 1928 U.S.G.S. 7.5 minute series quadrangle Keahole HI showing SIHP Site 2.

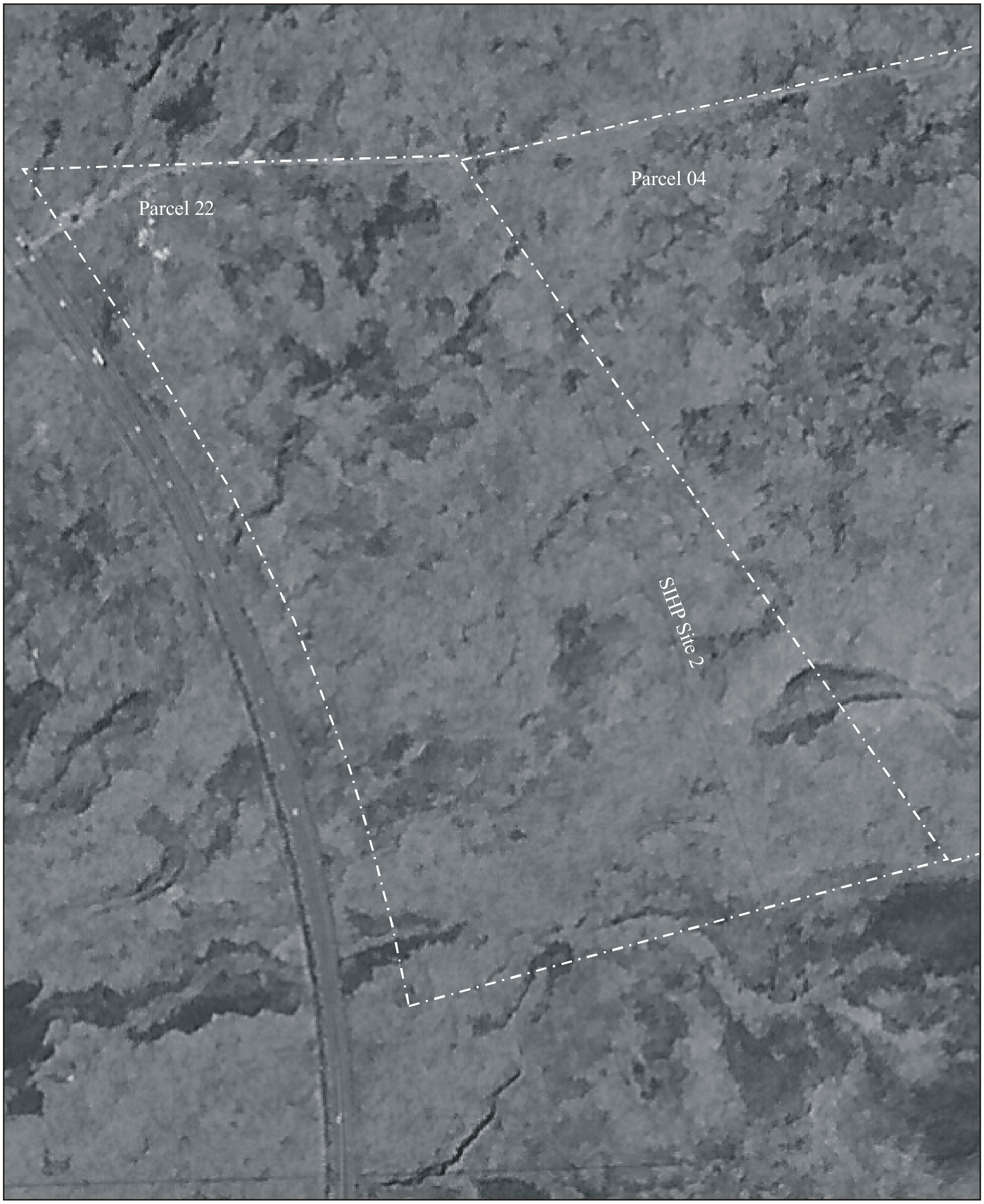

Figure 18. Aerial view of *mauka* portion of property showing route of SHIP Site 2.

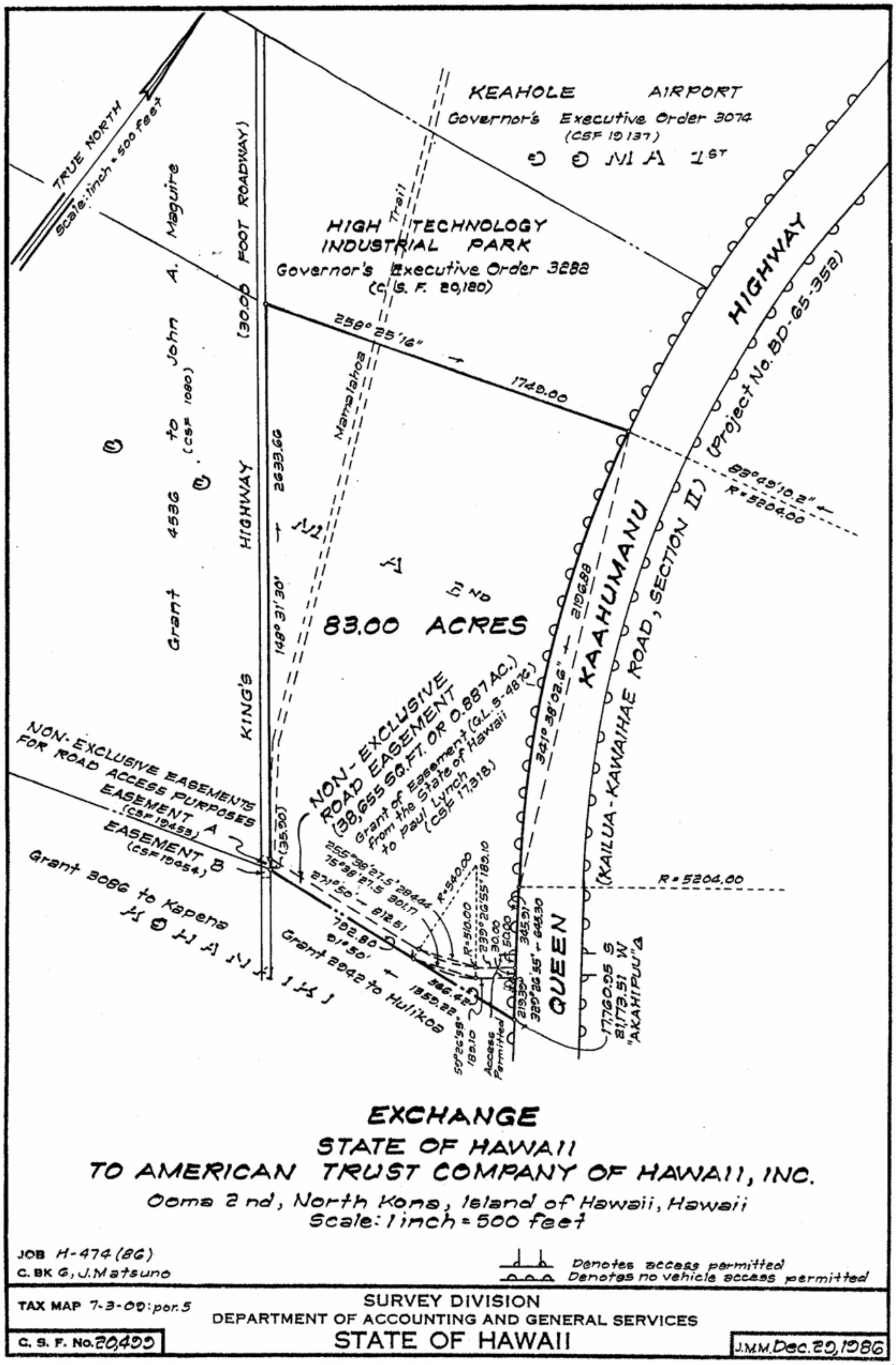

Figure 19. State Survey map depicting old Government Road alignment through ‘O‘oma 1st and 2nd.

SIHP Site 50-10-27-1910

First recorded by Reinecke (n.d.) in 1930 as "Site 68," by Martin in 1971 as 50-10-27-1910, this site was arbitrarily separated by Cordy in 1975 into D15-1 and D15-2 using the Bishop Museum nomenclature. However, as Donham expressed, "the reason for breaking up this complex is unclear, since the distance between the features at Sites D15-1 and D15-2 is no greater than the distance between the two features of Site D15-2." (1987:83). Thus, Site 1910 is reported here in its originally recorded configuration. The ten features that comprise this site are described by Donham (1987), and appear today as she described them (Figures 20-24).

> Site D15-1 is located at the west-central edge of a broad aa flow that extends to the coral beach. The features are situated along the west-facing slope of the flow and are 2.0 m to 5.0 m above the coral beach. The entire site area has been exposed to storm wash.
>
> Feature designations used here correspond with those assigned on the state inventory form. Features A through D correspond with Features 1 through 4, as shown on Cordy's plan map of the site (1986a:15).
>
> Feature A is a large, nearly square (9.0 by 10.0 m) coral pavement that is subdivided into two levels. The upper level is at the southern end of the pavement and is 2.9 m wide; it is defined by an eroded retaining wall and is a maximum of 0.2 m above the rest of the paving. The northeast corner of the pavement has been faced in order to maintain a leveled surface, and small patches of bedrock are exposed in areas. A small, raised platform is present in the southwest corner.
>
> Two linear rubble mounds extend out from the northwestern corner of the pavement. These mounds are situated between the platform and a prominent rock outcrop; they are 2.5 m long, 1.0 m wide, and 0.04 to 0.5 m high. The western mound is constructed from small aa cobbles and has a relatively flat surface. The eastern mound is constructed from larger aa boulders, but is also platform-like in from. . .
>
> A rubble mound is also located at the southeast corner of the pavement; this feature is more amorphous than the two linear mounds and may represent a clearing pile. A disturbed water worn boulder is located at the northeast corner; this stone was apparently upright at the time of Cordy's survey. A second water worn boulder is located on one of the linear mounds.
>
> A single., 1.0-m-sq test unit was excavated by Cordy in the northeast quarter of the pavement. No artifacts or volcanic glass specimens for dating were recovered from this unit (Cordy 1981:242, 248). Cordy interpreted the feature as a men's house, on the basis of size and on the presence of coral, which indicated to him a ceremonial function.
>
> Feature B is a walled shelter that incorporates a 1.55-m-high up thrust of bedrock. Two nearly straight walls have been constructed on the north side of the bedrock to form a roughly U-shaped shelter. The west wall is 2.4 m long and 0.9 m wide. It is double-faced and is core-filled to a maximum height of 1.0 m. The east wall is 2.2 m long and 0.8 to 1.0 m wide. It is faced on the interior and exterior sides and is stacked three to five stones wide, rather than being core filled. This wall has a maximum height to 1.10 m (six courses of stone). The deposit inside this small shelter (c. 2.5 sq m) is extremely rich in subsistence remains, charcoal, and lithic debris, and the floor appears to have been paved with small beach pebbles ('ili'ili).
>
> This feature was interpreted as a special purpose house and was designated as Site D15-1-3 by Cordy. A 1.0-m-sq test unit was excavated along the inside of the west wall. Two volcanic glass specimens collected from this unit were dated, along with four additional specimens collected from the surface of the feature . . . Cordy reports no artifacts collected from this feature; however, there is no question that a quantity of midden would have been collected from the excavation unit.
>
> Feature C, a three-sided, C-shaped wall, is constructed from rough pahoehoe and a'a slabs interspersed with water worn basalt stones. Cordy designated this structure as Site D15-1-2. The wall opens to the west and is aligned with a steppingstone path that leads westward for a distance of c. 6.0 m. The interior sides of the walls are nicely faced and are stacked three to

four courses high (0.7 m). The exterior sides slope outward from top to base; width at top is 0.7 m and at the bottom is 0.9 m. A bedrock outcrop occurs at the southeast corner of the structure, behind which is a filled crevice and a small cupboard-like excavation.

The deposit inside this structure is similar in composition to that in Feature B; however, it is less dense and contains considerably less wood charcoal. A test unit was excavated by Cordy along the interior side of the north wall . . . No artifacts were recovered from this excavation; the feature was interpreted as a sleeping house by Cordy.

Feature D is a platform constructed on a narrow projection of lava. It is nearly level with ground surface on the south side and is 0.6 m high on the north side. The general shape is rectangular (5.0 by 4.0 m), and the surface consists of chunky pahoehoe boulders without smaller paving stones. A small depression occurs in the center of the platform and a small, low-walled, C-shaped structure occurs immediately to the south. Cordy excavated a test unit at the southern edge of the platform where it was extremely shallow . . .

Feature E, a walled shelter, is located 11.0 m northeast of Feature C, and they are connected by a well-worn footpath (Feature E). It consists of two naturally up righted lava slabs, which form the roof for a sheltered area. The shelter measures 1.3 m wide and 0.8 m deep, with a ceiling height of 0.9 m. The area inside the overhang is cleared and leveled and is surrounded by a wall. The wall, which incorporates naturally occurring bedrock, encloses an area 2.89 m wide and 1.9 m deep, in front of the rock shelter. It is 0.9 m high and is roughly faced on the interior side. The exterior side slopes outward from top to bottom; there is a central opening in the wall. Shellfish remains are scattered inside the shelter.

Feature F is a walled shelter similar in from and construction to Feature E; however, it is somewhat smaller, and the surrounding wall has non-entranceway. This feature is located along the path that connects Features C and E.

This site has been determined to significant as site type example (Cordy 1986a), and it may also be significant as ceremonial . . . locale.

As noted above, . . . [Site D15-2] was designated by Reinecke and Martin as a component of a single complex, which included Site D15-1. It consists of three major features and a steppingstone footpath that connects Features A and B. The site is located northeast of Site D15-1, on a west facing slope of the rough pahoehoe and aa flow. A plan map of the site is given by Cordy (1986a:18).

Feature A, an enclosure, is situated along the lower slope, immediately east of an anchialine seep. It is 8.0 m long and 7.1 m wide, with the long axis oriented northwest-southeast. The walls are constructed from aa and rough pahoehoe slabs that are well staked and faced on two sides. Wall height varies from 1.0 to 1.9 m, and thickness varies from 0.7 to 0.9 m.

Three small, low, pebble and weathered coral platforms are located inside the enclosure. The longest of these platforms is located in the northeast corner and extends along the west wall of the enclosure. It is 4.7 m long, 1.6 m wide and 0.2 m high. A second platform is located at the northwest corner; it is 3.0 m long, 2.1 m wide and 0.2 m high. The third platform is along the center of the south wall; it is 3.7 m long, w.1 m wide and 0.2 m high. These platforms do not have faced sides.

A smaller, L-shaped wall section extends south from the southeast corner of the enclosure. This wall is 0.4 m thick and 0.5 m high. It is not as well constructed as the main enclosure wall and consists of piled aa boulders. The long axis 3.2 m, and the shorter, east-west section is 2.3 m long. A small wall remnant is present, parallel to the long wall, suggesting that this feature may have been a small, adjoining enclosure. Adjacent to the east wall at the southeast corner or the main enclosure is a concentration of weathered coral and cobbles.

This feature was designated as Site D15-2-1 by Cordy and was interpreted as a special purpose house. A test unit was excavated just off the long platform within the enclosure . . . A number of shellfish varieties were observed within the enclosure, as well as Echinodea fragments.

Feature B is located c. 35.0 m east and upslope from Feature A. It is a rectangular enclosure measuring 5.5 m long and 4.5 m wide, with a small opening at the northwest corner. The walls are well-faced on the interior and exterior sides and are constructed from aa and rough pahoehoe slabs. They are 0.7 m wide and range in height from 1.0 to 1.2 m. The interior and exterior areas immediately west of the wall are paved with weathered coral pebbles. The exterior pavement extends 4.0 m west from the wall and averages 4.7 m long. No artifacts were visible in the area; however, four shellfish families are represented in the surface scatter.

Feature B was interpreted by Cordy as a sleeping house and was designated as D15-2-2. The test units were excavated; one inside the structure at the southwest corner and another outside in the coral pavement . . . Three artifacts were recovered from inside the enclosure; a piece of metal wire (near surface), a coral abrader, and a bone fishhook (Cordy 1981:242).

Feature C is a steppingstone path that connects Features A and B. The path is best defined at the western end, where slabs and water worn basalt boulders are in place for a distance of 10.0 m from Feature B. The remainder of its distance is defined primarily by coral cobbles. Its exact location in relation to Feature A is uncertain.

Feature D is a walled shelter located 20.3 m southeast (120 degrees Az) of Feature B. It consists of a shallow overhang (2.3 m wide and 1.2 m deep) that is partially enclosed by two short walls. The southern wall extends up to the drip line of the overhang, increasing the sheltered area to 3.3 by 2.5 m. This wall is 2.0m long and o.8 m high. The opposite wall is 1.2m long; both walls are 0.3 to 0.5 m wide. A sparse scatter of shellfish remains was observed on the surface inside the shelter, Chamidae, Cypraeidae, Neritidae, and Thaididae families are present. No artifacts were observed.


Figure 20. SIHP Site 1910 (D15-1) Feature C, view to the east.

Figure 21. SIHP Site 1910 (D15-1) Feature E, view to the east.

Figure 22. SIHP Site 1910 (D15-1) Feature B, view to the south.

Figure 23. SIHP Site 1910 (D15-2) Feature B, view to the east.

Figure 24. SIHP Site 1910 (D15-2) Feature c, view to the west.

SIHP Site 50-10-27-1911

SIHP Site 1911 was first recorded by Reinecke (n.d.) as a portion of "Site 69." Martin assigned the SIHP Site 50-10-27-1911 designation in 1971, and in 1975 Cordy (1895) used the Bishop Museum designations D15-16 and D15-17 to describe the two extant features (an enclosure and a platform) of the site. Barrera referred to the enclosure as T-32 and the platform as T-34. Donham (1987) described the enclosure as:

> . . . a rectangular wall that encloses an area 30.3 m long and 12.7 m wide. The wall is constructed from wayterworn basalt and pahoehoe boulders, with inclusions of coral concretions and limestone boulders. It is double faced with boulder fill and currently stands eight to none cources high (2.20 m maximum height). Average wall thickness is 1.2 m. Sections of the wall have collapsed, particularly along the west side. The interior surface of the enclosure is covered with storm wash, an no use-related deposit is observable. The enclosure was interpreted by Reinecke as a cattle pen and by Martin as "perhaps for goats." It exhibits no features of a habitation enclosure. Cordy recorded this site . . . which he defines as a historic animal pen. (Donham 1987:101)

This enclosure appears today in a further state of collapse (Figures 25 and 26) than documented by Donham (1987), whose interpretations of function seem valid. Vegetation covers most of the site affecting it long-term stability.

Figure 25. SIHP Site 1911 collapsed western wall of enclosure in foreground and stacked eastern wall in background. The heavily utilized road is immediately adjacent to the site.

Figure 26. SIHP Site 1911 southeastern corner of enclosure documenting current state of wall collapse.

The platform at SIHP Site 1911, recorded by Cordy as D15-17, appears today (Figure 27) in a more degraded state than was documented by Donham (1987), who describes it thusly:

> This platform is 12.7 m northeast (29 degrees Az) of the west corner of the Site D-16 enclosure, It is roughly rectangular in plan, with a length of 11.5 m and a width of 7.0 m; major axis is oriented northeast-southwest. Height of the platform varies from 0.7 to 0.9 m. It is constructed from large, waterworn basalt boulders and pahoehoe slabs, with inclusions of weathered coral and limestone cobbles and boulders. Three of the sides are faced, with three to four courses of stone. The southwest side is extremely disturbed, and it is difficult to determine the exact location of the edge.
>
> Platform fill consists of large boulders, cobbles and weathered coral; the surface is roughly level. A sparse scatter of shellfish remains, kukui nut shell, branch coral, and recent glass and aluminum beverage containers occurs on the platform surface. (Donham 1987:101)

Figure 27. SIHP Site 1911 platform, view to the east.

SIHP Site 50-10-27-1912

SIHP Site 1912 was recorded by Reinecke (n.d.) as a portion of "Site 69." Martin assigned the SIHP Site 50-10-27-1912 designation in 1971, and in 1975 Cordy (1895) used the Bishop Museum designation D15-3 to describe the a cluster of five features (Features A–E). Barrera (1985) referred to a portion of this site (Feature B) as T-33. Donham (1987) noting the costal jeep road has potentially migrated in an east-west direct over the years, suggested that this site may have been significantly impacted by activities associated with the use of that road. While the features of the site are identifiable today, they are poorly preserved. Feature B (Figure 28) remains the most intact, however, it is considerably diminished compared to the description presented by Donham (1987). Donham described all of the features of the site as follows:

> Feature A is a low enclosure with a west-facing entrance at the southwest corner. The enclosed area is rectangular (6.8 by 5.4 m), with the major axis oriented northwest-southeast. The walls are in very poor preservation and are collapsed at the northwest corner. Wall height varies from 0.2 to 0.3 m. Waterworn basalt boulders were used in construction of the wall, and the interior area is covered with coral pebbles and sand, which is probably a natural deposit. Beneath this layer is a very rock deposit which may extend to a maximum depth of 0.2 m. A few scattered shellfish remains were observed among the fill stones. Feature A was designated D15-3-1 by Cordy, who interpreted it as a sleeping house. He excavated a test unit immediately inside the west wall, near the entrance.
>
> Feature B, a large rock mound, is located 6.2 m southwest (240 degrees Az) of Feature A. It is roughly square in plan, with basal dimensions of 2.2 by 2.6 m. It is faced on all sides, with three to four cources (0.6 to 0.8 m) still intact. Jumbled stones are piled on top of the faced portion, to a maximum height of 1.10 m. The feature has a waterworn basalt boulder base, and a coral concretion boulder is incorporated into the structure.

Feature C, a very low terrace (4.4 by 5.0 m), is located 11.4 meters southeast (115 degrees Az) of Feature B. Two sides of the structure are along a sloping ground surface and are 0.5 to 0.4 m high. The western side is nearly even with the ground surface, with a maximum height of 0.15m. The raised sides of the terrace are not faced, and stones are dispersed along the slopes on the north and east sides. The terrace surface is a rough fill of boulders and cobbles with coral pebbles or possibly natural deposit). A small area (0.8 by 0.6 m) in the center of the terrace is outlined with waterworn and rough boulders. This depression is interpreted by Cordy and Martin as a firepit or hearth. . . . Cordy excavated a test unit adjacent to the hearth. On the west side. No dates were determined for this feature. Cordy designated it Site D15-3-2 and interpreted the feature as a sleeping house.

Feature D is a very poorly preserved terrace or platform, located 3.3 m northwest (330 degrees Az) of Feature B. It consists of a somewhat amorphous and dispersed arrangement of basalt cobbles, with a major axis of 5.2 m and a minor axis of 3.7 m. The northwest and southwest sides are slightly raised; however, no side walls or facing are present. Surface concentrations of basalt boulders occur along three sides and probably represent collapsed sides. . . . This feature was designated as Site D15-3-4 by Cordy, who excavated a test unit along the southwest wall.

Feature E is a filled and leveled crevice with a very poorly defined semicircular alignment adjoining to the west. The filled area is terraced, primarily by naturally occurring bedrock, to form two levels. The upper level is 2.8 m long and 2.6 m wide; the lower level is 2.8 m long and 2.0 m wide. The alignment adjoins the upper level at the north and southwestern corners. It is roughly D-shaped (3.0 by 2.0 m), and the south side is indistinct to nonexistent. . . . Feature E was subdivided into two distinct features (D15-3-3 and -5) by Cordy, who suggested they represent two special-purpose structures. A test unit was excavated inside the alignment, at the southeast corner. (Donham 1987:89-90)

Figure 28. SIHP Site 1912 Feature B, view to the northeast.

SIHP Site 50-10-27-1913

SIHP Site 1913 was first recorded by Reinecke (n.d.) as "Site 70." He described only Feature A of the site, labeling it a walled platform that was rather unusual in appearance. During the 1971-1972 Hawai'i Island portion of the State Inventory of Historic Places conducted by DLNR-SHPD, Martin recorded the walled platform and three associated smaller platforms, which collectively were assigned the State Site Number 50-10-27-1913. Feature A of Site 1913 was then reexamined in 1975 by Cordy (1985), who assigned it the Bishop Museum Site number D15-18. Both Martin and Cordy describe Feature A as a *heiau.* Donham (1987) indicates that the associated small platforms (Features B, C, and D) have been subject to impacts from storm related events. Feature A is located on the adjacent state parcel, and the three other smaller are located within the current study area (see Figure 5). Donham (1987) summarized the previous work conducted at Site 1913 and described it—using the Bishop Museum designation (Site D15-18)—thusly:

> This site was first recorded as Site 70 by Reinecke, who described it as follows:
>
> > Walled platform, S.E. corner terraced, badly broken down. Platform amuka [sic. mauka]. Walls of this and of site 73 are built of thin plates of surface lava, rather unusual in appearance (Reinecke 1930:15).
>
> Reinecke's description of the building material refers to the fact that waterworn basalt boulders were not used in the construction of the main platform; rather, the building stones are flat-surfaced pieces of rather porous pahoehoe . . .
>
> Martin, who located the main platform and identified it as a heiau, recorded this site as 50-10-27-1913. He also located three, associated platforms to the east. Cordy recorded the heiau only and does not indicate additional platforms. This is surprising, since he was specifically looking for platforms of this type during his survey, and Martin described them as "house platforms." Barrera did not record the major feature, since it was located west of the coastal jeep road. He did record the largest platform to the west as Site T-35. This feature is described as containing a slab-lined central firepit, which Martin also identified in the largest associated platform.
>
> Four features were identified as part of this complex during the PHRI investigation. These features are spatially patterned, as shown on Martin's site plan map, and include the main heiau (Feature A) in addition to three platforms of variable sizes. The platforms are currently located directly across the jeep road, 22.0 m west [sic east] of the heiau. The largest platform (Feature B) is visible on the project area aerial photograph, as is the heiau. Features C and D are located south of Feature B.
>
> Feature A, a large rectangular, walled platform, is situated on a large pahoehoe bedrock finger which is elevated above the adjacent coral beach. This location has undoubtedly contributed to the preservation of the site, which is unusually good for a high, walled structure so close to the shoreline.
>
> Overall length of the structure is 19.5 m, and overall width is 15.25 m. The walls are double-faced and core-filled along the west side. The platform has been filled up to within 0.5 to 0.7 m of the top of the wall. Fill material is pahoehoe and aa rubble, with weathered basalt and coral pebbles used as paving material. Larger coral cobbles also occur on the platform surface. Two smaller platforms occur along the north and eastern walls of the platform; these are raised 0.4 m above the surface.

> Feature B is nearly square, with a length of 5.5 m and a width of 5.0 m. It is defined by perimeter large boulders and is filled with various-sized rubble. The surface is leveled, waterworn pebbles and coral. The feature is storm-washed, and it is difficult to determine whether the corral deposit is totally natural. A rectangular, slab-lined depression occurs in the center of the platform; it is 0.53 m long and 0.34 m wide. The depression has been partially filled with beach wash, and it is impossible to determine actual depth without excavation.
>
> Features C and D are smaller in size, but are constructed with techniques and materials similar to those used for Feature A [sic Feature B]. Feature D is located 10 m southwest [sic southeast] of Feature C. It is square in plan (2.6 by 2.6 m) and is outlined with large boulders and filled with small pieces of pahoehoe. (Donham 1987:102-103)

SIHP Site 1913 continues to be impacted by both vehicular and pedestrian traffic. While Feature A (Figure 29) exhibits the least amount of modern disturbance, it is further degraded than when documented by Donham (1987). Features B (Figure 30), C, and D have also been significantly impacted beyond that previously recorded.

Figure 29. SIHP Site 1913 Feature A view to the northwest.


Figure 30. SIHP Site 1913 Feature B, view to the east. Heavily utilized road bisects the site.

SIHP Site 50-10-27-10155

Site 10155 (Figure 31) is a temporary habitation cave and potential potable water source. This site appears to have been associated with travel along SIHP Site 2, the “Māmalahoa Trail.” Within the cave is a substantial amount of habitation debris, and during an earlier archaeological reconnaissance survey (Rechtman 2002) a seemingly old coconut shell “cup” was observed to have been cached within a *puka* formed by collapsed rocks. This cup may have served to aid in collecting water from small seeps at the rear of the cave. During the recent inspection of the site, the rear of the cave was observed to be damp. This site appears to be in the same condition as when it was first recorded (Barrera 1985) and later documented (Rechtman 2002).


Figure 31. Entrance to SIHP Site 10155, view to the southwest.

SIHP Site 50-10-27-18027

SIHP Site 18027 was originally recorded by Donham (1987) as temporary site T-63; a complex containing thirteen features (Features A-M), including four cairns, four rubble piles, a cave shelter, an enclosure, two modified outcrops, an alignment, and a rubble pavement. Feature M, a cave shelter, is located within the current study area (see Figure 5), and Features L and K, two cairns, are both located approximately along the study area boundary with NELHA. Donham (1987:68), based on presence of a glass vase with flowers in it left at Feature K, suggested that that cairn was possibly a recently constructed memorial shrine. However, its location along the parcel boundary suggests a boundary function for the feature is more likely. No evidence that Feature K contained a burial, or could contain a burial (the feature is constructed on bedrock), was observed during the current fieldwork. Donham describes Site 18027 (as Site T-63) thusly:

> This site consists of 13 features within an area 95:0 m north-south by 30.0 m east-west. It is located at the coastal/inland interface in an area of relatively flat, broken pahoehoe and is one of five extensive complexes that occur in this interface zone. All of these complexes (T-6l, T-63, T-64, T-66, and T-67) include a number of minimally used shelters, small cairns, and rubble piles. Site T-63 includes four cairns, four rubble piles, a cave shelter, an enclosure, two modified outcrops, an alignment, and a rubble pavement.
>
> Feature A is the largest cairn on the site. It is located at the southern end of a loose cluster of five cairns and/or rubble piles. It is roughly circular at its base, with axes of 4.2 and 4.8 m and a height of 1.41 m. It is constructed from loosely piled pahoehoe slabs and has no faced or vertical sides. A portion of the cairn surface is flat; however, the overall shape is mounded. A few pieces of Conidae shell and coral are situated near the cairn.
>
> Feature B, a smaller cairn, is located 8.2 m north (360 degrees Az) of Feature A. It is circular in plan, with base axes of 3.2 and 3.35 m; height is 0.39 m. Construction is very similar to that of Feature A. and the overall form is mounded rather than vertically stacked. No portable remains were observed near this feature.
>
> Feature C is a rubble pile with a central depression possibly created by relic hunters. This feature is located 3.0 m northeast of Feature B and is very similar in overall size and shape. Base axes are 3.3 and 2.7 m; height is 0.38 m. The central depression penetrates to 0.2 m below the top of the feature. A few pieces of waterworn coral are present in the central depression.
>
> Feature D is located 4.0 m east of Feature C. This small rubble pile is scattered over an area 2.2 by 2.0 m and has a maximum height of 0.52 m. The east side of this pile is defined with upright slabs that have a height of 0.42 m. No portable remains occur near this feature.
>
> Feature E is a single layer of small pahoehoe cobbles placed in an area 3.3 m long and 2.4 m wide. There is no indication of a filled crevice beneath this pavement, which is located 9.0 m northwest of Feature B. Small coral fragments and a single piece of Cypraeidae shell are scattered on the paved area.
>
> Feature F is the most substantial structure on the site. It is a small habitation enclosure with a 0.9-m-wide opening in the northern wall. It is rectangular in shape, with squared corners and walls 4.5 by 4.0 m long. The walls are constructed from thin pahoehoe slabs stacked up to eight courses high (0.8 m) and three stones wide, and they are faced on both sides. Average wall width is 0.7 m, and the corners are 1.0 m wide. Interior space within the enclosure is 2.3 by 2.4 m. No midden or portable remains were observed inside or outside this structure. It is located near the center of the complex and is somewhat isolated, with the nearest feature (G) located 12.0 m to the northeast.

Features G, H, I and J form a second loose cluster, the center of which is 20.0 m south of Feature A. Features G and H are rubble piles spaced 6.0 m apart. Both appear to be dismantled cairns, particularly Feature G, which has the remains of a square shape, 1.1 m on a side. Stones are presently scattered over an area 2.1 by 2.4 m and 0.4 m high. The center of the feature has been excavated, and there is one piece of Cypraeidae shell nearby.

Feature H is a rubble pile that is currently scattered over an area 2.7 by 2.8 m. The original shape appears to have been square, 1.5 m on a side. Maximum height is currently 0.4 m Features G and H may have functioned as shelter post supports.

Feature I is an L-shaped alignment that incorporates a naturally uplifted pahoehoe shelf. The longest portion of the alignment is oriented northwest-southeast and is 6.0 m long. It curves southward at the western end and continues for 1.3 m. The bedrock portion of the alignment occurs at the curved section and is 0.8 m long. The alignment consists of large blocky pahoehoe boulders positioned two to three stones wide and a single stone high. No portable remains were observed in the area of the alignment, which is 5.0 m northeast of Feature H.

Feature J, a small modified outcrop, may have functioned as a storage facility. It consists of a small, cleared overhang, with stones piled around the entrance to create a smaller opening. Overall size of the overhang is 1.4 m wide and 0.7 m deep. An artificial opening, 0.4 sq m, was left in the positioned stones, creating a small sheltered area 0.24 m deep, with a ceiling height of 0.47 m. A few pieces of weathered coral were observed near this feature, which is located 7.0 m northeast of Feature I.

Features K, L, and M form the southernmost cluster of the complex. They are located on a prominent extension of the pahoehoe ridge, 20.0 to 30.0 m south of Feature F. feature K is a cairn and recent memorial shrine. The cairn is in much better condition than are the features north, and it is probably of recent construction. It is constructed from large pahoehoe slabs piled eight courses high, with two pieces of weathered coral positioned on top. The base is roughly circular (1.1 m in diameter), and the cairn is conical in shape.

At the base of Feature K cairn are two large slabs that lean upright against a fault line, forming a type of backdrop for several pieces of weathered coral and a glass vase with dried flowers (ginger?). The vase is modern, and the condition of the flowers indicates quite recent placement.

Feature L, a large cairn, is located 5.0 m west of Feature K. It is situated on a high uplift, which gives the feature the appearance of being larger than its actual constructed size. The cairn is constructed from stacked pahoehoe slabs and is roughly circular (2.0 by 1.67 m). It incorporates bedrock into the form, so that six courses are stacked on the south side and four courses on the north side to obtain a consistent height of 1.0 m. A well-defined hole is present in the center of the cairn and appears to have been part of the original structure. It is 0.25 m in diameter and 0.7 m deep, and it may be a posthole.

Feature M, a small cave shelter, is located along the west-facing slope of the ridge, 15.0 m south of Feature K. The entrance to the tube cave is oriented to the west and is 1.14 m above the cave floor; it is rather small (0.79 by 0.55 m). The main chamber of the shelter is 6.0 m long, 2.28 m wide, and has a ceiling height of 0.8 m. The tube continues as a crawlspace for a distance of 10.0 m northward from the main chamber. It is accessible, but only with difficulty. Minor modifications occur inside the cave and are confined to rockfall clearing and piling. A pile of rockfall near the entrance appears to have been formed into a circle for use as a hearth; however, there was no concentration of ash or midden within this formation.

> Portable remains observed in thee shelter include Conidae, Cypraeidae, Neritidae (common) and Thaididae shellfish families; waterworn pebbles; a few Echinoidea spines; and a modern Pepsi can. The deposit of material represents the most concentrated occurrence on the site; however, it is quite sparse. One crevice directly beneath Feature K may have been artificially filled. (Donham 1987:66-69)

As SIHP Site 18027 is set back from the coastal road, it is seldom visited by the general public. As such this site is in the same condition as reported by Donham (1987), and her site map (Figure 32) is reproduced here. Features K, L, and M are shown in Figures 33-36.

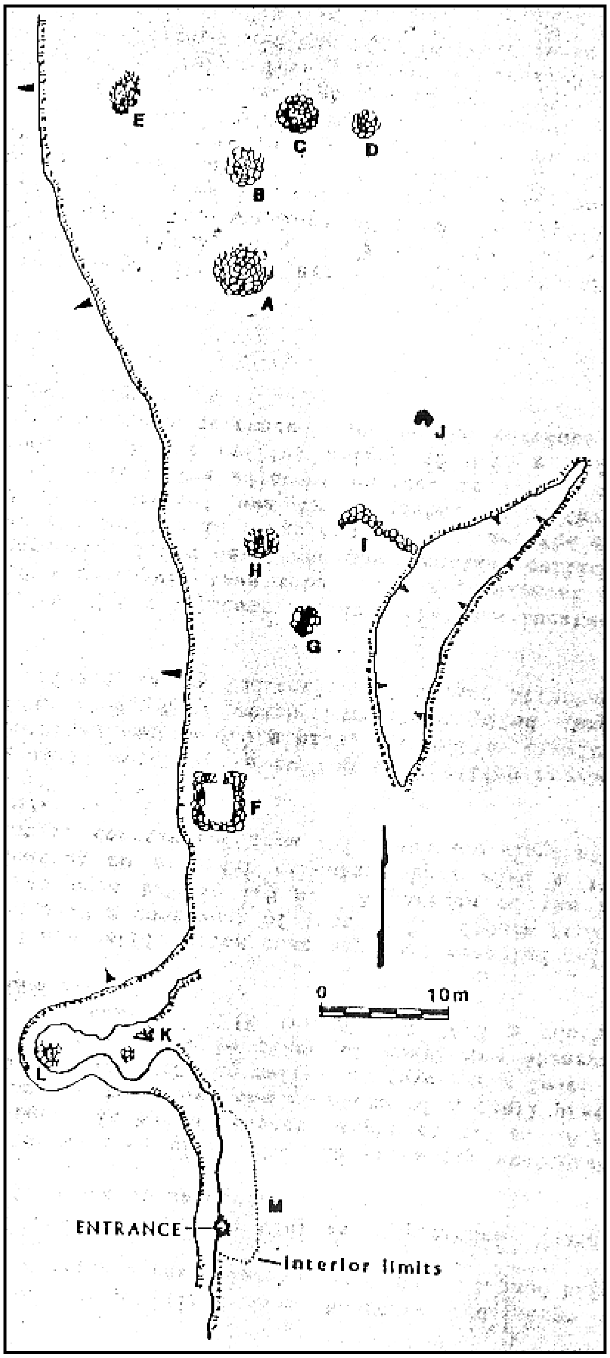

Figure 32. SIHP Site 18027 plan view (from Donham 1987:67).

Figure 33. SIHP Site 18027 Feature K, view to the south.

Figure 34. SIHP Site 18027 Feature L, view to the northeast.

Figure 35. Figure 36. SIHP Site 18027 Feature M, view to the north.

Figure 36. SIHP Site 18027 Feature M, view to the east.

SIHP Site 50-10-27-18773

Originally recorded by Barrera (1985) and later tested by Donham (1987) this site is an isolated rock mound built over a bedrock crevice containing buried human remains, and located roughly 240 meters *mauka* of Site 1911. Donham description of this burial site is as follows:

> This isolated rock mound is in open rocklands . . . It is oval in shape, with a major axis of 2.8 m, oriented east-west. The minor axis is 2.3 m, and average mound height is 0.6 m. The mound is constructed from pahoehoe slabs and boulders that are stacked to form somewhat vertical, unfaced sides and a roughly level mound surface. This feature was tentatively interpreted by Barrera as a possible grave.
>
> A 1.0 by 0.5 m excavation unit was established over a portion of the mound, and the stones were removed in order to determine if it was in fact a burial. The unit bisected the mound on a north-south axis. A natural bedrock crevice, which was found at the base of the mound, had been filled with cobble-sized stones and capped with two large pahoehoe slabs. After removal of these stones, skeletal remains were visible in the crevice, 0.75 m below bedrock surface. The remains were extremely weatheres and deteriorated and were not removed from the crevice. The crevice was covered, and a portion of the original mound was reconstructed over the burial. (Donham 1987:27)

This site was located during the current study, and found to be in the condition described and left by Donham (1987).

Newly Discovered Site

As a result of the current fieldwork one new site, a lave tube containing three burials, was discovered.

SIHP Site 50-10-27-25932

Site 25932 is situated in the *mauka* portion of the project area roughly 250 meters *makai* of the *Alanui Aupuni* (SIHP Site 2) (see Figure 5). The site consists of a lava tube that conatins a minimal amount of cultural material and the skeletal remains of three individuals (Figure 37). The primary tube is accessed through a surface collapse (Figure 38) and extends for roughly 25 meters before it becomes unpassable. The floor in the portion of the tube is soldi rock and a single basalt flake was found one meter from the entrance. At a distance of 14 meters within the tube along the northern edge is a 2 meter long by 90 centimeter tall (3-4 courses) stacked wall. This wall once concealed a small (6 meters by 4 meters) side chamber. The central portion of the wall had been dismantled and the side chamber was visible. A scatter of goat bone was found within the chamber, which was otherwise devoid of any natural or cultural material.

At one meter within the entrance, a second side passage extends for roughly 20 meters in an easterly direction. This narrow (maximum width 4 meters), low (maximum height 80 centimeters) passage can also be access by squeezing through a surface crack (Figure 39). At a distance of roughly 10 meters east of the primary entrance, three sets of human remains were placed under two large slabs that were positioned to partially conceal the location. The individuals represented by the remains appear to be a subadult, an adult, and an elderly adult. No other cultural material was observed in the lava tube. A small tube segment is also accessible from the northeastern side of the surface collapse; a single crab claw was discovered in this segment.

On the ground surface of the site above the burials and slightly to the east is a surface crack in the *pāhoehoe* in which three cowry shells (*Cypraea* sp.) were observed (Figure 40). These shells are all modified in various stages of completion as either *kilo* or *leho he'e*, or octopus (squid) fishing lures (Figure 41) (Buck 1957). It seems more than coincidental that there are three such artifacts above and three burials below, thus these items are considered to be *moepū* (grave associated artifacts).

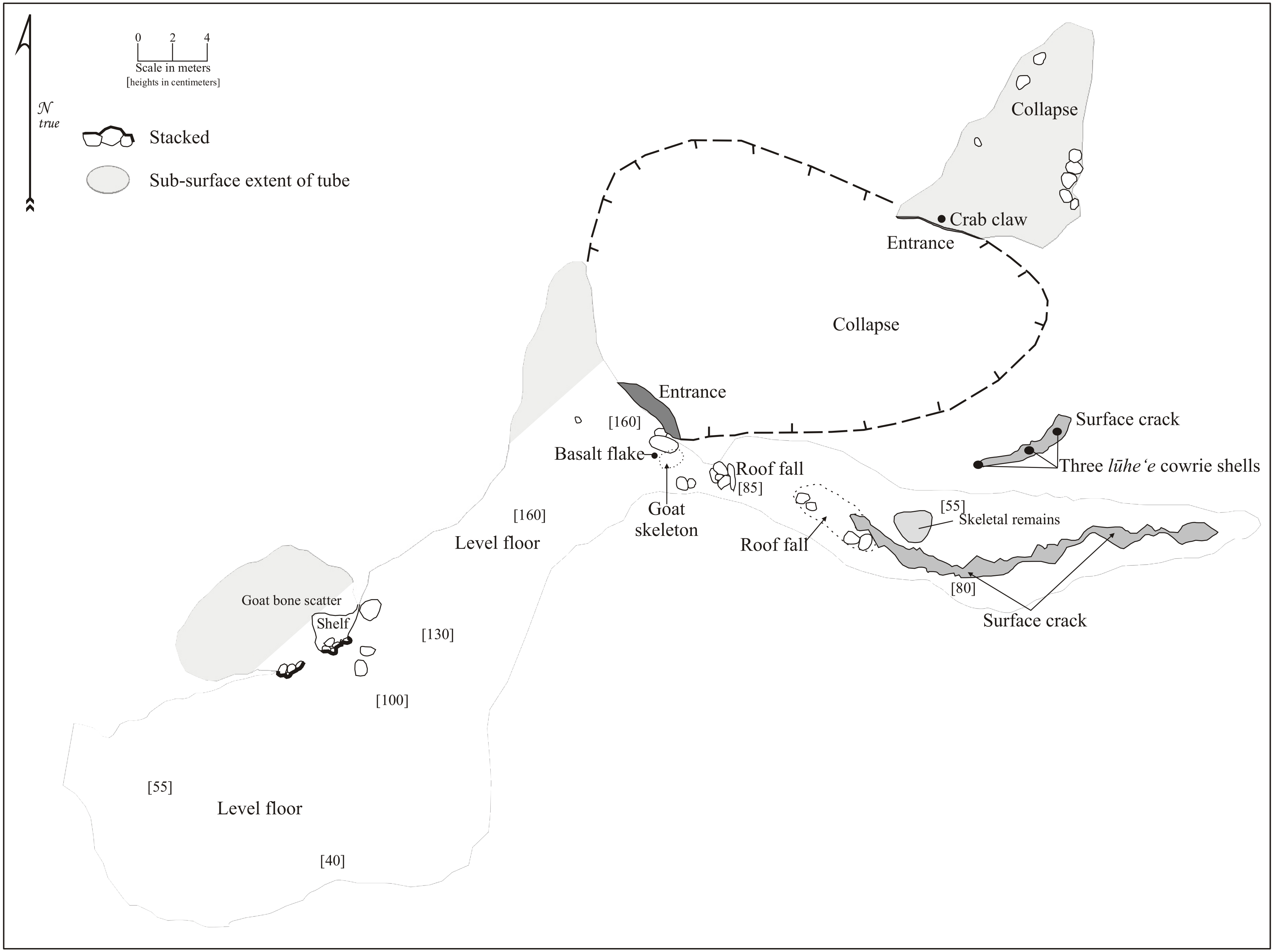

Figure 37. SIHP Site 25932 plan view.

Figure 38. SIHP Site 25932 primary tube entrance, view to the southwest.

Figure 39. SIHP Site 25932 crack entrance near burials.

Figure 40. SIHP Site 25932 surface crack with cowry shells.

Figure 41. SIHP Site 25932 one of three *leho he'e* found in a surface crack.

SIGNIFICANCE EVALUATION AND TREATMENT RECOMMENDATION

Eight of the above-described archaeological resources have already been assessed for their significance based on criteria established and promoted by the DLNR-SHPD and contained in the Hawai‘i Administrative Rules 13§13-284-6. The significance of those sites and that of the one newly discovered site are presented below. The significance evaluation for the newly discovered site should be considered as preliminary until DLNR-SHPD provides concurrence. For resources to be significant they must possess integrity of location, design, setting, materials, workmanship, feeling, and association and meet one or more of the following criteria:

A Be associated with events that have made an important contribution to the broad patterns of our history;

B Be associated with the lives of persons important in our past;

C Embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; or possess 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 accounts—these associations being important to the group’s history and cultural identity.

Table 1 presents a summary of the significance and treatment for all nine sites.

Table 1. Significance and treatment for the unmitigated archaeological sites in the study area.

SIHP No.	*Function*	*Temporal Association*	*Significance*	*Treatment*
2	Trail	Precontact	A, C, D, E	Preservation
1910	Habitation	Precontact	C, D, E	Preservation
1911	Habitation	Precontact/Historic	D	Preservation
1912	Habitation	Precontact	D, E	Preservation
1913*	*Heiau*	Precontact	D, E	Preservation
10155	Habitation	Precontact	D	Preservation
18027*	Habitation	Precontact	D, E	Preservation
18773	Burial	Precontact	D, E	Preservation
25932§	Burial	Precontact	D, E	Preservation

* Portions of both of these sites are included in the archaeological preservation area established on the NELHA property to the north.
§ Significance and treatment for this site should be considered recommendations until DLNR-SHPD provides concurrence.

The two sites containing burials (SIHP Site 18773 and 25932), which are significant under both Criterion D and Criterion E, will be preserved pursuant to a burial treatment plan prepared in consultation with recognized descendants and the Hawai‘i Island Burial Council. The seven other preservation sites, considered significant under multiple criteria, will be treated in accordance with a preservation plan submitted to and approved by DLNR-SHPD prior to final subdivision approval. Development activities will not commence until the site protection measures and stewardship aspects of these preservation plans are implemented. Two of these sites (SIHP Sites 1913 and 18027) are direct extensions of sites that exist to the north on state (NELHA) land, and the several others are part of the larger continuous archaeological landscape that remains for coastal ‘O‘oma. NELHA has committed to preserving a significant portion of this landscape (15 acres), and the developers of the current project area are committed to spatially extending that preservation commitment. In a effort to reduce direct impacts to significant cultural resources, as part of the NELHA preservation plan the coastal jeep road may in the near future be closed to vehicular traffic, as a more direct public access route for the “Pine Trees” recreational area is developed in neighboring Kohanaiki. The developers of the current project area will support this road closure, if and when it occurs.

Given the nature of the volcanic substrate within the project area, with its potential for concealed tubes and blisters, it is further recommended that a program of archaeological monitoring be maintained during the grading activities associated with the ‘O‘oma Beachside Village project. Such a program will help to ensure that any inadvertently discovered resources would receive immediate attention and protection, while their ultimate disposition is being determined by DLNR-SHPD.

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APPENDIX A — Past DLNR-SHPD Regulatory Documents

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

MICHAEL D. WILSON, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY
GILBERT COLOMA-AGARAN

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION DIVISION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

September 16, 1998

LOG NO: 22204
DOC NO: 9809PM04

Ms. Marilyn Metz
MCM Planning
703 Honua Street
Honolulu, Hawaii 96816

Dear Ms. Metz:

SUBJECT: Site 10174, HOST Park (NELHA)
O`oma 2, North Kona, Hawaii Island
TMK: 7-3-09: 4

This is in response to your memo of September 1, 1998 to Ross Cordy, Archaeology Branch Chief regarding the mitigation of Site 10174 at the above referenced location.

Your review of the 1989 Chiniago report indicates that Site 10174 was to be mitigated, but that there is no indication that it was actually done because there is no description of the site or what was found. It is our belief that the entire former HOST Park area has undergone satisfactory archaeological data recovery work. Preservation commitments still need to be executed for historic sites in several areas, but not in this project area. Thus, we conclude that all mitigation in your specific parcel has been concluded.

If you have any questions please contact Patrick McCoy (587-0006).

Aloha,

DON HIBBARD, Administrator
State Historic Preservation Division

PM:amk

SEP 16 1998

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII

GILBERT S. COLOMA-AGARAN, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCES MANAGEMENT

DEPUTIES
ERIC T. HIRANO
LINNEL NISHIOKA

DEPARTMENT OF LAND AND NATURAL RESOURCES

HISTORIC PRESERVATION DIVISION
KAKUHIHEWA BUILDING, ROOM 555
601 KAMOKILA BOULEVARD
KAPOLEI, HAWAII 96707

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND
STATE PARKS

October 21, 2002

Mr. Scott Ezer
Helber, Hastert & Fee
Bishop Street, Suite 2590
Honolulu, Hawaii 96813

LOG NO: 30935
DOC NO: 0210RC16

Dear Mr. Ezer:

SUBJECT: **Request for an Update on the Historic Preservation Status for this Parcel**
Ooma, North Kona, Hawaii
TMK: 7-3-9: 22

This follows-up on your phone conversations with Ross Cordy of our staff on October 15 and 16, 2002.

Our records indicate that when this parcel was part of the HOST Park, it underwent an acceptable archaeological inventory survey (Barrera 1985). As a result of that survey, four significant historic sites on this parcel were slated for mitigation. Two were to undergo archaeological data recovery, and two (the Mamalahoa Trail and a shelter cave in association with that trail, site 10,155) were committed to interpretive preservation.

Archaeological data recovery of the parcel (again when it was part of NELH/HOST Park) took place in 1988, and the report (Barrera 1989. Archaeological Data Recovery at the HOST Park and NELH, Kalaoa and O'oma Ahupua'a, North Kona, Hawaii Island. Chiniago ms.) was accepted in 1989 (March 9, 1989 letter to R. Nagata of DAGS from W. Paty of DLNR; Doc: 1750c). Thus, the two sites committed to data recovery have been data recovered, and no longer need protection.

Not long thereafter a land exchange took place with the State in which Ooma II Resort's owners gave up a small coastal parcel (with important historic sites) for this inland parcel (parcel 22). Part of this exchange included the passing of the historic preservation commitments with the land.

Thus, at this time, a preservation plan for the Mamalahoa Trail and site 10,155 still needs to be prepared and be submitted to our office for review and approval. We will then need to verify that the plan is successfully executed. Elements of this plan must include buffer zones around the sites (to preserve their setting), interim protection measures should any nearby construction be planned, and long-range preservation measures (which must include interpretive signage, as these sites were committed to interpretive preservation). Since the Mamalahoa Trail was built in the early to mid-1800s, it reflects transportation routes of that period in the Kona area. Much of the trail survives between this parcel and the airport to the north and between this parcel and the highway in the Kaloko-Honokohau National Historic Park area. Preservation-interpretation efforts should be compatible with efforts in adjacent parcels. A unique aspect of this parcel is that it includes the shelter cave along the trail, an excellent example of rest/overnight shelters along such trails.

We also suggest as part of the preservation planning efforts that a fieldcheck should be made by a professional archaeologist early-on to check on the conditions of the two sites.

If you have any questions, feel free to contact Dr. Patrick McCoy, our Hawaii Island Archaeologist (692-8029).

Aloha,

DON HIBBARD, Administrator
State Historic Preservation Division

RC:ak

Appendix F

Cultural Impact Assessment

RC-0445

Cultural Impact Assessment for the ‘O‘oma Beachside Village Project Area

(TMK: 3-7-3-09:004 and 022)

‘O‘oma 2nd Ahupua‘a
North Kona District
Island of Hawai‘i

PREPARED BY:

Robert B. Rechtman, Ph.D.
and
Kepā Maly
(Kumu Pono Associates)

PREPARED FOR:

North Kona Village, LLC
C/o Midland Pacific Homes
6955 El Camino Real, Suite 200
Atascadero, CA 93422

April 2007

RECHTMAN CONSULTING, LLC
HC 1 Box 4149 Kea‘au, Hawai‘i 96749-9710
phone: (808) 966-7636 fax: (808) 443-0065
e-mail: bob@rechtmanconsulting.com
ARCHAEOLOGICAL, CULTURAL, AND HISTORICAL STUDIES

RC-0445

Cultural Impact Assessment for the ‘O‘oma Beachside Village Project Area
(TMK: 3-7-3-09:004 and 022)

‘O‘oma 2nd Ahupua‘a
North Kona District
Island of Hawai‘i

Rechtman Consulting

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INTRODUCTION

At the request of PBR Hawaii & Associates Inc., on behalf of North Kona Village, LLC, Rechtman Consulting, LLC and Kumu Pono Associates have prepared this Cultural Impact Assessment for the ‘O‘oma Beachside Village Project, a masterplanned community encompassing approximately 300 acres in ‘O‘oma 2nd Ahupua‘a, North Kona District, Island of Hawai‘i (TMKs: 3-7-3-09:004 and 022) (Figure 1). This report is intended to accompany an Environmental Assessment (EA) compliant with Chapter 343 HRS, as well as fulfilling the requirements of the County of Hawai‘i Planning Department and the Department of Land and Natural Resources (DLNR) with respect to permit approvals for land-altering and development activities. This study has been prepared pursuant to Act 50, approved by the Governor on April 26, 2000; and in accordance with the Office of Environmental Quality Control (OEQC) *Guidelines for Assessing Cultural Impact*, adopted by the Environmental Council, State of Hawai‘i, on November 19, 1997 (the “Guidelines”).

The archival-historical research and oral-historical interviews that were conducted were performed in a manner consistent with Federal and state laws and guidelines for such studies. Among the pertinent laws and guidelines are the National Historic Preservation Act of 1966, as amended (36 CFR Part 800); the Advisory Council on Historic Preservation’s “Guidelines for Consideration of Traditional Cultural Values in Historic Preservation Review” (ACHP 1985); National Register Bulletin 38, “Guidelines for Evaluating and Documenting Traditional Cultural Properties” (Parker and King 1990); the Hawai‘i State Historic Preservation Statue (Chapter 6E), which affords protection to historic sites, including traditional cultural properties of on-going cultural significance; the criteria, standards, and guidelines currently utilized by the Department of Land and Natural Resources-State Historic Preservation Division (DLNR-SHPD) for the evaluation and documentation of cultural sites (cf. 13§13-275-8; 276-5); and the November 1997 guidelines for cultural impact assessment studies, adopted by the Office of Environmental Quality Control.

While the physical study area is limited to a portion of ‘O‘oma 2nd Ahupua‘a that lies *makai* of the Queen Ka‘ahumanu Highway extending to the shoreline, in an effort to provide a comprehensive and holistic understanding of the current study area, this report examines the entire *ahupua‘a* and its relationship to neighboring lands within the larger Kekaha region. The Guidelines also encourage the study of cultural resources and practices on a broader geographic area such as the region or district. Archival-historical literature from both Hawaiian and English language sources was reviewed, including an examination of Hawaiian Land Commission Award records from the *Māhele ‘Āina* (Land Division) of 1848; survey records of the Kingdom and Territory of Hawai‘i; and historical texts authored or compiled by Malo (1951), I‘i (1959), Kamakau (1961, 1964, 1976, and 1991), Ellis (1963), Fornander (1916-1919 and 1996), Thrum (1908), Stokes and Dye (1991), Beckwith (1970), Reinecke (n.d.); and Handy and Handy with Pukui (1972). Importantly, the current study also includes several native accounts from Hawaiian language newspapers (compiled and translated from Hawaiian to English, by Kepā Maly), and historical narratives authored by eighteenth and nineteenth century visitors to the region. This information is presented within thematic categories and ordered chronologically by the date of publication.

The archival-historical resources were located in the collections of the Hawai‘i State Archives (HSA), State Land Division (LD), State Survey Division (SD), and State Bureau of Conveyances (BoC); the Bishop Museum Archives (BPBM); Hawaiian Historical Society (HHS); University of Hawai‘i-Hilo Mo‘okini Library; private family collections; and in the collection of Kumu Pono Associates.

Over the last twelve years, Kepā Maly of Kumu Pono Associates has researched and prepared several detailed studies—in the form of review and translation of accounts from Hawaiian language newspapers, historical accounts recorded by Hawaiian and non-Hawaiian residents, and government land use records—for lands in the Kekaha region of which ‘O‘oma is a part. Most of the archival-historical research and oral interviews were previously assembled for an earlier, unrelated project that had been proposed within the current study area. A number of detailed oral history interviews were previously conducted with elder *kama‘āina* documenting their knowledge of the Kekaha region, including ‘O‘oma, that are highly relevant to the current Cultural Impact Assessment. As part of the current study, several new informal interviews were undertaken including a recent updated interview with the late *kupuna* Peter Keikua‘ana Park, the summary of which is outlined in this study. All of the interview participants (both past and present) have shared their personal knowledge of the land and practices of the families who lived in ‘O‘oma and vicinity.

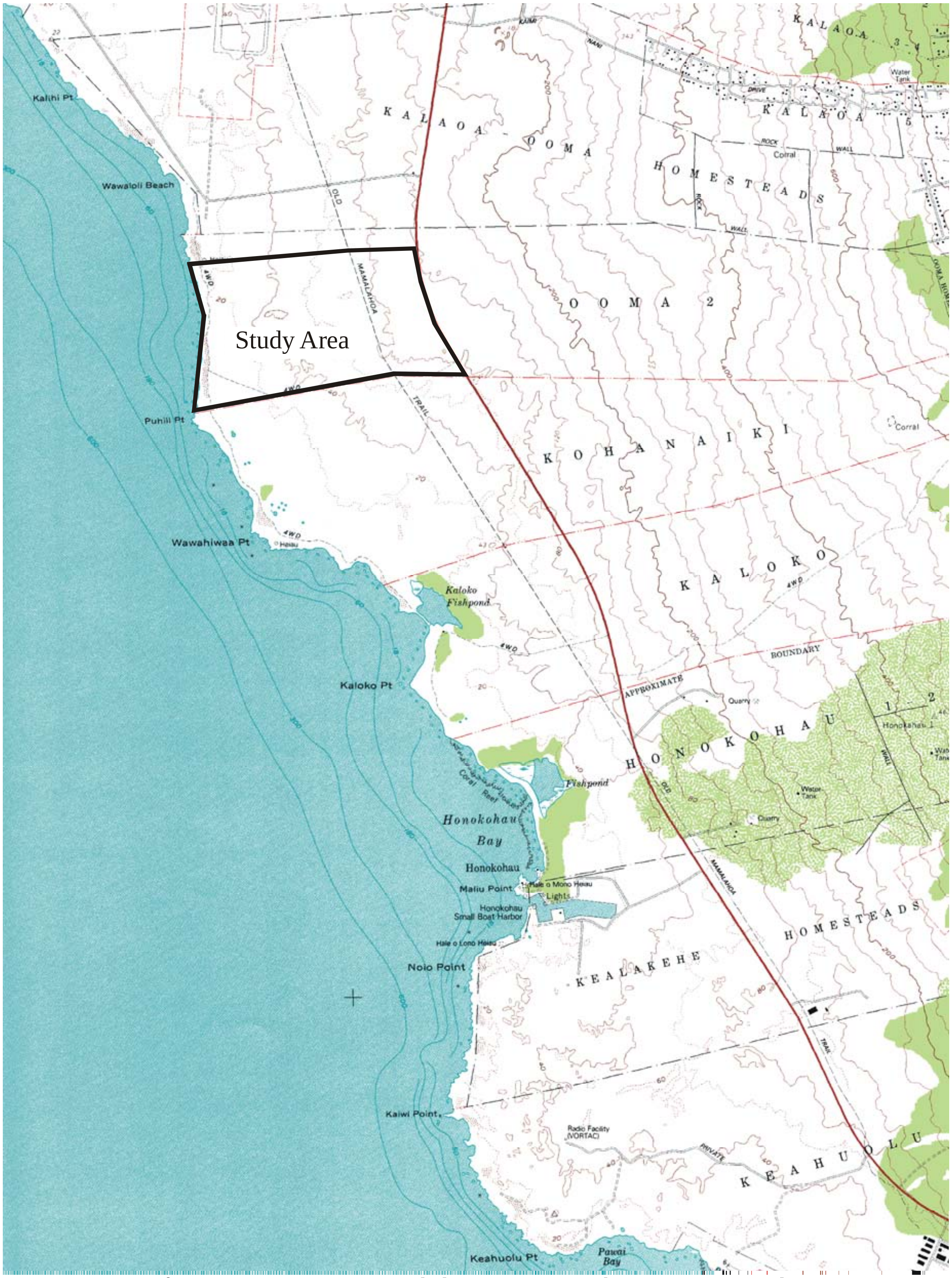


Figure 1. Portion of USGS 7.5 minute series Keahole Point, HI 1996 showing project area location.

This report begins with a description of the general project area and the proposed development activities. This is followed by a presentation of the archaeological background for the specific study area. A discussion of the cultural and historical background for the ‘O‘oma *ahupua‘a* and the Kekaha region was generated based on detailed archival research. It is a comprehension of this background information that facilitates a more complete understanding of the potential significance of any resources that might exist within the study area. Information from both prior and newly conducted oral-historical interviews is presented and summarized. While no specific traditional or ongoing cultural practices have been identified within the project area other than coastal access for beachgoers, fisherman, and surfers in more recent times, numerous archaeological studies (Barrera 1985, 1989, 1992; Cordy 1985, 1986; Donham 1987; Rechtman 2002, 2007; Rosendahl 1989; Walker and Rosendahl 1990) have documented a number of archaeological resources within the study area, nine of which merit preservation. These archaeological sites are described below together with, a discussion of the potential impacts, and the proposed mitigation measures.

PROJECT AREA DESCRIPTION AND PROPOSED DEVELOPMENT ACTIVITIES

The project area encompasses approximately 300 acres in ‘O‘oma 2nd Ahupua‘a, North Kona District, Island of Hawai‘i and consists of two current Tax Map parcels (TMK:3-7-3-09:004 and 3-7-3-09:022) (Figure 2). Elevation across the project area ranges from sea level to 120 feet above sea level, and the terrain is characterized by weathered *pāhoehoe* and *‘a‘ā* flows that eminated from Hualālai between 3,000 and 5,000 years ago (Wolfe and Morris 1996). Situated within the Kekaha region, the principle environmental features are a hot, dry climate, and extensive lava fields with little to no soil accumulation. This region receives roughly 10 inches of rain per year and has a mean annual temperature of 70 to 76 degrees Fahrenheit (Donham 1987). With the exception of a narrow strip of coral beach deposit, no soil is present within the subject parcel. Coastal vegetation includes tree heliotrope (*Messerschmidia argentea*) *naupaka* (*Scaevola sericea*), Christmas-berry (*Schinus terebithifolius*), and beach morning glory (*Ipomea pescaprae*), along with occasional stands of *‘ilima* (*Sida fallax*), *noni* (*Morinda citrifolia*), and *maiapilo* (*Capparis sandwichiana*), with a blanket of fountain grass (*Pennisetum setaceum*) slightly further inland

The development plans for the project area include a combination of mixed-use village, single-family and multi-family residential lots, with shoreline and inland park facilities. Aside from a proposed shoreline park facillity, the entire development is proposed to be set back a minimum of 1,100 feet from the shoreline (Figure 3).

ARCHAEOLOGICAL BACKGROUND

Thrum (1908) compiled the earliest systematic report on archaeological features—*heiau* or ceremonial sites—on the island of Hawai’i. Thrum’s work was the result of literature review and field visits spanning several decades. Unfortunately, Thrum’s work did not take him into ‘O‘oma, and his documentation on *heiau* ends at Lanihau, south of the study area; and picks up to the north, in the Pu‘u Anahulu vicinity. Likewise, the 1906-1907, J.F.G. Stokes detailed field survey of *heiau* on the island of Hawai‘i for the B. P. Pauahi Bishop Museum (Stokes and Dye 1991) stopped short of doing comprehensive work in the Kekaha region, and no sites were recorded in ‘O‘oma.

In 1929-1930, the Bishop Museum contracted John Reinecke to conduct a survey of Hawaiian sites in West Hawai‘i, including ‘O‘oma and the Kekaha region (Reinecke n.d.). A portion of Reinecke’s survey fieldwork extended north from Kailua as far as Kalāhuipua‘a. His work being the first attempt at a survey of sites of varying function, ranging from ceremonial to residency and resource collection.

During his study, Reinecke traveled along the shore of Kekaha, documenting near-shore sites. Where he could, he spoke with the few native residents he encountered. Among his general descriptions of the Kekaha region, Reinecke observed:

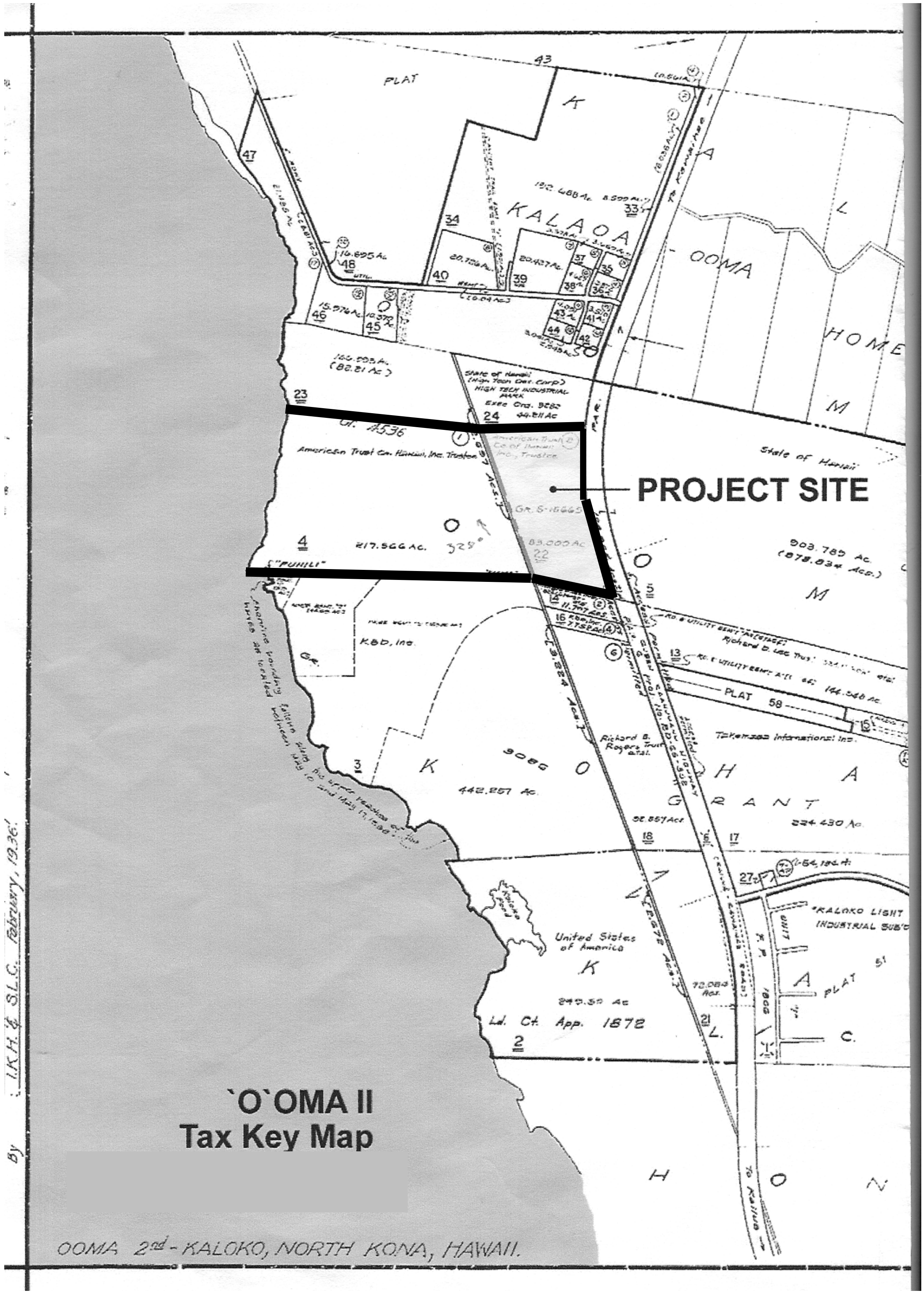


Figure 2. Portion of Tax Map Key 3-7-3 showing current project areas.

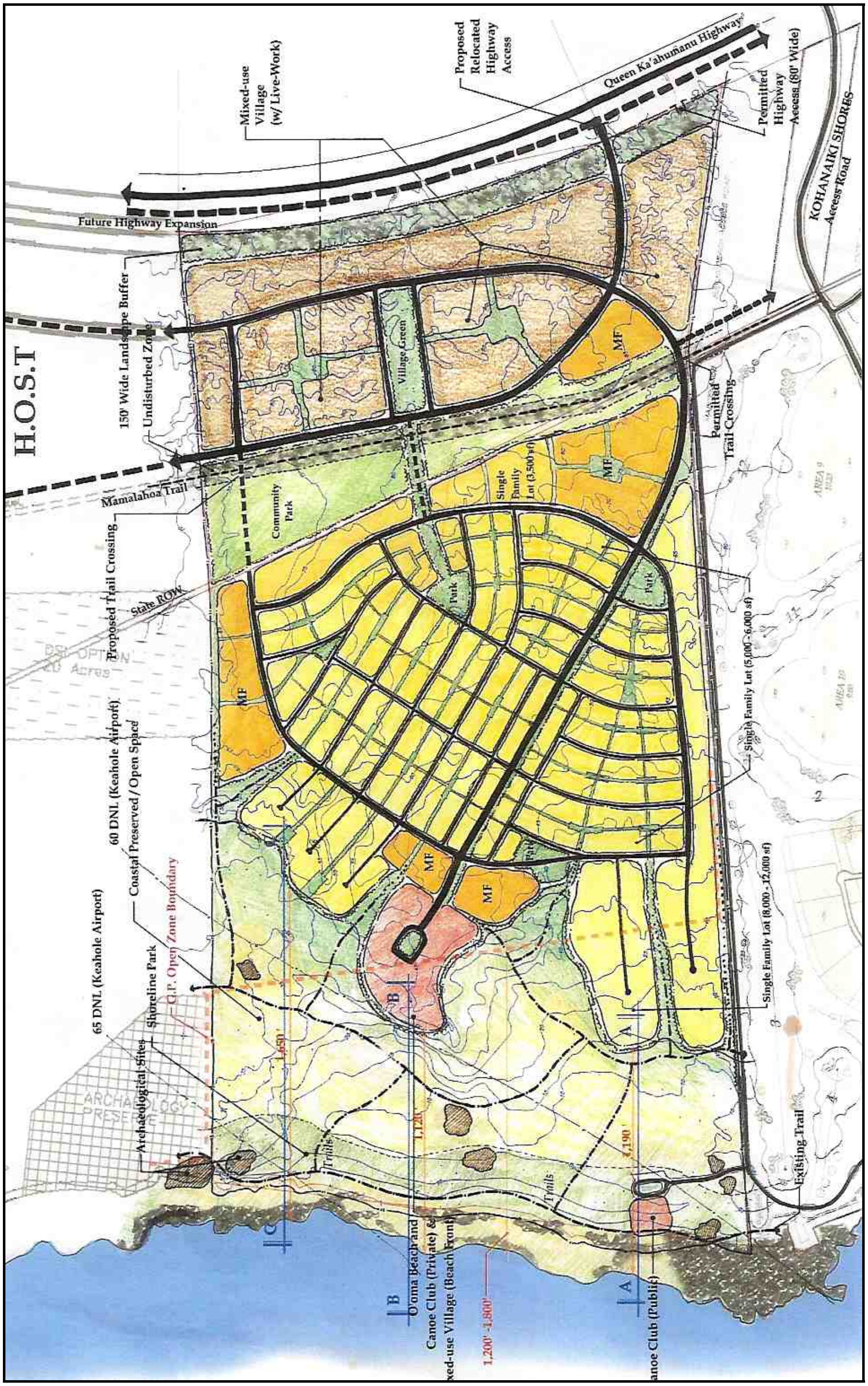


Figure 3. Proposed development plan.

> This coast formerly was the seat of a large population. Only a few years ago Keawaiki, now the permanent residence of one couple, was inhabited by about thirty-five Hawaiians. Kawaihae and Puako were the seat of several thousands, and smaller places numbered their inhabitants by the hundreds. Now there are perhaps fifty permanent inhabitants between Kailua and Kawaihae–certainly not over seventy-five.
>
> When the economy of Hawaii was based on fishing this was a fairly desirable coast; the fishing is good; there is a fairly abundant water supply of brackish water, some of it nearly fresh and very pleasant to the taste; and while there was no opportunity for agriculture on the beach, the more energetic Hawaiians could do some cultivation at a considerable distance *mauka*.
>
> The scarcity of remains is therefore disappointing. This I attribute to four reasons: (1) those simply over looked, especially those a short distance mauka, must have been numerous; (2) a number must have been destroyed, as everywhere, by man and by cattle grazing; (3) the coast is for the most part low and storm-swept, so that the most desirable building locations, on the coral beaches, have been repeatedly swept over and covered with loose coral and lava fragments, which have obscured hundreds of platforms and no doubt destroyed hundreds more; (4) many of the dwellings must have been built directly on the sand, as are those of the family at Kaupulehu, and when the posts have been pulled up, leave no trace after a very few years.
>
> The remains on this strip of coast have some special characteristics differentiating them from the rest in Kona. First, there is an unusual number of petroglyphs and papamu, especially about Kailua and at Kapalaoa. Second, probably because of the strong winds, there are many walled sites, both of houses and especially of temporary shelters… (Reinecke n.d.:1-2)

The following site descriptions are quoted from Reinecke's draft manuscript of fieldwork conducted between Pūhili Point on the Kohanaiki-ʻOʻoma 2nd boundary, and into Kalaoa 5th (Figure 4). In the site descriptions below, Reinecke references the occurrence of at least—6-house sites; 7 enclosures and pens (one of which is an "old cattle pen"); 11 terraces and platforms (one of which he felt was a "*heiau*"); 2 caves; 2 *ahu*; 1 stepping stone trail; 3 waterholes and a well; and 11 shelters. Apparently, no one was residing in the area at the time of his field survey.

Reinecke's site descriptions, south to north, across ʻOʻoma 2nd and ʻOʻoma 1st included:

> Site 66. Very doubtful dwelling site. Then a row of sand-covered platforms at the border of the sand and the beach lava, enough for 6-10 homes. Remains of an old, large pen.
>
> Site 67. Dry well on the crest of the beach.
>
> Site 68. Water hole, two small platforms, four or more shelters, pens with very small platform.
>
> Site 69. Large cattle pen. Doubtful old, rough platform at its north end. Remains of two old platforms by an ahu to the north.
>
> Site 70. Walled platform, S.E. corner terraced, badly broken down. Platform mauka. The walls of this and of Site 73 are built of thin pieces of pahoehoe surface lava, rather unusual in appearance. [Reinecke n.d.:15]
>
> Site 71. A knob partly walled on its slopes, with house site. Adjoining it on the south is a rough platform with three smooth boulders – heiau and kuula? Back of this a house platform and a platform about a fine shelter cave. Another platform and wall are about a slight natural depression filled with bones, including those of a whale.
>
> Site 72. Ruins of a pen.
>
> Site 73. Apparently a modern dwelling site of unusual construction; two terraces of pebbles, the upper 29x25x2 in front and 4-5' high elsewhere; the lower 19x10x25x3, with a three-sided pen at N.E.; surrounded by a carefully laid wall.

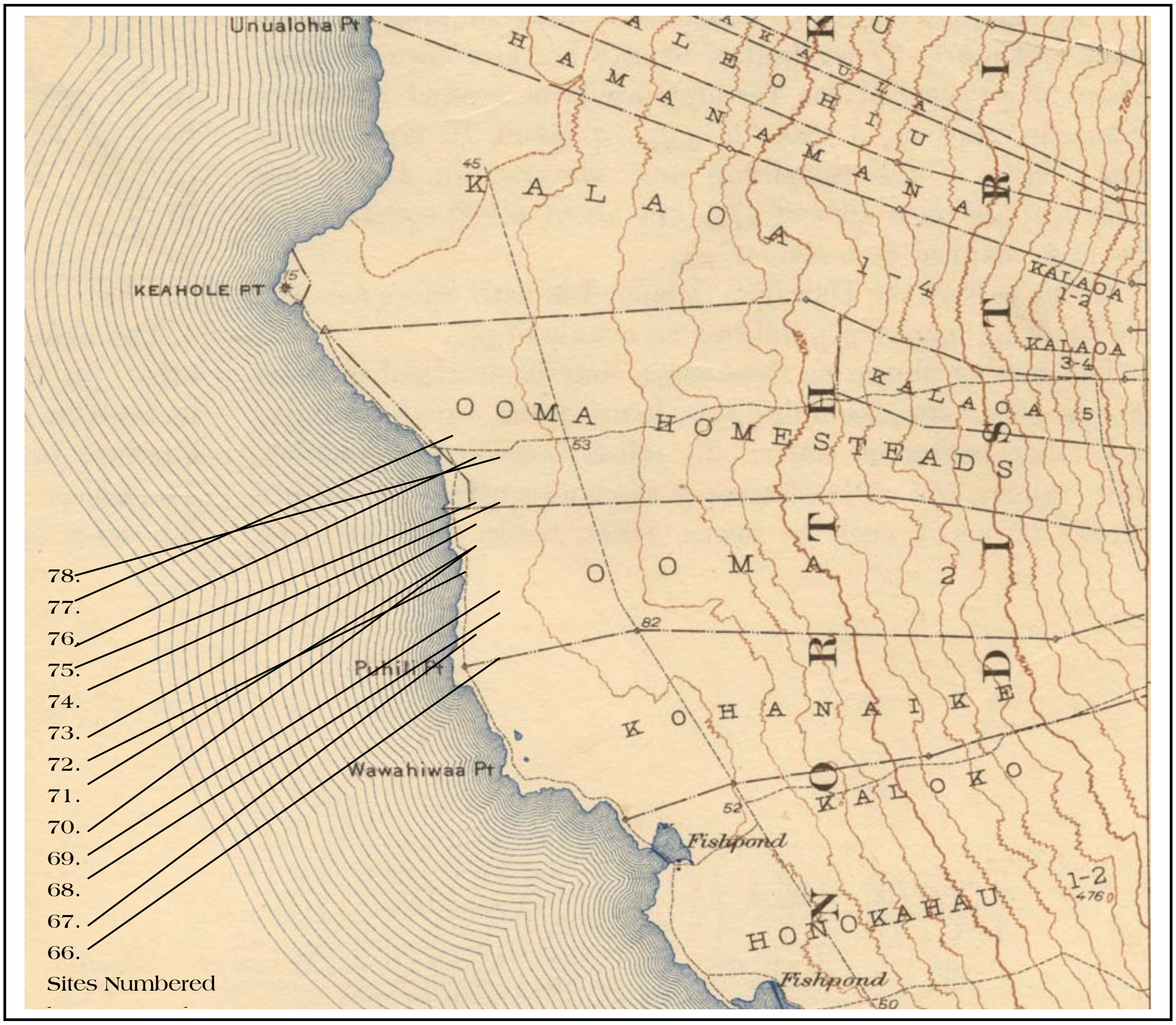


Figure 4. Approximate locations of sites described by Reinecke (n.d.:37) projected on USGS Keahole Quad, 1928.

> Site 74. A shelter about a shallow cave; remains of another shelter; an ahu.
>
> Site 75. Trace of site; house platform; enclosure on shore. There are many faint traces of sites on this strip of coast. Toward the north is an unmistakable small site.
> Site 76. Modern shelter pen; house or shelter site; shelter mauka by kiawe tree.
>
> Site 77. Platform; tiny pen; sites of some kind marked by stones in lines on the pahoehoe flow.
>
> Site 78. Slightly brackish springs and pools; house site, shelters, stepping stone path leading to the walled house site… [Reinecke n.d.:16]

More recently, the current project area has been subject to intensive archaeological study (Barrera 1985, 1989, 1992; Cordy 1985, 1986; Donham 1987; Rechtman 2002, 2007). As a result of these studies a total of forty archaeological sites were recorded (Corbin 2000; Rechtman 2007). Collectively these sites document Precontact and Historic use of the project area for habitation, burial, and resource extraction activities. A prominent landscape feature that dates to the Historic Period is the *Alanui Aupuni* (Government Road), which runs a roughly north-south course through the *mauka* third of the project area. Archaeological inventory survey recording and data recovery has already been completed within the project area, mitigating impacts to all but nine of these sites (Rechtman 2007), all of which (Figure 5) are slated for preservation (ibid). Two of these sites extend into, and will become part of, the newly created 15-acre archaeological preserve on the NELHA parcel to the north (Rechtman and Clark 2006).

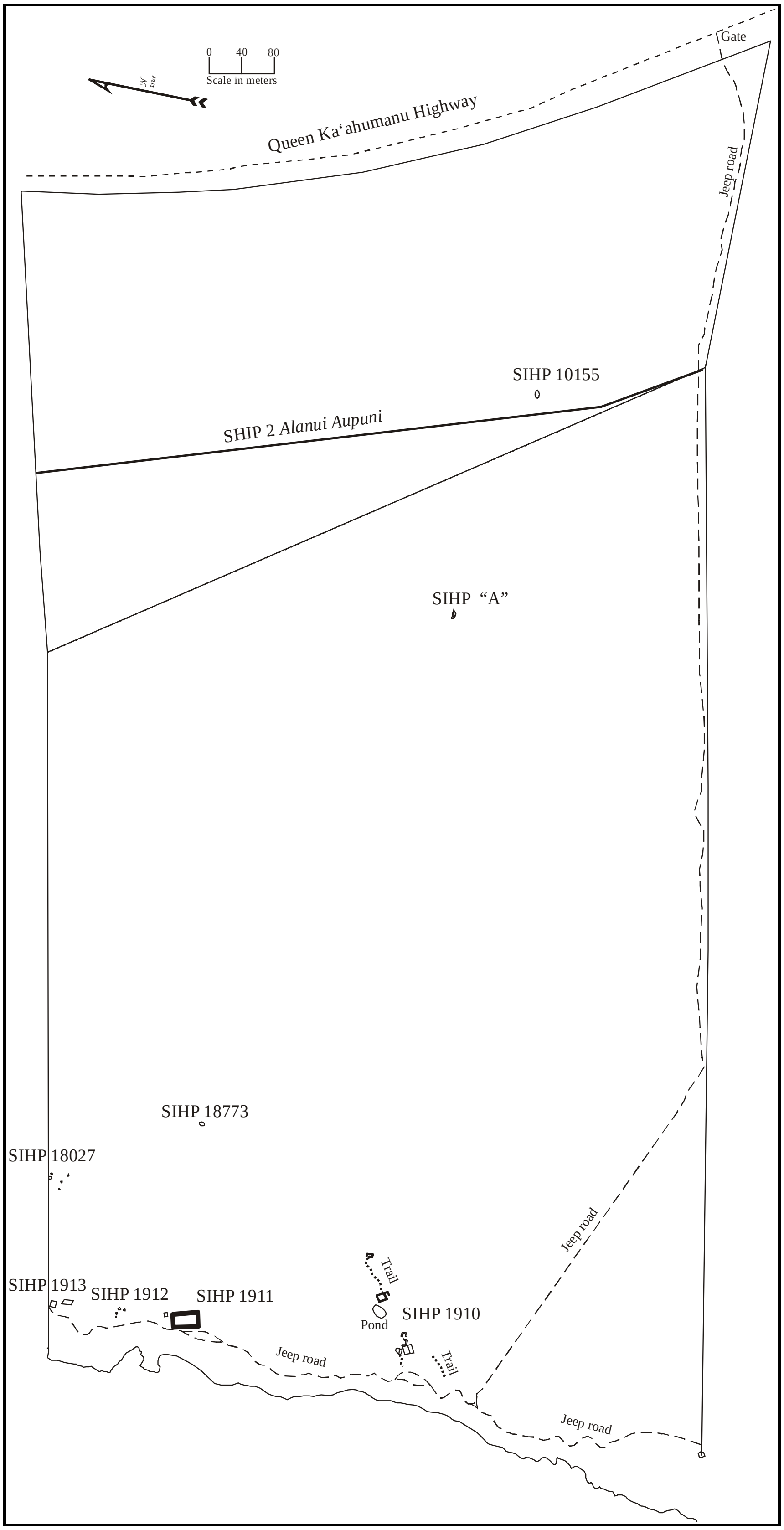


Figure 5. Distribution of archaeological preservation sites within the project area.

CULTURAL AND HISTORICAL BACKGROUND

Natural and Cultural Resources in a Hawaiian Context

In Hawaiian society, natural and cultural resources are one and the same. Native traditions describe the formation (the literal birth) of the Hawaiian Islands and the presence of life on and around them in the context of genealogical accounts. All forms in the natural environment, from the skies and mountain peaks, to the watered valleys and lava plains, and to the shoreline and ocean depths were believed to be embodiments of Hawaiian deities. One Hawaiian genealogical account, records that Wākea (the expanse of the sky–father) and Papa-hānau-moku (Papa—Earth-mother who gave birth to the islands)—also called Haumea-nui-hānau-wā-wā (Great Haumea—Woman-earth born time and time again)—and various gods and creative forces of nature, gave birth to the islands. Hawai‘i, the largest of the islands, was the first-born of these island children. As the Hawaiian genealogical account continues, we find that these same god-beings, or creative forces of nature who gave birth to the islands, were also the parents of the first man (Hāloa), and from this ancestor, all Hawaiian people are descended (cf. Beckwith 1970; Malo 1951:3; Pukui and Korn 1973). It was in this context of kinship, that the ancient Hawaiians addressed their environment and it is the basis of the Hawaiian system of land use.

An Overview of Hawaiian Settlement

Archaeologists and historians describe the inhabiting of these islands in the context of settlement that resulted from voyages taken across the open ocean. For many years, researchers have proposed that early Polynesian settlement voyages between Kahiki (the ancestral homelands of the Hawaiian gods and people) and Hawai‘i were underway by A.D. 300, with long distance voyages occurring fairly regularly through at least the thirteenth century. It has been generally reported that the sources of the early Hawaiian population—the Hawaiian Kahiki—were the Marquesas and Society Islands (Cordy 2000; Emory in Tatar 1982:16-18).

For generations following initial settlement, communities were clustered along the watered, windward (*ko‘olau*) shores of the Hawaiian Islands. Along the *ko‘olau* shores, streams flowed and rainfall was abundant, and agricultural production became established. The *ko‘olau* region also offered sheltered bays from which deep sea fisheries could be easily accessed, and near shore fisheries, enriched by nutrients carried in the fresh water, could be maintained in fishponds and coastal waters. It was around these bays that clusters of houses where families lived could be found (McEldowney 1979:15). In these early times, Hawai‘i's inhabitants were primarily engaged in subsistence level agriculture and fishing (Handy et al. 1972:287).

Over a period of several centuries, areas with the richest natural resources became populated and perhaps crowded, and by about A.D. 900 to 1100, the population began expanding to the *kona* (leeward side) and more remote regions of the island (Cordy 2000:130). In Kona, communities were initially established along sheltered bays with access to fresh water and rich marine resources. The primary "chiefly" centers were established at several locations—the Kailua (Kaiakeakua) vicinity, Kahalu‘u-Keauhou, Ka‘awaloa-Kealakekua, and Hōnaunau. The communities shared extended familial relations, and there was an occupational focus on the collection of marine resources. By the fourteenth century, inland elevations to around the 3,000-foot level were being turned into a complex and rich system of dryland agricultural fields (today referred to as the Kona Field System). By the fifteenth century, residency in the uplands was becoming permanent, and there was an increasing separation of the chiefly class from the common people. In the sixteenth century the population stabilized and the *ahupua‘a* land management system was established as a socioeconomic unit (see Ellis 1963; Handy et al. 1972; Kamakau 1961; Kelly 1983; and Tomonari-Tuggle 1985).

In Kona, where there were no regularly flowing streams to the coast, access to potable water (*wai*), was of great importance and played a role in determining the areas of settlement. The waters of Kona were found in springs and caves (found from shore to the mountain lands), or procured from rain catchments and dewfall. Traditional and historic narratives abound with descriptions and names of water sources, and also record that the forests were more extensive and extended much further seaward than they do today. These forests not only attracted rains from the clouds and provided shelter for cultivated crops, but also in dry times drew the *kēhau* and *kēwai* (mists and dew) from the upper mountain slopes to the low lands (see also traditional-historical narratives and oral history interviews in this study).

In the 1920s-1930s, Handy et al. (1972) conducted extensive research and field interviews with elder native Hawaiians. In lands of North and South Kona, they recorded native traditions describing agricultural practices and rituals associated with rains and water collection. Primary in these rituals and practices was the lore of Lono—a god of agriculture, fertility, and the rituals for inducing rainfall. Handy et al., observed:

> The sweet potato and gourd were suitable for cultivation in the drier areas of the islands. The cult of Lono was important in those areas, particularly in Kona on Hawaiʻi . . . there were temples dedicated to Lono. The sweet potato was particularly the food of the common people. The festival in honor of Lono, preceding and during the rainy season, was essentially a festival for the whole people, in contrast to the war rite in honor of Ku which was a ritual identified with Ku as god of battle. (Handy et al. 1972:14)

Handy et al. (1972) noted that the worship of Lono was centered in Kona. Indeed, it was while Lono was dwelling at Keauhou, that he is said to have introduced taro, sweet potatoes, yams, sugarcane, bananas, and *ʻawa* to Hawaiian farmers (Handy et al. 1972:14). The rituals of Lono "The father of waters" and the annual *Makahiki* festival, which honored Lono and which began before the coming of the *kona* (southerly) storms and lasted through the rainy season (the summer months), were of great importance to the native residents of this region (Handy et al. 1972: 523). The significance of rituals and ceremonial observances in cultivation and indeed in all aspects of life was of great importance to the well being of the ancient Hawaiians, and cannot be overemphasized, or overlooked when viewing traditional sites of the cultural landscape.

Hawaiian Land Use and Resource Management Practices

Over the generations, the ancient Hawaiians developed a sophisticated system of land and resources management. By the time ʻUmi-a-Līloa rose to rule the island of Hawaiʻi in ca. 1525, the island (*moku-puni*) was divided into six districts or *moku-o-loko* (cf. Fornander 1973–Vol. II:100-102). On Hawaiʻi, the district of Kona is one of six major *moku-o-loko* within the island. The district of Kona itself, extends from the shore across the entire volcanic mountain of Hualālai, and continues to the summit of Mauna Loa, where Kona is joined by the districts of Kaʻū, Hilo, and Hāmākua. One traditional reference to the northern and southern-most coastal boundaries of Kona tells us of the district's extent:

> *Mai Ke-ahu-a-Lono i ke ʻā o Kani-kū, a hōʻea i ka ʻūlei kolo o Manukā i Kaulanamauna e pili aku i Kaʻū!*—From Keahualono [the Kona-Kohala boundary] on the rocky flats of Kanikū, to Kaulanamauna next to the crawling (tangled growth of) ʻūlei bushes at Manukā, where Kona clings to Kaʻū! (*Kaʻao Hoʻoniua Puʻuwai no Ka-Miki in Ka Hōkū o Hawaiʻi*, September 13, 1917; Translated by Kepā Maly)

Kona, like other large districts on Hawaiʻi, was further divided into ʻokana or kalana (regions of land smaller than the *moku-o-loko*, yet comprising a number of smaller units of land). In the region now known as Kona ʻakau (North Kona), there are several ancient regions (*kalana*) as well. The southern portion of North Kona was known as "Kona kai ʻōpua" (interpretively translated as: Kona of the distant horizon clouds above the ocean), and included the area extending from Lanihau (the present-day vicinity of Kailua Town) to Puʻuohau (now known as Red Hill). The northern-most portion of North Kona was called "Kekaha" (descriptive of an arid coastal place). Native residents of the region affectionately referred to their home as *Kekaha-wai-ʻole o nā Kona* (Waterless Kekaha of the Kona District), or simply as the *āina kaha*. It is within this region of Kekaha, that the lands of ʻOʻoma are found.

The *ahupuaʻa* were also divided into smaller individual parcels of land (such as the *ʻili, kōʻele, māla*, and *kīhāpai*, etc.), generally oriented in a *mauka-makai* direction, and often marked by stone alignments (*kuaiwi*). In these smaller land parcels the native tenants tended fields and cultivated crops necessary to sustain their families, and the chiefly communities with which they were associated. As long as sufficient tribute was offered and *kapu* (restrictions) were observed, the common people, who lived in a given *ahupuaʻa* had access to most of the resources from mountain slopes to the ocean. These access rights were almost uniformly tied to residency on a particular land, and earned as a result of taking responsibility for stewardship of the natural environment, and supplying the needs of the *aliʻi* (see Kamakau 1961:372-377 and Malo 1951:63-67).

Entire *ahupua'a*, or portions of the land were generally under the jurisdiction of appointed *konohiki* or lesser chief-landlords, who answered to an *ali'i-'ai-ahupua'a* (chief who controlled the *ahupua'a* resources). The *ali'i-'ai-ahupua'a* in turn answered to an *ali'i 'ai moku* (chief who claimed the abundance of the entire district). Thus, *ahupua'a* resources supported not only the *maka'āinana* and *'ohana* who lived on the land, but also contributed to the support of the royal community of regional and/or island kingdoms. This form of district subdividing was integral to Hawaiian life and was the product of strictly adhered to resources management planning. In this system, the land provided fruits and vegetables and some meat in the diet, and the ocean provided a wealth of protein resources. Also, in communities with long-term royal residents, divisions of labor (with specialists in various occupations on land and in procurement of marine resources) came to be strictly adhered to. It is in this cultural setting that we find 'O'oma and the present study area.

The *ahupua'a* of 'O'oma (historically, 'O'oma 1st and 2nd) are two of some twenty ancient *ahupua'a* within the *'okana* of Kekaha-wai-'ole. The place name 'O'oma can be literally translated as concave. To date, no tradition explaining the source of the place name has been located, though it is possible that the name refers to the indentation of the shoreline fronting a portion of 'O'oma. A few place names within 'O'oma were discussed in traditional accounts, thus we have some indication of the histories associated with this land.

While there are only limited native accounts that have been recorded about 'O'oma, we do know that the land was so esteemed, that during the youth of Kauikeaouli (later known as Kamehameha III), the young prince—son of Kamehameha I and his sacred wife Keōpūolani—was taken to be raised near the shore of 'O'oma under the care of his stewards from infancy until he was five years old (Kamakau 1961:263-264). Again, this is a significant part of the history of this land, as great consideration went into all aspects of the young king's upbringing (see I'i 1959 and Kamakau 1961).

The Environmental Setting of 'O'oma

The *ahupua'a* of 'O'oma cross several environmental zones that are generally called *wao* in the Hawaiian language. These environmental zones include the near-shore fisheries and shoreline strand (*kahakai*) and the *kula kai/kula uka* (shoreward/inland plains). These regional zones were greatly desired as places of residence by the natives of the land.

While the *kula* region of 'O'oma and greater Kekaha is now likened to a volcanic desert, native and historic accounts describe or reference groves of native hardwood shrubs and trees such as *'ūlei* (*Osteomeles anthyllidifolia*), *ēlama* (*Diospyros ferrea*), *uhiuhi* (*Caesalpina kavaiensis*), and *ohe* (*Reynoldsia sandwicensis*) extending across the land and growing some distance shoreward. The few rare and endangered plants found in the region, along with small remnant communities of native dryland forest (Char 1991) give an indication that there was a significant diversity of plants growing upon the *kula* lands prior to the introduction of ungulates.

The lower *kula* lands receive only about 20 inches of rainfall annually, and it is because of their dryness, the larger region of which 'O'oma is a part, is known as "Kekaha." While on the surface, there appears to be little or no potable water to be found, the very lava flows which cover the land contain many underground streams that are channeled through subterranean lava tubes which feed the springs, fishponds and anchialine ponds on the *kula kai* (coastal flats). Also in this region, on the flat lands, about a half-mile from the shore, is the famed *Alanui Aupuni* (Government Trail), built in 1847, at the order of Kamehameha III. This trail or government roadway, was built to meet the needs of changing transportation in the Hawaiian Kingdom, and in many places it overlays the older near shore *ala loa* (ancient foot trail that encircled the island).

Continuing into the *kula uka* (inland slopes), the environment changes as elevation increases. Based on historic surveys, it appears that 'O'oma ends at a survey station named Kuhiaka, 2,145 feet above sea level (cf. Register Map No. 1449). This zone is called the *wao kanaka* (region of man) and *wao nahele* (forest region). Rainfall increases to 30 or 40 inches annually, and taller forest growth occurred. This region provided native residents with shelter for residential and agricultural uses, and a wide range of natural resources that were of importance for religious, domestic, and economic purposes. In 'O'oma, this region is generally between the 1,200 to 2,200 foot elevation, and is crossed by the present-day Māmalahoa Highway. The highway is situated not far below the ancient *ala loa*, or foot trail, also known as Ke-ala‘ehu, and was part of a regional trail system passing through Kona from Ka‘ū and Kohala.

The ancient Hawaiians saw (as do many Hawaiians today) all things within their environment as being interrelated. That which was in the uplands shared a relationship with that which was in the lowlands, coastal region, and even in the sea. This relationship and identity with place worked in reverse as well, and the *ahupua‘a* as a land unit was the thread that bound all things together in Hawaiian life. In an early account written by Kihe (in *Ka Hōkū o Hawai‘i*, 1914-1917), with contributions by John Wise and Steven Desha Sr., the significance of the dry season in Kekaha and the custom of the people departing from the uplands for the coastal region is further described:

> …*‘Oia ka wā e ne‘e ana ka lā iā Kona, hele a malo‘o ka ‘āina i ka ‘ai kupakupa ‘ia e ka lā, a o nā kānaka, nā li‘i o Kona, pūhe‘e aku la a noho i kahakai kāhi o ka wai e ola ai nā kānaka* – It was during the season, when the sun moved over Kona, drying and devouring the land, that the chiefs and people fled from the uplands to dwell along the shore where water could be found to give life to the people. (*Ka Hōkū o Hawai‘i*, April 5, 1917 translated by Kepā Maly)

It appears that the practice of traveling between upland and coastal communities in the ‘O‘oma *ahupua‘a* greatly decreased by the middle nineteenth century. Indeed, the only claimant for *kuleana* land in ‘O‘oma, during the *Māhele ‘Āina* of 1848—when native tenants were allowed to lay claim to lands on which they lived and cultivated—noted that he was the only resident in ‘O‘oma at the time (see *Helu* 9162 to Kahelekahi, in this study). This is perhaps explained by the fact that at time of the *Māhele* there was a significant decline in the Hawaiian population, and changes in Hawaiian land tenure led to the relocation of many individuals from various lands.

Native Traditions and Historical Accounts of ‘O‘oma and the Kekaha Region

This section of the study presents *mo‘olelo*—native traditions and historical accounts (some translated from the original Hawaiian by Kepā Maly)—of the Kekaha region that span several centuries. There are very few accounts that have been found to date, that specifically mention ‘O‘oma. Thus, narratives that describe neighboring lands within the Kekaha region help provide an understanding of the history of ‘O‘oma, describing features and the use of resources that were encountered on the land.

It may be, that the reason there are so few accounts for ‘O‘oma, is that it may have been considered a marginal settlement area, occupied only after the better situated lands of Kekaha—those lands with the sheltered bays, and where fresh water could be easily obtained—were populated. As the island population grew, so too did the need to expand to more remote or marginal lands. This thought is found in some of the native traditions and early historic accounts below. However, as people populated the Kekaha lands, they came to value its fisheries—those of the deep sea, near shore, and inland fishponds.

The native account of Punia (also written Puniaiki – cf. Kamakau 1964), is perhaps among the earliest accounts of the Kekaha area, and in it is found a native explanation for the late settlement of Kekaha. The following narratives are paraphrased from Fornander’s *Hawaiian Antiquities and Folklore* (Fornander 1959):

> *Punia: A Tale of Sharks and Ghosts of Kekaha*
>
> Punia was born in the district of Kohala, and was one of the children of Hina. One day, Punia desired to get lobster for his mother to eat, but she warned him of Kai‘ale‘ale and his hoards of sharks who guarded the caves in which lobster were found. These sharks were greatly feared by all who lived along, and fished the shores of Kohala for many people had been killed by the sharks. Heeding his mother’s warning, Punia observed the habits of the sharks and devised a plan by which to kill each of the sharks. Setting his plan in motion, Punia brought about the deaths of all the subordinate sharks, leaving only Kai‘ale‘ale

behind. Punia tricked Kaiʻaleʻale into swallowing him whole. Once inside Kaiʻaleʻale, Punia rubbed two sticks together to make a fire to cook the sweet potatoes he had brought with him. He also scraped the insides of Kaiʻaleʻale, causing great pain to the shark. In his weakened state, Kaiʻaleʻale swam along the coast of Kekaha, and finally beached himself at Alula, near the point of Maliu in the land of Kealakehe. The people of Alula, cut open the shark and Punia was released.

At that time Alula was the only place in all of Kekaha where people could live, for all the rest of the area was inhabited by ghosts. When Punia was released from the shark, he began walking along the trail, to return to Kohala. While on this walk, he saw several ghosts with nets all busy tying stones for sinkers to the bottom of the nets, and Punia called out in a chant trying to deceive the ghosts and save himself:

Auwe no hoi kuu makuakane o keia kaha e!	*Alas, O my father of these coasts!*
Elua wale no maua lawaia o keia wahi.	*We were the only two fishermen of this place (Kaha).*
Owau no o koʻu makuakane,	*Myself and my father,*
E hoowili aku ai maua i ka ia o ianei,	*Where we used to twist the fish up in the nets,*
O kala, o ka uhu, o ka palani,	*The kala, the uhu, the palani,*
O ka ia ku o ua wahi nei la,	*The transient fish of this place.*
Ua hele wale ia no e maua keia kai la!	*We have traveled over all these seas,*
Pau na kuuna, na lua, na puka ia.	*All the different place, the holes, the runs.*
Make koʻu makuakane, koe au.	*Since you are dead, father, I am the only one left.*

Hearing Punia's wailing, the ghosts said among themselves, "Our nets will be of some use now, since here comes a man who is acquainted with this place and we will not be letting down our nets in the wrong place." They then called out to Punia, "Come here." When Punia went to the ghosts, he explained to them, the reason for his lamenting; "I am crying because of my father, this is the place where we used to fish. When I saw the lava rocks, I thought of him." Thinking to trick Punia and learn where all the kuʻuna (net fishing grounds) were, the ghosts told Punia that they would work under him. Punia went into the ocean, and one-by-one and two-by-two, he called the ghosts into the water with him, instructing them to dive below the surface. As each ghost dove into the water, Punia twisted the net entangling the ghosts. This was done until all but one of the ghosts had been killed. That ghost fled and Kekaha became safe for human habitation (Fornander 1959:9-17).

One of the earliest datable accounts that describes the importance of the Kekaha region fisheries comes from the mid-sixteenth century, following ʻUmi-a-Līloa's unification of the island of Hawaiʻi under his rule. Writing in the 1860s, native historian, Samuel Mānaiakalani Kamakau (1961) told readers about the reign of ʻUmi, and his visits to Kekaha:

ʻUmi-a-Liloa did two things with his own hands, farming and fishing...and farming was done on all the lands. Much of this was done in Kona. He was noted for his skill in fishing and was called Puʻipuʻi a ka lawaiʻa (a stalwart fisherman). Aku fishing was his favorite occupation, and it often took him to the beaches (Ke-kaha) from Kalahuipuaʻa to Makaula[1]. He also fished for ʻahi and kala. He was accompanied by famed fishermen such as Pae, Kahuna, and all of the chiefs of his kingdom. He set apart fishing, farming and other practices… (Kamakau 1961:19-20)

In his accounts of events at the end of ʻUmi's life, Kamakau (1961) references Kekaha once again. He records that Koʻi, one of the faithful supporters and a foster son of ʻUmi, sailed to Kekaha, where he killed a man who resembled ʻUmi. Koʻi then took the body and sailed to Makaʻeo in the *ahupuaʻa* of Keahuolu.

[1] Kalāhuipuaʻa is situated in the district of Kohala, bounding the northern side of Puʻuanahulu in Kekaha. Makaʻula is situated a few *ahupuaʻa* north of ʻOʻoma.

Landing at Maka‘eo in the night, Ko‘i took the body to the cave where ‘Umi’s body lay. Replacing ‘Umi’s body with that of the other man, Ko‘i then crossed the lava beds, returning to his canoe at Maka‘eo. From there, ‘Umi’s body was taken to its’ final resting place… (Kamakau 1961:32-33).

As a child in ca. 1812, Hawaiian historian John Papa I‘i passed along the shores of Kekaha in a sailing ship, as a part of the procession by which Kamehameha I returned to Kailua-Kona from his residency on O‘ahu. In his narratives, I‘i described the shiny lava flows and fishing canoe fleets of the “Kaha” (Kekaha) lands:

> The ship arrived outside of Kaelehuluhulu, where the fleet for aku fishing had been since the early morning hours. The sustenance of those lands was fish.
>
> When the sun was rather high, the boy [I‘i] exclaimed, “How beautiful that flowing water is!” Those who recognized it, however, said, “That is not water, but pahoehoe. When the sun strikes it, it glistens, and you mistake it for water…”
>
> Soon the fishing canoes from Kawaihae, the Kaha lands, and Ooma drew close to the ship to trade for the pa‘i‘ai (hard poi) carried on board, and shortly a great quantity of aku lay silvery-hued on the deck. The fishes were cut into pieces and mashed; and all those aboard fell to and ate, the women by themselves.
>
> The gentle Eka sea breeze of the land was blowing when the ship sailed past the lands of the Mahaiulas, Awalua, Haleohiu, Kalaoas, Hoona, on to Oomas, Kohanaiki, Kaloko, Honokohaus, and Kealakehe, then around the cape of Hiiakanoholae… (I‘i 1959:109-110)

Ka-Lani-Kau-i-ke-Aouli (Kamehameha III)

In ca. 1813, Ka-lani Kau-i-ke-aouli, who grew up to become Kamehameha III, was born. S.M. Kamakau (1961) tells us that the baby appeared to be still-born, but that shortly after birth, he was revived. Upon the revival of the baby, he was given to the care of Ka-iki-o-‘ewa, who with Keawe-a-mahi and family, raised the child in seclusion at ‘O‘oma for the first five years of the young king’s life. Kauikeaouli apparently held some interest in the land of ‘O‘oma 2^{nd} through the *Māhele ‘Āina*, as he originally claimed ‘O‘oma 2^{nd} as his personal property. Though he subsequently gave it up to the Kingdom (Government) later during the Division (see records of *Māhele ‘Āina* in this study).

Kamakau provides us with the following description of Kauikeaouli’s birth and early life at ‘O‘oma:

> Ka-lani-kau-i-ke-aouli was the second son of Ke-opu-o-lani by Kamehameha, and she called him Kiwala‘o after her own father. She was the daughter of Kiwala‘o and Ke-ku‘i-apo-iwa Liliha, both children of Ka-Iola Pupuka-o-Hono-ka-wai-lani, and hence she [Ke-opu-o- lani] was a ni‘aupi‘o and a naha chiefess, and the ni‘aupi‘o rank descended to her children and could not be lost by them. While she was carrying the child [Kau-i-ke-aouli] several of the chiefs begged to have the bringing up of the child, but she refused until her kahu, Ka-lua-i-konahale, known as Kua-kini, came with the same request. She bade him be at her side when the child was born lest some one else get possession of it. He was living this side of Keauhou in North Kona, and Ke-opu-o-lani lived on the opposite side.
>
> On the night of the birth the chiefs gathered about the mother. Early in the morning the child was born but as it appeared to be stillborn Kua-kini did not want to take it. Then came Ka-iki-o-‘ewa from some miles away, close to Kuamo‘o, and brought with him his prophet who said, “The child will not die, he will live.” This man, Ka-malo-‘ihi or Ka-pihe by name, came from the Napua line of kahunas descended from Makua-kau-mana whose god was Ka-‘onohi-o-ka-la (similar to the child of God). The child was well cleaned and laid upon a consecrated place and the seer (kaula) took a fan (pe‘ahi), fanned the child, prayed, and sprinkled it with water, at the same time reciting a prayer addressed to the child of God, something like that used by the Roman Catholics—

"He is standing up, he is taking a step, he walks" (*Kulia-la, ka'ina-la, hele ia la*).

Or another—

Huila ka lani i ke Akua,	*The heavens lighten with the god,*
Lapalapa ka honua i ke keiki	*The earth burns with the child,*
E ke keiki e, hooua i ka punohu lani,	*O son, pour down the rain that brings the rainbow,*
Aia i ka lani ka Haku e,	*There in heaven is the Lord.*
O ku'u 'uhane e kahe mau,	*Life flows through my spirit,*
I la'a i kou kanawai.	*Dedicated to your law.*

The child began to move, then to make sounds, and at last it came to life. The seer gave the boy the name of "The red trail" (Ke-aweawe-'ula) signifying the roadway by which the god descends from the heavens.

Ka-iki-o-'ewa became the boy's guardian and took him to rear in an out-of-the-way place at 'O'oma, Kekaha. Here Keawe-a-mahi, the lesser chiefs, the younger brothers and sisters of Ka-iki-o-'ewa, and their friends were permitted to carry the child about and hold him on their laps (uha). Ka-pololu was the chief who attended him; Ko'i-pepeleleu and Ulu-nui's mother [were] the nurses who suckled him. Later Ka-'ai-kane gave him her breast after she had given birth to Ke-kahu-pu'u. Here at 'O'oma he was brought up until his fifth year, chiefly occupied with his toy boats rigged like warships and with little brass cannon loaded with real powder mounted on [their] decks. The firing off of these cannon amused him immensely. He excelled in foot races. On one occasion when the bigger boys had joined in the sport, a [rascal] boy named Ka-hoa thought to play a practical joke by smearing with mud the stake set up to be grasped by the one who first reached the goal. He expected one of the larger boys to be the winner, but it was the little prince who first caught the stick and had his hands smeared. "You will be burnt alive for dirtying up the prince. We are going to tell Ka-pololu on you!" the boys threatened; but the prince objected, saying, "Anyone who tells on him shall never eat with me again or play with me and I will never give him anything again." Kau-i-ke-aouli was a splendid little fellow. He loved his playmates and never once did them any hurt, and he was kind and obedient to his teachers… [Kamakau 1961:264]

It is not until the early twentieth century, that we find a few detailed native accounts which tell of traditional features and residents of 'O'oma and vicinity. The writings of John Whalley Hermosa Isaac Kihe, a native son of Kekaha, in Hawaiian language newspapers (recently translated by Kepā Maly from the original Hawaiian texts), share the history of the land and sense the depth of attachment that native residents felt for 'O'oma and the larger Kekaha-wai-'ole-o-nā-Kona.

Kihe (who also wrote under the name of Ka-'ohu-ha'aheo-i-nā-kuahiwi-'ekolu) was born in 1853, his parents were native residents of Honokōhau and Kaloko (his grandfather, Kuapāhoa, was a famed kahuna of the Kekaha lands). During his life, Kihe taught at various schools in the Kekaha region; served as legal counsel to native residents applying for homestead lands in 'O'oma and vicinity; worked as a translator on the Hawaiian Antiquities collections of A. Fornander; and was a prolific writer himself. In the later years of his life, Kihe lived at Pu'u Anahulu and Kalaoa, and he is fondly remembered by elder kama'āina of the Kekaha region. Kihe, who died in 1929, was also one of the primary informants to Eliza Maguire, who translated some of the writings of Kihe, publishing them in abbreviated form in her book "Kona Legends" (1926).

Writers today have varying opinions and theories pertaining to the history of Kekaha, residency patterns, and practices of the people who called Kekaha-wai-'ole-o-nā-Kona home. For the most part, our interpretations are limited by the fragmented nature of the physical remains and historical records, and by a lack of familiarity with the diverse qualities of the land. As a result, most of us only see the shadows of what once was, and it is difficult at times, to comprehend how anyone could have carried out a satisfactory existence in such a rugged land.

Kihe and his co-authors provide readers with several references to places and events in the history of ʻOʻoma and neighboring lands. Through the narratives, we learn of place name origins, areas of ceremonial significance, how resources were managed and accessed, and the practices of those native families who made this area their home.

One example of the rich materials recorded by native writers, is found in "*Kaʻao Hoʻoniua Puʻuwai no Ka-Miki*" (The Heart Stirring Story of Ka-Miki). This tradition is a long and complex account, that was published over a period of four years (1914-1917) in the weekly Hawaiian-language newspaper *Ka Hōkū o Hawaiʻi*. The narratives were primarily recorded for the paper by Hawaiian historians John Wise and J.W.H.I. Kihe.

While "*Ka-Miki*" is not an ancient account, the authors used a mixture of local stories, tales, and family traditions in association with place names to tie together fragments of site-specific histories that had been handed down over the generations. Also, while the personification of individuals and their associated place names may not be entirely "ancient," such place name-person accounts are common throughout Hawaiian (and Polynesian) traditions. The English translations below are a synopsis of the Hawaiian texts, with emphasis upon the main events and areas being discussed. Diacritical marks and hyphenation have been placed to help with pronunciation of certain words.

"Kaao Hooniua Puuwai no Ka-Miki" (The Heart stirring Story of Ka-Miki)

This *moʻolelo* (tradition) is set in the 1300s (by association with the chief Pili-a-Kaʻaiaea), and is an account of two supernatural brothers, Ka-Miki (The quick, or adept, one) and Ma-Kaʻiole (Rat [squinting] eyes). The narratives describe the birth of the brothers, their upbringing, and their journey around the island of Hawaiʻi along the ancient *ala loa* and *ala hele* (trails and paths) that encircled the island. During their journey, the brothers competed alongside the trails they traveled, and in famed *kahua* (contest fields) and royal courts, against *ʻōlohe* (experts skilled in fighting or in other competitions, such as running, fishing, debating, or solving riddles, that were practiced by the ancient Hawaiians). They also challenged priests whose dishonorable conduct offended the gods of ancient Hawaiʻi. Ka-Miki and Ma-Kaʻiole were empowered by their ancestress Ka-uluhe-nui-hihi-kolo-i-uka (The great entangled growth of uluhe fern which spreads across the uplands), who was one of the myriad of body forms of the goddess Haumea, the earth-mother, creative force of nature who was also called Papa or Hina. Among her many nature-form attributes were manifestations that caused her to be called upon as a goddess of priests and competitors (people, places named for them, and other place names are marked below with underlining):

> …<u>Kūmua</u> was the husband of Ka-uluhe-nui-hihi-kolo-i-uka. The place that is named for Kūmua is in the uplands of <u>Kohanaiki</u>, an elevated rise from where one can look towards the lowlands. The shore and deep sea are all clearly visible from this place. The reason that Kūmua dwelt there was so that he could see the children and grandchildren of he and his wife.
>
> <u>Wailoa</u>, a daughter, was the mother of <u>Kapaʻihilani</u>, also called <u>Kapaʻihi</u>. There is a place in the uplands of Kohanaiki, below Kūmua, to the northwest, a hidden water hole, that is called Kapaʻihi. Wailoa is a pond there on the shore of Kohanaiki. Because Wailoa married Kahunakalehu, a native of the area, she lived and worked there. Thus the name of that pond is Wailoa, and it remains so to this day.
>
> <u>Pipipiʻapoʻo</u> was another daughter of Kūmua and Ka-uluhe-nui-hihi-kolo-i-uka. She married <u>Haleolono</u>, one who cultivated sweet potatoes upon the ʻilima covered flat lands of <u>Nānāwale</u>, also called <u>Nāhiʻahu</u> (Nāwahʻiahu), as it has been called from before and up to the present time. Cultivating the land was the skill of this youth Haleolono, and because he was so good at it, he was able to marry the beauty, Pipipiʻapoʻo.
>
> Pipipiʻapoʻo's skill was that of weaving pandanus mats, and there are growing many pandanus trees there, even now. The grove of pandanus trees and a nearby cave, is called Pipipiʻapoʻo to this day, and you may ask the natives of Kohanaiki to point it out to you.
>
> <u>Kapukalua</u> was a son of Kūmua and Kaʻuluhe. He was an expert at aku lure fishing, and all

> other methods of fishing of those days gone by. He married Kauhiʻonohua a beauty with skin as soft as the blossoms of the hīnano, found in the pandanus grove of ʻOʻoma. This girl was pleasingly beautiful, and because of her fame, Kapukalua, the exceptionally skilled son of the sea spray of ʻApoʻula, secured her as his wife. Here, we shall stop speaking of the elders of Ka-Miki… [January 8, 1914]

The tradition continues, recounting the training of the brothers, and preparations of their *hālau aliʻi* (royal compound) at Kohanaiki. At the dedication ceremonies it was revealed that one of the *kahuna* of the Kaha lands, had taken up the habit of killing people, and that he had also thought to take the lives of Ka-Miki and Ma-Kaʻiole. We revisit the story here, and learn the name of a priest of ʻOʻoma and Kohanaiki—

> …The sun broke forth and the voices of the roosters and the ʻelepaio of the forests were heard resonating and rising upon the mountain slopes. The day became clear, with no clouds to be seen, it was calm. So too, the ocean was calm and the shore of Laʻi a ʻEhu (Kona) was calm. The flowers of the upland forest reddened and unfolded, and nodded gently in the kēhau breezes.
>
> The priests gathered together to discuss these events and prepared to apologize to the children of the chief, asking for their forgiveness. They selected ʻElepaio, Pūhili, Kaluaʻōlapa, and Kalua-ʻōlapa-uwila to go before the brothers for this purpose.
>
> ʻElepaio was the high priest of Honokōhau. The place where he dwelt bears the name ʻElepaio [an ʻili on the boundary of Honokōhau nui & iki]. It is in the great grove of *ʻulu (kaulu ʻulu)* on the boundary between Honokōhau-nui and Honokōhau-iki… [April 23, 1914]
>
> Pūhili was the high priest of ʻOʻoma and Kohanaiki, the place where he lived is on the plain of Kohanaiki, at the shore, and bears his name to this day. It is on the boundary between Kohanaiki and ʻOʻoma.
>
> Kaluaʻōlapa was the high priest of Haleʻōhiʻu and Kamāhoe, that is the waterless land of Kalaoa (Kalaoa wai ʻole). The place where he lived was in the uplands of Maulukua on the plain covered with *ʻilima* growth. This place bears his name to this day.
> Kalua-ʻōlapa-uwila was the high priest of Kealakehe and Keʻohuʻolu (Keahuolu), and it was he who built the *heiau* named Kalua-ʻōlapa-uwila, which is there along the shore of Kealakehe, next to the road that goes to Kailua. The nature of this priest was that of a shark and a man. The shark form was named Kaiwi, and there is a stone form of the shark that can be seen near the *heiau* to this day.
>
> These priests all went to the door of the house and presented the offerings of the black pig, the red fish, the black *ʻawa*, the white rooster, the *malo* (loin clothes), and all things that had been required of their class of priests. They also offered their prayers and asked forgiveness for their misspoken words. They then called for their prayers to be freed and the *kapu* ended… [April 30, 1914]

Through the 1920s, up to the time of his death in 1929, J.W.H.I. Kihe continued to submit traditional accounts and commentary on the changing times to the paper, *Ka Hōkū o Hawaiʻi*. In 1923, Kihe penned a series of articles, some of which formed the basis of Eliza Maguire's *Kona Legend*s (1926). One of the accounts, "*Ka Punawai o Wawaloli*" (The Pond of Wawaloli), describes that the pond of Wawaloli, on the shore of ʻOʻoma, was named for a supernatural ocean being, who could take the form of the *loli* (sea cucumber) and of a handsome young man. Through this account it is learned that people regularly traveled between the uplands and shore of ʻOʻoma; the *kula* lands were covered with *ʻilima* growth; and that a variety of fish, seaweeds, and shellfish were harvested along the shore. Also, the main figures in the tradition are memorialized as places on the lands of ʻOʻoma, Kalaoa, and neighboring *ahupuaʻa*. These individuals and places include Kaluaʻōlapa (a hill on the boundary of Hāmanamana and Haleohiʻu), Wawaloli (a bay between ʻOʻoma and Kalaoa), Hoʻohila (on the boundary of Kaū and Pu'ukala), Pāpa'apo'o (a cave site in Hāmanamana), Kamakaoiki and Malumaluiki (locations unknown). The following narratives were translated by Kepā Maly from the original Hawaiian texts published in *Ka Hōkū o Hawai'i* (September 23rd, October 4th & 11th, 1923):

Ka Punawai o Wawaloli (The Pond of Wawaloli)

The place of this pond (Wawaloli) is set there on the shore of 'O'oma near Kalaoa. It is a little pond, and is there to this day. It is very close to the sandy shore, and further towards the shore there is also a pond in which one can swim. There is a tradition of this pond that is held dearly in the hearts of the elders of this community.

Wawaloli is the name of a loli (sea cucumber) that possessed dual body forms (kino pāpālua), that of a loli, and that of a man!

Above there on the 'ilima covered flat lands, there lived a man by the name of Kalua'ōlapa and his wife, Kamakaoiki, and their beautiful daughter, Malumaluiki.

One day the young maiden told her mother that she was going down to the shore to gather limu (seaweeds), 'ōpihi (limpets), and pupu (shellfish). Her mother consented, and so the maiden traveled to the shore. Upon reaching the shore, Malumaluiki desired to drink some water, so she visited the pond and while she was drinking she saw a reflection in the rippling of the water, standing over her. She turned around and saw that there was a handsome young man there, with a smile upon his face. He said… [September 27, 1923] "…Pardon me for startling you here as we meet at this pond, in the afternoon heat which glistens off of the pāhoehoe."

She responded, "What is the mistake of our meeting, you are a stranger, and I am a stranger, and so we have met at this pond." The youth, filled with desire for the beautiful young maiden, answered "I am not a stranger here along this shore, indeed, I am very familiar with this place for this is my home. And when I saw you coming here, I came to meet you."

These two strangers, having thus met, then began to lay out their nets to catch kala, uhu, and pālani, the native fish of this land. And in this way, the beauty of the plains of Kalaoa was caught in the net of the young man who dwelt in the sea spray of 'O'oma.

These two strangers of the long day also fished for hīnālea, and then for kawele'ā. It was during this time, that their lines became entangled like those of the fishermen of Wailua (a poetic reference to those who become entangled in a love affair).

The desire for the limu, 'ōpihi, and pūpū was completely forgotten, and the fishing poles bent as the lines were pulled back in the sea spray. The handsome youth was moistened in the rains that fell, striking the land and the beloved shore of the land. The sun drew near, entering the edge of the sea and was taken by Lehua Island. Only then did these two fishers of the long day take up their nets.

Before the young maiden began her return to the uplands, she told the youth, "Tell me your name." He answered her, "The name by which I am known is Wawa. But my name, when I go and dwell in the pond here, is Loli. And when you return, you may call to me with the chant:

E Loli nui kīkewekewe[2]	*Oh great Loli moving back and forth*
I ka hana ana kīkewekewe	*Doing your work moving back and forth*
I ku'u piko kīkewekewe	*You are in my mind moving back and forth*

[2] "Kīkewekewe" is translated by Eliza Maguire (1926) as "charmer." Kepā Maly was unfamiliar with this meaning of the word. It is most commonly used in the refrain of a song, and is here translated as "moving back and forth," as the word is used in the spoken language. Kewe also means concave, similar to the place name 'O'oma.

A ka makua kīkewekewe	*The parents moving back and forth*
I hana ai kīkewekewe	*Are at their work moving back and forth*
E pi'i mai 'oe kīkewekewe	*Won't you arise moving back and forth*
Ka kaua puni kīkewekewe	*To that which we two desire moving back and forth*
Puni kauoha kīkewekewe	*Your command is desired moving back and forth*

Having finished their conversation, the maiden then went to the uplands. It was dark, and the kukui lamps had been lit in the house. Malumaluiki's parents asked her, "Where are your limu, 'ōpihi and pūpū?" She replied, "It is proper that you have asked me, for when I went to the shore it was filled with people who took all there was? Thus I was left with nothing, not even a fragment of limu or anything else. So I have returned up here."

Well, the family meal had been made ready, so they all sat to eat together. But after a short while the maiden stood up. Her parents inquired of this, and she said she was no longer hungry, and that her feet were sore from traveling the long path. So the maiden went to sleep. She did not sleep well though, and felt a heat in her bosom, as she was filled with desire, thus she had no sleep that night.

With the arrival of the first light of day, the Malumaluiki went once again down to the shore. Upon arriving at the place of the pond, she entered the water and called out as described above. Then, a loli appeared and turned into the handsome young man. They two then returned to their fishing for the kala, uhu and pālani, the native fish the land.

So it was that the two lovers met regularly there on the shore of 'O'oma. Now Malumaluiki's parents became suspicious because of the actions of the daughter, and her regular trips to the shore. So they determined that they should secretly follow her and spy on her.

One day, the father followed her to the shore, where he saw his daughter sit down by the side of the pond. He then heard her call out —

E Loli nui kīkewekewe	*Oh great Loli moving back and forth*
I ka hana ana kīkewekewe	*Doing your work moving back and forth*
I ku'u piko kīkewekewe	*You are the center of my life moving back and forth*
Piko maika'i kīkewekewe	*It is good moving back and forth*
A ka makua kīkewekewe	*The parents moving back and forth*
I hana ai kīkewekewe	*Are at their work moving back and forth*
E pi'i mai 'oe kīkewekewe	*Won't you arise moving back and forth*
Ka kaua puni kīkewekewe	To that which we two desire *moving back and forth*
Puni kauoha kīkewekewe	*Your command is desired moving back and forth*
[October 4, 1923]	

"O Loli, here is your desire, the one you command, Malumaluiki, who's eyes see nothing else."

Her father then saw a loli coming up from the pond, and when it was up, it turned into the youth. He watched the two for a while, unknown to them, and saw that his daughter and the youth of the two body forms (kino pāpālua), took their pleasure in one another.

The father returned to the uplands and told all of this to her mother, who upon hearing it, was filled with great anger, because of the deceitfulness of her daughter. But then she learned that the man with whom her daughter slept was of dual body forms. Kamakaoiki then told Kalua'ōlapa that he should "Go down and capture the loli, and beat it to death," to which he agreed.

One day, Kaluaʻōlapa went down early, and hid, unseen by the two lovers. Malumaluiki arrived at the pond and called out, and he then memorized the lines spoken by his daughter. When she left, returning to the uplands, he then went to the pond and looked closely at it. He then saw a small circular opening near the top of the water in the pond. He then understood that that was where the loli came up from. He then slept that night and in the early morning, he went to the pond and set his net in the water. He then began to call out as his daughter had done with the above words.

When he finished the chant, the loli began to rise up through the hole, and was ensnared in the net. Kaluaʻōlapa then carried him up onto the kula, walking to the uplands. On his way, he saw his daughter coming down, and he hid until she passed him by.

When the daughter arrived at the pond, she called out in the chant as she always did. She called and called until the sun was overhead, but the loli did not appear in the pond, nor did he come forward in his human form. Thus, she thought that he had perhaps died, and she began to wail and mourn for the loss of her lover. Finally as evening came, the beautiful maiden stood, and ascended the kula to her home.

Now, let us look back to the Kaluaʻōlapa. He went up to his house and showed the loli to his wife. Seeing the loli, she told her husband, "Take it to the kahuna, Pāpaʻapoʻo who lives on the kula of Hoʻohila." So he went to the kahuna and explained everything that had occurred to him, and showed him the loli in his net. Seeing this and hearing of all that had happened, Pāpaʻapoʻo told the father to build an imu in which to kālua the great loli that moves back and forth (loli kīkewekewe). He said, "When the loli is killed, then your daughter will be well, so too will be the other daughters of the families of the land." Thus, the imu was lit and the supernatural loli cooked.

When the daughter returned to her home, her eyes were all swollen from crying. Her mother asked her, "What is this, that your eyes are puffy from crying, my daughter?" She didn't answer, she just kneeled down, giving no response. At that time, her father returned to the house and saw his daughter kneeling down, and he said "Your man, with whom you have been making love at the beach has been taken by the kahuna Pāpaʻapoʻo. He has been cooked in the imu that you may live, that all of the girls who this loli has loved may live."

That pond is still there on the shore, and the place with the small round opening is still on the side of that pond to this day. It is something to remember those things of days gone by, something that should not be forgotten by those of today and in time to come. [October 11, 1923]

Ka Loko o Paaiea (The fishpond of Pāʻaiea)

The tradition of *Ka loko o Paaiea* (The fishpond of Pāʻaiea) was written by J.W.H.I. Kihe, and printed in *Ka Hōkū o Hawaiʻi* in 1914 and 1924. The narratives describe traditional life and practices in various *ahupuaʻa* of Kekaha, and specifically describes the ancient fishpond Pāʻaiea. The following excerpts from Kihe's *moʻolelo*, include references to Wawaloli, on the shore of ʻOʻoma and Kalaoa. Pāʻaiea, was destroyed by the Hualālai lava flows of 1801, reportedly as a result of the pond overseer's refusal to give the goddess Pele—traveling in human form—any fish from the pond:

Pāʻaiea was a great fishpond, something like the ponds of Wainānāliʻi and Kīholo, in ancient times. At that time the high chiefs lived on the land, and these ponds were filled with fat awa, ʻanae, āhole, and all kinds of fish that swam inside. It is this pond that was filled by the lava flows and turned into pāhoehoe, that is written of here. At that time, at Hoʻonā. There was a Konohiki (overseer), Kepaʻalani, who was in charge of the houses (hale papaʻa) in which the valuables of the King [Kamehameha I] were kept. He was in charge of the King's food supplies, the fish, the hālau (long houses) in which the fishing canoes were kept, the fishing nets and all things. It was from there that the King's fishermen and the retainers were provisioned. The houses of the pond guardians and Konohiki were situated at Kaʻelehuluhulu and Hoʻonā.

> In the correct and true story of this pond, we see that its boundaries extended from Ka'elehuluhulu on the north, and on the south, to the place called Wawaloli (between 'O'oma and Kalaoa). The pond was more than three miles long and one and a half miles wide, and today, within these boundaries, one can still see many water holes.
>
> While traveling in the form of an old woman, Pele visited the Kekaha region of Kona, bedecked in garlands of the *ko'oko'olau* (*Bidens* spp.). Upon reaching Pā'aiea at Ho'onā, Pele inquired if she might perhaps have an *'ama'ama*, young *āholehole*, or a few *'ōpae* (shrimp) to take home with her. Kepa'alani, refused, "they are *kapu*, for the King." Pele then stood and walked along the *kuapā* (ocean side wall) of Pā'aiea till she reached Ka'elehuluhulu. There, some fishermen had returned from aku fishing, and were carrying their canoes up onto the shore…
>
> …Now because Kepa'alani was stingy with the fishes of the pond Pā'aiea, and refused to give any fish to Pele, the fishpond Pā'aiea and the houses of the King were all destroyed by the lava flow. In ancient times, the canoe fleets would enter the pond and travel from Ka'elehuluhulu to Ho'onā, at Ua'u'ālohi, and then return to the sea and go to Kailua and the other places of Kona. Those who traveled in this manner would sail gently across the pond pushed forward by the '*Eka* wind, and thus avoid the strong currents which pushed out from the point of Keāhole
>
> It was at Ho'onā that Kepa'alani dwelt, that is where the houses in which the chiefs valuables (*hale papa'a*) were kept. It was also one the canoe landings of the place. Today, it is where the light house of America is situated. Pelekāne (in Pu'ukala) is where the houses of Kamehameha were located, near a stone mound that is partially covered by the *pāhoehoe* of Pele. If this fishpond had not been covered by the lava flows, it would surely be a thing of great wealth to the government today… [J.W.H.I. Kihe in *Ka Hoku o Hawaii*; compiled and translated by Kepā Maly, from the narratives written February 5-26, 1914 and May 1-15, 1924].

Na Ho'omanao o ka Manawa (The Recollections of a Native Son)

Later in 1924, Kihe, described the changes which had occurred in the Kekaha region since his youth. In the following article, titled *Na Ho'omanao o ka Manawa* (in *Ka Hōkū o Hawai'i* June 5th & 12th 1924), Kihe wrote about the villages that were once inhabited throughout Kekaha, identifying families, practices, and schools of the historic period (ca. 1860-1924). In the two part series (translated by Kepā Maly), he also shared his personal feelings about the changes that had occurred, including the demise of the families and the abandonment of the coastal lands of Kekaha.

> There has arisen in the mind of the author, some questions and thoughts about the nature, condition, living, traveling, and various things that bring pleasure and joy. Thinking about the various families and the many homes with their children, going to play and strengthening their bodies.
>
> In the year 1870, when I was a young man at the age of 17 years old, I went to serve as the substitute teacher at the school of <u>Honokōhau</u>. I was teaching under William G. Kanaka'ole who had suffered an illness (ma'i-lolo, a stroke).
>
> In those days at the Hawaiian Government Schools, the teachers were all Hawaiian and taught in the Hawaiian language. In those days, the students were all Hawaiian as well, and the books were in Hawaiian. The students were all Hawaiian… There were many, many Hawaiian students in the schools, no Japanese, Portuguese, or people of other nationalities. Everyone was Hawaiian or part Hawaiian, and there were only a few part Hawaiians.

The schools included the school house at Kīholo where Joseph W. Keala taught, and later J.K. Kaʻailuwale taught there. At the school of Makalawena, J. Kaʻelemakule Sr., who now resides in Kailua, was the teacher. At the Kalaoa School, J.U. Keaweʻake was the teacher. There were also others here, including myself for four years, J. Kainuku, and J.H. Olohia who was the last one to teach in the Hawaiian language. At Kaloko, Miss Kaʻaimahuʻi was the last teacher before the Kaloko school was combined as one with the Honokōhau school where W.G. Kanakaʻole was the teacher. I taught there for two years as well... [Kihe includes additional descriptions on the schools of Kona]

It was when they stopped teaching in Hawaiian, and began instructing in English, that significant changes took place among our children. Some of them became puffed up and stopped listening to their parents. The children spoke gibberish (English) and the parents couldn't understand (*nā keiki namu*). Before that time, the Hawaiians weren't marrying too many people of other races. The children and their parents dwelt together in peace with the children and parents speaking together… [June 5, 1924]

…Now perhaps there are some who will not agree with what I am saying, but these are my true thoughts. Things which I have seen with my own eyes, and know to be true…In the year 1870 when I was substitute teaching at Honokōhau for W.G. Kanakaʻole, I taught more than 80 students. There were both boys and girls, and this school had the highest enrollment of students studying in Hawaiian at that time [in Kekaha]. And the students then were all knowledgeable, all knew how to read and write.

Now the majority of those people are all dead. Of those things remembered and thought of by the people who yet remain from that time in 1870; those who are here 53 years later, we cannot forget the many families who lived in the various (*ʻāpana*) land sections of Kekaha.

From the lands of Honokōhau, Kaloko, Kohanaiki, the lands of ʻOʻoma, Kalaoa, Haleʻohiʻu, Makaʻula, Kaū, Puʻukala-ʻŌhiki, Awalua, the lands of Kaulana, Mahaiʻula, Makalawena, Awakeʻe, the lands of Kūkiʻo, Kaʻūpūlehu, Kīholo, Keawaiki, Kapalaoa, Puʻuanahulu, and Puʻuwaʻawaʻa. These many lands were filled with people in those days.

There were men, women, and children, the houses were filled with large families. Truly there were many people [in Kekaha]. I would travel around with the young men and women in those days, and we would stay together, travel together, eat together, and spend the nights in homes filled with aloha.

The lands of Honokōhau were filled with people in those days, there were many women and children with whom I traveled with joy in the days of my youth. Those families are all gone, and the land is quiet. There are no people, only the rocks remain, and a few scattered trees growing, and only occasionally does one meet with a man today [1924]. One man and his children are all that remain.

Kaloko was the same in those days, but now, it is a land without people. The men, the women, and the children are all gone, they have passed away. Only one man, J.W. Haʻau, remains. He is the only native child (keiki kupa) besides this author, who remains.

At Kohanaiki, there were many people on this land between 1870 and 1878. These were happy years with the families there. In those years Kaiakoili was the haku ʻāina (land overseer)...

Now the land is desolate, there are no people, the houses are quiet. Only the houses remain standing, places simply to be counted. I dwelt here with the families of these homes. Indeed it was here that I dwelt with my kahu hānai (guardian), the one who raised me. All these families were closely related to me by blood. On my fathers' side, I was tied to the families of Kaloko [J.W.H.I. Kihe's father was Kihe, his grandfather was Kuapāhoa, a noted kahuna of Kaloko]. I am a native of these lands.

> The lands of <u>ʻOʻoma, and Kalaoa</u>, and all the way to Kaulana and Mahaiʻula were also places of many people in those days, but today there are no people. At Mahaiʻula is where the great fishermen of that day dwelt. Among the fishermen were Poʻokoʻai mā, Pāʻaoʻao senior, Kaʻao mā, Kaiʻa mā, Kaʻāʻīkaula mā, Pāhia mā, and John Kaʻelemakule Sr., who now dwells at Kailua.
>
> Kaʻelemakule moved from this place [Mahaiʻula] to Kailua where he prospered, but his family is buried there along that beloved shore (kapakai aloha). He is the only one who remains alive today… At Makalawena, there were many people, men, women, and their children. It was here that some of the great fishermen of those days lived as well. There were many people, and now, they are all gone, lost for all time.
>
> Those who have passed away are Kahaʻialiʻi mā, Mamaʻe mā, Kapehe mā, Kauaionuʻuanu mā, Hopulāʻau mā, Kaihemakawalu mā, Kaomi, Keoni Aihaole mā, and Pahukula mā. They are all gone, there only remains the son-in-law of Kauaionuʻuanu, J.H. Mahikō, and Jack Punihaole, along with their children, living in the place where Kauaionuʻuanu and Ahu once lived.
>
> At Kūkiʻo, not one person remains alive on that land, all are gone, only the ʻaʻā remains. It is the same at Kaʻūpūlehu, the old people are all gone, and it is all quiet… [June 12, 1924]

Ko Keoni Kaelemakule Moolelo Ponoi – Kakau ponoi ia mai no e ia (The True Story of John Kaʻelemakule – Actually written by him[3])

In the period between 1928 and 1930, John Kaʻelemakule Sr., who was a native of Kekaha, living at Mahaiʻula, Kaulana and Kohanaiki, wrote a series of articles that were published in serial form in *Ka Hōkū o Hawaiʻi*. The story is a rich account of life in Kekaha between 1854 and 1900. Kaʻelemakule's texts introduce us to the native residents of Kekaha, and include descriptions of the practices and customs of the families who resided there. In the following excerpts from Kaʻelemakule's narratives (translated by Kepā Maly), we find reference once again to ʻOʻoma and neighboring lands, and the practices associated with procuring water in this region:

> *"Kekaha Wai Ole o na Kona"* (Waterless Kekaha of Kona)
>
> …We have seen the name "Kekaha wai ole o nā Kona" since the early part of my story in *Ka Hōkū o Hawaiʻi*, and we have also seen it in the beautiful tradition of Mākālei. An account of the boy who dwelt in the uplands of Kekaha wai ʻole, that was told by Ka-ʻohu-haʻaheo-i-nā-kuahiwi-ʻekolu [the penname used by J.W.H.I. Kihe]. I think that certain people may want to know the reason and meaning of this name. So it is perhaps a good thing for me to explain how it came about. The source of it is that in this land of Kekaha even in the uplands, between Kaulana in the north and ʻOʻoma in the south, there was no water found even in the ancient times. For a little while, I lived in the uplands of Kaulana, and I saw that this land of Kekaha was indeed waterless.
>
> The water for bathing, washing one's hands or feet, was the water of the banana stump (*wai pūmaʻia*). The *pūmaiʻa* was grated and squeezed into balls to get the juice. The problem with this water is that it makes one itchy, and one does not really get clean. There were not many water holes, and the water that accumulated from rain dried up quickly. Also there would be weeks in which no rain fell… The water which the people who lived in the

[3] This account was published in serial form in the Hawaiian newspaper *Ka Hōkū o Hawaiʻi*, from May 29, 1928 to March 18, 1930. The translated excerpts in this section include narratives that describe Mahaiʻula and nearby lands in Kekaha with references to families, customs, practices, ceremonial observances, and sites identified in text. The larger narratives also include further detailed accounts of Kaʻelemakule's life, and business ventures. A portion of the narratives pertaining to fishing customs (November 13, 1928 to March 12, 1929), and canoeing practices (March 19 to May 21, 1929) were translated by M. Kawena Pukui, and may be viewed in the Bishop Museum-Hawaiian Ethnological Notes (BPBM Archives).

uplands of Kekaha drank, was found in caves. There are many caves from which the people of the uplands got water… [September 17, 1929:3]

…The *kūpuna* had very strict *kapu* (restrictions) on these water caves. A woman who had her menstrual cycle could not enter the caves. The ancient people kept this as a sacred *kapu* from past generations. If a woman did not know that her time was coming and she entered the water cave, the water would die, that is, it would dry up. The water would stop dripping. This was a sign that the *kapu* of Kāne-of-the-water-of-life (Kaneikawaiola) had been desecrated. Through this, we learn that the ancient people of Kekaha believed that Kāne was the one who made the water drip from within the earth, even the water that entered the sea from the caves. This is what the ancient people of Kekaha wai ʻole believed, and there were people who were *kiaʻi* (guardians) who watched over and cleaned the caves, the house of Kāne… [September 24, 1929:3]

When the *kapu* of the water cave had been broken, the priest was called to perform a ceremony and make offerings. The offerings were a small black pig; a white fish, and *āholehole*; young taro leaves; and *awa*. When the offering was prepared, the priest would chant to Kane:

E Kane i uka, e Kane i kai,	*O Kane in the uplands, O Kāne at the shore,*
E Kane i ka wai, eia ka puaa,	*O Kane in the water, here is the pig,*
Eia ka awa, eia ka luau,	*Here is the ʻawa, here are the taro greens,*
Eia ka ia kea.	*Here is the white fish.*

Then all those people of the uplands and coast joined together in this offering, saying:

He mohai noi keia ia oe e Kane,	*This is a request offering to you o Kāne,*
E kala i ka hewa o ke kanaka i hana ai,	*Forgive the transgression done by man,*
A e hoomaemae i ka hale wai,	*Clean the water house (source),*
A e hoonui mai i ka wai o ka hale,	*Cause the water to increase in the house,*
I ola na kanaka,	*That the people may live,*
Na ohua o keia aina wai ole.	*Those who are dependent on this waterless land.*
Amama.	*It is finished…*

[October 1, 1929:3; Kepā Maly, translator]

It is not surprising today, when we hear of caves in which cultural materials are found. Along trails, near residences, and in once remote areas, a wide range of uses occurred. Caves in the Kekaha lands were used to store items, keep planting shoots cool and fresh for the next season, to hide or take shelter in, to catch water, and as burial sites.

Land Tenure in ʻOʻoma and Vicinity

Through the traditions and early historical accounts cited above, we see that there are descriptions of early residences and practices of the native families on the lands of ʻOʻoma and within greater Kekaha. Importantly, we find chiefly associations with the land of ʻOʻoma 2nd, as documented by the residency of the chiefs Kaikioʻewa, Keaweamahi, their families and retainers, while they were serving as the guardians of the young king, Kauikeaouli (Kamehameha III in ca. 1813-1818) (Kamakau 1961; Gov. Kapeau, 1847 correspondence reproduced in this study). Among the earliest government records documenting residency in ʻOʻoma and vicinity, are those of the *Māhele ʻĀina* (Land Division), Interior and Taxation Departments, Roads and Public Works, and the Government Survey Division.

This section of the study describes land tenure (residency and land use) and identifies families associated with ʻOʻoma and it's neighboring lands. The documentation is presented in chronologically within the following subsections, The *Māhele ʻĀina* (1848): Disposition of ʻOʻoma, Land Grants in ʻOʻoma and Vicinity (1855-1864), The Government Homesteading Program in Kekaha, Field Surveys of J.S. Emerson (1882-1889), and Trails and Roads of Kekaha (Governmental Communications).

A review of the records below reveals that none of the claims by native tenants made during the *Māhele,* or any of the applications for Royal Patent Grants, included lands that are a part of the current development area.

The *Māhele ʻĀina* (1848): Disposition of ʻOʻoma

In Precontact Hawaiʻi, all land, ocean, and natural resources were held in trust by the high chiefs (*aliʻi ʻai ahupuaʻa* or *aliʻi ʻai moku*). The use of land, fisheries and other resources were given to the *hoaʻāina* (native tenants) at the prerogative of the *aliʻi* and their representatives or land agents (*konohiki*), who were considered lesser chiefs. By 1845, the Hawaiian system of land tenure was being radically altered, and the foundation for implementing the *Māhele ʻĀina* was set in place, which led to the current system of fee-simple land ownership.

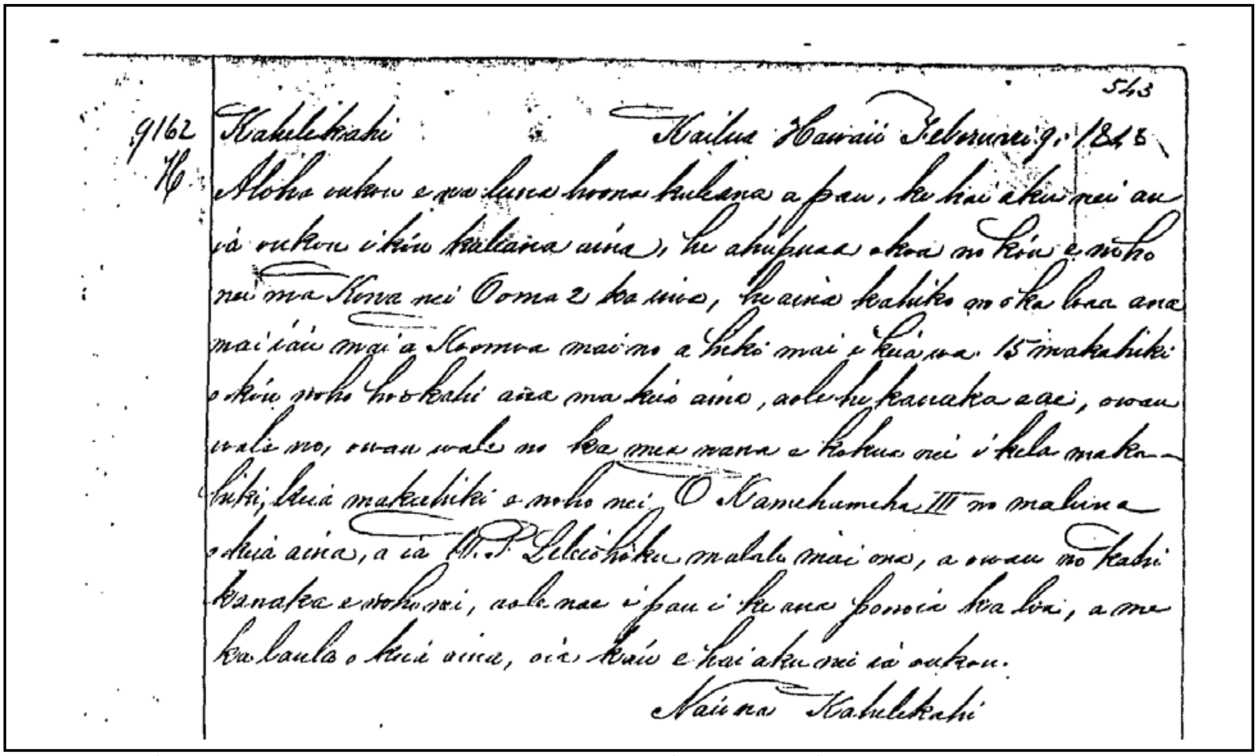
As the *Māhele* evolved, it defined the land interests of Kauikeaouli (King Kamehameha III), some 252 high-ranking *Aliʻi* and *Konohiki*, and the Government. As a result of the *Māhele*, all land in the Kingdom of Hawaiʻi came to be placed in one of three categories: (1) Crown Lands (for the occupant of the throne); (2) Government Lands; and (3) *Konohiki* Lands (cf. Indices of Awards 1929). The "Enabling" or "*Kuleana Act*" of the *Māhele* (December 21, 1849) further defined the frame work by which *hoaʻāina* (native tenants) could apply for, and be granted fee-simple interest in "*Kuleana*" lands (cf. Kamakau in *Ke Au Okoa* July 8 & 15, 1869; 1961:403-403). The *Kuleana Act* also reconfirmed the rights of *hoaʻāina* to access, subsistence and collection of resources necessary to their life upon the land in their given *ahupuaʻa* ("Enabling Act"[4], August 6, 1850 – HSA DLNR 2-4).

In the *Buke Kakau Paa no ka Mahele Aina* (Land Division Book), between Kamehameha III and his supporters, we learn that by the time of the *Māhele ʻĀina*, ʻOʻoma was divided into two *ahupuaʻa*, ʻOʻoma 1st and 2nd. ʻOʻoma 1st was claimed by Moses Kekūāiwa (brother of Kamehameha IV and V, and Victoria Kamāmalu), one of the children of Kīnaʻu and M. Kekūanaoʻa, thus, a grandson of Kamehameha I. ʻOʻoma 2nd was held by Kamehameha III (*Buke Māhele*, January 27, 1848:13-14). On March 8, 1848, Kamehameha III assigned his interest in ʻOʻoma 2nd to the Government land inventory (*Buke Māhele*, 1848:183).

Moses Kekūāiwa died on November 24, 1848, and his father, Mataio Kekūanaoʻa, administrator of the estate, relinquished in commutation, his rights to ʻOʻoma 1st, giving the land over to the Government land inventory (Foreign Testimony Volume 3:408). Thus, both ʻOʻoma 1st and 2nd were assigned to the Government Land inventory (Government Lands - Indices of Awards 1929:10).

In 2000, Kumu Pono Associates digitized the entire collection of handwritten records from the *Māhele ʻĀina*. Most of the records are in the Hawaiian language. An extensive review of all the records identifies only one native tenant who filed a claim of residency and land use in ʻOʻoma during the *Māhele*. The claim—*Helu* 9162, by Kahelekahi—was not awarded, and except for an entry in Native Register Volume 8 (Figure 6), there is no further record of the claim. Below, is a copy of the original Hawaiian text from the Native Register. The account is of particular interest as Kahelekahi reported that in 1848, he was the only resident in ʻOʻoma:

[4] See also *"Kanawai Hoopai Karaima no ko Hawaii Pae Aina"* (Penal Code) 1850.


543

9162 Kahelekahi Kailua Hawaii Feberuari 9, 1848

Aloha oukou e na luna hoona kuleana a pau, ke hai aku nei au ia oukou i kuu kuleana aina, he ahupuaa okoa no kuu e noho nei ma Kona nei Ooma 2 ka inoa, he aina kahiko no o ka loaa ana mai iau mai a Koomoa mai no a hiki mai i keia wa. 15 makahiki o kuu noho hookahi ana ma keia aina, aole he kanaka e ae, owau wale no, owau wale no ka mea nana e kokua nei i kela makahiki, keia makahiki e noho nei, O Kamehameha III no maluna o keia aina, a ia W.P. Leleiohoku malalo mai ona, a owau no kahi kanaka e noho nei, aole nae i pau i ke ana ponoia ka loa, a me ka laula o keia aina, oia kau e hai aku nei ia oukou.

Naiuna Kahelekahi

Figure 6. Copy of Native Register Vol. 8:543 Helu 9162, claim of Kahelekahi for *kuleana* at ‘O‘oma.

Kahelekahi – Helu 9162
Kailua, Hawaii February 9, 1848

Greetings to all of you commissioner who quiet land titles, I hereby tell you of my claim for land. I have an entire ahupuaa situated there in Kona, it’s name is Ooma 2. It is an old land gotten by me from Koomoa, and held to this time. For 15 years, I have been the only one residing on this land, there are no other people, only me. I am the only one, there is no one living here to help from one year to the next year. Kamehameha III is the one above, who has this land, and W.P. Leleiohoku is below him, and I am the one man dwelling there. The survey of the length and width of this land is not accurately completed. That is what I have to tell you.

Done by me, Kahelekahi
[Native Register Vol. 8:543; translated by Kepā Maly]

In 1849, S. Haanio, Tax Assessor of North Kona, submitted a report to the Board of Education regarding those individuals who were subject to the Tuesday Tax Laws (*Poalua*), to be worked as a part of the School Tax requirements of the time. At the time of Haanio’s report, three individual families were identified as residents of ‘O‘oma. Residents in the neighboring lands of Kalaoa and Kohanaiki were also listed, they were:

Kalaoa: 1. Kila, 2. Piena, 3. Nakuala, 4. Kupono, 5. Loa, 6. Kaeha, 7. Keliipuipui, 8. Kapuolokai, 9. Kaainoa, 10. Paina, 11. Kalimaonaona, 12. Kaikeleaukai, 13. Kanahele, 14. Kukaani, 15. Kupuai, and 16. Helekahi[5]

Ooma: 1. Kalua, 2. Kamaka and 3. Mamali

Kohanaiki: 1. Hulikoa, 2. Kaoeno, 3. Honolii and 4. Awa [HSA – Series 262, Hawaii 1849].

[5] Helekahi or Kahelekahi – the one who made a claim for a *kuleana* in ‘O‘oma during the Māhele (Helu 9162).

Unfortunately, there is no indication of where Kalua, Kamaka, and Mamali were living in ‘O‘oma at the time. Based on traditional patterns of residency in the region, it is likely that they had primary residences in the uplands, near sheltered *māla ‘ai* (agricultural fields), and kept near shore residences for seasonal fishing, collection of salt, and other resources of the coastal zone. Of the three names given for ‘O‘oma, descendants of the Kalua and Kamaka lines are known to still be residing in the Kekaha region.

Land Grants in ‘O‘oma and Vicinity (1855-1864)

In conjunction with the *Māhele*, the King also authorized the issuance of Royal Patent Grants to applicants for tracts of land, larger than those generally available through the Land Commission. The process for applications was set forth by the “Enabling Act” of August 6, 1850, which set aside portions of government lands for grants.

> Section 4. Resolved that a certain portion of the Government lands in each Island shall be set apart, and placed in the hands of special agents to be disposed of in lots of from one to fifty acres in fee simple to such natives as may not be otherwise furnished with sufficient lands at a minimum price of fifty cents per acre. [HSA – “Enabling Act” Series DLNR 2-4]

The Kingdoms’ policy of providing land grants to native tenants was further clarified in a communication from Interior Department Clerk, A. G. Thurston, on behalf of Keoni Ana (John Young), Minister of the Interior; to J. Fuller, Government Land Agent-Kona:

> *February 23, 1852*
> …His Highness the Minister of the Interior instructs me to inform you that he has and does hereby appoint you to be Land Agent for the District of Kona, Hawaii. You will entertain no application for the purchase of any lands, without first receiving some part, say a fourth or fifth of the price; then the terms of sale being agreed upon between yourself and the applicant you will survey the land, and send the survey, with your report upon the same to this office, for the Approval of the Board of Finance, when your sales have been approved you will collect the balance due of the price; upon the receipt of which at this office, the Patent will be forwarded to you.
>
> <u>Natives who have no claims before the Land Commission have no Legal rights in the soil.</u>
>
> <u>They are therefore to be allowed the first chance to purchase their homesteads.</u> <u>Those who neglect or refuse to do this, must remain dependant upon the mercy of whoever purchases the land: as those natives now are who having no kuleanas are living on lands already Patented, or belonging to Konohikis.</u>
>
> <u>Where lands have been granted, but not yet Patented, the natives living on the land are to have the option of buying their homesteads, and then the grant be located, provided this can be done so as not to interfere with them.</u>
>
> <u>No Fish Ponds are to be sold, neither any landing places.</u>
>
> <u>As a general thing you will charge the natives but 50 cents pr. acre, not exceeding 50 acres to any one individual.</u>
>
> Whenever about to survey land adjoining that of private individuals, notice must be given them or their agents to be present and point out their boundaries… [Interior Department Letter Book 3:210-211]

Between 1855 and 1864, at least six applications were made for land in the *ahupua‘a* of ‘O‘oma, and four of them were patented. The applications were made by:

Grant	Applicant	Land	Acreage	Book and Year
1590	Kauhini	Hamanamana, Kalaoa and Ooma 1	1,816	8:1855 (canceled)
1599	J. Hall	Ooma 2	101.33	8:1855 (canceled)
1600	Kaakau	Ooma 2	58.5	8:1855
2027	Kameheu	Ooma 2	101.33	11:1856 (same area as Grant 1599)
2031	Koanui	Ooma 1	24.5	11:1856
2972	Kaakau & Kama	Kalaoa 5 & Ooma 1	515	14:1864

["Index of all Grants Issued…Previous to March 31, 1886;" 1887]

The grants to Kaʻakau and Kameheu in ʻOʻoma 2nd were patented by 1859, as recorded in the following letter:

April 8, 1859
S. Spencer, Interior Department Clerk;
to Lot Kamehameha, Minister of the Interior;
Lands in Puaa and Ooma 2 in Kona, Hawaii which were sold by the Government Agent:

Royal Patent 1600, Kaakau 58 50/100 acres in Ooma $29.25
Royal Patent 2027, Kameheu, 101 33/100 acres in Ooma $38.00
[HSA – Interior Department, Lands]

In the years following issuance of the first Royal Patents in ʻOʻoma and vicinity, native tenants and others continued to express interest in the lands of ʻOʻoma and neighboring *ahupuaʻa*. Applications were made to either lease or purchase portions of the remaining government lands. In 1865, Government Surveyor and Land Agent, S.C. Wiltse, wrote to the Minister of the Interior, describing the condition and status of the lands remaining to the government.

September 5, 1865
S.C. Wiltse, Government Surveyor and Land Agent;
to F.W. Hutchinson, Minister of the Interior.
Kona Hawaii. Government Lands in this District not Sold;
also those Sold and Not Patented:

…"Kalaoa 5th"
Not in the Mahele book but believed to be Gov't. land. This land above the Govt. Road has been sold and Patented. Below the road I have surveyed 515 acres which was sold by Sheldon to "Kaakau" & "Kama" who payed him $165.00. As no valuation was made of this land per acre by Sheldon I afterwards valued it myself as follows, 300 Ac. at 50 cts. per acre, 215 at 25 cts. per Ac. The balance due according to this valuation including Patent was $42.75 which was payed to me in March 1864 and forwarded by me to your office. The survey of this land is in your office. If the payments made are satisfactory, these men would be very glad to get their Patent.

This is a piece of 3rd rate land, used only as goat pasture, no improvements on it. Makai of this survey is about 400 Ac. remaining to the Govt., but of very little value.

"Ooma 1st & 2nd"
The best part of these lands have been sold, there remains to the Govt. the forest part, 2 or 300 Ac., and the makai part some 1500 Ac., about 500 of which is 3rd rate land, the balance rocks.

> "Kohanaiki"
> The forest part of this land is all that remains to the Gov't., this is extensive, extending to the mauka side of the forest. It may contain 1500 to 2000 Ac.
>
> The makai part of this land containing 220 Ac. has been sold both by Sheldon and myself. In April 1863 I was surveying in Kona when "Nahuina" (who lives on the adjoining land of "Kaloko") applied to me to survey the makai part of the Gov't. land Kohanaiki which he wished to purchase. I inquired whether he had applied to Sheldon for this lands (Sheldon was then in Honolulu) he told me that he had not, but would do so immediately, if it was necessary he would go to Honolulu for that purpose. I told him that I was then writing to Sheldon and I would make the application for him which I did, but never got an answer. I wrote several times to him about that time, for information about Gov't. lands, but he declined to answer my letters.
>
> On the 30th of May following, I surveyed said piece of land for "Nahuina." When I was making this survey "Kapena" (who bought this land from Sheldon) was present, and afterwards went to Honolulu and payed Sheldon for this land.
>
> "Nahuina" had the money then to pay for this land, and I told him to keep it until he knew who he was paying it to. I was perfectly satisfied then that Sheldon's transaction as Gov't. land Agt. was not honest. Mr. Sheldon had then been away from Kona nearly three months, he had previous to this resigned his office as Judge and taken up his residence permanently in Honolulu. Afterwards when requested by Mr. S. Spencer to act as land Agt. for Kona, "Nahuina" payed me for this land at 25 cents per Acre. Its only value is for a place for a residence on the beach.
>
> I have been thus particular in giving you the history of this affair, so that you might be able to decide which of the parties were intitled to said land… [HSA – Interior Department, Lands]

Historical records document that the primary use of the *kula* – lowlands in the Kekaha region, was for goat ranching, with limited cattle ranching. Throughout the 1800s, most of the cattle ranching occurred on the *mauka* slopes nearer the old upper government road.

Summary of Land Tenure Described in Grant Records

Grant No.'s 1600 (for Kaakau) and 2031 (for Koanui) are situated on the *mauka* side of the Alanui Aupuni (the Upper Government Road, near present-day Māmalahoa Highway) in ʻOʻoma 2nd and 1st.

Grant No. 1599 (surveyed for Kauhini), was situated across the *kula* lands from Oʻoma 1st in the south, to Hāmanamana, in the north. Communications from the 1880s, indicate that the parcel was never patented, though Kauhini had lived in ʻOʻoma 1st, through the time of his death (before 1888). J.S. Emerson's Register Map No. 1449, identifies a Triangulation Station in ʻOʻoma 1st as "Kauhini." At almost the same time that Kauhini's grant was surveyed, other grants in Kalaoa and ʻOʻoma covering a portion of the area described under Kauhini's grant were patented to Kakau and Kama (Royal Patent Grant No. 2972). In 1888, this confusing situation was brought to the government's attention in a letter from more than 70 native residents of ʻOʻoma and the larger Kekaha region, when the Minister of the Interior was developing homestead lots for applicants (see communications below).

Grant No. 2027 (for Kameheu), situated in ʻOʻoma 2nd, extends from the *makai* edge of the Upper Government Road, to a short distance below the historic Homestead Road between Kaloko and Kalaoa, at about 900 feet above sea level (see Register Map No. 1449).

ʻOʻoma grantee Kaakau (Grant No. 1600), also held an interest in Grant No. 2972 in the land of Kalaoa 5th and ʻOʻoma 1st, which he shared with his relative, Kama. Historic survey records (in Register Maps and Survey

Field Books) do identify "Kama's house" near the Wawaloli pond (Register Map No. 1449) in ʻOʻoma 2nd. The same house is later identified as "Keoki Mao's House" (Register Map No. 1280).

In 1888, government surveyor J.S. Emerson identified Kama as a resident in ʻOʻoma, near the *mauka* government road (see communication below). This Kama is identified in oral history interviews as being an elder of the Kamaka line, from whom the often-mentioned Palakiko Kamaka and others descend. A temporary beach shelter—in the vicinity of "Kama's House" marked near the shore of ʻOʻoma 2nd on Register Maps 1449 and 1280—remained in use by family members at least until the outbreak of World War II (based on interviews with Peter Kaikuaana Park, Geo. Kinoulu Kahananui, and Valentine K. Ako).

While no formal awards or grants of land appear to have been made for the near shore *kula* or beach lands, it is logical to assume that families living in the uplands of the ʻOʻoma and Kalaoa-Kohanaiki *ahupuaʻa*, made regular visits to the near shore lands. The practice of continued travel between upland residences and near-shore shelters, is also described by *kūpuna* Peter K. Park, and Elizabeth Lee, who was born and raised in the *mauka* section of ʻOʻoma, and by other *kupuna* from neighboring lands.

No records indicating that the above Royal Patent Grantees had applied for coastal parcels as a part of their original claims were found while conducting the present research. A further review of the *Māhele* records was also made to determine if any of the grant applicants had been *Māhele* claimants (as is sometimes the case). Their names did not appear in the Register or Testimony volumes for the area.

Ka ʻĀina Kaha–(A Native's Perspective)

In 1875, J.P Puuokupa, a native resident of Kalaoa wrote a letter to the editor of the Hawaiian newspaper, *Ku Okoa*, responding to a letter which had been previously published in the paper (written by a visitor to Kona). The first account apparently described the Kekaha region as a hard land that presented many difficulties to the residents. It was also reported that a drought on Hawaiʻi had significantly impacted crop production, and that a "famine" was occurring. Puuokupa, responded to the account and described the situation as he knew it, from living upon the land. His letter is important as it provides us with an explanation as to why people of the region—including ʻOʻoma—lived mostly in the uplands, for it was there that the rich soils enabled residents to cultivate the land and sustain themselves.

> *Mai Kailua a hiki i Kiholo*–(From Kailua to Kiholo)
> …The people who live in the area around Kailua are not bothered by the famine. They all have food. There are sweet potatoes and taro. These are the foods of these lands. There are at this time, breadfruit bearing fruit at Honokohau on the side of Kailua, and at Kaloko, Kohanaiki, Ooma and the Kalaoas where lives J.P. [the author]. All of these lands are cultivated. There is land on which coffee is cultivated, where taro and sweet potatoes are cultivated, and land livestock is raised. All of us living from Kailua to Kalaoa are not in a famine, there is nothing we lack for the well being of our bodies.
>
> Mokuola[6] is seen clearly upon the ocean, like the featherless back of the *ʻukeke* (shore bird). So it is in the uplands where one may wander gathering what is needed, as far as Kiholo which opens like the mouth of a long house into the wind. It is there that the bow of the boats may safely land upon the shore. The livelihood of the people there is fishing and the raising of livestock. The people in the uplands of Napuu are farmers, and as is the custom of those people of the backlands, they all eat in the morning and then go to work. So it is with all of the native people of these lands, they are a people that are well off.
>
> …As was said earlier, coffee is the plant of value on these lands, and so, is the raising of livestock. From the payments for those products, the people are well off, and they have built wooden houses. If you come here you shall see that it is true. Fish are also something which benefits the people. The people who make the *pai ai* on Maui bring it to Kona and trade it.

[6] *Moku-ola* — literally: Island of life — is a poetic reference to a small island in Hilo Bay which was known as a place of sanctuary, healing, and life. By poetic inference, the Kekaha region was described as a place of life and well-being.

Some people also trade their *poi* for the coffee of the natives here… (J.P. Puuokupa, in *Ku Okoa* November 27, 1875; translated by Kepā Maly)

The Government Homesteading Program in Kekaha

Following the *Māhele* and Grant programs of the middle 1800s, it was found that many native tenants still remained on lands for which they had no title. In 1884, the Hawaiian Kingdom initiated a program to create Homestead lots on Government lands—a primary goal being to get more Hawaiian tenants in possession of fee-simple property (Homestead Act of 1884). The Homestead Act allowed applicants to apply for lots of up to 20 acres in size, and required that they own no other land.

On Hawaiʻi, several lands in the Kekaha region of North Kona, were selected and a surveying program was authorized to subdivide the lands. Initially, those lands extended from Kohanaiki to Kūkiʻo. Because it was the intent of the Homestead Act to provide residents with land upon which they could cultivate crops or graze animals, most of the lots were situated near the *mauka* road (near the present-day Māmalahoa Highway) that ran between Kailua and ʻAkāhipuʻu.

Early in the process, native residents of Kekaha soon began writing letters to the Minister of the Interior, observing that 20 acre parcels were insufficient "to live on in every respect." They noted that because of the rocky nature of the land, goats were the only animals that they could raise, and thus, try to make their living (cf. State Archives–Land File, December 26, 1888, and Land Matters Document No. 255; and communications below).

During the first years of the Homestead Program, all of the remaining government lands in the Kekaha region, from Kohanaiki to Kūkiʻo 2nd, had been leased to King David Kalākaua for grazing purposes. The following lease was issued, with the notation that should portions of the land be desired for Homesteading purposes, the King would relinquish his lease:

August 2nd 1886
General Lease 364
Between His Majesty Kalakaua;
and Walter M. Gibson, Minister of the Interior
[Lease of unencumbered government lands between Kealakehe to Kukio 2nd]:

…Oma [Ooma] No. 1 & 2 – yearly rent Ten dollars…
Each and every of the above mentioned lands are let subject to the express condition that at any time during the term of this lease, the Minister of the Interior may at his discretion peaceably enter upon, take possession, and dispose of such piece or pieces of land included in the lands hereby demised, as may be required for the purposes of carrying out the terms and intent of the Homestead Laws now in force, or that may be hereafter be enacted during the term of this lease… [State Land Division Lease Files]

By 1889, the demand for homestead lots in ʻOʻoma and other Kekaha lands was so great that King Kalākaua gave up his interest in the lands:

January 22, 1889
J.W. Robertson, Acting Chamberlain;
to J.A. Hassinger, Chief Clerk, Interior Department
[Regarding termination of Lease No. 364 for lands from Kukio to Kohanaiki]:

…I have the honor to acknowledge the receipt of your communication, of the 17th, instant, informing me that you are directed, by His Excellency the Minister of the Interior, to say, that he desires to take possession of the lands, described in Government Lease No. 364, for Homestead purposes, and requests the surrender of the lease.

His Majesty the King, is willing, for the purpose of assisting in carrying out the Homestead

> Act, to accede to the terms of the lease, so far as to give up only such portions of the lands, as are suitable to be apportioned off for Homestead purposes.
>
> It has come to the knowledge of His Majesty, that several of the applicants for portions of the above lands, are already in possession of lands elsewhere, and living in comfortable homes. They are not poor people, nor are they entitled to the privilege of obtaining lands under the Homestead Act, but are desirous of obtaining more of such property, for the purpose of selling or leasing to the Chinese, which class is beginning to outnumber the natives in nearly every district…
>
> His Majesty is desirous of retaining the balance of lands, that may be left after the apportionment has been completed; and also desires to lease remnants of other Government lands in that section of the Island…
>
> Reply attached – Dated January 22, 1889:
> The lands of Kohanaiki and Kalaoa and Makaula have been divided up into Homestead lots, and taken up.
>
> Lands marked * are in Emerson's List of lands to be sold. Emerson's List attached.
>
> His Majesty has paid rent to Aug. 22, 1889. Another rent is due in adv. from this date…

* Kukio 2	* Maniniowali
* Mahaiula	* Kaulana
* Awalua	Puukala
+ Makaula	+ Kalaoa 1, 2, 3, 4 & 5
* Ooma 1 & 2	+ Kohanaiki

> Lease cancelled by order – Minister of Int. August 2, 1889 [HSA – Interior Department, Lands]

One of the significant issues that arose with the development of homesteads in the Kekaha region, involved the lands of ʻOʻoma, Kalaoa and Hāmanamana, which had been surveyed for Kauhini in 1855, under Grant No. 1590. The grant was apparently never patented, and questions regarding the government's authority to divide portions of the ʻOʻoma-Kalaoa-Hāmanamana lands into Homestead lots were raised. Adding to the confusion, in 1888, John A. Maguire was also making his move from Kohala to Kona, and in the process of establishing his Huʻehuʻe Ranch. One of the lands he reportedly purchased was covered under the unperfected Grant No. 1590. Thus, homestead applicants and program managers met with a wide range of challenges during the program's history.

Homestead Communications

There are a number of letters between native residents (applicants for Homestead lands) and government agents, documenting the development of the homesteading program and residency in Kekaha. Tracts of land in Kohanaiki, ʻOʻoma, Kalaoa and neighboring *ahupuaʻa* were let out to native residents, and eventually to non-native residents as well. Those lands which were not sold to native tenants were sold or leased to ranching interests—most of which came under John A. Maguire of Huʻehuʻe Ranch.

One requirement of the Homestead Program was that lots which were to be sold as homesteads to the applicants, needed to be surveyed. J.S. Emerson, one of the most knowledgeable and best-informed surveyors to work in Kona, began surveying the Kekaha region homestead lots in 1888. Emerson's letters to Surveyor General, W. D. Alexander, provide valuable historical documentation about the community and land. Writing from ʻOʻoma in April 1888, Emerson spoke highly of the Hawaiian families living on the land; he also described land conditions and weather at the time. In the letter, we find that questions regarding the status of several lands in Kona had arisen, and that John A. Maguire was planning to "settle" in Kona (see communications in Part 4 of this section of the study). Emerson's letters along with those below from the native tenants of the land, provide first hand accounts of the land development of the communities in Kekaha. The following communications are among those found in the collection of the Hawai‘i State Archives (HSA).

May 1888
J.W.H. Isaac Kihe, Jr., et al.; to L.A. Thurston, Minister of the Interior
[Petition with 71 signatures, regarding discrepancy in land grant to Kauhini in Kalaoa and Ooma; and desires that said land be divided into Homestead Lots for applicants]:

…We, the undersigned, subjects residing within the boundaries of Kekaha, from Kohanaiki to Makalawena, and Whereas, the land said to belong to Kauhini is within the boundaries above set forth; Whereas, some doubt and hesitancy has come into our minds concerning the things relating to said land of Kauhini, and that it is proper that a very careful investigation be made, because, we have never known said Kauhini to have lands in the Kalaoas and Ooma 1, and because of such doubt, the Government sold some pieces in said land of 687 acres to Kama, Kaakau and Hueu, and they have been living with all the rights for 20 years and over, on pieces that were acquired by them. Therefore, we leave this request before your Excellency, the honorable one, with the grounds of this request:

First: The said land of Kauhini is not a land that is clear in every way, so that it can be shown truthfully and clearly that it belongs to Kauhini and his heirs – said kuleana.

Second: The land said to belong to Kauhini was only surveyed, but the money was not paid, that is the price for the land, only the payment for the survey was paid. We are ready with witnesses to prove this ground, as well as other grounds.

Third: Because of Kama and Kaakau and Hueu’s knowing that Kauhini had no true interest in the land, therefore, they bought from the Government some acres of in the piece which Kauhini had surveyed, and the Government readily agreed to sell to them. This is real proof that said land was not conveyed to Kauhini, and the second is that Kauhini was living right there and he made no protest against the sale by the Government of those 687 acres to Kama (k), Kaakau (k) and Hueu (k), up to the time of his death, and only now has the question been raised through the plat of the survey, and thereby basing the claim that Kauhini had some land.

…We ask your honor that this matter be traced in the Government Departments, so as to find out the truth, there is much trouble and uncertainty about this land.
And our inquiry to be based upon these great questions. Does the land belong to Kauhini? Or to the Government?… [HSA – Interior Department, Lands]

May 16, 1888
Interior Department Clerk; to J.W.H. Isaac Kihe, Jr.:
…I have been directed by the Honorable Minister of the Interior, to say, that your request asking that Kauhini’s interest in the lands of Kalaoa & Ooma 1 be investigated, and to let you know the you are wanted to send, or to bring here to Honolulu, 2 or 3 good witnesses, and all the papers found by you or them, concerning this land of Kauhini… [HSA Interior Department Lands]

May 16, 1888
J.F. Brown, Government Surveyor; to L.A. Thurston, Minister of the Interior
[Regarding disposition of Grant No. 1590, to Kauhini for Lands in Hamanamana, Kalaoa, and Ooma; Figure 7]:

…With reference to the letter of inquiry of numerous natives in N. Kona, Hawaii, I beg to report:

That as regards the land belonging to Kauhini, I find that Grant 1590 on record and signed in due form, assigned to Kauhini something over 1800 acres shown in sketch by yellow tinted boundary line. At the bottom of the page however and in different handwriting is the following remark “Memo – this to be cancelled” S.S. (Stephen Spencer)?

Later the grants shown in sketch by blue lines were issued to the parties indicated in the sketch, and this fact together with the memo attached to the Grant, and the statements and beliefs of the natives leads me to think that the Grant to Kauhini was actually cancelled, but of this I have not yet obtained further proof than I have here given… [HSA – Interior Department, Lands]

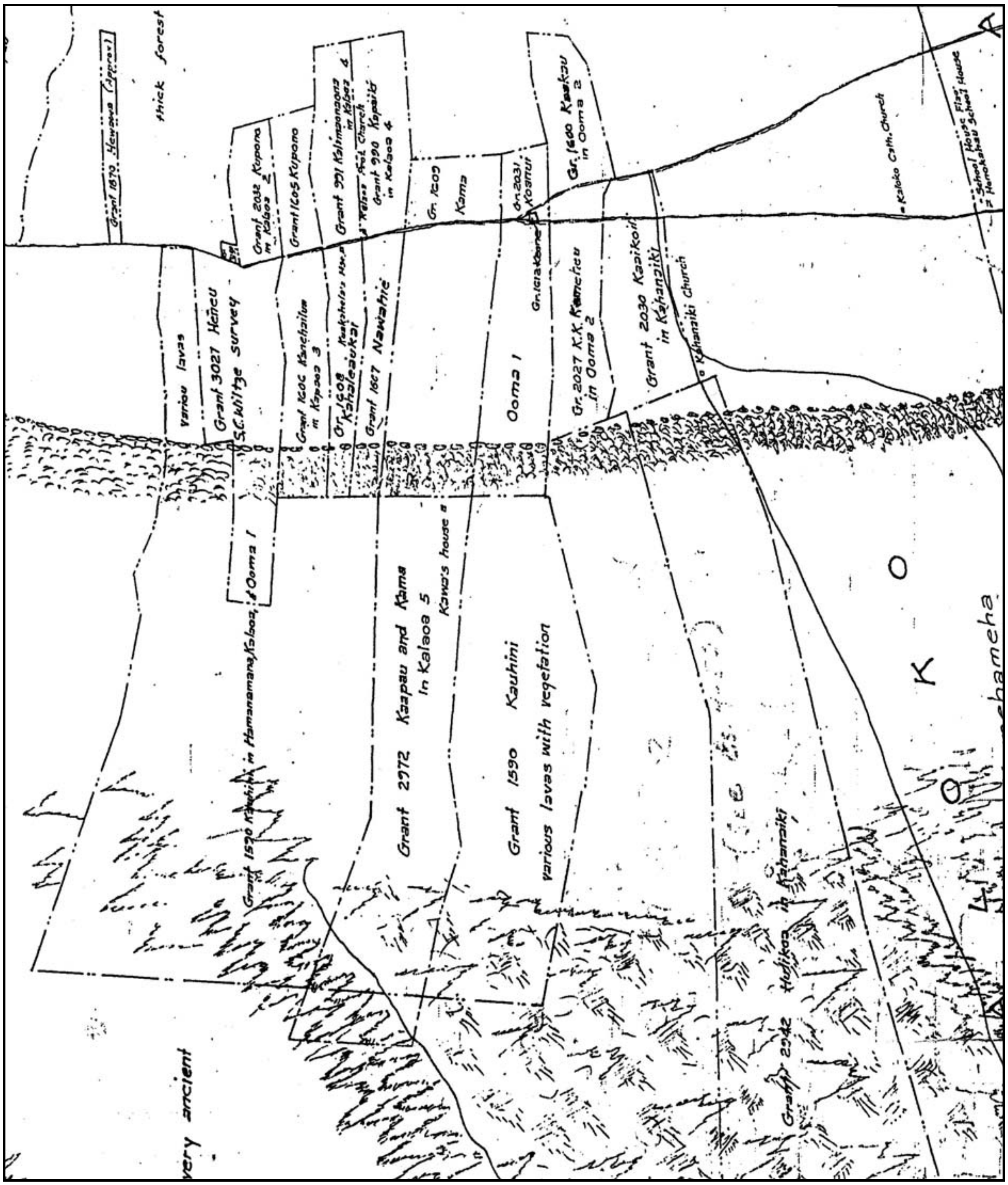


Figure 7. Portion of 1882 Register Map No. 1280 showing original boundaries of Grant No. 1590, to Kauhini.

May 1888 - J.W.H.I. Kihe, Jr.; to L.A. Thurston, Minister of the Interior:
…Oh honorable one, I am ready with the right witnesses to come when I receive the order, and if you agree, oh honorable one, to help with the fares for us on the vessel, and for our support while staying there and coming back.

Proofs are ample to prove that the land belongs to the Government, when I arrive with the witnesses, according to what you wish to be done… [HSA – Interior Department, Lands]

[Applying to purchase remnant lands from Makaula to Ooma 2nd, as a native Hui; and that land not be sold to outsiders.]

…We the undersigned, kamaaina (old residents) who reside from "Makaula" to "Ooma 2," joining "Kohanaiki," hereby petition and we also file this petition with you, and for you to consider and conferring with the Minister of the Interior, whether to consent or refuse the petition which we humbly file, and at the same time setting forth the nature of the land and the boundaries desired.

We ask that all be sold to us as a Hui, that the remnants of all the Government lands from "Hamanamana" to "Ooma 2 (two)," that is from the Government remnant of "Hamanamana, Kalaoa 1, 2, 3, 4, 5, Ooma 1 & 2" running until it meets the sea. Being the remnants remaining from the "Homesteads" lately, and remaining after the sale of the lands formerly sold by the Government, these are the remnants which we wish to buy as a "HUI." If you consent, and also the "Minister of the Interior," for these reasons:

1. The "remnants of Government lands" aforesaid, join our land kuleanas and were lately surveyed, and for that reason we believe it proper that they be sold to us.

2. The "kuleanas" that were surveyed for us are not sufficient to live on in every respect, they are too small, and are not in accordance with the law, that is one hundred acres, (Laws 1888).

3. Because of our belonging to, and being old residents of said places, is why we ask that consent be granted us for the sale to us and not to any one from other places, or we may be put to trouble in the future.

With these reasons, we leave this with you, and for you to approve, and we also adhere to our first offer per acre, and the explanations in regards to said offer.

FIRST: The price per acre to be 10 cents per acre.

SECOND: The nature of the land is rocky and lava stones in all from one and to the other, and there is only one kind of animal which can roam thereon, and it is goats, and that is the only thing to make anything out of, and to benefit us if we acquire it.

THIRD: If this land is acquired by others, they will probably cause us trouble, because the kuleanas which we have got are very small and not enough, not 20 acres of the land were acquired by us; very few of the lots reach 20 acres or more.

And because of these reasons and the explanations herein, we leave before your Excellency for the granting of the consent or not… [HSA – Interior Department, Lands]

ca. February 1889
Petition of J.W.H. Isaac Kihe, Jr. and 21 others;
to L.A. Thurston, Minister of the Interior
[Transmitting first payment for Homestead Land from Makaula to Kohanaiki]:

…We, the ones whose names are below, persons who but for the pieces of "Homestead" lands from Makaula to Kohanaiki, present to you documents of proof and money as first payment of ten ($10.00) dollars in the hands of J. Kaelemakule, the Agent appointed for the "Homestead" lands in North Kona, Hawaii.

We ask that the Agreements be sent up, with the Government for five years to J. Kaelemakule, the Agent here, in number the same as there are names below…

1. J.W.H. Isaac Kihe, Jr.	9. P. Nahulanui	17. Keawehawaii
2. S. Mahauluae	10. Kaukaliinea	18. D. Kaninau
3. D.P. Manuia	11. Kamahiai (w)	19. Mokuaikai
4. S.M. Kaawa	12. C.K. Kapa	20. Nuuanau
5. H.P. Ku	13. P.K. Kanuha	21. S. Kaimuloa
6. W.N. Kailiino	14. J. Haau	22. J. Kaloa
7. Z. Kawainui	15. G. Mao	
8. Kikane	16. J. Pule	

[HSA – Interior Department Document No. 227]

February 18, 1889
J. Kaelemakule, Land Agent; to L.A. Thurston, Minister of the Interior:
I am sending the correct report of the applicants for homestead lands here in North Kona, and their respective names, and the amount they have paid for their initial deposits in order that the agreements will be made correctly…

Pule $10.	Keoki Mao $10.	Mahuluae $10.	Haau $10.
Nuuanu $10.	Manuia $10.	Kaukaliinea $10.	Kamahiai (w) $10.
Kaawa $10.	Kaninau $10.	J. Kaelemakule $10.	Kawainui $10.
Mokuaikai $10.	Keawehawaii $10.	Nahulanui $10.	Kaloa $10.
Haiha $10.	Kapa $10.	Kaumuloa $10.	Isaac Kihe $10.
Kailiino $10.	Kanuha $10.	Ku $10.	Kikane $10.

[HSA – Interior Department, Lands]

October 7, 1889
J. Kaelemakule, Land Agent; to L.A. Thurston, Minister of the Interior:
…The applications of Kahinu and Lilinoe which were sent down during the month of August, please have the lots changed, because the map of Ooma has arrived with new numbers, as follows: Kahinu, Lot 51; Lilinoe, Lot 49, in Ooma 1st … [HSA – Interior Department, Lands]

October 10, 1889
J.W.H. Isaac Kihe, Secretary; to L.A. Thurston, Minister of the Interior:
…I leave some more names who make applications for homestead lands here in North Kona… The places wanted by those named are:

Pika Kaninau at Ooma 1
Kahinu at Ooma 2
Keaweiwi at Ooma 2… [HSA – Interior Department, Lands]

October 28, 1889
J. Kaelemakule, Land Agent; to L.A. Thurston, Minister of the Interior:
…The eight lots in Ooma have all been taken, none are left… These lots have been very quickly taken by the bidders, before the issuance of the notice from the Minister… Bear in mind the agreements for Kahinu and Lilinoe… [HSA – Interior Department, Lands]

December 31, 1890
J.W.H.I. Kihe, Jr.; to C.N. Spencer, Minister of the Interior:
We, the undersigned, who are without homes, and are destitute and have no place to live on, and whereas, the government has permitted all the people who have no lands, and that they receive homesteads, and for that reason, your humble servants make application that our

application may be speedily granted which we now place before Your Excellency, that the Government land which was divided and surveyed by Joseph S. Emerson, be immediately sub-divided , the same being portions of Kalaoa 5 and Ooma, on the mauka side of Kama (k), Koanui (k), to the junction with Ooma of Kaakau (k), containing an area of one hundred and fifteen acres (115), and it is those acres which your applicants are applying for before Your Excellency, and where as your applicants are native Hawaiians by birth, residing at Kalaoa, North Kona, Island of Hawaii. And the minds of your servants hope and desire to have a place to live on in the future, and to have a home for all time, and Your Excellency, your servants humbly place their petition with the hope that you will grant this application...

M.E. Kuluwaimaka (k)
H. Hanawahine (k)
D.W. Kanui (k)
Mr. Kahumoku (k)
[HSA – Interior Department, Lands]

July 30, 1890
Petition of Kaihemakawalu and 63 native residents of Kekaha;
to C.N. Spencer, Minister of the Interior
[Requesting that lands available for Homesteading be sub-divided and granted to applicants]:

…We, the undersigned, old-timers living from Kealakehe to Kapalaoa, who are subject to taxes, and who have the right to vote in the District of Kona, Hawaii, and ones who are really without lands, and who wish to place this application before Your Excellency, that all of these Government lands here in North Kona, be given to the native Hawaiians who are destitute and poor, being the lots which were sub-divided by the Government which are lying idle and for which no Agreements have been given out, and also the lots which were granted Agreements and issued in the time when Lorrin A. Thurston was Minister of the Interior, and also the lots which still remain undivided. All of these Government lands are what we are now again asking that the dividing and sub-dividing be continued in these remnants of Government lands, until all of the poor and needy ones are provided for.

Your Excellency, we ask that no consent whatever be given to permitting lands to be acquired by the rich through sale at auction, or by lease, and if there is to be any lease, then to be leased to the poor ones, if they are supplied with homes.

Your Excellency, we ask that you immediately send copies of all agreements of the Government lands which were cut up and sub-divided, which are remaining and have no documents for those lots. And we also ask that a surveyor be sent now to again survey and sub-divide the remaining Government lands, being the Government lands of Kaulana, Mahaiula, Kukio 1 & 2, mauka of the Government Road, and Kalaoa 5 & Ooma 1, mauka of the Government Road, joining Kama’s and Koanui’s.

And now, Your Excellency, we also ask that all of the pieces of Government land lying idle outside of these lands which have been sub-divided, and lands which are to be sub-divided, applied for above, to be allowed to be leased to use for five cents per acre, because, they are rocky and pahoehoe lands only left, and the number of acres being about three thousand and over, thereby giving the Government some income from these which have been lying idle and without any value… [HSA – Interior Department, Lands]

June 22, 1893
J. Kaelemakule, Land Agent; to J.A. King, Minister of the Interior:
…I am forwarding you with this, the copy of the agreement of Wm. Harbottle, and some applications as herein below set forth (Figure 8):

107, Kalua (w), for Lot # 59, Map 6, Ooma;
108, G.M. Paiwa, for Lot # 56, Map 6, Ooma;
109, Namakaokalani, for Lot # 58, Map 6, Ooma;
110, Pika Kaninau, for Lot # 57, Map 6, Ooma.

Lot # 57 above set forth, was formerly agreed with D. Kealoha Hoopii, but this applicant left altogether and lived a long time in Kohala, and has done nothing towards the land, and has never signed the agreement to this day. As two years have gone by, I thought it would be better to give the lands to the new applicant… [HSA – Interior Department, Lands]

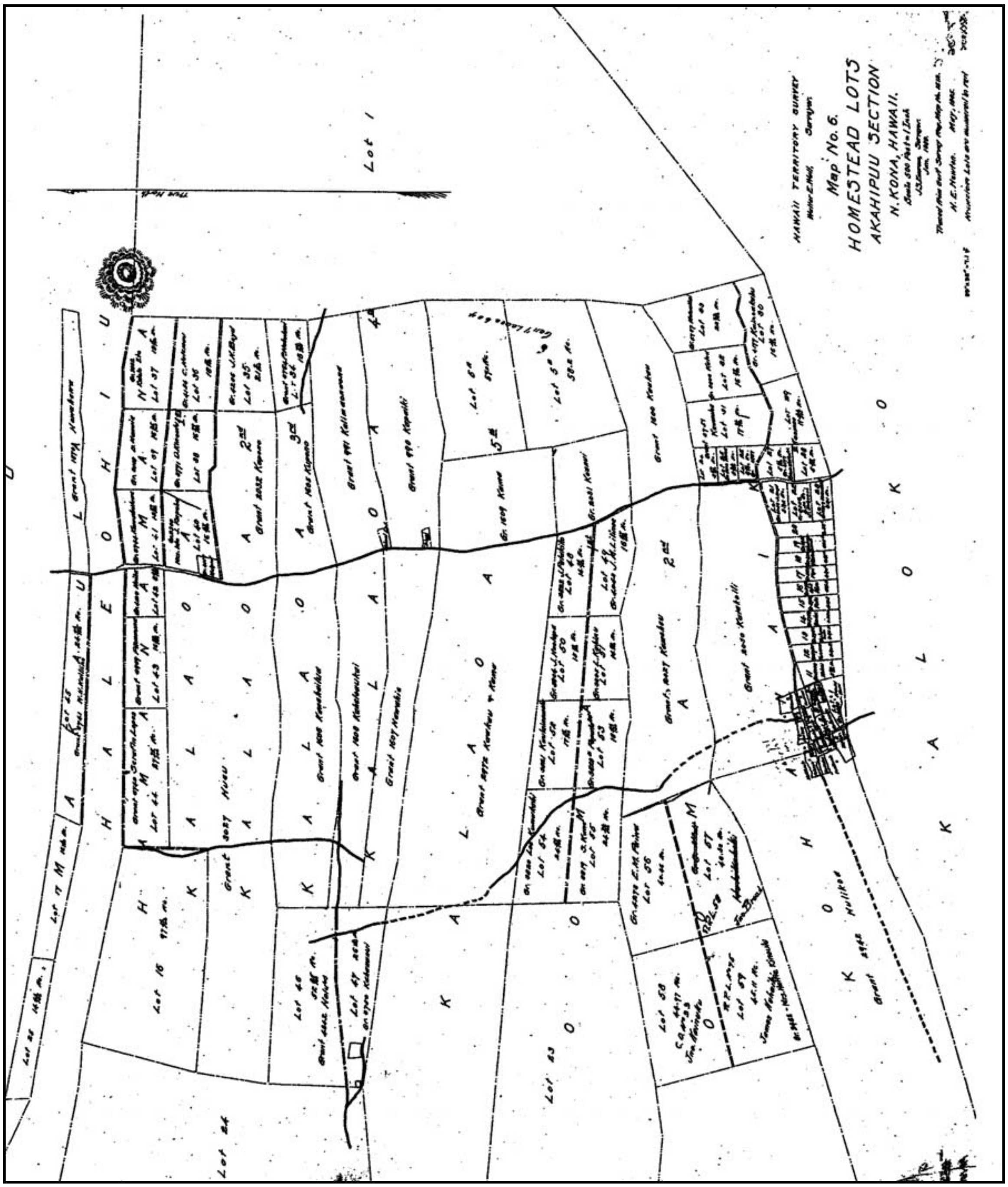


Figure 8. 1902 homestead map No. 6 showing Ooma-Kalaoa Homestead Lots (State Survey Division).

August 31, 1898
Statement of Leases of Public Lands
Under Control of the Commissioner of Public Lands…
…Ooma (mauka) 1160 acres – Coffee, wood lands & grazing
Lease No. 432 – Annual rent $60. – Expires August 1st, 1906…
Reservation in lease by which the Gov't. may take up portions suited to settlement. [HSA – F.O. & Ex, 1898 – Public Lands]

In May 1902, the Territorial Survey Office issued Register Map No. 2123, depicting a portion of the Kalaoa-Ooma Homesteads. ‘O‘oma 1st had been divided into 25 lots extending from near the shore (excluding the shore line) to the upper limits of the ahupua‘a; also excluding the early Royal Patent Grant parcels previously sold to native tenants.

<u>Applicants for land in ‘O‘oma 1st</u> (from *maka*i to *mauka*) included:

- Kanealii – Right of Purchase Lease # 30; Lot 4-B (cancelled);
Kanealii's parcel was just mauka of the shore line exclusion.

- Wm. Keanaaina – Right of Purchase Lease #33; Lot 13
(Patented by Grant No. 5472);
The makai end of Wm. Nuuanu Keanaaina's Grant 5472, is situated at approximately 325 feet above sea level.

- J. Maiola – Right of Purchase Lease # 28; Lot 14 (cancelled);
J. Maiola's parcel was situated about 525 feet above sea level.

- K. Kama Jr. – Right of Purchase Lease #27; Lot 15
(Patented by Grant No. 5046).
The makai end of K. Kama's Grant No. 5046, is situated at approximately 725 feet above sea level.

Territorial Survey Map No. 6 (Homestead Lots, Akahipuu Section), surveyed by J.S. Emerson in 1889, depicts the eight original homestead lots sold to applicants. The lots are in the area extending from 1,022 feet above sea level to the old Māmalahoa Highway. The lots contained approximately 15 to 25 acres each, and were (*makai* to *mauka*) sold to:

- S. Kane – Grant No. 3819, Lot 55;
- Loe Kumukahi – Grant No. 3820, Lot 54;
- Papala (w) – Grant No. 3820 B, Lot 53;
- Kaulainamoku – Grant No. 3821, Lot 52
- L. Kahinu – Grant No. 3805, Lot 51
- J. Hoolapa – Grant No. 3804, Lot 50
- J.M. Lilinoe – Grant No. 4343, Lot 49
- J. Palakiko – Grant No. 3822, Lot 48

Except for the Homestead parcels and the two lots patented to Keanaaina and Kama (totaling ten parcels of the available 25 parcels), no other land in ‘O‘oma 1st was sold during this time. The land was retained by the government and portions leased out for grazing (see General Lease No.'s 590 and 604).

‘O‘oma 2nd was also divided into homestead parcels, but only six lots were made in the subdivision (see Figure 8 and Figure 9). Between 700 and 1,100 feet elevation four Homestead lots were subdivided, containing 40.50 to 45 acres each. Applicants for the lots (*makai* to *mauka*) were:

James Kuhaiki – Right of Purchase Lease # 75, Lot 59
(Patented to Mrs. Hattie Kinoulu; current Parcel 09:007);

Jno. Kainuku – C.O. No. 33, Lot 58 (not granted by 1902; current Parcel 09:008);

Holokahiki – C.O. No. 11, Lot 57
(cancelled; R.P.L. # 59 to Jno. Broad; current Parcel 07:038); and

E.M. Paiwa – Grant No. 4273, Lot 56 (current Parcel 07:039).

Land use on these parcels associated with the Homestead Grants began in the early twentieth century and consisted of both livestock grazing and small-scale agriculture (primarily sweet potato cultivation).

The two *makai* lots consisted of approximately 1,333 acres—the first lot from above the shore to the 1847 *Alanui Aupuni*, containing approximately 302 acres, and the other lot running *mauka* from the same *Alanui Aupuni*, to about the 800 foot elevation (containing approximately 1,031 acres). In 1899, John A. Maguire, founder of Hu‘ehu‘e Ranch applied for a Patent Grant on both of the *makai* lots, but he only secured Grant No. 4536, for the lower parcel of 302 acres, in ‘O‘oma 2nd (coincident with the bulk of the current project area). Maguire’s Hu‘ehu‘e Ranch did hold General Lease No.’s 1001 and 590 for grazing purposes on the remaining government lands—both below and above the *mauka* highway—in ‘O‘oma 2nd. The notes of survey from Maguire’s Grant No. 4536 describes the near shore parcel in ‘O‘oma 2nd. Of particular interest, it also references one of the prominent cultural-historical features on the boundary between ‘O‘oma 2nd and Kohanaiki, an “old ‘Kahua hale’ on white sand…” The “kahua hale” being an old house site. The notes of survey read (see Figure 9):

> Grant No. 4536
> To J.A. Maguire
> Purchase Price $351.00
> A Portion of Ooma 2nd, N. Kona, Hawaii Applied for by J.C. Lenhart, June 8, 1899.
> Beginning at Puhili Gov’t. trig. St. on the boundary between Kohanaiki and Ooma marked by a drill hole in stone 9 feet South of the South corner of an old “Kahua hale” on white sand at a point from which
> Akahipuu Gov’t. trig. Sta. is N 55º 27’ 39” E true 32634.7 feet
> Keahole Gov’t. Trig. Sta. is N 21º 52’ 36” W true 9310.5 ft.
> Keahuolu Gov’t Trig. Sta. is S 22º 24’ 36” E true 20,141.8 ft., and running —
> 1. S. 79º 26’ W. true 298.0 feet along Gr. 3086 Kapena, to a large [mark] on solid pahoehoe by the sea at Puhili Point, thence continuing the same line to the sea shore and along the sea shore to a point whose direct bearing and distance is:
> 2. N. 4º 54’ W. true 4192.0 feet;
> 3. Due east true 2920.0 feet along Ooma 1st;
> 4. S. 31º 30’ E. true 3920.0 feet along reservation for Gov’t. Road 30 feet wide;
> 5. S 790º 45’ W. true 4387.0 feet along Grant 3086 Kapena, to initial point and including an area of 302 acres.
>
> J.S. Emerson, Surveyor
> Oct. 10, 1901.

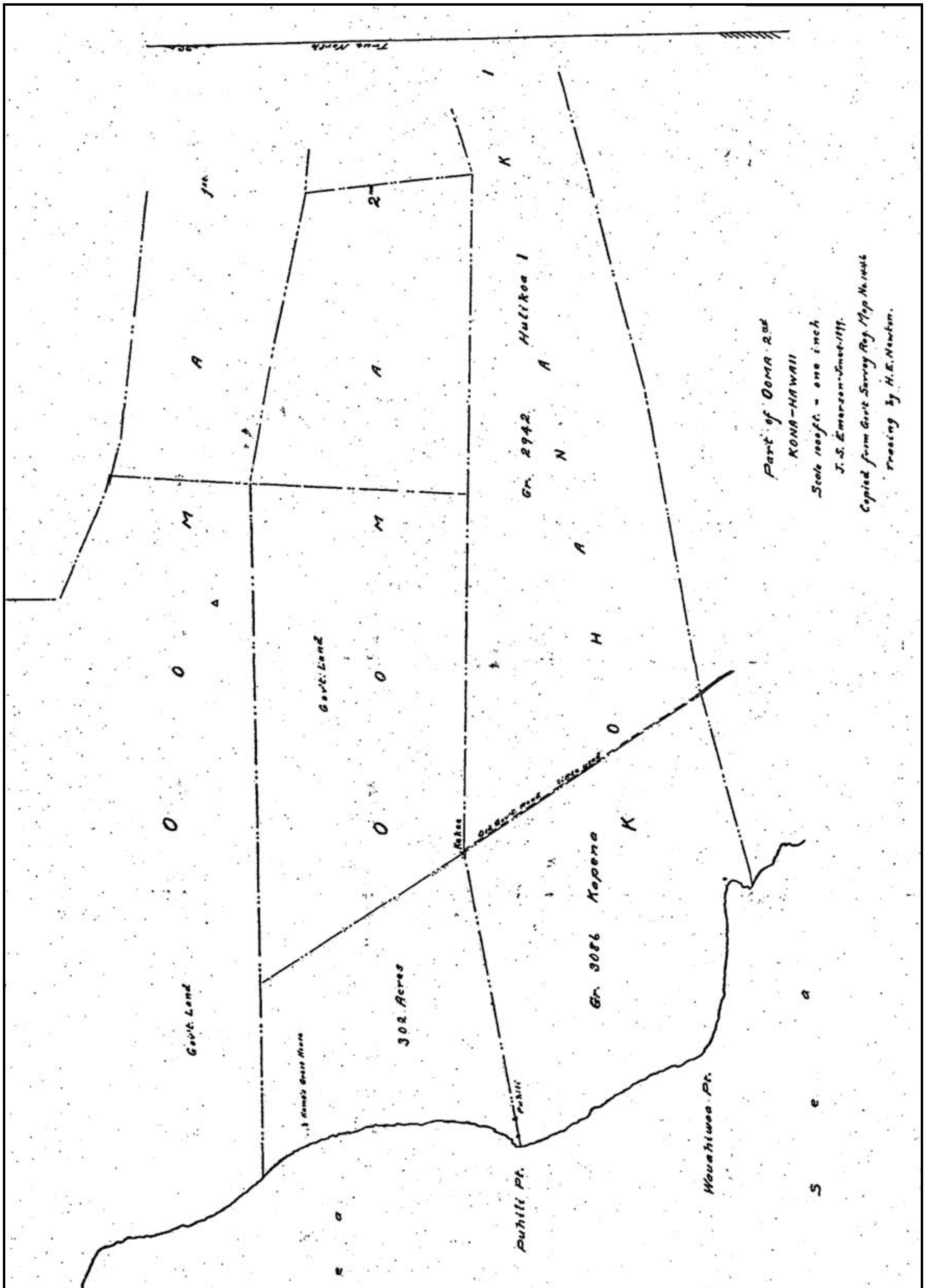


Figure 9. 1899 Grant Map No. 4536 showing *makai* portion of ‘O‘oma 2nd to John A. Maguire.

Field Surveys of J.S. Emerson (1882-1889)

Among the most interesting historic Government records of the study area—in the later nineteenth century—are the communications and field notebooks of Kingdom Surveyor, Joseph S. Emerson. Born on Oʻahu, J.S. Emerson (like his brother, Nathaniel Emerson, a compiler of Hawaiian history) had the ability to converse in Hawaiian, and he was greatly interested in Hawaiian beliefs, traditions, and customs. As a result of this interest, his letters and field notebooks record more than coordinates for developing maps. While in the field, Emerson also sought out knowledgeable native residents of the lands he surveyed, as guides. Thus, while he was in the field he also recorded their traditions of place names, residences, trails, and various features of the cultural and natural landscape (including the extent of the forest and areas impacted by grazing). Among the lands that Emerson worked in was the greater Kekaha region of North Kona, including the lands of ʻOʻoma and vicinity.

One of the unique facets of the Emerson field notebooks is that his assistant J. Perryman, was also a sketch artist. While in the field, Perryman prepared detailed sketches that help to bring the landscape of the period to life. In a letter to W.D. Alexander, Surveyor General, Emerson described his methods and wrote that he took readings off of:

> …every visible hill, cape, bay, or point of interest in the district, recording its local name, and the name of the *Ahupuaa* in which it is situated. Every item of local historical, mythological or geological interest has been carefully sought & noted. Perryman has embellished the pages of the field book with twenty four neatly executed views & sketches from the various trig stations we have occupied… [Emerson to Alexander, May 21, 1882; HSA – DAGS 6, Box 1]

Discussing the field books, Emerson also wrote to Alexander, reporting "I must compliment my comrade, Perryman, for his very artistic sketches in the field book of the grand mountain scenery…" (HSA – HGS DAGS 6, Box 1; Apr. 5, 1882). Later he noted, "Perryman is just laying himself out in the matter of topography. His sketches deserve the highest praise…" (ibid. May 5, 1882). Field book sketches and the Register Maps that resulted from the fieldwork provide a glimpse of the country side of more than 100 years ago.

Field Notebooks and Correspondence from the Kekaha Region

The following documentation is excerpted from the field notebooks and field communications of J. S. Emerson. Emerson undertook his original surveys of lands in the Kekaha region in 1882-1883 (producing Register Maps No. 1278 and 1280). Subsequently, in 1888-1889, Emerson returned to Kekaha to survey out the lots to be developed into Homesteads for native residents of ʻOʻoma and vicinity (see above, The Government Homesteading Program in Kekaha). Through Emerson's letters and notes taken while surveying, we learn about the people who lived on the land—some of them identified in preceding parts of the study—and about places on the landscape. The numbered sites and place names cited from the field books coincide with sketches prepared by Perryman, which are shown as figures in the current study.

J.S. Emerson Field Notebook Vol. 111 Reg. No. 253
West Hawaii Primary Triangulation, Kona District
Akahipuu; May 27, 1882
(Figures 9 and 10)

Site # and Comment:

…6 – Koanui's frame house. E.G. In Honokohau – nui.

7 – Aimakapaa Cape. Extremity. In Honokohau-nui.

11 – Beniamina's house (frame). N.G. In Aiopio. In Honokohau-nui.

12 – Beniamina's house No. 2. E.G. In Honokohau-nui.

18 – Lae o Palaha. Between Kaloko and Honokohau-nui.

19 – Awanuka Bay (Haven of rest) Retreat during storms in this dist.

20 – Kealiihelepo's (frame house). N.G. In Kaloko.

21 – Lae Maneo. From the “Maneo” fish in Kaloko.

22 – Kohanaiki Bay. By sea wall of fish pond.

23 – Kaloko-nui fish pond. Tang. S. end by Nuuanu’s grass house.

24 – Wall between fish pond of Kaloko nui and iki.

25 – Kaloko iki fish pond. Tang. N. extremity.

Kaloko nui was originally a bay, shut off from the sea by a wall by Kamehameha 1st order.

26 – Kawaimaka’s frame house. In Kohanaiki.

27 – Lae o Wawahiwaa. Rock cape. In Kohanaiki.

28 – Keoki Mao’s grass house. In Ooma.

29 – Pahoehoe hill. Between Ooma and Kalaoa 5.

30 – Lae o Keahole. Extremity. In Kalaoa 5.

31 – Lae o Kukaenui. Resting place for boats.

32 – Makolea Bay.

33 – Lae o Unualoha.

34 – Pohaku Pelekane.

35 – Lae o Kahekaiao. Kahe-ka-iao – place of the “iao” which abound there. [Notebook 253:33,35]

…Keahole Bay.

Lae o Kalihi in Kalaoa 5.

Wawaloli Bay in Kalaoa 5.

Lae o Kekaaiki.

Limu Koko in Ooma 1.

Lae o Puhili in Kohanaiki.

Lae o Kealakehe in Kealakehe.

Hueu’s frame house in Kalaoa 4, makai side of Gov’t. Road.

Kuakahela’s frame house in Kalaoa 5.

Protestant Church Steeple in Kalaoa 5.

Kama’s frame house, N. gable in Ooma 1.

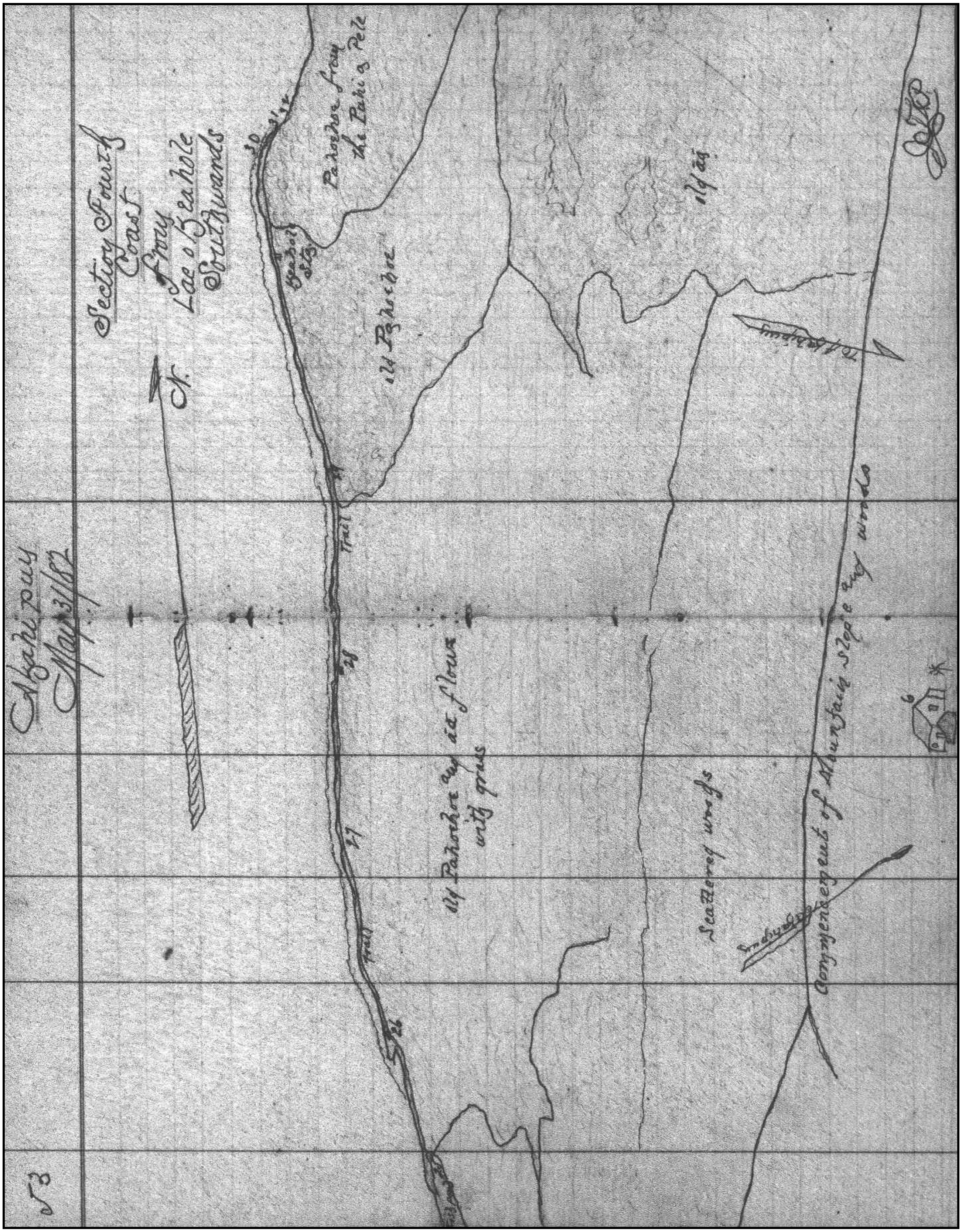


Figure 10. J. S. Emerson, field notebook map, Book 253:53 (State Survey Division).

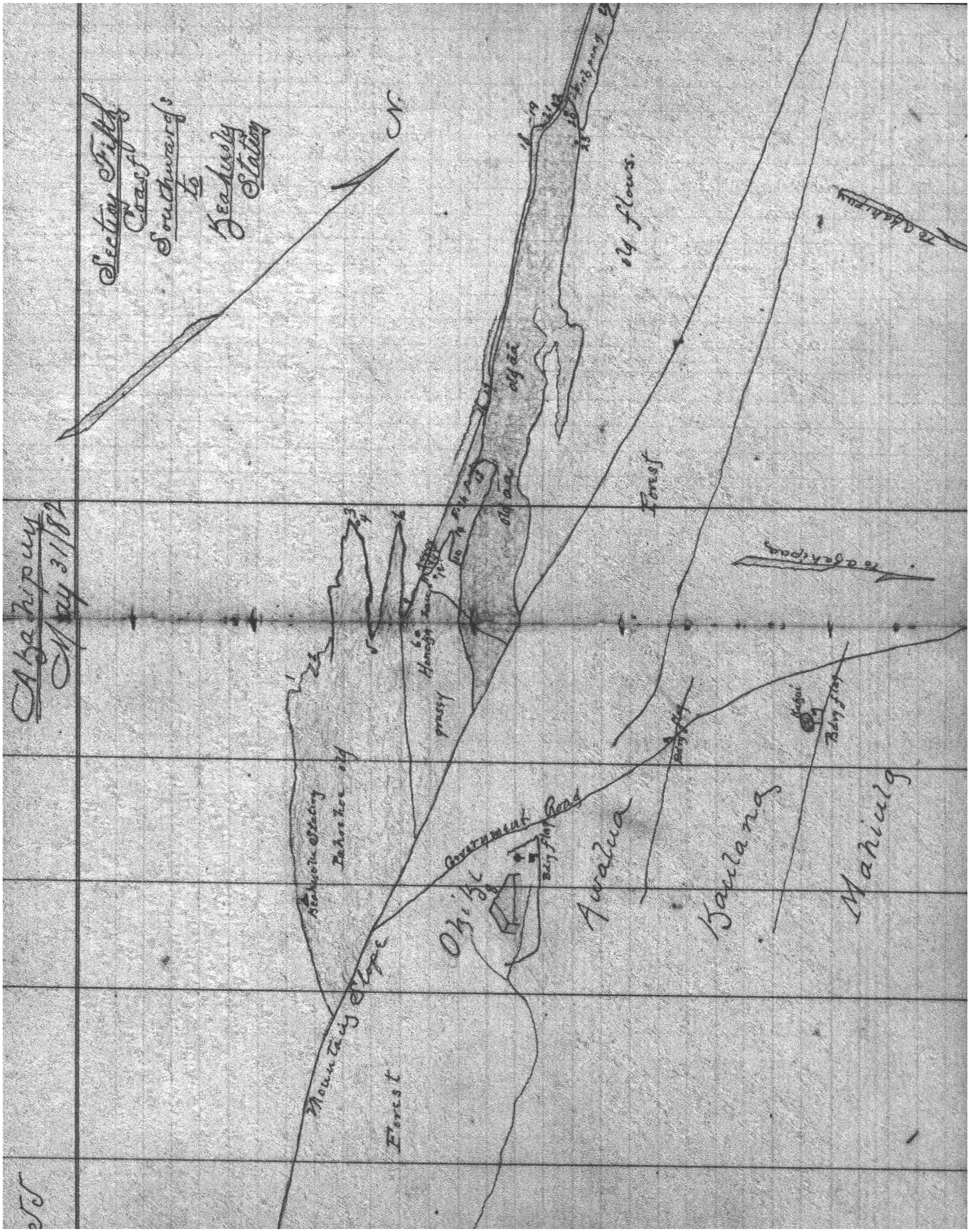


Figure 11. J. S. Emerson, field notebook map, Book 253:55 (State Survey Division).

While taking sightings from Keāhole, Perryman prepared additional sketches of the landscape. One sketch on page 69 of the field book (Figure 12) depicts the view up the slope of Hualālai. Dated June 4, 1882, the sketch is of importance as it also depicts Kalaoa Village and church; the upper Government road; Kohanaiki Village; and two trails to the coast, one trail to Honokōhau, and the other near the Kaloko-Kohanaiki boundary. Use of these trails continued through the 1950s.

The other sketch on page 73 of the field book (dated June 8, 1882) depicts the coastline south from Keāhole, to an area beyond Keauhou (Figure 13). Of interest, we see only the near-shore "Trail" in the foreground, with no trail on the *kula* lands. Then a short distance south, a house is depicted on the shore, in the ‘O‘oma vicinity (identified as the house of Kama or Keoki Mao on Emerson's Register Maps). And a little further beyond (south) the house, two trails are indicated—presumably the *Alanui Aupuni* on the *kula* lands to ‘O‘oma, and the near shore trail, seen coming in from Honokōhau.

While surveying the uplands on Hualālai in August 1882, Perryman drew a sketch of the Keāhole-Honokōhauiki coastal lands. This sketch (Figure 14) from field Book No. 254 shows the reverse view of Figure 13. Noting again, that the only trail given at that time, was the near shore trail, running out of Honokōhau-Kaloko, Kohanaiki, ‘O‘oma and on to Keāhole.

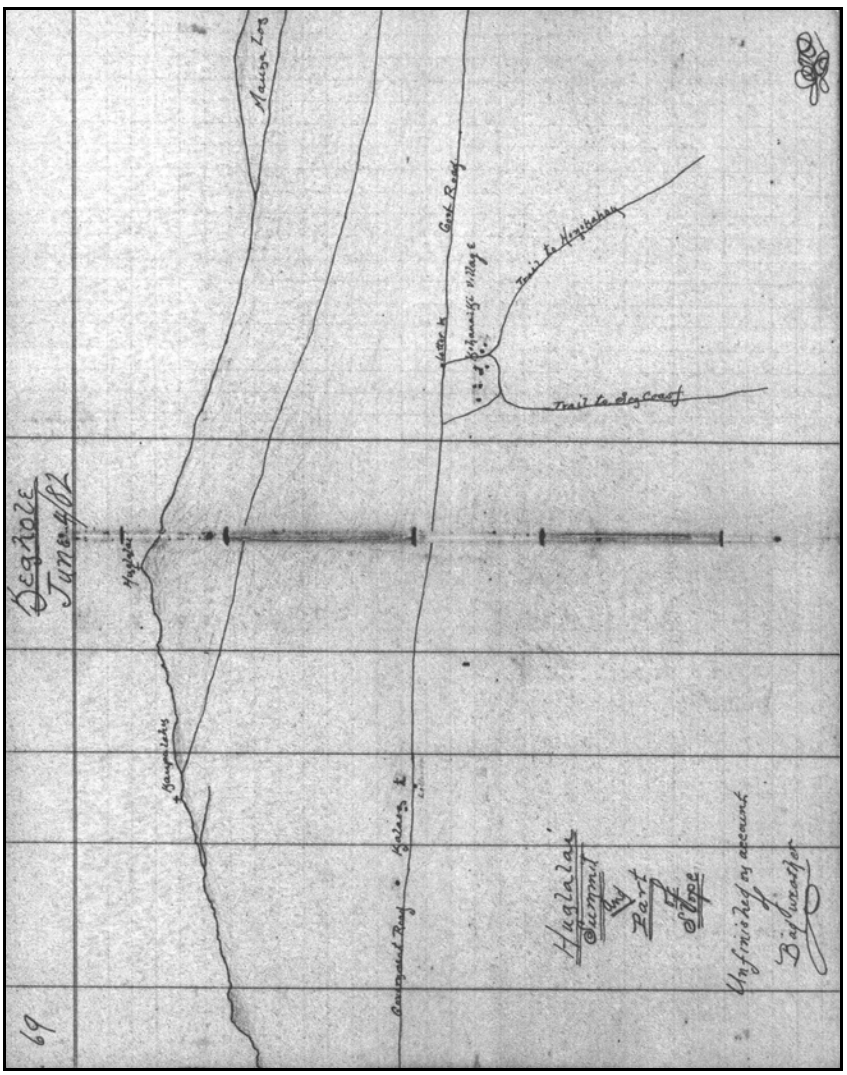


Figure 12. J. S. Emerson, field notebook map, Book 253:69 (State Survey Division).

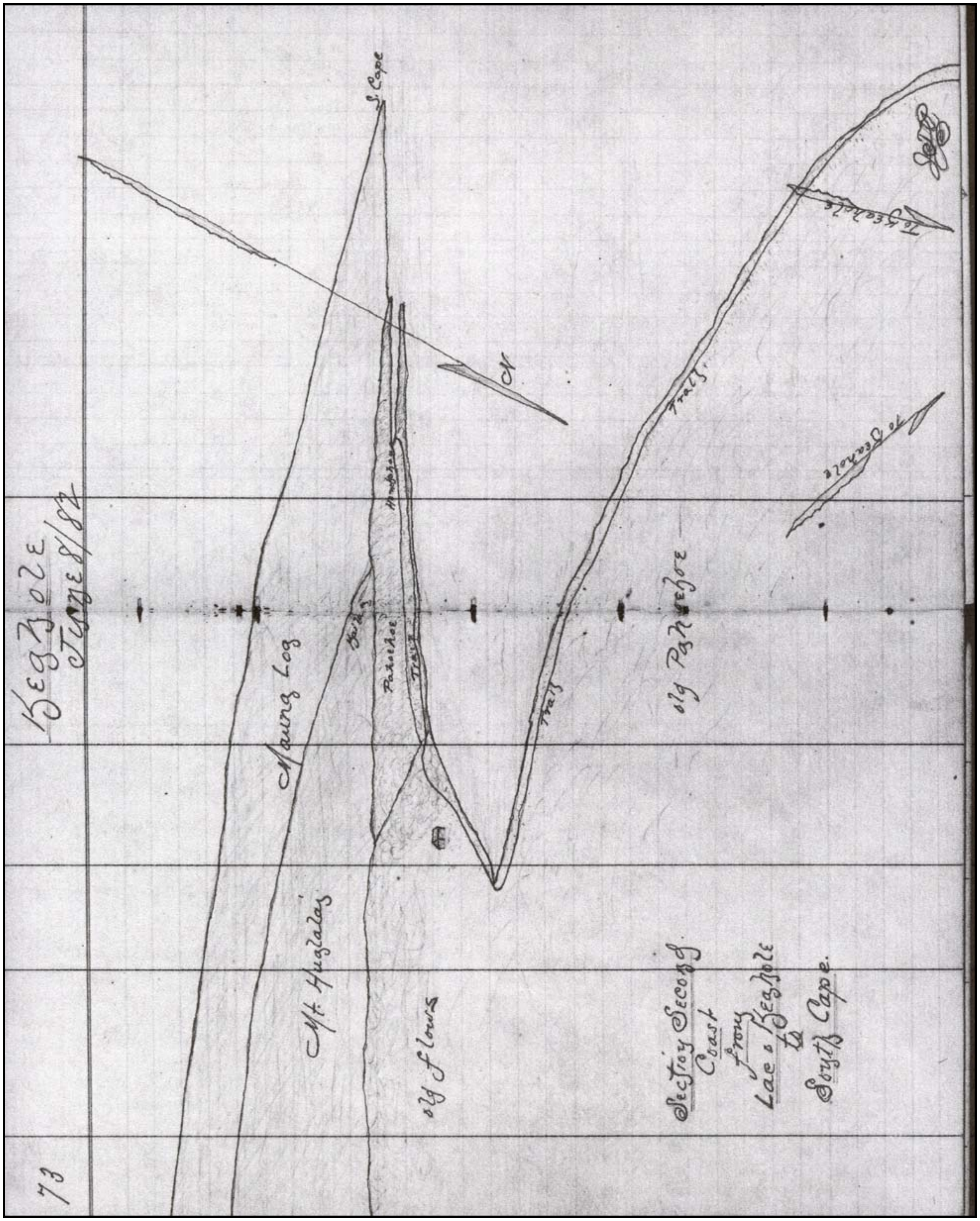


Figure 13. J. S. Emerson, field notebook map, Book 253:73 (State Survey Division).

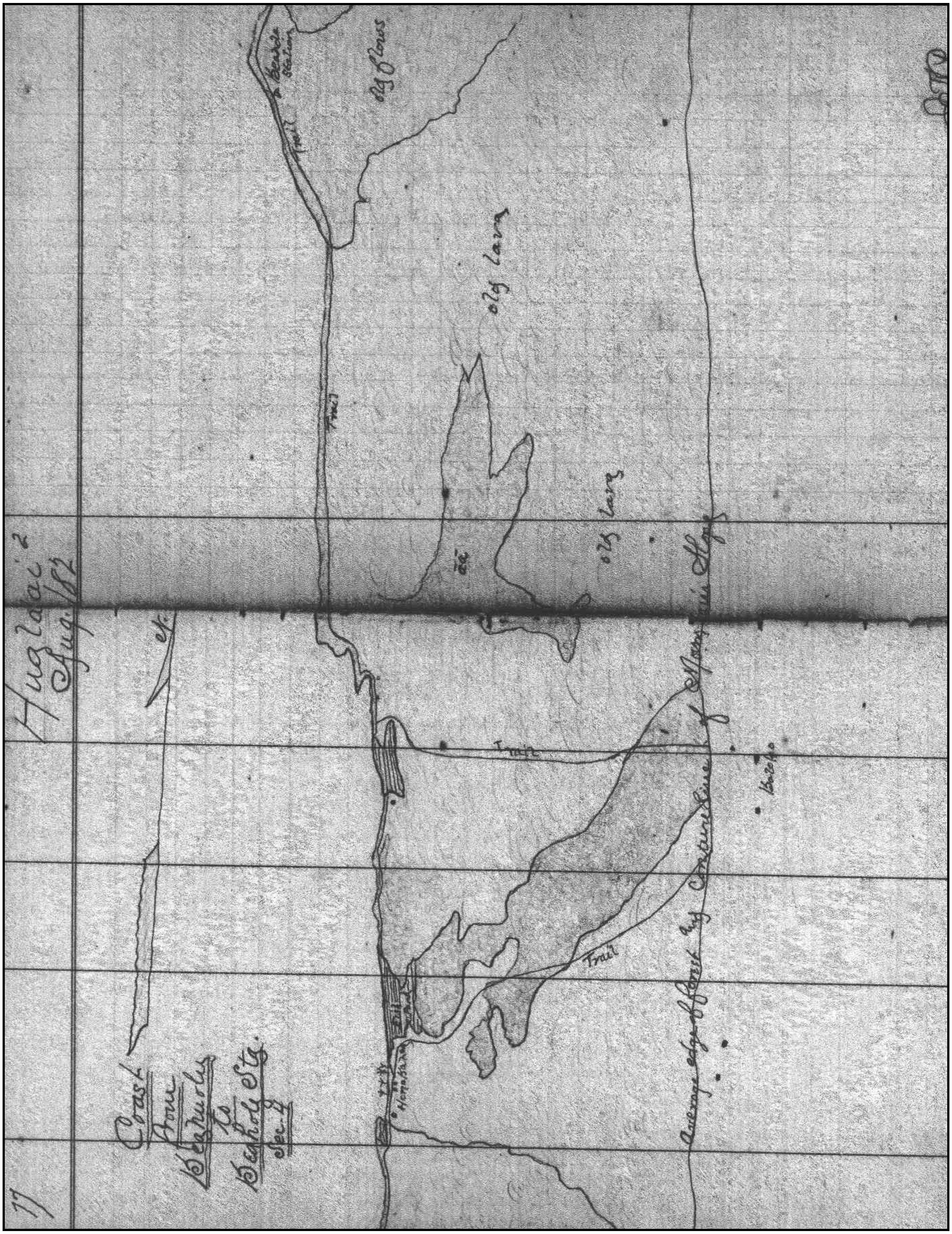


Figure 14. J. S. Emerson, field notebook map, Book 254:77 (State Survey Division).

While surveying the ‘O‘oma and vicinity homestead lots in 1888-1889, Emerson camped near Kama’s house in ‘O‘oma 1st. The following communications were sent by Emerson to W.D. Alexander, and tell us more about the people of the land, their beliefs, and commentary on then current events in the Kingdom. Of interest, we also find that J.W.H. Isaac Kihe, whose writing of traditions, and as a representative of the native families in the land application process—which have been cited extensively in this study—is also mentioned in Emerson’s narratives.

(Underlining, italics and brackets are inserted to draw attention to certain passages.)

> *April 8, 1888*
> …Our tent is pitched in Ooma on the *mauka* Govt. road at a convenient distance from Kama’s fine cistern which supplies us with the water we need. The pasturage is excellent and fire wood abundant. As I write 4:45 P.M. the thermometer is 71º, barometer 28.78. The entire sky is overcast with black storm clouds over the mountains. The rainy season comes late to Kona this year and has apparently just begun. We have had about three soaking rains with a good deal of cloud & drizzle. We are now having a gentle rain which gladdens the residents with water for their cisterns… We have set a large number of survey signals and identified many important corners of Gov’t. lands etc. from Puhiapele on the boundary of Kaupulehu to the boundary line of Kaloko. The natives welcome us and do a great deal to help the work along. Tomorrow I expect to go to Kuili station with a transit and make a few observations & reset the old signal... The Kamaainas tell me that Awakee belongs to the Gov’t. though I see it put down as LCA 10474 Namauu no Kekuanaoa.
>
> They also tell me that the heirs of Kanaina estate still receive rent for the Ahupuaa of Kaulana, though I have recorded as follows in my book, Kaulana ½ Gov’t. per civil Code 379, ½ J. Malo per Mahele Bk. Title not perfected; all Gov’t. Please examine into the facts about Kaulana and instruct me as to what I shall do about it. Kealoha Hopulaau rents it and if it is Gov’t. land the Gov’t. should receive the rent or sell it off as homesteads. It is a desirable piece of land, a part of it at least… [HSA – HGS DAGS 6, Box 2]
>
> *April 17, 1888*
> ...The work is being pushed rapidly and steadily forward. The natives render me most valuable assistance and find all the important corners for me as fast as I can locate them. It is hard getting around on account of the rocks & stones, to say nothing of trees etc., but there is a great deal of really fine land belonging to the Government, admirably adapted to coffee etc. The more I see of it the better it appears.
>
> As to Kaulana, if I hear nothing to the contrary from you, I will leave it all as Gov’t. land.
>
> Mr. McGuire [sic] of Kohala, the representative for that district, proposes to settle in Kona. He has bought Grant 1590, Kauhine, in Ooma, Kalaoa etc. and wants the Gov’t. to make good to him the amount taken from him by Grants 2972, Kaakau & Kama, and 3027, Hueu, which occupy portions of the same land granted to Kauhine. If his title is good, would it not be just to leave Kaakau & Kama as well as Hueu in possession of their lots where they have lived for over 20 years, and give McGuire an area in adjoining lands equal to that taken from him by these two grants.
>
> It is said that Chas. Achi has written to the natives that Grant 1590, Kauhine, has been cancelled. Will you learn the true state of the case and be so kind as to inform me… [HSA – HGS DAGS 6, box 2 Jan.-Apr. 1888]

In his field book notes, on May 1st, 1888, Emerson noted that he had placed the “Pulehu” station on the “ground by ahu, about 4 feet makai of Kama’s goat pen, on the iwi aina between Kalaoa 5 and Ooma 1…” (J.S. Emerson Field Book 291:83).

In the same field book on May 19th, 1888, while surveying the area near the boundary of ʻOʻoma 1st and 2nd, at the 325 foot elevation, Emerson cited off of a station named "Kahokukahi." The point is "on the entrance of the cave, Kahokukahi… The above is the vertical entrance of a famous *ana kaua*, which extends for a long distance to the E. and to the W…" (J.S. Emerson Field Book 291:137). An "ana kaua" would be a place, where during times of war, people could hide and fortify themselves. Emerson's description indicates that the cave runs some distance *mauka* and *makai* of "Kahokukahi."

On May 23, 1888, Emerson surveyed Pūhili, the boundary between Kohanaiki and ʻOʻoma 2nd. He observed, "Large [mark] on solid pahoehoe, on bound. bet. Kohanaiki & Ooma, by the sea, near the end of a cape… Station mark, drill hole in stone, 9 ft. S. of the S. corner of an old "kahua hale" on white sand…" (J.S. Emerson Field Book 291:151).

Returning to his "old camp Ooma," in August 1888, Emerson submitted the following letter to Alexander:

> *August 25th, 1888*
> …I have to report that the very intricate and irregular remainder of Gov't. land situated in Kealakehe is cut up into homesteads, ready for the committee to estimate its values. The job has been made unusually long & tedious by the absurd arrangement of the old kuleanas scattered around at random. I have also run out the boundaries of Papaakoko, ready for fencing. Thursday P.M. I made my way through a heavy rain to this place and set up tent in the storm. It rained a good deal every day since and is raining now. In spite of the weather the work of cutting up Ooma 1st goes bravely on. I have a huge umbrella to camp under while it rains. I propose to finish up Ooma 1st & return to Honolulu by the next trip of the *Hall*.
>
> Kailua beach is the great rendezvous for men & asses from all parts of the country when the steamer arrives from Honolulu. It has in consequence become the natural place to tell and hear gossip & news. Here, the sand-lot orator, mounted on a packing box, can address the largest crowd. T.N. Simeona, who stole the church money, keeps the pound and takes care of the court house wanting to make a speech, repaired to the beach last Wednesday morning and is reported to have made a windy harangue to the effect that the King was hewa and that the Ministers were pono! Up to that time he had always been the contemptible too of the King's party and was loud in his denunciation of the Government. I explain this change in his talk by his wish to retain his Gov't. billets & his desire to avoid arrest as a rebel.
>
> A native man told me the other day (Wednesday) that the Cabinet was hewa in two things viz.
>
> 1st They taxed chickens, banana trees and many other things that had not been heretofore taxed.
>
> 2nd They arrested and sent to Molokai many who were not lepers. For these reasons many justified Wilcox for trying to out the ministers.
>
> There is a sturdy old native living at Kaloko named Kealiihelepo, whom I greatly respect. Said he to me "When King Kalakaua returned from his foreign trip he made a speech at Kailua and said that 'in foreign lands the foreign God was losing his power. His former worshippers were deserting him. That the old Hawaiian Gods were still mana and them he would worship.'" But said Kealiihelepo "The King was mistaken. Our old Gods were once mighty, but the coming of the foreigner with his Gods has robbed them of their strength. Therefore the King has made the mistake to oppose the God who is now in power, and Jehovah is opposing him. Hence the King's pilikia."
>
> You are entirely justified in calling Kona "that heathen district." [HSA – HGS DAGS 6, box 2 Jan.-Apr. 1888]

On October 14th 1888, Emerson wrote to Alexander, briefing him on conversations he was having with J.W.H. Isaac Kihe, his "encyclopedia," "the son of a famous sorcerer." Later, Emerson used many of the notes taken during his conversations with Kihe, to develop his paper on Hawaiian religion (Emerson 1892). J.W.H. Isaac Kihe, was the son of Kihe, who was the son of Kuapahoa, of Kaloko (notes of J.S. Emerson, September 25, 1915; in collection of the Hawaiian Historical Society). While at ʻOʻoma, Kihe described the various nature forms taken by the deceased, and their role in the spiritual practices. On October 14th Kihe named for him some of the gods called upon by those who practiced the Kahuna Kuni sorcery.

> *Ooma*
> *October 14, 1888*
> *J.S. Emerson; to W.D. Alexander:*
> …I have just been having a chat with a son of a famous sorcerer, with the following for a summary of what he said.
>
> There are four gods worshipped by murders and sorcerers viz:
>
> (1). Kui-a-Lua, the god of the Lua, Mokomoko, Haihai and other forms of violence.
>
> (2). Uli, the god of the Anaana, Kuni, Hoopiopio and Lawe Maunu.
>
> (3). Kalaipahoa, god of the Hoounauna, Hookomokomo and Hooleilei.
>
> (4). Hiiaka-i-ka-poli-o-Pele, the goddess of the Poi uhane, Apo leo, Pahiuhiu and Hoonoho uhane… [J.S. Emerson, in collection of the Hawaiian Historical Society]

Trails and Roads of Kekaha (Governmental Communications)

Alahele (trails and byways) and *alaloa* (regional thoroughfares) are an integral part of the cultural landscape of Hawaiʻi. The *alahele* provided access for local and regional travel, subsistence activities, cultural and religious purposes, and for communication between extended families and communities. Trails were, and still remain important features of the cultural landscape.

Traditional and historical accounts (cited in this study) describe at least two traditional trails that were of regional importance which pass through the lands of ʻOʻoma. One trail is the *alaloa*—parts of which were modified in the 1840s and later, into what is now called the *Alanui Aupuni* (Government Road) or Māmalahoa Trail or King's Highway—that crosses the *makai* (near shore) lands, linking royal centers, coastal communities, and resources together. The other major thoroughfare of this region is "*Kealaehu*" (The path of Ehu), which passes through the uplands, generally a little above the *mauka* Government Road or old Māmalahoa Highway, out to the ʻAkāhipuʻu vicinity, and then cuts down to Kīholo in Puʻu Waʻawaʻa. From Kīholo, the *makai alaloa* and Kealaehu join together as the *Alanui Aupuni,* and into Kohala, passing through Kawaihae and beyond. The *mauka* route provided travelers with a zone for cooler traveling, and access to inland communities and resources. It also allowed for more direct travel between the extremities of North and South Kona (cf. Malo 1951; Iʻi 1959; Kamakau 1961; Ellis 1963; and *Māhele* and Boundary Commission Testimonies).

In addition to the *alahele* and *alaloa,* running laterally with the shore, there are another set of trails that run from the shore to the uplands. By nature of traditional land use and residency practices, every *ahupuaʻa* also included one or more *mauka-makai* trail. In native terminology, these trails were generally known as—*ala piʻi uka* or *ala piʻi mauna* (trails that ascend to the uplands or mountain). Some of these trails are described in native accounts and oral history interviews cited in this study.

Along the trails of the Kekaha region of which ʻOʻoma is a part, are found a wide variety of cultural resources, including, but not limited to residences (both permanent and temporary), enclosures and exclosures, wall alignments, agricultural complexes, resting places, resource collection sites, ceremonial features, *ilina* (burial sites), petroglyphs, subsidiary trails, and other sites of significance to the families who once lived in the vicinity of the trails. The trails themselves also exhibit a variety of construction methods, generally determined by the environmental zone and natural topography of the land. "Ancient" trail construction methods included the making of worn paths on *pāhoehoe* or *'a'ā* lava surfaces, curbstone and coral-cobble lined trails, or cobble stepping stone pavements, and trails across sandy shores and dry rocky soils.

Following the early nineteenth century, western contact brought about changes in the methods of travel (horses and other hoofed animals were introduced). By the mid-nineteenth century, wheeled carts were also being used on some of the trails. In the Kona region portions of both near shore and upland *ala hele-ala loa* were realigned (straightened out), widened, and smoothed over, while other sections were simply abandoned for newer more direct routes. In establishing modified trail—and early road-systems—portions of the routes were moved far enough inland so as to make a straight route, thus, taking travel away from the shoreline.

It was not until 1847, that detailed communications regarding road construction on Hawai'i began to be written and preserved. It was also at that time that the ancient trail system began to be modified and the alignments became a part of a system of "roads" called the "*Alanui Aupuni*" or Government Roads. Work on the roads was funded in part by government appropriations, and through the labor or financial contributions of area residents and prisoners working off penalties (see communications below). Where the *Alanui Aupuni* crosses the lands of 'O'oma, the alignment includes several construction methods, such as being lined with curbstones; elevated; and with stone filled "bridges" in areas that level out the contour of the roadway.

The following letters provide readers with a historical overview of the *Alanui Aupuni*, and travel through 'O'oma and the Kekaha region. Of particular interest to the lands of 'O'oma, are those communications addressing the lower Government Road which passes through the proposed development area.

(Underlining, italics, and square brackets have been added.)

> *June 26, 1847*
> *George L. Kapeau to Keoni Ana*
> I have received your instructions, that I should explain to you about the *alaloa* (roadways), *alahaka* (bridges), lighthouses, markets, and animal pounds. I have not yet done all of these things. I have thought about where the *alanui heleloa* (highways) should be made, from Kailua to Kaawaloa and <u>from Kailua to Ooma, where our King was cared for</u> [7], and then afterwards around the island. It will be a thing of great value, for the roads to be completed. Please instruct me which is the proper thing for me to do about the *alaloa*, *alahaka*, and the laying out of the *alaloa*… [HSA – Interior Department Misc., Box 142; Kepā Maly, translator)
>
> *August 13, 1847*
> *Governor of Hawaii, George L. Kapeau; to*
> *Premier and Minister of Interior, Keoni Ana*
> *Aloha oe e ka mea Hanohano –*
> I have a few questions which I wish to ask you. Will the police officers be required to pay, when they do not attend the Tuesday (*Poalua*) labor days? How about parents who have several children? What about school teachers and school agents? Are they not required to work like all other people when there is Government work on the roads and highways?
>
> I believe that school agents, school teachers and parents who have several children, should only go and work on the weeks of the public, and not on the *konohiki* days…
>
> …<u>The roads from Kailua and down the pali of Kealakekua, and from Kailua to Honokohau, Kaloko, Ooma, at the places that were told our King, and from thence to Kaelehuluhulu [at Kaulana in Kekaha], are now being surveyed</u>. When I find a suitable day, I will go to

[7] For the first five years of his life (until ca. 1818), Kauikeaouli was raised at 'O'oma, by Ka-iki-o-'ewa and Keawe-a-mahi *mā* (see Kamakau 1960; and this study).

Napoopoo immediately, to confer with the old timers of that place, in order to decide upon the proper place to build the highway from Napoopoo to Honaunau, and Kauhako, and thence continue on to meet the road from Kau. The road is close to the shore of Kapalilua…

The width of the highways around Hawaii, is only one fathom, but, where it is suitable to widen where there is plenty of dirt, two fathoms and over would be all right… If the roads are put into proper condition, there are a lot of places for the strangers to visit when they come here. The Kilauea volcano, and the mountains of Maunaloa, Maunakea, Hualalai.

There is only one trouble to prevent the building of a highway all around, it is the steep gulches at Waipio and Pololu, but this place can be left to the very last… [HSA – Roads, Hawaii]

March 29, 1848
Governor Kapeau; to Minister of the Interior, Keoni Ana:
[Acknowledging receipt of communication and answering questions regarding construction methods used in building the roads.]

…I do not know just what amount of work has been done, but, I can only let you know what has come under my notice.

The highway has been laid from Kailua to Kaloko, and running to the North West, about four miles long, but it is not completely finished with dirt. The place laid with dirt and in good condition is only 310 fathoms.

The highway from Kealakekua to Honaunau has been laid, but is not all finished, and are only small sections… [HSA – Roads, Hawaii]

July 9, 1873
R.A. Lyman; to
E.O. Hall, Minister of the Interior.
Notifies Minister that *the road from Kiholo to Kailua needs repairing*. [HSA – Interior Department – Land Files]

August 14, 1873
R.A. Lyman; to
E.O. Hall, Minister of the Interior:
I have just reached here [Kawaihae] from Kona. I have seen most of the roads in N. Kona, and they are being improved near where the people live. If there is any money to be expended on the roads in N. Kona, I would say that the place where it is most needed is from Kiholo to Makalawena, or the Notch on Hualalai.

This is the main road around the island and is in very bad condition. Hardly anyone lives there, and there are several miles of road across the lava there, that can only be worked by hiring men to do it. There is also a road across a strip of Aa a mile & a half or 2 in length in the south end of S. Kohala next to the boundary of N. Kona, that needs working, and then the road from here [Kawaihae] to Kona will be quite passable… [HSA – Roads, Hawaii]

November 4, 1880
J.W. Smith, Road Supervisor, North Kona; to
A.P. Carter, Minister of the Interior:
…Heretofore I have been paying one dollar per day, but few natives will work for that, they want $1.50 per day. Thus far I have refused to pay more than $1.00 and have been getting men for that sum.

The most urgent repairs are needed on the main road from Kaupulehu to Kiholo, and north of Kiholo to the Kohala boundary, a distance of about 20 miles… [HSA – Roads, Hawaii]

Kailua Nov. 19th, 1880
Geo. McDougall; to
A.P. Carter, Minister of the Interior —
…I noticed among the appropriation passed by the last Legislature, an item of $5000 for Roads in North Kona Hawaii — as I am very much interested about roads in this neighbourhood, I take the liberty to express my opinions what is wanted to put the roads in good repair and give the most satisfaction to all concerned.

The Road from Kailua going north for about eight miles to where it joins the upper Road, has never been made, it is only a mule track winding through the lava. It could cost to make it a good cart road, fully two thousand dollars. And from Kailua to where it joins the South Kona road, about 12 miles was made by Gov. Adams, and is in pretty much the same state as he left it, only a little worse of the ware of 20 years or more, it could cost to make it in good repair about 15 hundred dollars. Then we could have 20 miles of good road… [HSA – Interior Department Letters]

March 21st, 1885
C.N. Arnold, Road Superintendent-in-Chief, Hawaii; to
Charles Gulick, Minister of Interior:
…In accordance with your instructions I beg to hand you the following list of names as being those I would select for Supervisors in the different Road Districts under my charge:

… Judge J.K. Hoapili, North Kona District…

Hoping these parties may meet with your approval… [HSA – Roads, Hawaii]

March 1886
Petition to Charles Gulick, Minister of the Interior:
[Signed by 53 residents of North Kona, asking that the appropriated funds be expended for the Kailua-Kohanaiki Road]:

We the people whose names are below, subjects of the King, residing in North Kona, Island of Hawaii:

The funds have been appropriated by the Legislature for the opening of the road from Kailua to Kohanaiki, therefore, we humbly request that the road be made there. The length of this road being thought of is about five miles more or less. The road that is there at the present time is not fit for either man nor beast.

Your people have confidence that as so explained, you will kindly grant our request, and end this trouble in our District…

[those signing included names of individuals known to have ties to the ‘O‘oma vicinity]: …J. Kamaka, Kuakahela, Kahulanui, & Palakiko… [HSA – Roads Hawaii; Maly, translator]

March 9th, 1887
C.N. Arnold, Road Superintendent-in-Chief, Hawaii; to
Chas. Gulick, Minister of the Interior:
[Arnold provides documentation of the early native trail from Kailua to the upper Kohanaiki region, and its’ ongoing use at the time. He also notes that McDougall (resident at Honokōhau) and others are presently in the business of dairy ranching]:

…The enclosed petition [cited above] has just come to hand from North Kona. The petitioners are mistaken when they say that any special appropriation has been made for this road as there has never been a Government road in this part of the District. There is however an old native trail which has always been used as a short cut, from the lower part of the district between Keahou [sic] and Kailua, by persons who were traveling to Kawaihae and Waimea. The opening of a good road here would be a great convenience to the traveling public and also a great accommodation to a great many people who live on, or nearly on the line of it. I may mention among the number, Messrs. McDougall and Clark who are engaged in dairy ranching near the head of the proposed line. I may also mention that I, with Mr. Smith, made a preliminary survey of it, at the request of His Majesty the King, who is also interested in the opening of this road, as itopens up all of His Kailua lands for settlement. I regard the road as necessary for the above reasons.

From the preliminary survey made, I estimate that a wagon road 12 feet wide will cost from Kailua to the *mauka* Govt. road at Kohanaiki $6000. The length of the road is 5 ¾ miles. The elevation of highest point (*mauka* Road) is 1600 feet above tide at Kailua. Mr. Smith Supt. of Public Works has all the notes of the survey, and can give you full information in regard to this matter… [HSA – Roads, Hawaii]

July 14th, 1887
C.N. Arnold, Road Superintendent-in-Chief, Hawaii; to
L.A. Thurston, Minister of the Interior:
…In obedience to your request I beg to hand you the following list of the District Supervisors under my jurisdiction:

…North Kona – Hon. J.K. Nahale; Native… [HSA – Roads Hawaii]

March 8, 1888
J. Kaelemkule; Supervisor, North Kona Road Board; to
L.A. Thurston, Minister of the Interior.
[Ka‘elemakule provides Thurston with an overview of work on the roads of North Kona, and describes the Government roads (*Ala nui Aupuni* or *Ala loa*) which pass through the Kekaha region]:

The road that runs from Kailua to Kohanaiki, on the north of Kailua, perhaps 6 miles. It is covered with aa stone, and is perhaps one of the worst roads here. The Road Board of North Kona has appropriated $200 for work in the worst areas, and that work has been undertaken and the road improved. The work continues at this time. This is one of the important roads of this district, and it is one of the first roads that should be worked on.

The government road or ala loa from upland Kainaliu (that is the boundary between this district of South Kona) [Kealaehu], runs straight down to Kiholo and reaches the boundary of the district adjoining South Kohala, its length is 20 and 30 miles. With a troubled heart I explain to your Excellency that from the place called Kapalaoa next to South Kohala until Kiholo – this is a very bad section of about 8 miles; This place is always damaged by the animals of the people who travel along this road. The pahoehoe to the north of Kiholo called Ke A. hou, is a place that it is justified to work quickly without waiting. Schedule A, attached, will tell you what is proposed to care for these bad places…

Schedule A: [Appropriations needed]
The road from Kailua to Kohanaiki, and then joining with the inland Government Road – $500.

The upland Road from Kainaliu to the boundary adjoining S. Kohala – $1,500.00. [HSA – Roads Hawaii; Kepā Maly, translator]

September 30, 1889
Thos. Aiu, Secretary, North Kona Road Board (for J. Kaelemakule); to
L.A. Thurston, Minister of the Interior.
[Provides Thurston with an overview of work on the roads of North Kona, and identifies individuals who are responsible for road maintenance (cantoniers) in various portions of the district; several of the individuals named were also old residents and applicants for Homestead lots. Of interest, Kaelemakule's report indicates that maintenance of the Alanui Aupuni which crossed into the kula lands of ʻOʻoma, had not been assigned to anyone. (see report of Dec. 22, 1890)]:

1. In that section of the road which proceeds from Kailua near the shore to Kohanaiki, Mano is the cantonier.
2. That section of the road from Kukuiooohiwai to Keahuolono, Paiwa is the cantonier…
3. That section of road from Kailua to the shore of Honokohau, Keaweiwi is the cantonier …
4. That section of road from Kukuioohiwai to Lanihau along the upland road, Isaac Kihe is the caretaker…

The work done along these sections is the cutting of brush – guava, lantana and such – which trouble the road, and the removal of bothersome stones… [HSA – Roads Hawaii; Kepā Maly, translator]

December 22, 1890
J. Kaelemkule; Supervisor, North Kona Road Board; to
C.N. Spencer, Minister of the Interior
[Reports on the cantoniers assigned to road work in various sections of North Kona. As in 1889, apparently no one was assigned to the lower Alanui Aupuni through the ʻOʻoma kula lands. Though Kaelemakule did include the road section on the land, extending through Kalaoa, on his attached diagram]:

…I forward to you the list of names of the cantoniers who have been hired to work on the roads of this district, totaling 15 sections; showing the alignment of the road and the length of each of the sections. The monthly pay is $4.00 per month, at one day of work each week. The board wanted to increase it totwo days a week, but if that was done, there would not have been enough money as our road tax is only $700.00 for this district… You will receive here the diagram of the roads of North Kona. [HSA – Roads Hawaii; Kepā Maly, translator] (Figure 14)

Twentieth Century Travel in ʻOʻoma and Neighboring lands of Kekaha

Kamaʻāina who have participated in oral history interviews, describe on-going travel between the uplands and coastal lands of ʻOʻoma and other *ahupuaʻa* in Kekaha. The primary method of travel between 1900 and 1947, was by foot or on horse or donkey, and those who traveled the land, were generally residents of the ʻOʻoma, Kalaoa, Kohanaiki Homesteads and other lands in the immediate vicinity. After World War II, retired military vehicles became available to the public, after that time, the *Alanui Aupuni* (Figure 15) and some of the smaller trails along the shore were modified for vehicular traffic.

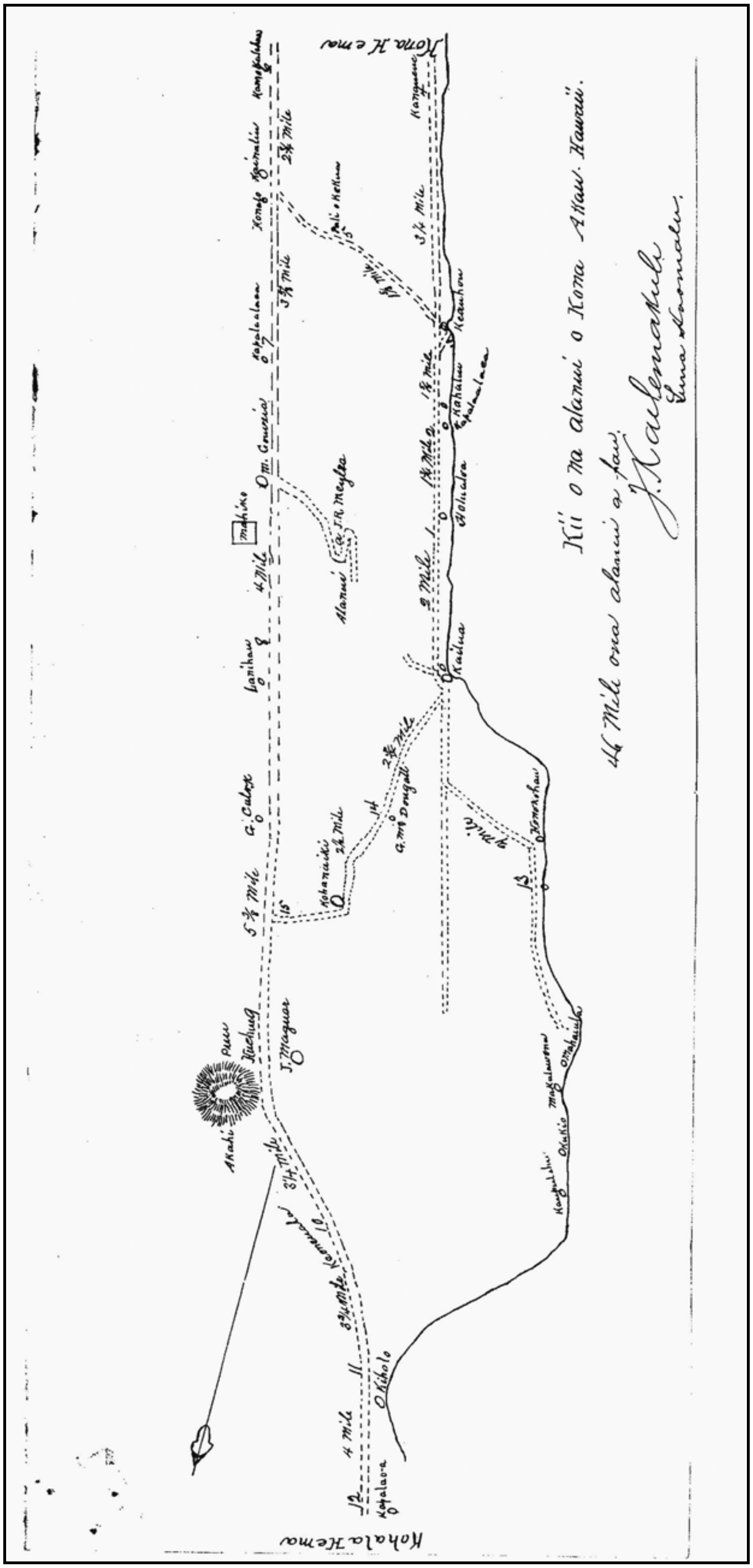


Figure 15. *Kii o na alanui o Kona Akau* (diagram of the roads of North Kona); J. Kaelemakule Sr., Road Supervisor (HSA – Roads, Hawaii; December 22, 1890).

Figure 16. Portion of the *Alanui Aupuni* crossing the *kula kai* lands of ʻOʻoma 2nd; view toward Kohanaiki.

The primary routes of travel through the 1960s, descended from upland Kohanaiki and Kaloko, or came out of Kailua. In the 1950s, Huʻehuʻe Ranch bulldozed a jeep road to the shore at Kaloko. The ranch, and some individuals who went to the shore either as a part of their ranch duties, or for leisure fishing along the coast, used this jeep road. The *Alanui Aupuni* was modified from Kailua, to at least as far as Honokōhau and Kaloko, and remained in use through the 1970s. It was not until the Queen Kaʻahumanu Highway was opened (ca. 1973) that travel across the *kula kai* (shoreward plains) of ʻOʻoma was once again made possible for the general public.

ORAL HISTORY INTERVIEWS

Information is presented from six oral history interviews that had been previously conducted by Kepā Maly of Kumu Pono Associates. One of these interviews was conducted in 1996 and the others between 2000 and 2003. Rechtman Consulting, LLC conducted five additional interviews, two in 2005, one in 2006, and two in 2007. Transcripts of the recorded interviews are available upon request and are archived with Rechtman Consulting, LLC. A more socially oriented, community–based public analysis was also conducted for the current proposed development (Preister 2007); the informal and formal interviews conducted for that analysis were conducted independently of the present study.

Interview Method

The oral-historical information was collected using a standard interview format that included the following process. Personal and demographic information about each interviewee was obtained, as well as the details about how she or he came to know the lands of ʻOʻoma and the larger Kekaha region. Information was obtained from the interviewee concerning the time and/or place of specific events they recalled The formal interviews were recorded, transcribed, and returned to the interviewees for review, correction, and release-approval. Copies of the final interview transcripts, along with the historical background and summary information were provided to each of the interviewees or their families. The informal interviews were conducted both in person on the land and over the telephone.

All of the interviewees had genealogical ties to early residents of lands within or adjoining the study area. Each is recognized within the community as being someone possessing specific knowledge of lore or historical wisdom pertaining to the lands, families, practices, and land use and subsistence activities in the region, and the older the informant, the greater the likelihood that the individual had personal communications or first-hand experiences with even older, now deceased Hawaiians and area residents.

Readers are asked to keep in mind that while this component of the study records a depth of cultural and historical knowledge of ‘O‘oma and the Kekaha region, by nature, the documentation is incomplete. In the process of conducting oral history interviews, it is impossible to record all the knowledge or information that the interviewees possess. Thus, the records provide only glimpses into the stories being told, and of the lives of the interview participants. Every effort has been made to accurately relay the recollections, thoughts and recommendations of the people who so openly shared their personal histories.

Interview Participants

All of the individuals that participated in the oral history interviews cited in this sudy are directly descended from traditional residents of ‘O‘oma and adjoining lands, and many of the personal recollections date back to the 1920s. The interviewees also benefited from the words of their own elders and extended family members, whose personal recollections dated back to the middle 1800s. Following is a summary of the interviewees.

Valentine K. Ako is of Hawaiian ancestry and was born at Hōlualoa in 1926. He currently resides on Kaua‘i. Interviewed in 1996, *kupuna* Ako visited families and fished at ‘O‘oma and neighboring lands of Kekaha (ca. 1930s-1940s). He is well known for his knowledge of Hawaiian fishing customs and fisheries, and is a member of several cultural committees.

George Kinoulu Kahananui Sr. is of Hawaiian ancestry and was born at Hōlualoa in 1925. Raised from infancy at ‘O‘oma 2nd, he continues to reside on old family land in ‘O‘oma. Uncle Kino regularly traveled the uplands and coastal lands of ‘O‘oma and Kekaha, learned of traditions and practices; and later managed the lands under Hu‘ehu‘e Ranch. He continues to fish on the coastal lands of ‘O‘oma and Kohanaiki. As a child he farmed the family lands that make up a portion of the current project area, a portion of which he retained ownership of until recently. Uncle Kino is well respected and known for his knowledge of the land, and is a valued resource on a number of cultural committees.

Elizabeth Maluihi Ako Lee is of Hawaiian ancestry and is the sister of Uncle Kino. Auntie Elizabeth was born in 1929 and was raised by her *hanai* family, Kahananui, in upland ‘O‘oma. As a child she walked the upland trails and cultivated sweet potatoes on her family land in ‘O‘oma 2nd Ahupua‘a, which are now part of the current project area. She is a well-respected *lauhala* weaver and retains valuable cultural knowledge.

Samuel Keanaaina is of Hawaiian ancestry and was born at Kolaoa in 1926, where he remains resident. Descendant of families with generational ties to various lands of the Kekaha region, including ‘O‘oma, *kupuna* Keanaaina regularly traveled the uplands and coastal lands of ‘O‘oma and Kekaha. He learned of traditions and practices of the families of the land, and was a fisherman in his youth.

Malaea Agnes Keanaaina-Tolentino (with daughter Cynthia Torres) is of Hawaiian ancestry and was born at Kolaoa in 1928. She currently resides in Kealakehe and is the Sister of Samuel Keanaaina, who shared in similar experiences as her brother. She was raised by her grandparents in Honokōhau Nui and as a youth she regularly traveled between the uplands and coastal lands of Honokōhau-Kaloko, Kalaoa-‘O‘oma and Kohanaiki. Kupuna Malaea has served on several cultural committees and is known for her knowledge of the land.

Ruby Keanaaina McDonald was born at Kalihi on O‘ahu in 1942 and moved to Kona when she was about six years old. *Kūpuna* Keanaaina and Malaea are her uncle and auntie. Ruby grew up with her aunties and uncles in Kona (*mauka* Kalaoa and Hōlualoa) and spent a lot of time with her *kūpuna* listening to their stories and later documenting the family geneology. As a child her experiences on the land in ‘O‘oma included stopovers at the family’s *kula* house (Kamaka homestead) on the way to the shore to gather and process *lauhala*. She currently works as the Office of Hawaiian Affairs liason for west Hawai‘i.

Peter Keka is of Hawaiian ancestry and was born at Waiki‘i in 1940. His family resided for years in the Kalaoa-Kohanaiki-Honokōhau vicinity, and he currently resides in Kohanaiki. Peter traveled the Kekaha region and fished at ‘O‘oma and neighboring lands. He has been employed by the National Park Service and was responsible for the restoration of the Kaloko-Honokōhau fishponds and other cultural sites in the park.

Peter Keikua‘ana Park was born at ‘O‘oma 2nd in 1918. He currently resides in Kalaoa 5th. He was also raised there from infancy by his maternal grandparents, Peter Kaawa and Kahanawale Kamaka. Until *kupuna* Park’s recent passing, he resided nearby in Kalaoa 5th.Although he grew up on his grandparents 10 acre homestead in the upland section of ‘O‘oma 2nd he regularly traveled with his grandparents to the coastal lands of ‘O‘oma. *Kupuna* Park described life on the lands and identified the elder families of ‘O‘oma and neighboring lands. He noted that there was much more eveidence of house sites and other features, some quite large, on the shores of ‘O‘oma when he was younger. He also shared important documentation pertaining to traditions associated with fishing and cultivation of the land. Kupuna Park’s elders were noted *lauhala* weavers, a craft that was passed on to him and his sisters, and was an activity that sustained their family. They collected *lauhala* from ‘Ohikapua on the *kula* lands of Kalaoa 5th. Kupuna Park was a noted weaver and resource for several cultural programs and his loss will be greatly felt. A summary of a recent informal interview conducted with *kupuna* Park on July 24, 2007 is attached as Appendix A to this report..

Summary of Oral-Historical Information

Elder *kama‘āina* of the Kekaha region, tell much the same story as that described in the communications from the period of homestead development, and in the accounts given by J. Puuokupa in 1875 and J.W.H. Isaac Kihe in 1924. By the late 1800s, only a few permanent residence remained along the ‘O‘oma (and Kekaha) coastline. Primary residences were in the uplands, in the vicinity of the old Māmalahoa Highway. In that region, people were able to cultivate a wide range of crops—both native staples and new introductions—with which to sustain themselves, and in some case even as cash crops.

By the middle to late 1800s, the *kula* lands, from around the 900-foot elevation to shore, were primarily used for goat, cattle, and donkey pasturage. The families of the uplands regularly traveled to the coast via trails. This was usually done to go fishing, or to round up cattle, goats, or donkeys. During periods of extreme dry weather, when water resources dried up, the families relied on the brackish water ponds in the near-shore lands. In ‘O‘oma, near Wawaloli, the area marked on J.S. Emerson’s Register Maps 1280 (see Figure 7), as Kama’s or Keoki Mao’s house, families still took shelter, and drank the water from the spring, through the 1940s. Such was the case at various locations of the coast, between Kohanaiki, ‘O‘oma, Kalaoa, Ho‘onā, Kaulana, and lands further north to Kapalaoa.

Near the coastline several sites were described and, during field visits, pointed out by *kūpuna* Peter Kaikuaana Park and George Kinoulu Kahananui. These are also described by other elder *kama‘āina*. The features included old goat and cattle corrals, old *kahua hale* (house sites), shelters, springs, burial sites, and fishery resources. Except for the old *mauka/makai* trail, the *Alanui Aupuni* (*makai* Government Road – “Old Māmalahoa Trail”), and walls, few other features were known by the interviewees on the lower *kula* lands (the area of the current proposed development). This is not surprising as the interviewees observed, when they were young, they were instructed not to wander around, and *maha‘oi* (poke their noses) into caves and such. Their primary interest while traveling *makai* was to get to the fishing ground, and in reverse, to get back home. In the region of the lower homestead lots (the area of the current project) and above, interviewees have described the occurrence of caves, walls, and various features, including burials. Occasionally, when working the range, rounding up cattle, *huaka‘i pō* or night marchers have been heard, or even seen. The explanation being that the people of old, who once lived on the land, were traveling the trails in one direction or the other to attend to some ceremony or to venture out on fishing journeys, or other such activities. Both Auntie Elizabeth Maluihi Ako Lee and George Kinoulu Kahananui described their family’s agricultural practices within portion of the current project area, and their father’s use of the *mauka/makai* trails to access the shore for fishing.

When asked about proposed development on the ‘O‘oma lands and in other locations of Kekaha, the interviewees all speak with hesitancy. It is difficult for them to see the landscape that they have known all their lives, and for which traditions were handed down, change. None of the interviewees shared any specific knowledge about traditional cultural resources and associated practices within the boundaries of the current project area. All interviewees believe that *ilina* (burial sites) should be preserved in place; likewise, should any *heiau*, or other important sites be located, they should be protected. Whenever possible all sites, such as house sites, petroglyphs, walls, and other features should be protected.

IDENTIFICATION AND MITIGATION OF POTENTIAL CULTURAL IMPACTS

The OEQC guidelines identify several possible types of cultural practices and beliefs that are subject to assessment. These include subsistence, commercial, residential, agricultural, access-related, recreational, and religious and spiritual customs. The guidelines also identify the types of potential cultural resources, associated with cultural practices and beliefs that are subject to assessment. Essentially these are nature features of the landscape and historic sites, including traditional cultural properties. In the Hawaiʻi Revised Statutes–Chapter 6E a definition of traditional cultural property is provided.

> "Traditional cultural property" means any historic property associated with the traditional practices and beliefs of an ethnic community or members of that community for more than fifty years. These traditions shall be founded in an ethnic community's history and contribute to maintaining the ethnic community's cultural identity. Traditional associations are those demonstrating a continuity of practice or belief until present or those documented in historical source materials, or both.

The origin of the concept of traditional cultural property is found in National Register Bulletin 38 published by the U.S. Department of Interior-National Park Service. "Traditional" as it is used, implies a time depth of at least 50 years, and a generalized mode of transmission of information from one generation to the next, either orally or by act. "Cultural" refers to the beliefs, practices, lifeways, and social institutions of a given community. The use of the term "Property" defines this category of resource as an identifiable place. Traditional cultural properties are not intangible, they must have some kind of boundary; and are subject to the same kind of evaluation as any other historic resource, with one very important exception. By definition, the significance of traditional cultural properties should be determined by the community that values them.

It is however with the definition of "Property" wherein there lies an inherent contradiction, and corresponding difficulty in the process of identification and evaluation of potential Hawaiian traditional cultural properties, because it is precisely the concept of boundaries that runs counter to the traditional Hawaiian belief system. The sacredness of a particular landscape feature is often times cosmologically tied to the rest of the landscape as well as to other features on it. To limit a property to a specifically defined area may actually partition it from what makes it significant in the first place. However offensive the concept of boundaries may be, it is nonetheless the regulatory benchmark for defining and assessing traditional cultural properties. As the OEQC guidelines do not contain criteria for assessing the significance for traditional cultural properties, this study will adopt the state criteria for evaluating the significance of historic properties, of which traditional cultural properties are a subset. To be significant the potential historic property or traditional cultural property must possess integrity of location, design, setting, materials, workmanship, feeling, and association and meet one or more of the following criteria:

A Be associated with events that have made an important contribution to the broad patterns of our history;

B Be associated with the lives of persons important in our past;

C Embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; or possess 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 accounts—these associations being important to the group's history and cultural identity.

While it is the practice of the DLNR-SHPD to consider most historic properties significant under Criterion D at a minimum, it is clear that traditional cultural properties by definition would also be significant under

Criterion E. A further analytical framework for addressing the preservation and protection of customary and traditional native practices specific to Hawaiian communities resulted from the *Ka Pa'akai O Ka'āina* v Land Use Commission court case. The court decision established a three-part process relative to evaluating such potential impacts: first, to identify whether any valued cultural, historical, or natural resources are present; and identify the extent to which any traditional and customary native Hawaiian rights are exercised; second, to identify the extent to which those resources and rights will be affected or impaired; and third, specify any mitigative actions to be taken to reasonably protect native Hawaiian rights if they are found to exist.

As a result of the several archaeological studies (Barrera 1985, 1989, 1992; Cordy 1985, 1986; Donham 1987; Rechtman 2002, 2007; Rosendahl 1989; Walker and Rosendahl 1990) that have been conducted within the current project area, nine historic properties or portions thereof (Table 1) are recognized by DLNR-SHPD to retain the potential to be impacted by the proposed development activities. These impacts could be direct, as the result of development activities; or indirect, resulting from increased access and site visitation traffic. Preservation is the DLNR-SHPD approved treatment for all of these.

Table 1. Historic properties that might be impacted by the proposed development activities.

SIHP No.	*Function*	*Temporal Association*	*Significance*	*Treatment*
2	Trail	Precontact	A, C, D, E	Preservation
1910	Habitation	Precontact	C, D, E	Preservation
1911	Habitation	Precontact/Historic	D	Preservation
1912	Habitation	Precontact	D, E	Preservation
1913*	*Heiau*	Precontact	D, E	Preservation
10155	Habitation	Precontact	D	Preservation
18027*	Habitation	Precontact	D, E	Preservation
18773	Burial	Precontact	D, E	Preservation
25932	Burial	Preconatct	D, E	Preservation

* portions of both of these sites are included in the archaeological preservation area established on the NELHA property to the north.

The two sites containing burials (SIHP Site 18773 and 25932), which are significant under both Criterion D and Criterion E, will be preserved pursuant to a burial treatment plan prepared in consultation with recognized descedants and the Hawai'i Island Burial Council. The seven other preservation sites, considered significant under multiple criteria, will be treated in accordance with a preservation plan submitted to and approved by DLNR-SHPD prior to final subdivision approval. Development activities will not commence until the site protection measures and stewardship aspects of these preservation plans are implemented. Two of these sites (SIHP Sites 1913 and 18027) are direct extensions of sites that exist to the north on state (NELHA) land, and the several others are part of the larger continuous archaeological landscape that remains for coastal 'O'oma. NELHA has committed to preserving a significant portion of this landscape (15 acres), and the developers of the current project area are committed to spatially extending that preservation commitment. In a effort to reduce direct impacts to significant cultural resources, as part of the NELHA preservation plan the coastal jeep road may in the near future be closed to vehicular traffic, as a more direct public access route for the "Pine Trees" recreational area is developed in neighboring Kohanaiki. The developers of the current project area will support this road closure, if and when it occurs.

While there were no specific ongoing traditional cultural practices identified relative to the land within the proposed development area, there are potential cultural impacts, both specific and nonspecific, related to coastal and near-shore subsistence and recreational activities, primarily among beachgoers, fisherman, and surfers. As these activities could be characterized as traditional and customary practices, the locations of these activities could thus be considered traditional cultural properties and as such would be significant under Criterion E. As the proposed development will in no way inhibit coastal access, and as most of the proposed development elements are significantly setback a minimum of 1,100 feet from the shoreline, it is envisioned that the protection and preservation of the 'O'oma shoreline will be enhanced; and that no traditional and customary practices will be impacted. One additional resource deserves consideration, as it is associated with traditional practices. During their botanical survey of the study area Terry and Hart (2006) identified stands of *pilo* (*Capparis sandwichiana*), which is used in traditional Hawaiian medicine. While there is no evidence that this plant is currently being collected within the study area, *pilo* habitat could be conserved and the plants made available to cultutral practitioners.

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Traffic Impact Assessment Report

Traffic Impact Analysis Report
‘O‘oma Beachside Village

Kaloko, North Kona, Island of Hawai‘i, Hawai‘i

Tax Map Key Number *(3)7-3-009: 004 & 022*

MAY 2008

Prepared for:

‘O‘oma Beachside Village, LLC

Prepared by:

M&E Pacific, Inc.

METCALF & EDDY | AECOM

Davies Pacific Center, 841 Bishop Street
Suite 1900, Honolulu, Hawai‘i 96813

‘O‘OMA BEACHSIDE VILLAGE

‘O‘oma, North Kona, Hawai‘i

Traffic Impact Analysis Report

TMK: (3)7-3-9: 004 and 022

May 2008

WARREN M. YAMAMOTO
LICENSED PROFESSIONAL ENGINEER
NO. 3893–C
HAWAII, U.S.A.

Expiration Date:
April 30, 2010

This Traffic Impact Analysis Report has been conducted and prepared by the undersigned professional engineer licensed in the State of Hawai‘i in accordance with the best practices of the industry.

Signature
M & E Pacific, Inc.
METCALF & EDDY | AECOM

May 7, 2008
Date

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TRAFFIC IMPACT ANALYSIS REPORT
for the
‘O‘OMA BEACHSIDE VILLAGE

‘O‘oma Beachside Village, a 302.38-acre residential and commercial mixed use community, is being planned at ‘O‘oma, North Kona, Hawai‘i. This report documents a study that was conducted to identify the traffic impacts of the proposed community and to recommend any mitigating measures.

PROJECT DESCRIPTION

‘O‘oma Beachside Village LLC intends to develop a 302.38-acre property (the Property) at ‘O‘oma, North Kona, Hawai‘i. The Property is comprised of a:

- 217.566-acre parcel identified by TMK (3)7-3-009:004 (Parcel 4);
- 83-acre parcel identified by TMK (3)7-3-009:022 (Parcel 22); and
- 1.814-acre portion of the State-owned Right-of-Way (ROW) located on by TMK (3)7-3-009: (State ROW).

The Property is on the *makai* side of Queen Ka‘ahumanu Highway about two miles south of the Kona International Airport at Keahole. Other major cross streets in the vicinity include Ka‘iminani Drive and the entrance to the Natural Energy Laboratory of Hawai‘i Authority (NELHA) to the north, and Huliko‘a Drive (the entrance to the Kohanaiki Business Park) and Hina Lani Street to the south. The Property’s location relative to these other roadway facilities is shown on **Figure 1**.

‘O‘oma Beachside Village is planned to include the following:

- Approximately 950 to 1,200 homes, including:
  - Single family units,
  - Multi-family units, and
  - “Live-work” units with commercial uses on the ground floor and residential uses above.
- Approximately 200,000 square feet of commercial space, including:
  - Space for a small grocery store,
  - Restaurants, and
  - Retail and office space.
- A private or charter school site.
- A public beach park, including a community pavilion.

Construction of ‘O‘oma Beachside Village is expected to begin in 2011 (with first occupancy projected in 2012) and will continue through approximately 2029. For the purpose of this analysis ‘O‘oma Beachside Village is roughly divided into three areas: Area A, Area B, and Area C, as shown on **Figure 2**. The development of each area could overlap into other areas at any one time. For the purpose of this analysis, the projection is to deliver about 20-40 single family residential units, 30-50 multi-family residential units, and 10-25,000 square feet of commercial space per year.

The study analyzed three forecast years to comply with the Concurrency Conditions of County of Hawai‘i Ordinance 07-99 which requires analyses for 5, 10, and 20 year forecasts. This study analyzed years 2015, 2020, and 2029 corresponding to 7, 12, and 21 year forecasts. The number of project components which were assumed to be occupied by each analysis year for purposes of conducting the traffic impact analysis is summarized on **Table 1**. The actual development schedule for the ‘O‘oma Beachside Village could deviate from the schedule shown on **Table 1**.

The State of Hawai‘i Department of Transportation (HDOT) is currently preparing for the second phase of widening of the Queen Ka‘ahumanu Highway to four lanes from Honokohau Harbor to the Kona International Airport at Keahole, with completion of construction currently scheduled for 2011. HDOT intends to restrict access to the widened highway and permit fully accessible signalized intersections only at Kealakehe Parkway (the harbor access road), Hina Lani Street, Huliko‘a Drive (Kohanaiki), Ka‘iminani Drive, and Keahole Airport Road. The developments on the *makai* side of the highway may be permitted right turn in, right turn out movements onto the highway. For this study, it was assumed that ‘O‘oma Beachside Village would have such an access.

‘O‘oma Beachside Village would also be serviced by a frontage road that would have connections to fully accessible signalized intersections. This frontage road would extend from Huliko‘a Drive at Kohanaiki Industrial subdivision (crossing Queen Ka‘ahumanu Highway into the Shores of Kohanaiki and resulting in a full, four-way intersection) to the Keahole Airport Road, and would allow vehicles from connecting makai projects direct access to the airport without having to enter the highway. The frontage road alignment has not been determined but it is not expected to be a high speed design roadway. Within ‘O‘oma Beachside Village there would be urban land uses and several intersecting streets along the roadway as traffic calming measures. ‘O‘oma Beachside Village would also be served by a transit stop.

EXISTING CONDITIONS

A survey of the existing roadway and traffic conditions was made in September 2006.

Existing Roadways

The main roadways currently in the study area include Queen Ka‘ahumanu Highway, Ka‘iminani Drive, the NELHA access road, Huliko‘a Drive, and Hina Lani Street.

Queen Ka‘ahumanu Highway is the primary arterial highway on the west side of the island of Hawai‘i. The highway passes through the North Kona and South Kohala districts and connects Kailua Village with the Kona International Airport, the Kohala resort areas, and Kawaihae. It is a two-lane Class I State Highway with limited access and a design speed of 70 miles per hour. Intersections on this highway are fully channelized and signalized where warranted, including the Ka‘iminani Drive and Hina Lani Street intersections.

Ka‘iminani Drive is a collector road within a 60-foot right-of-way that provides *mauka-makai* access between Queen Ka‘ahumanu Highway and Mamalahoa Highway and provides access to the Kona Palisades subdivision.

The NELHA access road and Huliko‘a Drive provide access to two separate industrial parks and their intersections with the highway are channelized but not signalized.

Hina Lani Street is a two-lane County secondary arterial road within an 80-foot right-of-way. It provides *mauka-makai* access between Queen Ka‘ahumanu Highway and Mamalahoa Highway and serves the Kaloko Light Industrial Subdivision at its *makai* end.

Traffic Volumes

Traffic turning movement counts were taken at the Hina Lani Street and Ka‘iminani Drive intersections on Queen Ka‘ahumanu Highway during the morning and afternoon peak periods on September 12 and 14, 2006. Traffic turning movement counts require a traffic surveyor to observe traffic flow and record the movements of each vehicle crossing the intersection as through or turning movements by 15 minute intervals. The worksheets from these traffic counts are included in **Appendix A**.

The resultant morning and afternoon peak hour traffic volumes are shown on **Figure 3**, with volumes for two consecutive morning and afternoon peak hours shown. The volumes are rounded to the nearest five vehicles per hour (vph). The northbound direction of traffic on Queen Ka‘ahumanu Highway south of Hina Lani Street is higher in the first hour of the morning peak, then about equal to the southbound flow in the second hour. The northbound volumes north of Ka‘iminani Drive are higher for both peak hours. This reflects the commute of workers from Kona to the Kohala resort area in the early morning, followed by the commute of workers to Kailua later in the morning. During the afternoon peak, the southbound volumes south of Hina Lani Street are about equal to the northbound volumes in the first hour while the northbound volumes are much higher in the second hour. The southbound volumes north of Ka‘iminani Drive are higher during both afternoon peak hours. Long traffic queues in the southbound lane were observed for short periods in the early afternoon period due to backup of traffic from Kailua Village. The existing traffic operations at the study intersections are discussed in the **Level of Service Analysis** section of this report.

The HDOT took metered traffic counts at selected locations on Hawai‘i Island roadways in even numbered years. Station T-8-M is located on Queen Ka‘ahumanu Highway 850 feet north of the NELHA access roadway. HDOT has converted this station to a telemetry station that provides continuous traffic data. The data from the previous counts and the average weekday daily traffic volumes for 2006 provides the historic trend in daily traffic volumes on the highway over a 14 year period ending in 2006. The biannual change in two way daily traffic volumes on Queen Ka‘ahumanu Highway is shown in tabular and graph form on **Figure 4**. Queen Ka‘ahumanu Highway shows a 94% increase in traffic volumes over the 14 year period, which corresponds to a 4.8% compounded annual growth rate.

The pattern of hourly traffic volumes on Queen Ka‘ahumanu Highway on June 1, 2004, is shown in tabular and graph form on **Figure 5**. Separate curves are shown for the northbound and southbound traffic volumes. The northbound traffic volumes are higher than the southbound volumes for the first two hours of the morning. The southbound traffic volumes are higher for most of the afternoon hours except the last two hours.

PROPOSED ROADWAY IMPROVEMENTS

The HDOT and County of Hawai‘i have many roadway improvements planned to meet the expected growth in the area. The “Keahole to Honaunau Regional Circulation Plan County Action Plan” (August 2006) prepared by the County of Hawai‘i Planning Department identifies several specific improvements pertinent to this study. Those improvements include the widening of Queen Ka‘ahumanu Highway from Henry Street to the airport and the development of an extensive roadway network *mauka* of the highway.

The HDOT is currently widening the highway from two to four lanes from Henry Street to Kealakehe Parkway under Phase 1 of the widening project which is expected to be completed in 2008. The second phase is expected to be completed by 2011 and would extend the four lane design past the airport access roadway. The project would also add a northbound bicycle lane and a southbound bicycle route/paved shoulder lane.

The new roadway network mauka of the highway would create more *mauka-makai* roadways between Queen Ka‘ahumanu Highway and Mamalahoa Highway and create more north-south roadways between and parallel to these two existing highways. The three important north-south roadways include the Kealaka‘a Street Extension, Ane Keohokalole Highway Extension, and Main Street (Kamanu Street) Extension. Their net effect would be the diversion of trips from the existing highways.

A timetable for the development of these new roadways has not been established but would be tied in to new projects being built along the roadway alignments. The draft Kona Community Development Plan has developed a list of roadway projects in this area:

- Keanalehu Street-Manawale‘a Street connection
- Ane Keohokalole Highway Extension (Mid-level road) in stages from Palani Road to Ka‘iminani Drive
- Kamanu Street Extension
- Kealakaa Street Extension
- Hienaloli Street Extension
- University Drive
- Frontage Road
- Queen Ka‘ahumanu Highway widening, Phase II

TRAFFIC FORECASTS

The three forecast years for the ‘O‘oma Beachside Village are 2015, 2020, and 2029. During the three periods, the ambient or background traffic on Queen Ka‘ahumanu Highway can be expected to increase due to regional growth and new projects in the area. The traffic patterns in the study area would also change as new roadways are placed in operation. The traffic that would be generated from the ‘O‘oma Beachside Village was added to the ambient traffic forecast to obtain the total with project traffic forecast.

Ambient Traffic Forecast

The results of several traffic impact analysis reports for proposed projects in the area were analyzed to develop ambient traffic forecasts on Queen Ka‘ahumanu Highway at Ka‘iminani Drive, the NELHA access roadway, Huliko‘a Drive, and Hina Lani Street for the three forecast years. The forecast procedures and summary results for each study intersection are described below.

Ka‘iminani Drive - The traffic forecasts prepared by Rowell for UH Center at West Hawai‘i Main Street Collector Road (June 2006) were used for the 2015 forecast. Other projects included in the forecast were the Makalei Estates, Palamanui and Lokahi Subdivision. Very large traffic increases were forecast for the two intersecting roadways since the mauka network of roadways were not assumed to be well developed by 2015. Also, traffic flows became significantly northbound in the AM and southbound in the PM. For the 2020 ambient traffic forecast, the 2015 traffic volumes at Ka‘iminani Drive were increased by 1.3% for the five year period. This represents a 4.83% annual growth but with 20% of the growth being routed to the by then more defined mauka roadway network. Then for 2029, the 2020 volumes were increased by 5% over the nine year period. This represents a 4.83% annual growth with 28% being routed to the mauka roadways. For each planning year, the through volumes were continued to the NELHA access road intersection. The current and ambient forecast inbound and outbound traffic volumes are summarized as follows.

YEAR	AM PEAK HOUR		PM PEAK HOUR	
	INBOUND	OUTBOUND	INBOUND	OUTBOUND
2006	155	720	595	145
2015	440	1,015	1,290	445
2020	445	1,025	1,305	450
2029	470	1,070	1,375	470

NELHA Roadway – Traffic counts were taken on the NELHA access road in 2002 by HDOT. There is a sharp peak inbound peak in the morning and a sharp outbound peak in the afternoon with less than 100 vph in the peak direction. Most of the volumes in the other hours were low. Entering and exiting peak hour volumes were increased by 3% annually as follows:

YEAR	AM PEAK HOUR		PM PEAK HOUR	
	INBOUND	OUTBOUND	INBOUND	OUTBOUND
2002	86	28	41	87
2006	96	31	46	97
2015	120	39	57	121
2020	132	43	63	134
2029	153	50	73	155

These volumes were then distributed as shown below reflecting the increasing urbanization of the area north of the Property:

YEAR	PERCENT DISTRIBUTION BY DIRECTION OF TRAVEL	
	INBOUND	OUTBOUND
2015	45%	55%
2020	48%	52%
2029	50%	50%

Huliko‘a Drive – Two separate projects are planned on the mauka and makai sides of the highway at this intersection. Only inbound and outbound traffic forecasts were made for these two projects.

The existing Kohanaiki Business Park is accessed by Huliko‘a Drive on the mauka side of the highway. This intersection is currently unsignalized but there are plans to make this a fully accessible signalized intersection with the highway widening project. In lieu of traffic counts, the traffic forecast prepared by Pacific Planning and Engineering, Inc., in 1991 for the Kohanaiki Mauka project was updated for the current land use classifications and trip generation rates. The business park project was assumed to be fully occupied by 2015 and the results of this analysis were assumed to be constant for the three forecast years as follows:

	AM PEAK HOUR				PM PEAK HOUR			
	INBOUND		OUTBOUND		INBOUND		OUTBOUND	
YEAR	North	South	North	South	North	South	North	South
2006	65	95	95	65	35	50	90	135
2015	125	190	130	195	65	100	180	270
2020	125	170	130	175	65	90	170	240
2029	125	170	130	175	65	90	170	240

For the purposes of this study, the existing 2006 volumes were assumed to be half of the 2015 forecasts. The south inbound and outbound volumes were reduced slightly for 2020 and 2029 since the Kamanu Street Extension would intersect the northern terminus of Huliko‘a Drive and provide an alternate route to the south, thereby diverting some trips.

The Shores of Kohanaiki is planned for the makai side of the highway. Its access road would intersect the highway across from Huliko‘a Drive and form the west leg of the fully accessible, signalized intersection. The access road would also serve as the southern terminus for the makai frontage road. A letter report prepared by Julian Ng, Inc., in 2003 discussed the trip generation characteristics of the Shores of Kohanaiki project with proposed new land uses (500 dwelling units, an 18-hole golf course, and

120 parking stalls for public beach access). The Shores of Kohanaiki has been approved and is expected to be in place by 2015. Only entering and exiting volumes were forecast for each analysis year:

PEAK HOUR	VEHICLE TRIPS/HOUR	
	INBOUND	OUTBOUND
AM	125	290
PM	465	235

The trips were distributed north and south on the highway and a small portion of trips was assumed to use the makai frontage road to access the airport. The through volumes on the highway were forecast at the Hina Lani Street intersection and continued to Huliko‘a Drive.

Hina Lani Street – For 2015, the existing 2006 through and turning volumes were increased by 1.529, which is the 4.83% annual growth rate compounded for 9 years. For 2020, the through volumes were increased by 1.3% similar to Ka‘iminani Drive, however turning volumes for 2020 from the TIAR prepared by Fehr & Peers/Kaku Associates for the Kula Nei Residential Development were used. This forecast also included the traffic which would be generated by the proposed Kaloko Heights subdivision. For 2029, the 5% growth factor used at Ka‘iminani Drive was also used here. The through traffic forecasts were carried to the Huliko‘a Drive intersection. The current and ambient forecast inbound and outbound traffic volumes are summarized below:

YEAR	AM PEAK HOUR		PM PEAK HOUR	
	INBOUND	OUTBOUND	INBOUND	OUTBOUND
2006	490	560	620	580
2015	740	860	960	975
2020	900	1,205	1,130	935
2029	930	1,050	1,215	995

The results of the ambient traffic forecasts are shown on **Figure 6** with the frontage road assumed in place. The AM peak hour forecasts for the three forecast years are shown on the first page of the figure, while the PM peak hour forecasts are shown on the second page. The NELHA access road was assumed to provide right turn in, right turn out access to the highway.

Project Generated Traffic

The traditional three-step process of trip generation, trip distribution, and trip assignment was used to forecast future traffic that would be generated by ‘O‘oma Beachside Village. The trip generation step forecasts the number of new trips that would be produced during each of the two study periods. The trip distribution step allocates these new trips by direction of travel. Finally, the trip assignment step assigns the trips to the specific turning movements at the study intersections.

The trip generation step forecasts the volume of vehicle trips that would be generated by ‘O‘oma Beachside Village during the morning and afternoon peak periods. The Institute of Transportation Engineers’ Trip Generation Report (Seventh Edition, 2003) has rates to calculate the number of morning and afternoon peak hour trips that would be generated by various land uses.

An initial step was to correlate the land uses proposed in ‘O‘oma Beachside Village with the land uses included in the Trip Generation Report that would have similar trip generation characteristics. The results of this analysis are summarized on Table 1 and are discussed below:

- The single family residential units utilized the equations/rates for single family detached housing (ITE land use 210).
- All multi-family residential units including the mixed use and live-work units were assumed to be low-rise condominiums/town houses (ITE land use 231) that are described as residential units that have at least one other unit located in the same building that has one or two levels.

- The makai mixed use village commercial area was assumed to be retail-oriented and was classified as a shopping center (ITE land use 820). The mauka mixed use/live-work village was assumed to be an office park (ITE land use 750). The ITE report describes the latter as suburban subdivisions or planned unit developments containing general office buildings and support services such as banks, restaurants, and service stations, arranged in a park-like setting. This was the closest land use to the suburban neighborhood commercial center envisioned for this proposed project.
- The charter school was assumed to have the trip generation characteristics of a private school with grades K-8 (ITE land use 534) and having 225 students.
- The grocery store was assumed to be a 15,000 sf supermarket (ITE land use 850).
- The restaurant and private canoe club was assumed to be a 20,000 sf quality restaurant (ITE land use 931) with turnover rates usually of one hour or longer.
- There are no trip generation rates for a public beach use. Based on the previously referenced letter report by Ng, the following number of beach use trips were forecast:

	HOURLY TRIPS			
YEAR	**AM PEAK HOUR**		**PM PEAK HOUR**	
	INBOUND	**OUTBOUND**	**INBOUND**	**OUTBOUND**
2015	50	10	20	50
2020	60	15	25	60
2029	70	20	25	70

The trip generation analysis for each land use in each analysis year is detailed on **Table 2**, including the trip generation equations and rates from the ITE report.

The Trip Generation Report also provides the percentage of inbound and outbound trips in each peak hour. The number of generated trips was divided into inbound and outbound trips based on the information from the report, as shown on **Table 2**.

The first forecast year (2015) of ‘O‘oma Beachside Village is summarized on the first page of **Table 2**, and it would generate 187 outbound and 131 inbound trips in the morning peak hour, and 310 inbound and 243 outbound trips in the afternoon peak hour. The second analysis year (2020) is summarized on the second page and it would generate 445 outbound and 421 inbound trips in the morning peak hour and 656 inbound and 701 outbound trips in the afternoon peak hour. The third analysis year (2029) is summarized on the third and fourth pages and it would generate 884 outbound and 906 inbound trips in the morning peak hour and 1,023 inbound and 1,128 outbound trips in the afternoon peak hour.

The project generated trips were then distributed by three primary direction of travel to and from the Property: north and south of the Property, and internal to the Property. The distribution of external trips was determined from the current distribution of population and employment in West Hawai‘i. The districts closer to the Property were weighted higher due to the propensity for shorter trips to be made more frequently. This analysis indicated that the current weighted population and employment distributions are 55% south and 45% north. These proportions were assumed for the employment distribution in all three forecast years. The proportion of population to the north was assumed to be 45% in 2015, 48% in 2020, and 50% in 2029, reflecting the trend of urbanization to the north. The morning outbound residential trips and the afternoon inbound trips were distributed based on the employment distribution. The distribution of population was used for all other trips. The percentage of internal trips were initially calculated for the non-residential land uses, and made to balance the corresponding resident-generated trips. The trip distribution rates also considered that a portion of the trips from the live-work units and to a smaller extent, the mixed use units, would not be made outside of ‘O‘oma Beachside Village and the proportion of internal trips were increased accordingly.

The results of the trip distribution analysis are shown on **Table 3** with the 2015 results on the first page, the 2020 results on the second page, and the 2029 results on the third page. The residential land uses were combined into a single land use for this calculation. Similarly, the two mixed-use village commercial uses and the live-work commercial use were combined together.

The project generated traffic volumes were assigned to the highway and frontage road network with movements as permitted. The results of the traffic assignment analysis are shown on **Figure 7** with the volumes not rounded.

A unique aspect of trips attracted by commercial centers is that a number of these trips are pass-by trips. Pass-by trips are attracted from traffic passing the site on an adjacent roadway having direct access to the commercial center. Therefore, these trips do not add to the through volumes on the roadway. They are added to the turning movements but are subtracted from the through movements where they turn off to access the commercial center. The commercial areas of ‘O‘oma Beachside Village are not expected to draw pass-by trips in the morning peak hour but would attract some pass-by trips in the afternoon peak hour, especially trips stopping for shopping purposes. These trips are shown as negative volumes on the trip assignments (**Figure 7**).

Total Forecast Volumes

The project generated traffic assignment volumes from **Figure 7** were added to their corresponding ambient traffic forecasts from **Figure 6** to obtain the total with project traffic forecasts shown on **Figure 8** for each forecast year. The traffic volumes are rounded to the nearest five vph.

LEVEL OF SERVICE ANALYSIS

The traffic forecast volumes in themselves do not indicate the quality of traffic operations. The concept of level of service is used to quantify the quality of traffic flow on roadway facilities. The Transportation Research Board (TRB) has developed procedures to calculate level of service value(s) by measuring traffic volumes against the capacities of different types of roadway facilities. Their Highway Capacity Manual 2000 (HCM2000) describes the various procedures developed for freeways, highways, signalized and unsignalized intersections, etc.

A variety of methodologies was used to analysis existing and forecast traffic conditions. The methodology for analyzing signalized intersections was used for the Ka‘iminani Drive, Huliko‘a Drive, and Hina Lani Street intersections. The methodology for analyzing unsignalized intersections was used for the existing NELHA access road and Huliko‘a Drive intersections. The methodology for analyzing highway on-ramps was used for the future right turn out movement at the NELHA and ‘O‘oma Beachside Village access roads. Finally, separate methodologies for analyzing two-lane and multi-lane highways were used for the current and forecast highway conditions fronting the Property.

Signalized Intersection Analysis

The Ka‘iminani Drive, Huliko‘a Drive and Hina Lani Street study intersections are/will be signalized. The methodology for analyzing signalized intersections calculates the levels of service for individual movements, approaches, and the intersection as a whole based on the average stopped delay per vehicle. The results range from level of service A (best with average delays less than ten seconds) to F (worst with average delays longer than 80 seconds, described as follows.

LEVEL OF SERVICE	CONTROL DELAY PER VEHICLE (Seconds/Vehicle)
A	< 10.0
B	10.1 to 20.0
C	20.1 to 35.0
D	35.1 to 55.0
E	55.1 to 80.0
F	> 80.1

The County of Hawai‘i considers levels of service A to D as acceptable by ordinance with levels of service E and F indicating the need for mitigating measures. As a matter of practice, the major streets of signalized intersections can be designed to have a higher level of service than the side streets or turning lanes with the latter having unacceptable levels of service in order to maintain an acceptable level of service on the main road. These unacceptable levels of service are often times caused by long waits for the green traffic signal phase rather than by capacity problems and are indicated by low values of the volume/capacity (V/C) ratio as described below.

The results of the signalized intersection level of service analysis for the Queen Ka‘ahumanu Highway intersections with Ka‘iminani Drive, Huliko‘a Drive, and Hina Lani Street are shown on **Tables 4, 5,** and **6,** respectively. Each table is for a single intersection and includes the results for the AM (morning) and PM (afternoon) peak hours for the intersection as a whole, each approach of the intersection, and the left turn, through and right turn movements of each approach. The results are shown for the 2006 existing conditions (for Ka‘iminani Drive on **Table 4** and for Hina Lani Street on **Table 6**) and the years 2015, 2020, and 2029 forecasts, with ambient without project and total with project results for each forecast year. The specific results data shown for each year includes the level of service (LOS), average stopped delay (DEL) and volume/capacity ratio (V/C), which is a percentage utilization of the traffic signal green time given the entire intersection and each movement. The level of service calculation worksheets are provided in **Appendix B**.

Queen Ka‘ahumanu Highway/Ka‘iminani Drive – The results of the signalized intersection level of service analysis for the Queen Ka‘ahumanu Highway/Ka‘iminani Drive intersection are shown on **Table 4**. The intersection is currently operating at an acceptable level of service B in the AM peak hour. With the large increases in traffic volumes forecast for 2015 ambient conditions, the Ka‘iminani Drive westbound approach would require two left turn lanes to maintain the acceptable levels of service. The frontage road approach is forecast to operate at level of service F due to the long wait for the green phase and not capacity problems, as evidenced by the low V/C ratio. The additional traffic generated by ‘O‘oma Beachside Village would cause the Ka‘iminani Drive approach to change from level of service D to E, but the intersection would continue to operate at level of service D. Similarly, the intersection levels of service would remain at acceptable levels for the 2020 and 2029 forecast years, although individual and approach levels could be at unacceptable levels.

The intersection is currently operating at an acceptable level of service B in the PM peak hour. As with the AM peak hour, the Ka‘iminani Drive westbound approach would require two left turn lanes by 2015 to maintain the acceptable levels of service for the ambient traffic forecast. The large traffic increases forecast for 2020 and 2029 would require additional mitigation in the form of two southbound left turn lanes and two northbound right turn lanes to maintain the intersection level of service D for both ambient and total with project conditions. The AM peak hour forecasts would not require these additional improvements but the AM peak hour results shown on **Table 4** do include these mitigating measures. As with the AM peak hour, several approaches/individual movements may have to operate at unacceptable levels of service to maintain an acceptable intersection level of service.

The analysis for the Queen Ka‘ahumanu Highway/Ka‘iminani Drive intersection indicates that this intersection could operate at acceptable levels of service with mitigation measures for the ambient traffic forecasts. These include having double left turn lanes on the Ka‘iminani Drive westbound approach by 2015, and double left turn lanes on the highway southbound approach and double right turn lanes on the highway northbound approach by 2020. Additional mitigating measures would not be required to accommodate traffic generated from ‘O‘oma Beachside Village.

Queen Ka‘ahumanu Highway/Huliko‘a Drive – The results for the Queen Ka‘ahumanu Highway/Huliko‘a Drive intersection are shown on **Table 5.** There is no existing analysis since the intersection is not currently signalized. The intersection is forecast to operate at an acceptable level of service C for the three ambient forecast years in the AM peak hour, although several individual movements would be at unacceptable levels. The AM peak hour 2029 ambient traffic forecast shows a double left turn lane for the northbound highway approach since it would be required for the PM peak hour condition.

The AM peak hour 2015 and 2020 total with project traffic forecasts shows a double left turn lane for the northbound highway approach since it would be required for the PM peak hour condition. With the additional traffic generated by ‘O‘oma Beachside Village in 2020 the intersection level of service would change from C to D, which is considered an acceptable level of service. The additional project generated traffic in 2029 would require a double left turn lane on the northbound highway approach to maintain the intersection level of service D. The long delays on the Huliko‘a Drive approaches are due to the long cycle lengths and not capacity problems, as noted by the low V/C ratios.

The PM peak hour has higher volumes and worse levels of service as a result. The intersection is forecast to operate at an acceptable level of service D for the three forecast year ambient conditions, although the 2029 forecast would require a double left turn lane on the northbound highway approach as a mitigating measure to maintain the intersection level of service D. The intersection levels of service for the 2015 and 2020 total with project forecasts could be maintained at D with a double left turn lane on the northbound highway approach. Additional mitigation in the form of double left turn lanes on the Huliko‘a Drive westbound approach would be needed to accommodate the 2029 total with project forecast.

The analysis for the Queen Ka‘ahumanu Highway/Huliko‘a Drive intersection indicates that this intersection would be impacted by traffic generated from ‘O‘oma Beachside

Village and would require mitigation to operate at acceptable levels of service. These measures include having double left turn lanes on the Queen Ka‘ahumanu Highway northbound approach by 2015, and double left turn lanes on Huliko‘a Drive westbound approach by 2029.

The level of service analysis indicated that the Huliko‘a Drive intersection would operate at an acceptable level D for the volumes forecast with the large conflicting volumes of southbound through traffic and northbound left turns. This assumes that sufficient traffic would be diverted to the mauka roadway network. If the highway volumes are higher than forecast due to insufficient traffic being diverted to the mauka roadway network or other unforeseen reasons, then the intersection could operate at unacceptable levels of service. As a contingency measure for this possibility, the “Michigan U-turn” should be considered as a supplemental mitigating measure to divert turning traffic movements from the intersection and reduce the conflicting movements.

The Michigan U-turn requires a U-turn facility in the highway median in concert with a right turn in, right turn out access roadway so that left turns are not made. Exiting left turns from the access roadway would make a right turn onto the highway, merge across highway traffic into the left-most lane, then make a U-turn on the highway median facility, and then proceed in the opposite direction from which they started. Similarly, incoming left turns would proceed on the opposite side of the median past the access road, make a U-turn on the highway median facility, then merge across highway traffic into the right-most lane, and then make a right turn into the access roadway. A Michigan U-turn on Queen Ka‘ahumanu Highway for the ‘O‘oma Beachside Village would eliminate some of the crossing and turning movements at the Ka‘iminani Drive and Huliko‘a Drive intersections and make them work more efficiently. The two median U-turn facilities would be located between the ‘O‘oma Beachside Village and Huliko‘a Drive and between the ‘O‘oma Beachside Village and NELHA access road. The second facility could be located further north between the NELHA access road and Ka‘iminani Drive to include NELHA in the Michigan U-turn.

Queen Ka‘ahumanu Highway/Hina Lani Street – The results of the signalized intersection level of service analysis for the Queen Ka‘ahumanu Highway/Hina Lani Street intersection are shown on **Table 6**. The intersection is currently operating at an acceptable level of service C in both peak hours, and is forecast to operate at a still acceptable level of service D for the 2015 ambient without project and total with project forecasts. The development of the mauka residential projects would generate the need for a double left turn lane on the westbound approach of Hina Lani Street by 2020. The additional traffic generated by the ‘O‘oma Beachside Village would not require any additional mitigation. Hence, the ‘O‘oma Beachside Village is not expected to contribute to adverse traffic impacts at the Hina Lani Street intersection until after 2020. However, the additional project generated traffic would require mitigation in 2029 to maintain acceptable level of service for the intersection. A double left turn lane on the southbound highway approach would improve the intersection level of service to C.

Signalized Intersection Conclusions – The preceding level of service analysis indicated the need for mitigating measures to accommodate the project generated traffic by 2029. This need should be considered as speculative due to the uncertainties associated with such a long forecast period, including regional development projects and *mauka* roadway plans that may or may not be actually accomplished. Contingencies should be made to implement these measures while recognizing that their needs may not actually occur.

Unsignalized Intersection Analysis

The NELHA access road and Huliko‘a Drive intersections are currently unsignalized. The procedure used for analyzing unsignalized intersections calculates vehicle delays and levels of service based on the distribution of gaps in traffic on the major street and driver judgment in selecting gaps through which to execute turns. For two-way stop intersections where only the minor street traffic is controlled by a stop sign, levels of service are calculated for the critical turning movements, including outbound movements from the stop-controlled approach and left turns from the major street to the minor street. The procedure does not calculate an overall intersection level of service.

The Highway Capacity Manual defines the relationship between level of service and delay (in seconds/vehicle) for unsignalized intersections as shown below:

LEVEL OF SERVICE	DELAY (Seconds/Vehicle)
A	< 10.0
B	10.1 to 15.0
C	15.1 to 25.0
D	25.1 to 35.0
E	35.1 to 50.0
F	> 50.1

The County of Hawai‘i considers levels of service A to D as acceptable for unsignalized intersections. Level of service F (with average delays longer than 50 seconds) is considered undesirable for unsignalized intersections and indicates the possible need for mitigation at that intersection.

The results of current operations at the two current unsignalized intersections are shown on **Table 7**. The critical movement at each intersection is the outbound left turn. Based on the estimated current volumes at each intersection, this movement at the NELHA access road intersection is at level of service F in the AM and E in the PM peak hour. Similarly, this movement at the Huliko‘a Drive intersection is at level of service F in both peak hours. These results indicate the current need for mitigating measures at both intersections. The level of service calculation worksheets are provided in **Appendix C**.

No future study intersections were analyzed as unsignalized intersections since none are expected to operate as unsignalized intersections.

Highway On-Ramp Analysis

The access roadways serving ‘O‘oma Beachside Village and NELHA are expected to be unsignalized and limited to right turn in, right turn out movements. The methodology for analyzing highway on-ramps was used instead of an unsignalized intersection analysis since the right turn lane would have adequate acceleration and taper lengths to perform like a highway on-ramp. The methodology for analyzing on-ramps calculates maximum flow rates in passenger cars/hour/lane based on the volumes of highway/roadway and merging traffic, and roadway capacities, and then calculates levels of service based on density as follows:

LEVEL OF SERVICE	DENSITY (passenger car/mile/lane)
A	$\leq$ 10
B	> 10 - 20
C	> 20 - 28
D	> 28 - 35
E	> 35
F	Demand > Supply

The results of the on-ramp analysis are summarized on **Table 8** for the total with project forecasts only. For each of the three forecast years, both access roads (for ‘O‘oma Beachside Village and NELHA) are calculated to operate at levels of service B in the AM peak hour and C in the PM peak hours, indicating acceptable levels of service in both analysis periods. This indicates that the traffic generated by ‘O‘oma Beachside Village would not have an adverse traffic impact on this aspect of the highway operations. The level of service calculation worksheets are provided in **Appendix D**.

Highway Analysis

Queen Ka‘ahumanu Highway is currently a two-lane highway that the HDOT is currently widening to a four multi-lane highway. Separate methodologies and criteria are used for calculating levels of service for these two distinct highway types.

The ideal (maximum) capacity of a two-way, two-lane highway is 1,700 passenger car equivalents per hour per lane, and 3,200 passenger car equivalents per hour for both directions of travel. This is lower than the capacity of a multi-lane highway that can range from 2,000 to 2,200 passenger car equivalents per hour per lane. The analysis procedure for two-way, two-lane highways takes into account the more restrictive aspects of its operations relative to wider multi-lane highways. The procedure considers the impact of geometric data: lane width, shoulder width, type of terrain, free flow speed, percent no passing zones; and demand characteristics: volumes, percent of heavy vehicles; as some of the inputs. For Class I highways like Queen Ka‘ahumanu Highway where efficient mobility is important and drivers expect to drive at relatively high speeds, level of service is defined in terms of both percent time spent following other vehicles and average travel speeds. The level of service criteria for Class I two-lane highways are shown below:

LEVEL OF SERVICE	PERCENT TIME SPENT FOLLOWING	AVE. TRAVEL SPEED (Miles/Hour)
A	< 35	> 55
B	>35 to 50	>50 to 55
C	>50 to 65	>45 to 50
D	>65 to 80	>40 to 45
E	> 80.0	<40

The methodology for analyzing multi-lane highways calculates several criteria based on the capacity and design characteristics of the highway and traffic volumes. There are several sets of criteria for levels of service based on the free flow speed of the highway. The criteria for a 55 mph free flow speed (FFS) are summarized as follows.

	LOS CRITERIA FOR 55 MPH FFS				
CRITERIA	**A**	**B**	**C**	**D**	**E**
Maximum Density (passenger car /mile/lane)	11	18	26	35	41
Average speed (mph)	55.0	55.0	54.9	52.9	51.2
Max. Volume/Capacity Ratio (V/C)	0.29	0.47	0.68	0.88	1.00
Max. Service Volume Flow Rate (passenger car/hour/lane)	600	990	1,430	1,850	2,100

The results of the highway analysis are shown on **Table 9**. The first line shows that the existing two-lane highway is currently operating at level of service E in both peak periods, primarily due to the high percentage of time spent following other cars and the lack of opportunity to pass slower vehicles. The remaining lines show the results for the ambient without project and total with project forecasts for southbound traffic fronting the Property. With the highway widening, the highway is calculated to operate at levels of service B in the AM peak hours and C in the PM peak hours, indicating acceptable levels of service in both analysis periods. There is no difference between the ambient without project and the total with project results, indicating that the traffic generated by ‘O‘oma Beachside Village would not have an adverse traffic impact on this aspect of the highway operations. The level of service calculation worksheets are provided in **Appendix E**.

CONCLUSIONS

The widening of Queen Ka‘ahumanu Highway and the development of the mauka roadway network would accommodate much of the anticipated growth in the North Kona region. The highway system is expected to operate at acceptable levels of service in the forecast future.

The ‘O‘oma Beachside Village is not expected to have a fully accessible intersection connection with the widened Queen Ka‘ahumanu Highway; however, the right turn in, right turn out access roadway intersection is expected to operate at acceptable levels of service in the forecast future.

The ‘O‘oma Beachside Village is planned to include a frontage road makai of and parallel to Queen Ka‘ahumanu Highway. This frontage road would allow access to fully accessible intersections at Ka‘iminani Drive and Huliko‘a Drive, where vehicles traveling from and to ‘O‘oma would be able to make left turns onto and from the highway, respectively. These intersections would require mitigating actions to accommodate the ambient forecast traffic. The additional traffic generated by the ‘O‘oma Beachside Village would require further mitigating measures to maintain acceptable levels of service at the Huliko‘a Drive and Hina Lani Street intersections including the following:

- Huliko‘a Drive - a double left turn lane on the northbound highway approach by 2015.

- Huliko‘a Drive - a double left turn lane on the westbound approach by 2029.
- Hina Lani Street - a double left turn lane on the southbound highway approach by 2029.

However, the need for mitigating measures to accommodate the project generated traffic by 2029 should be considered as speculative due to the uncertainties associated with such a long forecast period, including: 1) whether or not other development projects in the region are built or are built with as many units as currently anticipated; 2) the implementation of the mauka roadway network as currently planned and how much turning movement traffic is diverted to the mauka roadway system as it is completed; and 3) the level of mitigating measures that would be imposed on other development projects that could mitigate the impact of ambient traffic. Contingencies should be made to implement these measures while recognizing that their needs may not actually occur. The right turn in, right turn out access roadway intersection and highway system are expected to operate at acceptable levels of service in the forecast future.

References

References

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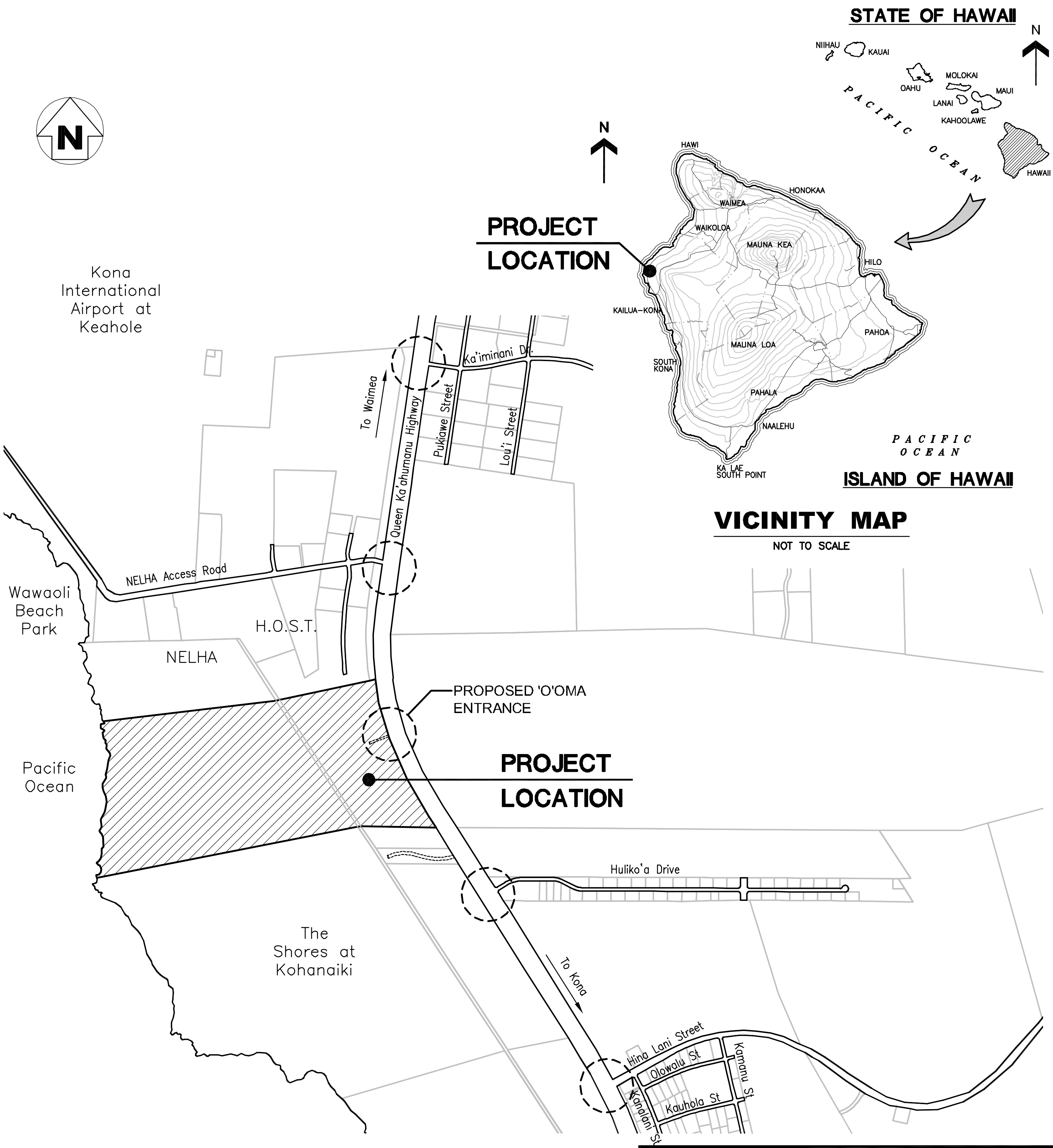
Figures



LOCATION MAP

NOT TO SCALE

STUDY INTERSECTIONS

M&E Pacific, Inc.

METCALF&EDDY | AECOM

DAVIES PACIFIC CTR, STE 1900 · 841 BISHOP ST, HONOLULU, HAWAII 96813

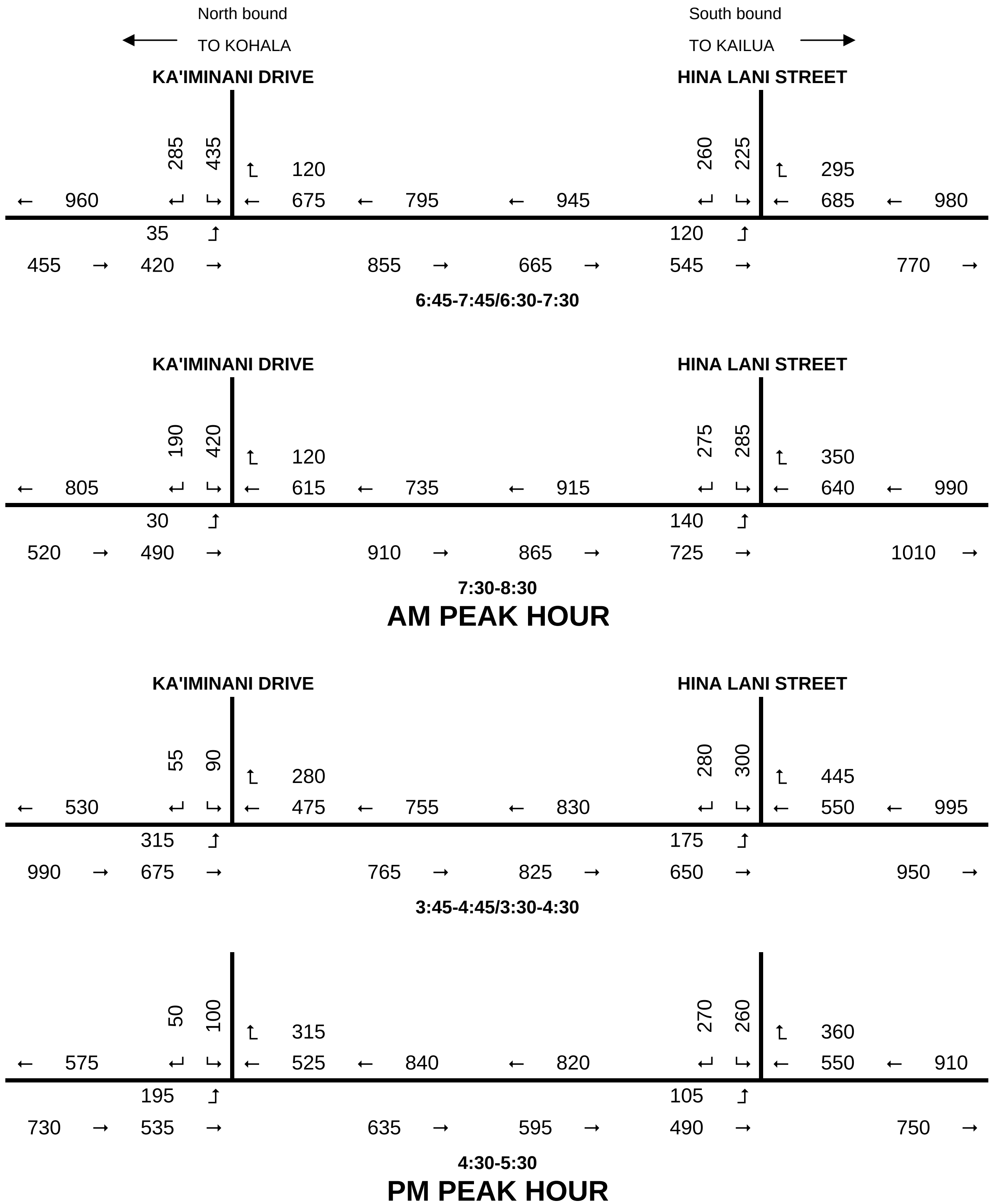
Figure 1
Location Map
Traffic Impact Analysis Report
'O'oma Beachside Village
May 2008

M&E Pacific, Inc.

METCALF & EDDY | AECOM

DAVIES PACIFIC CTR, STE 1900 · 841 BISHOP ST, HONOLULU, HAWAII 96813

Figure 2
Conceptual Master Plan
Traffic Impact Analysis Report
'O'oma Beachside Village
May 2008



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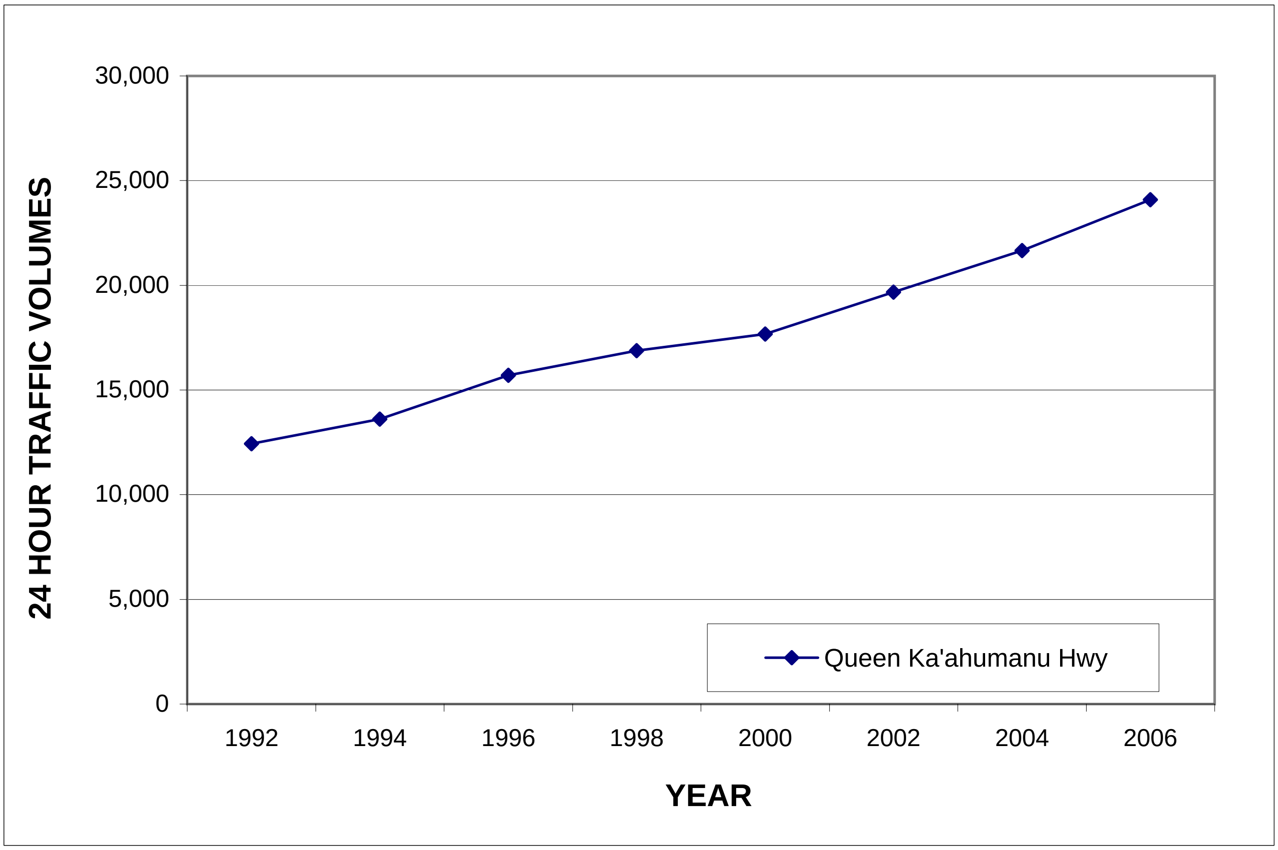
2006 EXISTING TRAFFIC VOLUMES
FIGURE 3

TWO-WAY DAILY TRAFFIC VOLUMES	
YEAR	QUEEN KA'AHUMANU HWY
1992	12,432
1994	13,610
1996	15,709
1998	16,882
2000	17,670
2002	19,678
2004	21,654
2006	24,085

*Average Weekday Daily Traffic

Source: State of Hawai'i Department of Transportation

Station T-8-M, June 1, 2004



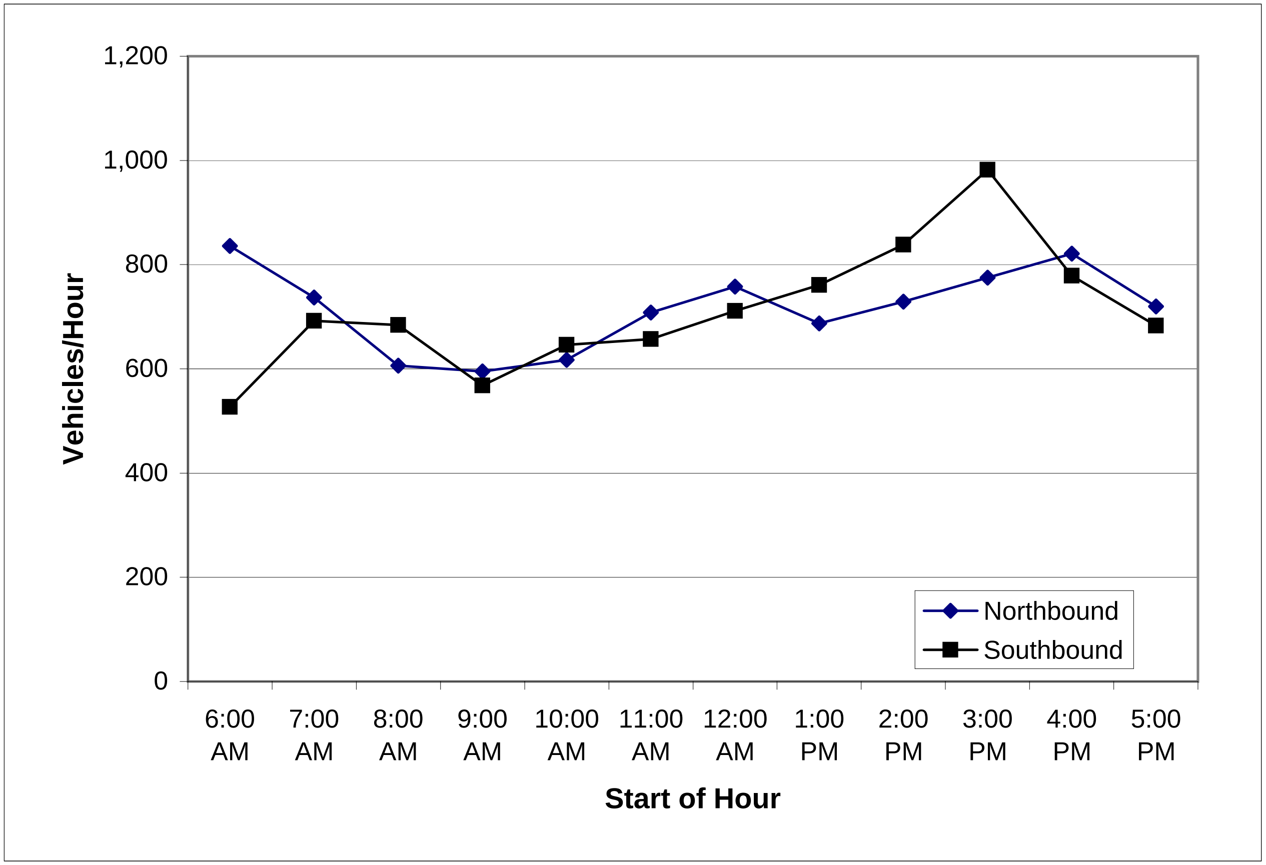
HISTORICAL TREND IN DAILY TRAFFIC VOLUMES ON QUEEN KA'AHUMANU HIGHWAY AT NELHA ACCESS ROAD

FIGURE 4

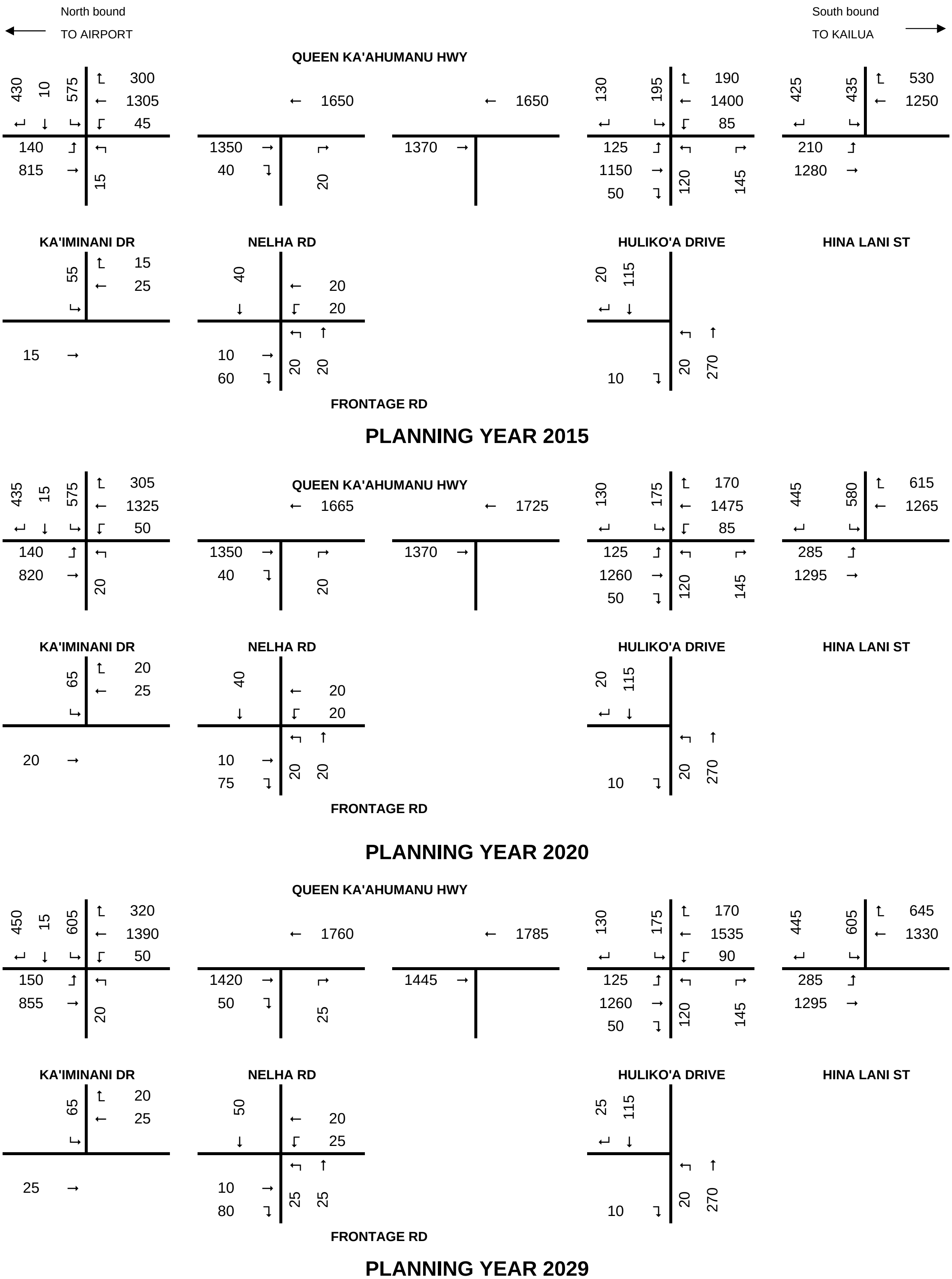
HOURLY TRAFFIC VOLUMES ON QUEEN KA'AHUMANU HIGHWAY
AT STATION T-8-M, North of NELHA access road, June 1, 2004

Vehicles/Hour		
Start of Hour	North-Bound	South-Bound
6:00 AM	836	527
7:00 AM	737	692
8:00 AM	606	684
9:00 AM	595	568
10:00 AM	617	646
11:00 AM	708	657
12:00 AM	758	711
1:00 PM	687	761
2:00 PM	729	838
3:00 PM	775	982
4:00 PM	821	779
5:00 PM	720	683

Source: State of Hawaii
Department of Transportation



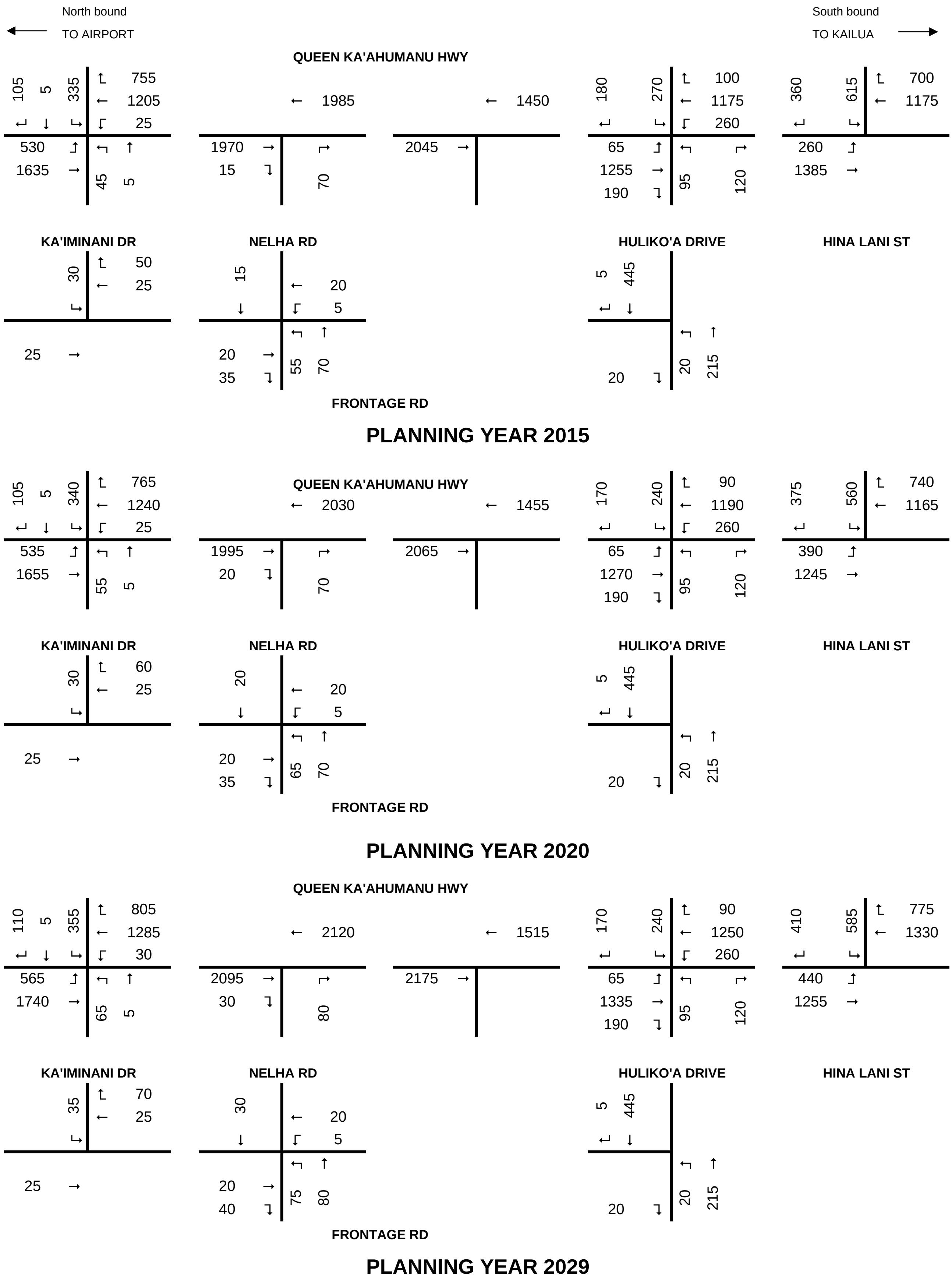
HOURLY TRAFFIC VOLUMES ON
QUEEN KA'AHUMANU HIGHWAY AT NELHA ACCESS ROAD
FIGURE 5



AM PEAK HOUR

Not To Scale

AMBIENT TRAFFIC FORECAST
FIGURE 6



PM PEAK HOUR

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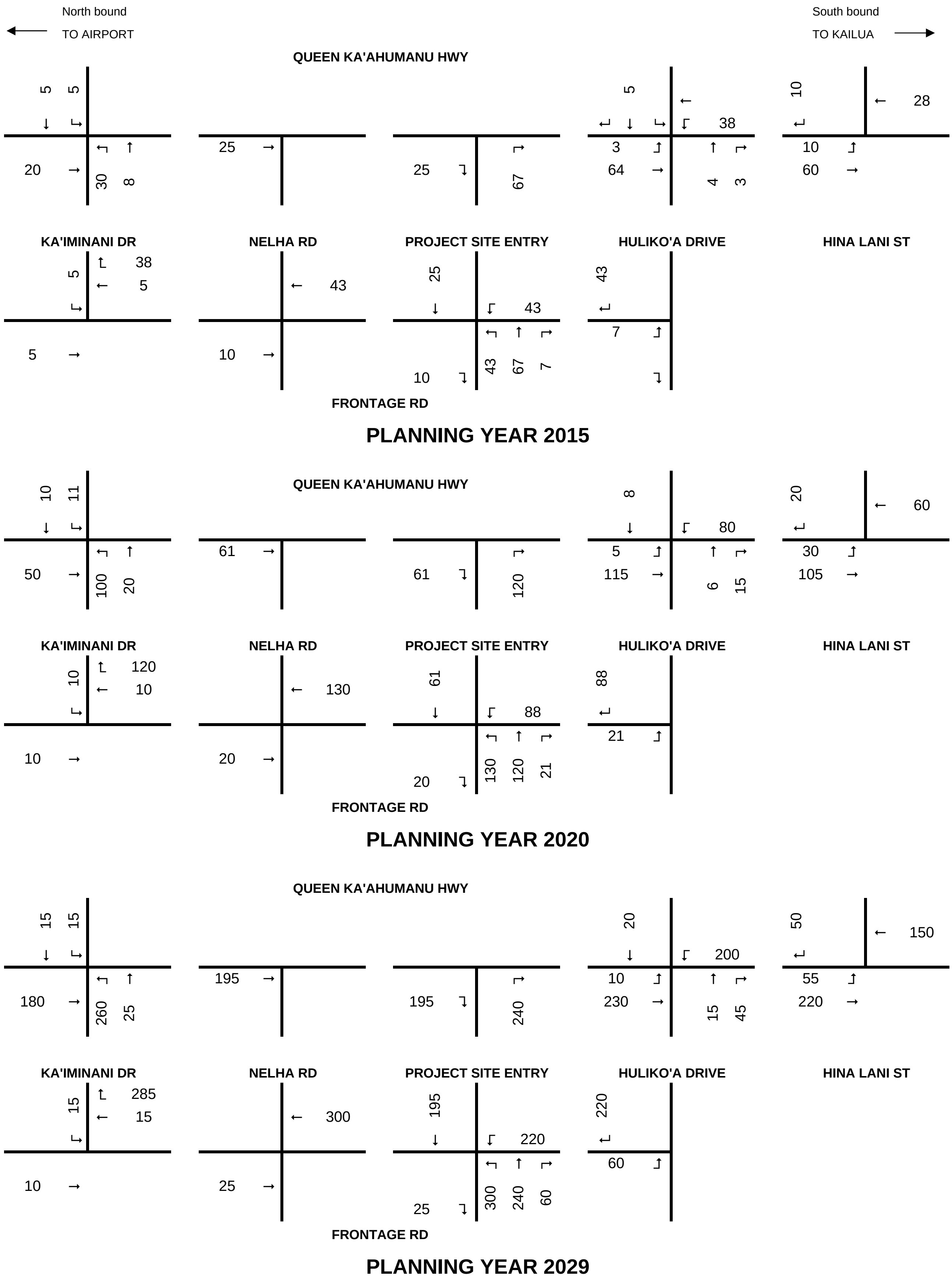
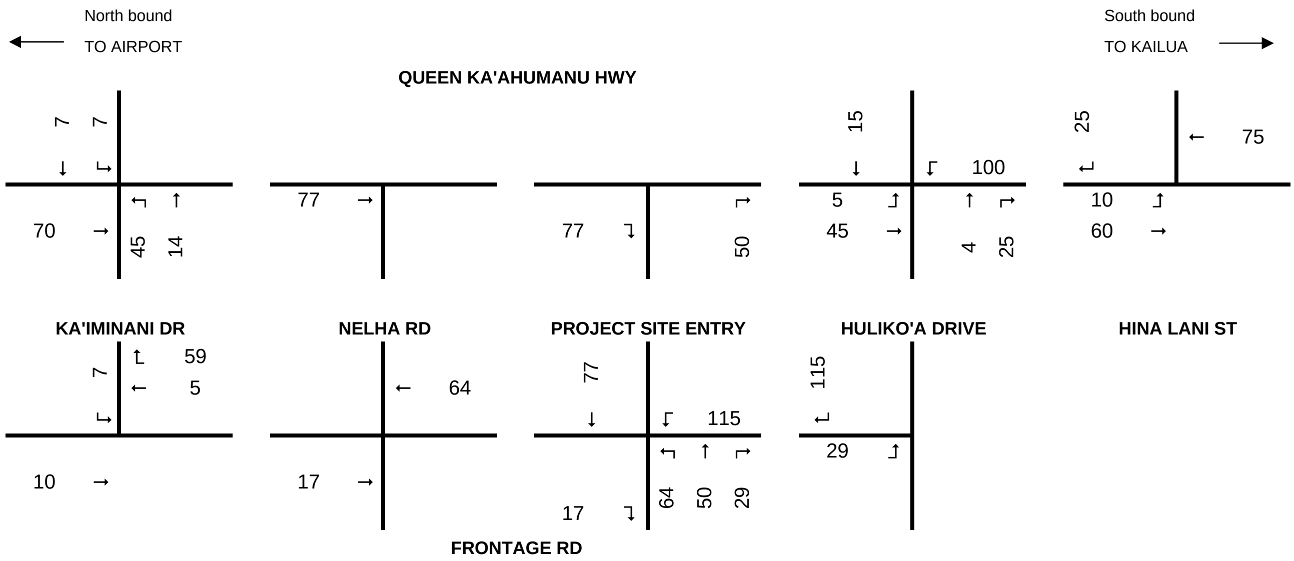
AMBIENT TRAFFIC FORECAST
FIGURE 6



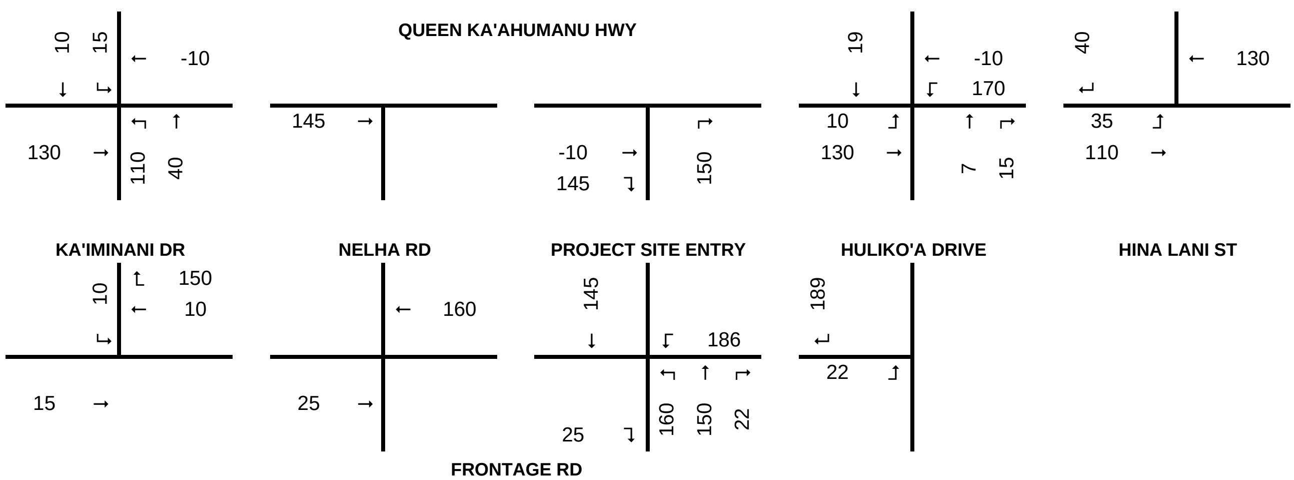
AM PEAK HOUR

Not To Scale

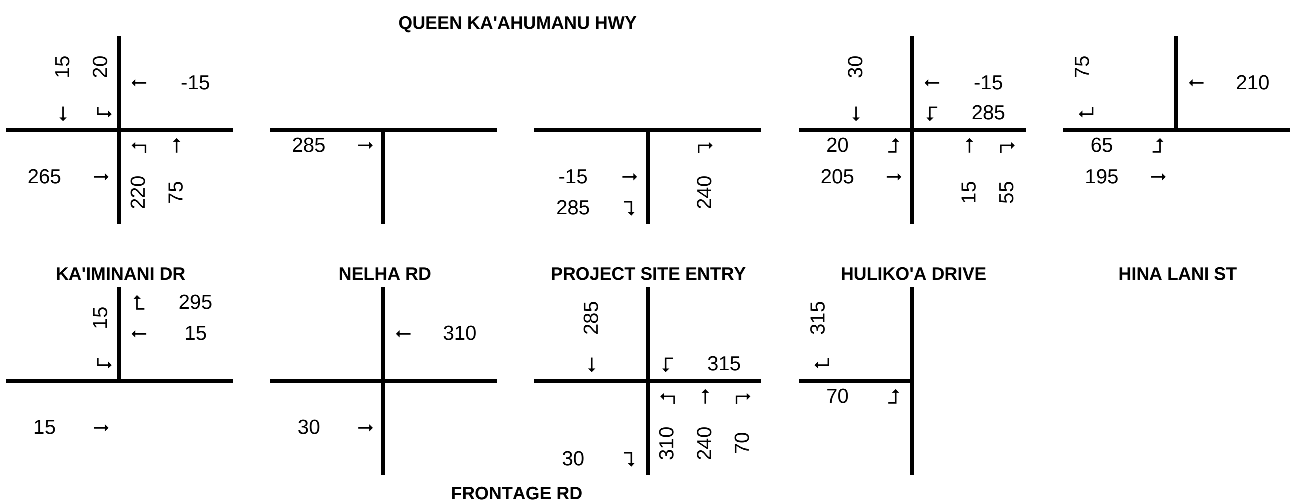
PROJECT GENERATED TRAFFIC ASSIGNMENT
FIGURE 7



PLANNING YEAR 2015



PLANNING YEAR 2020

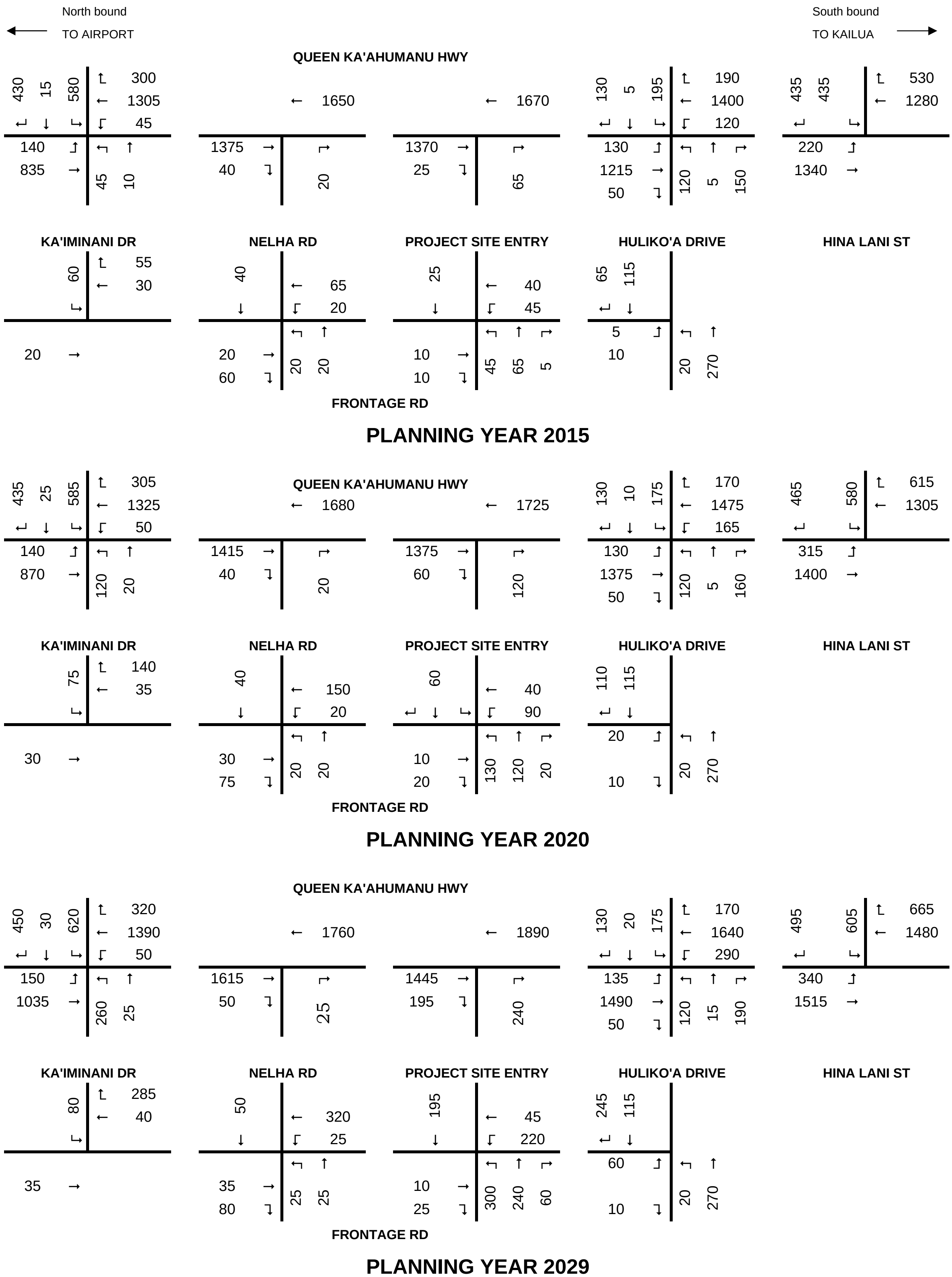


PLANNING YEAR 2029

PM PEAK HOUR

Not To Scale

PROJECT GENERATED TRAFFIC ASSIGNMENT
FIGURE 7



AM PEAK HOUR

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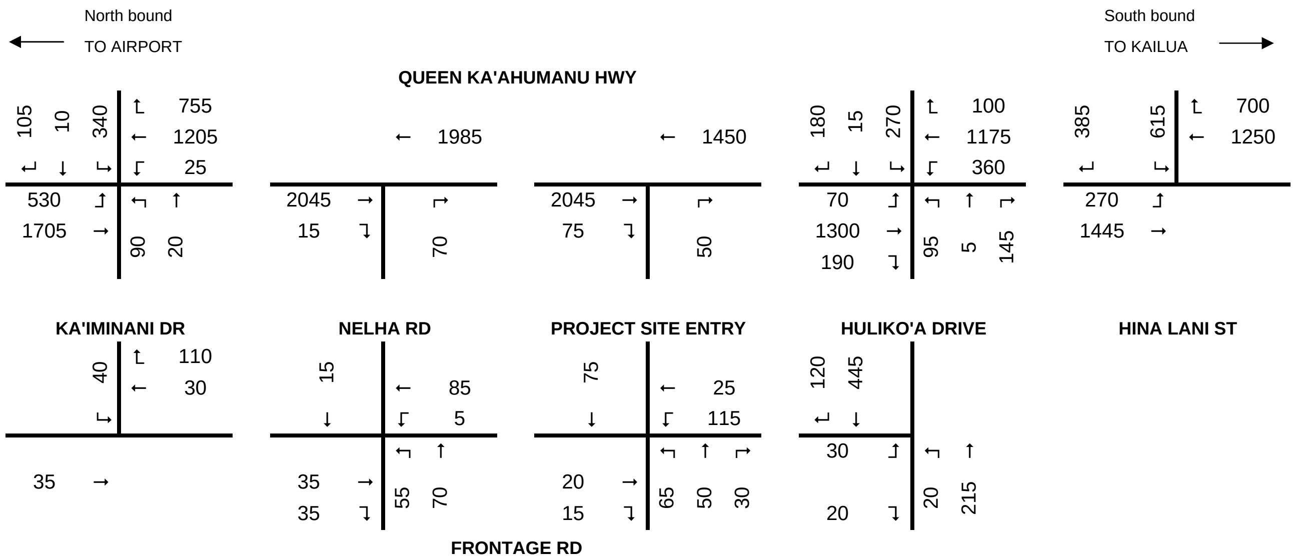
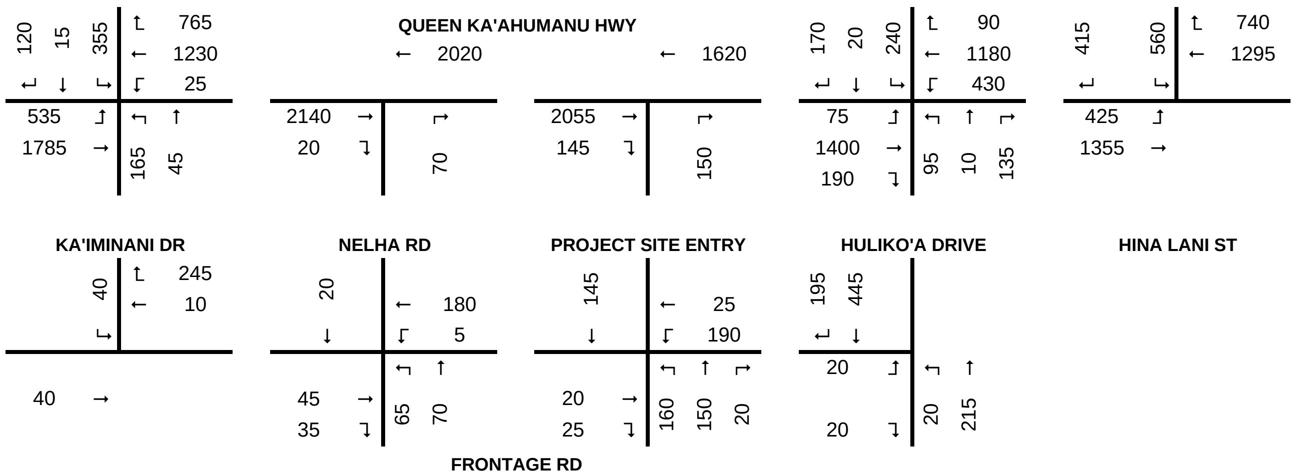
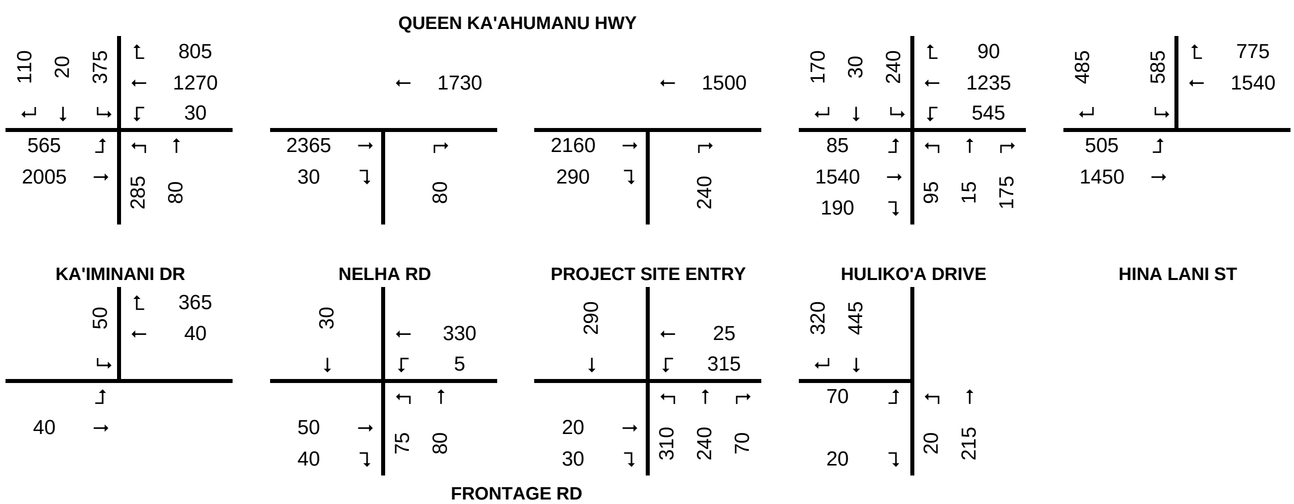
TOTAL WITH PROJECT FORECAST
FIGURE 8



PLANNING YEAR 2015



PLANNING YEAR 2020



PLANNING YEAR 2029

PM PEAK HOUR

Not To Scale

TOTAL WITH PROJECT FORECAST
FIGURE 8

Tables

TABLE 1
PROJECT MILESTONE SCHEDULE

LAND USE	PLANNING YEAR MILESTONE			TG REPORT LAND USE
	2015	2020	2029	
	Cumulative Number of Units			
Single Family DU Residential	120	275	475	SFDU (210)
Multi-family DU Residential	115	355	715	Low-rise Townhome (231)
TOTAL RESIDENTIAL	**235**	**630**	**1,190**	
Makai Village - MU Commercial (sf)	30,000	30,000	30,000	Shopping Center (820)
Restaurant & Canoe Club (sf)	20,000	20,000	20,000	Quality Restaurant (931)
TOTAL COMMERCIAL - Area A (sf)	**50,000**	**50,000**	**50,000**	
Mauka Village - MU&LW Commercial (sf)	0	35,000	135,000	Office Park (750)
Grocery Store (sf)		15000	15,000	Supermarket (850)
TOTAL COMMERCIAL - Area B (sf)	**0**	**50,000**	**150,000**	
Charter School (students)			225	Private School (534)
Public Beach Clubhouse (ac)	1	1	1	Constant assumed

Proposed development schedule assumed for forecasting project generated traffic.
This schedule does not reflect the actual project development schedule.

TABLE 2
TRIP GENERATION ANALYSIS

TIME PERIOD Land Use	Cumulative Units		Trip Generation Equation	Ln(T)	T = Number of Trips	Direction of Travel	Percent	Number of Trips
PLANNING YEAR 2015								
WEEKDAY AM PEAK HOUR								
Single Family Residential	120	units	T = 0.7(x) + 12.05		96	Enter	26%	25
						Leave	74%	71
MF & Mixed Use Vill Residential	115	units	T = 0.88(x) - 49.7		115	Enter	25%	29
						Leave	75%	86
Mixed Use Commercial (Area A)	30	ksf GLA	T = 1.03(X)		31	Enter	61%	19
						Leave	39%	12
Restaurant	20	ksf GLA	T = 0.81(X)		16	Enter	50%	8
						Leave	50%	8
Public Beach Clubhouse						Enter		50
						Leave		10
TOTAL						**Enter**		**131**
						Leave		**187**
WEEKDAY PM PEAK HOUR								
Single Family Residential	120	units	Ln(T)=0.89Ln(X)+0.61	4.87	130	Enter	64%	83
						Leave	36%	47
MF & Mixed Use Vill Residential	115	units	T = 0.78(X)		90	Enter	58%	52
						Leave	42%	38
Mixed Use Commercial (Area A)	30	ksf GLA	T = 3.75(X)		113	Enter	48%	54
						Leave	52%	59
Restaurant	20	ksf GLA	T = 7.49(X)		150	Enter	67%	100
						Leave	33%	49
Public Beach Clubhouse						Enter		20
						Leave		50
TOTAL						**Enter**		**310**
						Leave		**243**

TABLE 2 (continued)
TRIP GENERATION ANALYSIS

TIME PERIOD Land Use	Cumulative Units	Trip Generation Equation	Ln(T)	T = Number of Trips	Direction of Travel	Percent	Number of Trips
PLANNING YEAR 2020							
WEEKDAY AM PEAK HOUR							
Single Family Residential	275 units	T = 0.7(x) + 12.05		205	Enter	26%	53
					Leave	74%	151
MF, M/U, L/W Residential	355 units	T = 0.88(x) - 49.7		263	Enter	25%	66
					Leave	75%	197
Mixed Use Commercial (Area A)	30 ksf GLA	T = 1.03(X)		31	Enter	61%	19
					Leave	39%	12
M/U, L/W Commercial (Area B)	35 ksf GLA	Ln(T)=0.84Ln(X)+1.51	4.50	90	Enter	89%	80
					Leave	11%	10
Grocery Store	15 ksf GLA	Ln(T)=01.70Ln(X)-1.42	3.18	24	Enter	61%	15
					Leave	39%	9
Restaurant	20 ksf GLA	T = 0.81(X)		16	Enter	50%	8
					Leave	50%	8
Public Beach Clubhouse					Enter		60
					Leave		15
TOTAL					**Enter**		**300**
					Leave		**403**
WEEKDAY PM PEAK HOUR							
Single Family Resident	275 units	Ln(T)=0.89Ln(X)+0.61	5.61	273	Enter	64%	175
					Leave	36%	98
MF, M/U, L/W Residential	355 units	T = 0.78(X)		277	Enter	58%	161
					Leave	42%	116
Mixed Use Commercial (Area A)	30 ksf GLA	T = 3.75(X)		113	Enter	48%	54
					Leave	52%	59
M/U, L/W Commercial (Area B)	35 ksf GLA	T = 1.21(x) + 106.22		149	Enter	14%	21
					Leave	86%	128
Grocery Store	15 ksf GLA	Ln(T)=0.79Ln(X)+3.20	5.34	208	Enter	51%	106
					Leave	49%	102
Restaurant	20 ksf GLA	T = 7.49(X)		150	Enter	67%	100
					Leave	33%	49
Public Beach Clubhouse					Enter		25
					Leave		60
TOTAL					**Enter**		**642**
					Leave		**612**

TABLE 2 (continued)
TRIP GENERATION ANALYSIS

TIME PERIOD Land Use	Cumulative Units		Trip Generation Equation	Ln(T)	T = Number of Trips	Direction of Travel	Percent	Number of Trips
PLANNING YEAR 2029								
WEEKDAY AM PEAK HOUR								
Single Family Residential	475	units	T = 0.7(x) + 12.05		345	Enter	26%	90
						Leave	74%	255
MF, M/U, L/W Residential	715	units	T = 0.88(x) - 49.7		580	Enter	25%	145
						Leave	75%	435
Mixed Use Commercial (Area A)	30	ksf GLA	T = 1.03(X)		31	Enter	61%	19
						Leave	39%	12
M/U, L/W Commercial (Area B)	135	ksf GLA	Ln(T)=0.84Ln(X)+1.51	5.63	279	Enter	89%	248
						Leave	11%	31
Grocery Store	15	ksf GLA	Ln(T)=01.70Ln(X)-1.42	3.18	24	Enter	61%	15
						Leave	39%	9
Restaurant	20	ksf GLA	T = 0.81(X)		16	Enter	50%	8
						Leave	50%	8
Charter School (K-8)	225	students	Ln(T)=Ln(X)-0.13	5.29	198	Enter	55%	109
						Leave	45%	89
Public Beach Clubhouse						Enter		70
						Leave		20
TOTAL						**Enter**		**703**
						Leave		**859**

TABLE 2 (continued)
TRIP GENERATION ANALYSIS

TIME PERIOD Land Use	Cumulative Units		Trip Generation Equation	Ln(T)	T = Number of Trips	Direction of Travel	Percent	Number of Trips
PLANNING YEAR 2029								
WEEKDAY PM PEAK HOUR								
Single Family Residential	475	units	Ln(T)=0.89Ln(X)+0.61	6.10	444	Enter	64%	284
						Leave	36%	160
MF, M/U, L/W Residential	715	units	T = 0.78(X)		558	Enter	58%	323
						Leave	42%	234
Mixed Use Commercial (Area A)	30	ksf GLA	T = 3.75(X)		113	Enter	48%	54
						Leave	52%	59
M/U, L/W Commercial (Area B)	135	ksf GLA	T = 1.21(x) + 106.22		270	Enter	14%	38
						Leave	86%	232
Grocery Store	15	ksf GLA	Ln(T)=0.79Ln(X)+3.20	5.34	208	Enter	51%	106
						Leave	49%	102
Restaurant	20	ksf GLA	T = 7.49(X)		150	Enter	67%	100
						Leave	33%	49
Charter School (K-8)	225	students	T = 0.58(x) + 14.03		145	Enter	47%	68
						Leave	53%	77
Public Beach Clubhouse						Enter		25
						Leave		70
TOTAL						**Enter**		**999**
						Leave		**982**

TABLE 3
TRIP DISTRIBUTION ANALYSIS

TIME PERIOD Land Use	Direction of Travel	No. of Trips	NORTH %	NORTH No. of Trips	SOUTH %	SOUTH No. of Trips	INTERNAL %	INTERNAL No. of Trips
PLANNING YEAR 2015								
WEEKDAY AM PEAK HOUR								
Single Family Residential	Enter	25						
	Leave	71						
MF & Mixed Use Vill Residential	Enter	29						
	Leave	86						
COMBINED RESIDENTIAL	Enter	54	17%	9	20%	11	61%	33
	Leave	157	34%	53	41%	64	25%	40
Mixed Use Commercial (Area A)	Enter	19	32%	6	42%	8	26%	5
	Leave	12	25%	3	33%	4	42%	5
Restaurant	Enter	8	25%	2	25%	2	50%	4
	Leave	8	25%	2	25%	2	50%	4
Public Beach Clubhouse	Enter	50	36%	18	44%	22	20%	10
	Leave	10	30%	3	40%	4	30%	3
TOTAL	Enter	131	27%	35	33%	43	40%	52
	Leave	187	33%	61	40%	74	28%	52
WEEKDAY PM PEAK HOUR								
Single Family Residential	Enter	83						
	Leave	47						
MF & Mixed Use Vill Residential	Enter	52						
	Leave	38						
COMBINED RESIDENTIAL	Enter	135	32%	43	39%	52	30%	40
	Leave	85	18%	15	21%	18	61%	52
Mixed Use Commercial (Area A)	Enter	54	33%	18	41%	22	26%	14
	Leave	59	36%	21	42%	25	24%	14
Restaurant	Enter	100	27%	27	33%	33	40%	40
	Leave	49	27%	13	33%	16	41%	20
Public Beach Clubhouse	Enter	20	30%	6	40%	8	30%	6
	Leave	50	30%	15	40%	20	30%	15
TOTAL	Enter	309	30%	94	37%	115	32%	100
	Leave	243	26%	64	33%	79	42%	101

TABLE 3 (continued)
TRIP DISTRIBUTION ANALYSIS

TIME PERIOD Land Use	Direction of Travel	No. of Trips	NORTH %	NORTH No. of Trips	SOUTH %	SOUTH No. of Trips	INTERNAL %	INTERNAL No. of Trips
PLANNING YEAR 2020								
WEEKDAY AM PEAK HOUR								
Single Family Residential	Enter	53						
	Leave	151						
MF, M/U, L/W Residential	Enter	66						
	Leave	197						
COMBINED RESIDENTIAL	Enter	119	38%	45	42%	50	20%	24
	Leave	348	33%	115	36%	125	31%	108
Mixed Use Commercial (Area A)	Enter	19						
	Leave	12						
M/U, L/W Commercial (Area B)	Enter	80						
	Leave	10						
COMBINED COMMERCIAL	Enter	99	10%	10	11%	11	79%	78
	Leave	22	26%	6	29%	6	45%	10
Grocery Store	Enter	15	0%	0	0%	0	100%	15
	Leave	9	0%	0	0%	0	100%	9
Restaurant	Enter	8	48%	4	52%	4	0%	0
	Leave	8	48%	4	52%	4	0%	0
Public Beach Clubhouse	Enter	60	36%	22	39%	23	25%	15
	Leave	15	33%	5	33%	5	33%	5
TOTAL	Enter	301	27%	81	29%	88	44%	132
	Leave	402	32%	130	35%	141	33%	132
WEEKDAY PM PEAK HOUR								
Single Family Resident	Enter	175						
	Leave	98						
MF, M/U, L/W Residential	Enter	161						
	Leave	116						
COMBINED RESIDENTIAL	Enter	336	23%	77	25%	84	52%	174
	Leave	214	24%	51	26%	56	50%	108
Mixed Use Commercial (Area A)	Enter	54						
	Leave	59						
M/U, L/W Commercial (Area B)	Enter	21						
	Leave	128						
COMBINED COMMERCIAL	Enter	75	36%	27	44%	33	20%	15
	Leave	187	32%	60	34%	64	34%	64
Grocery Store	Enter	106	28%	30	31%	33	41%	43
	Leave	102	15%	15	16%	16	69%	70
Restaurant	Enter	100	29%	29	31%	31	40%	40
	Leave	49	29%	14	31%	15	41%	20
Public Beach Clubhouse	Enter	25	29%	7	31%	8	40%	10
	Leave	60	32%	19	35%	21	33%	20
TOTAL	Enter	642	26%	170	29%	189	44%	282
	Leave	612	26%	160	28%	172	46%	282

TABLE 3 (continued)
TRIP DISTRIBUTION ANALYSIS

TIME PERIOD Land Use	Direction of Travel	No. of Trips	NORTH %	NORTH No. of Trips	SOUTH %	SOUTH No. of Trips	INTERNAL %	INTERNAL No. of Trips
PLANNING YEAR 2029								
WEEKDAY AM PEAK HOUR								
Single Family Residential	Enter	90						
	Leave	255						
MF, M/U, L/W Residential	Enter	145						
	Leave	435						
COMBINED RESIDENTIAL	Enter	235	41%	96	41%	96	18%	43
	Leave	690	34%	235	34%	235	32%	220
Mixed Use Commercial (Area A)	Enter	19						
	Leave	12						
M/U, L/W Commercial (Area B)	Enter	248						
	Leave	31						
COMBINED RESIDENTIAL	Enter	267	18%	47	18%	47	65%	174
	Leave	43	33%	14	33%	14	35%	15
Grocery Store	Enter	15	0%	0	0%	0	100%	15
	Leave	9	0%	0	0%	0	100%	9
Restaurant	Enter	8	50%	4	50%	4	0%	0
	Leave	8	50%	4	50%	4	0%	0
Public Beach Clubhouse	Enter	70	36%	25	36%	25	29%	20
	Leave	20	30%	6	30%	6	40%	8
Charter School (K-8)	Enter	109	45%	49	45%	49	10%	11
	Leave	89	44%	39	44%	39	12%	11
TOTAL	Enter	704	31%	221	31%	221	37%	263
	Leave	859	35%	298	35%	298	31%	263
WEEKDAY PM PEAK HOUR								
Single Family Resident	Enter	284						
	Leave	160						
MF, M/U, L/W Residential	Enter	323						
	Leave	234						
COMBINED RESIDENTIAL	Enter	607	30%	179	30%	179	41%	247
	Leave	394	35%	138	35%	138	30%	120
Mixed Use Commercial (Area A)	Enter	54						
	Leave	59						
M/U, L/W Commercial (Area B)	Enter	38						
	Leave	232						
COMBINED COMMERCIAL	Enter	92	39%	36	39%	36	22%	20
	Leave	291	28%	81	28%	81	44%	129
Grocery Store	Enter	106	30%	31	30%	31	41%	43
	Leave	102	16%	16	16%	16	69%	70
Restaurant	Enter	100	30%	30	30%	30	40%	40
	Leave	49	30%	14	30%	15	41%	20
Public Beach Clubhouse	Enter	25	30%	8	30%	7	40%	10
	Leave	70	36%	25	36%	25	29%	20
Charter School (K-8)	Enter	68	45%	30	45%	31	10%	7
	Leave	77	45%	34	45%	35	10%	8
TOTAL	Enter	998	31%	314	31%	314	37%	367
	Leave	983	31%	308	32%	310	37%	367

TABLE 4
LEVEL OF SERVICE ANALYSIS (SIGNALIZED)
QUEEN KA'AHUMANU HIGHWAY AT KAI'MINANI DRIVE

	2006			2015						2020						2029					
	EXISTING			AMBIENT[1]			TOTAL[1]			AMBIENT[2]			TOTAL[2]			AMBIENT[2]			TOTAL[2]		
APPROACH & MOVEMENTS	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**
AM PEAK HOUR	B	17.3	0.79	D	41.8	0.70	D	45.2	0.72	D	40.1	0.7	D	45.2	0.77	D	41.6	0.74	D	41.6	0.95
Frontage Rd Eastbound	NA	-	-	F	86.9	-	F	86.8	0.57	E	78.7	-	F	82.0	-	F	88.7	-	E	71.2	-
Left	-	-	-	F	86.9	0.34	F	87.1	0.57	E	78.7	0.19	F	82.8	0.90	F	88.7	0.46	E	69.9	0.99
Through/Right	-	-	-	F	86.1	0.00	F	85.1	0.1	E	77.8	0	E	77.7	0.16	F	87.6	0	E	77.8	0.55
Ka'iminani Dr WB	C	25.7	-	D	54.8	-	E	57.4	-	E	55.4	-	E	59.3	-	E	59.4	-	E	70.5	-
Left	C	26.8	0.98	E	63.9	0.75	E	67	0.78	E	60.0	0.73	E	64.8	0.80	E	66.5	0.81	E	70.0	1.17
Through	NA	-	-	D	52.6	0.02	E	55.2	0.04	D	49.5	0.04	D	53.4	0.08	D	54.2	0.04	E	78.3	0.64
Right	C	23.8	0.65	D	39.8	0.57	D	41.7	0.58	D	48.2	0.69	D	50.5	0.69	D	47.8	0.67	E	70.0	1.43
Queen Ka'ahumanu Hwy NB	B	14.9	-	D	42.5	-	D	45.6	-	D	35.9	-	D	40.1	-	D	37.4	-	C	28.7	-
Left	NA	-	-	F	86.6	0.74	F	85.2	0.48	F	83.2	0.77	F	84.8	0.62	F	83.5	0.47	E	78.7	0.58
Through	B	16.9	0.83	D	43.1	0.86	D	46.4	0.88	D	36.4	0.81	D	40.9	0.84	D	38.1	0.83	C	28.8	0.76
Right	A	1.2	0.83	C	30.9	0.35	C	33.3	0.36	C	23.9	0.19	C	26.8	0.20	C	24.3	0.2	B	18.4	0.18
Queen Ka'ahumanu Hwy SB	A	8.6	-	C	27.1	-	C	30.7	-	C	31.2	-	C	34.6	-	C	30.3	-	C	25.8	-
Left	A	8.6	0.13	E	71.3	0.56	E	73	0.56	E	78.5	0.6	F	80.2	0.55	E	76.3	0.42	E	74.2	0.54
Through	A	8.6	0.42	B	19.5	0.42	C	23.6	0.45	C	23.2	0.45	C	27.5	0.52	C	22.3	0.45	B	19.1	0.54
Right	NA	-	-	C	25.9	0.00	C	27.9	0.01	C	21.7	0.01	C	24.3	0.01	C	21.9	0.01	B	16.6	0.01

	2006			2015						2020						2029					
	EXISTING			AMBIENT[1]			TOTAL[1]			AMBIENT[2]			TOTAL[2]			AMBIENT[2]			TOTAL[2]		
APPROACH & MOVEMENTS	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**
PM PEAK HOUR	B	11.5	0.67	D	38.6	0.97	D	39.2	1.00	D	42.7	0.71	D	42.0	0.93	D	48.2	0.75	D	51.5	1.00
Frontage Rd Eastbound	NA	-	-	E	73.6	-	E	75.5	-	F	82.2	0.71	F	115	-	F	100	-	F	84.4	-
Left	-	-	-	E	73.8	0.44	E	76	0.89	F	82.5	0.46	F	123	0.92	F	101	0.63	F	82.9	0.79
Through/Right	-	-	-	E	72	0.05	E	72.4	0.13	E	78.2	0.04	F	87.0	0.48	F	87.2	0.05	F	89.8	0.57
Ka'iminani Dr WB	C	26	-	E	62.9	-	E	63	-	E	75.5	-	F	91.8	-	E	78.6	-	F	85.0	-
Left	C	26.3	0.24	E	65.3	0.69	E	65.5	0.71	F	83.4	0.78	F	98.7	0.89	F	86.6	0.75	F	84.3	0.77
Through	NA	-	-	E	58.6	0.02	E	58.8	0.05	E	67.4	0.02	E	76.7	0.10	E	72.0	0.02	F	96.60	0.67
Right	C	25.5	0.12	C	31.1	0.04	C	31.1	0.04	D	40.5	0.15	E	67.3	0.37	D	43.5	0.16	F	85.7	0.54
Queen Ka'ahumanu Hwy NB	B	12	-	D	40.5	-	D	40.5	-	D	36.9	-	C	30.4	-	D	41.6	-	D	36.1	-
Left	NA	-	-	E	75.9	0.37	E	75.9	0.37	F	87.1	0.43	F	83.9	0.34	F	156	0.78	F	90.8	0.42
Through	B	16.4	0.59	D	37.7	0.80	D	37.7	0.8	D	39.0	0.76	D	37.9	0.75	D	42.9	0.78	D	46.2	0.82
Right	A	2.5	0.20	D	44	1.04	D	44	1.04	C	31.0	0.51	B	14.0	0.38	C	34.1	0.54	B	14.9	0.41
Queen Ka'ahumanu Hwy SB	A	9.2	-	C	32.1	-	C	32.5	-	D	40.5	-	D	35.2	-	D	46.4	-	D	52.6	-
Left	A	8.9	0.67	E	65	0.20	E	65	1.61	F	93.7	0.93	E	76.3	0.82	F	114	0.99	F	91.1	0.9
Through	A	9.3	0.62	C	21.4	0.79	C	22.4	0.82	C	23.3	0.77	C	22.9	0.81	C	24.6	0.79	D	41.9	0.95
Right	NA	-	-	C	23.8	0.01	C	23.8	0.01	C	22.9	0.01	A	3.0	0.01	C	24.7	0.01	A	1.2	0.01

[1] With 2 left turn lanes on westbound approach

[2] With 2 northbound right turn, 2 southbound left turn lanes and 2 westbound left turn lanes

TABLE 5
LEVEL OF SERVICE ANALYSIS (SIGNALIZED)
QUEEN KA'AHUMANU HIGHWAY AT HULIKO'A DRIVE

	2006			2015						2020						2029					
	EXISTING			AMBIENT			TOTAL[1]			AMBIENT			TOTAL[1]			AMBIENT[1]			TOTAL[1]		
APPROACH & MOVEMENTS	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**
AM PEAK HOUR				C	29.2	0.74	C	29.7	0.71	C	29.6	0.72	D	37.0	0.72	C	30.2	0.74	D	46.4	0.77
Frontage Road Eastbound				D	47.7	-	D	47.7	-	D	47.7	-	D	45.0	-	D	47.7	-	E	59.7	-
Left				D	48.3	0.44	D	48.3	0.44	D	48.3	0.44	D	45.1	0.36	D	48.3	0.44	E	59.3	0.40
Through				D	43.2	0.01	D	43.3	0.01	D	43.2	0.01	D	40.8	0.01	D	43.2	0.01	D	54.0	0.04
Right				D	47.1	0.38	D	47.2	0.38	D	47.1	0.38	D	45.0	0.36	D	47.1	0.38	E	60.6	0.45
Huliko'a Drive Westbound				D	54.6	-	D	54.7	-	D	51.6	-	D	46.6	-	D	51.6	-	E	61.5	-
Left				E	59.0	0.72	E	59.3	0.72	D	54.8	0.64	D	48.6	0.52	D	54.8	0.64	E	64.6	0.58
Through				D	43.3	0.01	D	43.3	0.01	D	43.3	0.04	D	41.2	0.04	D	43.3	0.01	D	54.1	0.05
Right				D	46.5	0.33	D	46.5	0.33	D	46.5	0.33	D	43.9	0.26	D	46.5	0.33	E	57.5	0.29
Queen Ka'ahumanu Hwy NB				C	25.0	-	C	25.7	-	C	26.4	-	D	36.8	-	C	27.7	-	D	38.9	-
Left				E	60.5	0.48	E	58.0	0.36	E	60.5	0.48	E	62.7	0.55	E	57.4	0.26	E	72.2	0.55
Through				C	24.1	0.75	C	24.1	0.75	C	25.7	0.79	C	34.5	0.85	C	27.2	0.82	C	34.8	0.85
Right				B	14.4	0.19	B	14.4	0.19	B	14.2	0.17	B	18.5	0.18	B	14.2	0.17	B	17.2	0.16
Queen Ka'ahumanu Hwy SB				C	25.3	-	C	26.0	-	C	26.1	-	C	34.2	-	C	26.1	-	D	50.7	-
Left				E	73.2	0.72	E	74.9	0.74	E	73.2	0.72	E	67.4	0.63	E	73.2	0.72	F	98.3	0.77
Through				C	20.5	0.62	C	21.3	0.65	C	21.9	0.68	C	31.4	0.80	C	21.9	0.68	D	47.2	0.89
Right				B	13.2	0.05	B	13.2	0.05	B	13.2	0.05	B	17.2	0.05	B	13.2	0.05	C	22.9	0.05

	2006			2015						2020						2029					
	EXISTING			AMBIENT			TOTAL[1]			AMBIENT			TOTAL[1]			AMBIENT[1]			TOTAL[2]		
APPROACH & MOVEMENTS	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**
PM PEAK HOUR				D	45.3	0.80	D	43.6	0.77	D	41.6	0.78	D	50.3	0.79	D	36.1	0.73	D	45.7	0.85
Frontage Road Eastbound				D	53.4	-	D	53.5	-	D	51.3	-	E	63.7	-	D	45.5	-	E	75.9	-
Left				D	53.6	0.27	D	53.3	0.28	D	51.6	0.28	E	64.3	0.29	D	46.1	0.27	F	105.0	0.74
Through				D	49.7	0.01	D	49.4	0.01	D	47.8	0.01	E	59.7	0.01	D	42.7	0.01	F	86.5	0.17
Right				D	53.2	0.24	D	53.7	0.31	D	51.1	0.25	E	63.2	0.23	D	44.8	0.17	D	52.2	0.29
Huliko'a Drive Westbound				E	67.6	-	E	67.7	-	E	61.8	-	E	75.6	-	D	54.2	-	E	77.0	-
Left				E	74.2	0.79	E	75.6	0.81	E	66.9	0.74	F	82.1	0.75	E	58.1	0.69	F	82.0	0.62
Through				D	49.8	0.01	D	49.8	0.03	D	47.8	0.01	E	60.3	0.05	D	42.7	0.01	E	78.9	0.18
Right				E	55.7	0.39	E	55.3	0.40	D	53.2	0.38	E	65.1	0.33	D	46.7	0.31	E	66.5	0.42
Queen Ka'ahumanu Hwy NB				D	35.1	-	C	34.4	-	D	35.8	-	D	44.2	-	C	32.4	-	C	33.7	-
Left				F	87.1	0.83	E	72.2	0.65	F	113	0.96	F	97.8	0.84	E	78.1	0.75	E	77.6	0.8
Through				C	24.8	0.61	C	24	0.61	C	20.1	0.59	C	26.1	0.59	C	23.8	0.66	B	16.0	0.56
Right				B	16.3	0.09	B	15.8	0.08	B	13.1	0.07	B	17.2	0.07	B	14.8	0.07	A	2.8	0.05
Queen Ka'ahumanu Hwy SB				D	48.4	-	D	44.9	-	D	41.1	-	D	49.2	-	C	34.6	-	D	47.4	-
Left				F	84.7	0.50	F	83.7	0.53	F	100	0.71	F	99.3	0.56	E	77.8	0.55	F	97.6	0.67
Through				D	48.8	0.84	D	44.9	0.83	D	40.0	0.8	D	48.6	0.84	C	33.9	0.79	D	47.6	0.9
Right				C	30.8	0.24	C	27.9	0.23	C	25.6	0.23	C	28.4	0.19	C	20.6	0.18	B	14.8	0.15

[1] With 2 left turn lanes on northbound approach

[2] With 2 left turn lanes on westbound approach

TABLE 6
LEVEL OF SERVICE ANALYSIS (SIGNALIZED)
QUEEN KA'AHUMANU HIGHWAY AT HINA LANI STREET

	2006			2015						2020						2029					
	EXISTING			AMBIENT			TOTAL			AMBIENT[1]			TOTAL[1]			AMBIENT[1]			TOTAL[2]		
APPROACH & MOVEMENTS	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**
AM PEAK HOUR	C	27.5	0.75	D	36.9	0.92	D	36.9	0.93	C	33.2	1.04	D	38.4	1.06	D	35.5	1.09	C	30.9	1.07
Hina Lani St WB	C	29.5	-	D	38.6	-	D	41.1	-	D	46.1	-	D	52.1	-	D	47.4	-	D	52.1	-
Left	C	29.0	0.47	D	50.0	0.77	D	53.5	0.8	E	57.6	0.74	E	65.9	0.75	E	59.2	0.78	E	62.8	0.84
Right	C	30.0	0.52	C	24.1	0.47	C	25.9	0.49	C	27.7	0.52	C	31.5	0.54	C	27.7	0.52	D	36.5	0.67
Queen Ka'ahumanu Hwy NB	D	37.3	-	D	41.2	-	D	39.6	-	D	36.6	-	D	43.3	-	D	40.7	-	C	33.9	-
Through	D	43.2	0.93	D	54.0	0.93	D	51.7	0.93	D	47.7	0.89	E	56.1	0.92	D	53.5	0.94	D	44.0	0.93
Right	B	18.5	0.34	A	3.9	0.37	A	3.9	0.37	A	9.1	0.459	B	10.8	0.50	A	9.5	0.52	A	6.6	0.50
Queen Ka'ahumanu Hwy SB	B	13.0	-	C	31.1	-	C	31.7	-	C	21.8	-	C	25.5	-	C	21.8	-	B	15.9	-
Left	B	13.0	0.38	E	71.1	0.85	E	78.9	0.89	E	56.1	0.76	E	67.5	0.81	E	56.5	0.76	C	23.6	0.21
Through	B	13.0	0.55	C	24.5	0.70	C	23.9	0.71	B	14.2	0.60	B	16.1	0.64	B	14.2	0.60	B	14.2	0.68

	2006			2015						2020						2029					
	EXISTING			AMBIENT			TOTAL			AMBIENT[1]			TOTAL[1]			AMBIENT[1]			TOTAL[2]		
APPROACH & MOVEMENTS	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**	**LOS**	**Delay**	**V/C**
PM PEAK HOUR	C	27.9	0.69	D	49.3	0.60	D	53.5	1.11	C	33.8	0.74	D	39.7	0.76	D	41.3	0.77	C	33.0	1.16
Hina Lani St WB	D	42.6	-	E	76.4	-	E	75.1	-	D	52.7	-	D	54.6	-	D	54.8	-	E	60.8	-
Left	D	44.1	0.74	F	100.8	1.04	F	100.8	1.04	E	67.2	0.83	E	72.1	0.85	E	70.9	0.87	E	66.5	0.72
Right	D	40.8	0.66	C	22.7	0.36	C	23.3	0.39	C	25.2	0.41	C	25.6	0.46	C	26.3	0.46	D	52.7	0.72
Queen Ka'ahumanu Hwy NB	C	33.6	-	D	41.6	-	D	49.7	-	C	33.7	-	D	46.2	-	D	42.9	-	C	30.3	-
Through	D	36.8	0.82	E	59.7	0.92	E	70.5	0.98	D	44.0	0.83	E	60.2	0.96	E	56.4	0.95	D	41.4	0.87
Right	C	28.8	0.64	A	6.2	0.52	A	6.2	0.52	B	15.0	0.65	B	17.7	0.67	B	16.2	0.69	A	4.8	0.56
Queen Ka'ahumanu Hwy SB	B	11.9	-	D	42.9	-	D	46.0	-	C	24.0	-	C	25.2	-	C	32.3	-	C	21.8	-
Left	B	11.3	0.36	F	107.3	0.98	F	118.6	1.02	E	65.2	0.88	E	68.8	0.89	F	92.8	0.99	C	31.1	0.34
Through	B	12	0.60	C	30.8	0.77	C	32.4	0.80	B	11.1	0.55	B	11.5	0.59	B	11.2	0.55	B	18.6	0.67

[1] With 2 left turn lanes on westbound approach

[2] With 2 southbound left turn lanes and 2 westbound left turn lanes

TABLE 7
LEVEL OF SERVICE ANALYSIS (UNSIGNALIZED)
QUEEN KA'AHUMANU HIGHWAY AT EXISTING (2006) INTERSECTIONS

			AM PEAK HOUR		PM PEAK HOUR	
			LOS	DELAY	LOS	DELAY
NELHA ACCESS RD INTERSECTION						
	NELHA Access Rd	EB Approach	D	34.9	D	35
		EB RT	C	17.6	B	14.4
		EB LT	F	64.2	E	47.3
	Queen Ka'ahumanu Hwy	NB LT	B	10.6	A	9.1
HULIKOA DRIVE INTERSECTION						
	Hulikoa Drive	WB Approach	F	107.3	F	104
		WB RT	C	21.1	C	19
		WB LT	F	237	F	161
	Queen Ka'ahumanu Hwy	SB LT	B	10.9	A	9.8

TABLE 8
LEVEL OF SERVICE ANALYSIS (ON-RAMP)
QUEEN KA'AHUMANU HIGHWAY AT
'O'OMA BEACHSIDE VILLAGE AND NELHA ACCESS ROADS

PEAK	2015		2020		2029	
HOUR	LOS	DENSITY	LOS	DENSITY	LOS	DENSITY
At 'O'oma Beachside Village Access Road						
AM	B	17.3	B	17.9	B	19.5
PM	C	23.2	C	24.1	C	25.8
At NELHA Access Road						
AM	B	16.9	B	17.3	B	19.2
PM	C	23.3	C	24.2	C	26.3

Legend:
LOS = Level of Service for vehicles entering Queen Ka'ahumanu Highway
from access road
DENSITY = Passenger Cars/Mile/Lane

TABLE 9
LEVEL OF SERVICE ANALYSIS (HIGHWAY)
QUEEN KA'AHUMANU HIGHWAY SOUTHBOUND AT
'O'OMA BEACHSIDE VILLAGE ACCESS ROAD

		AM PEAK HOUR			PM PEAK HOUR		
2-LANE HIGHWAY ANALYSIS							
		LOS	% PASS	ATS	LOS	% PASS	ATS
2006 Existing		E	91.4	46	E	91.1	47.2
		LOS	DENSITY	VOLUME	LOS	DENSITY	VOLUME
MULTI-LANE HIGHWAY ANALYSIS							
2015	Ambient	B	14.24	783	C	21.26	1,169
2015	Total	B	14.5	797	C	22.04	1,212
2020	Ambient	B	14.24	783	C	21.46	1,180
2020	Total	B	14.92	820	C	22.87	1,258
2029	Ambient	B	15.02	826	C	22.61	1,243
2029	Total	B	17.05	938	C	25.47	1,401

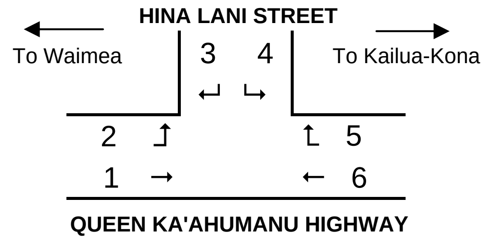
Legend:
LOS = Level of Service
% PASS = Percent Time Spent Following
ATS = Average Travel Speed (mi/hr)
DENSITY = Passenger Cars/Mile/Lane
VOLUME = Hourly Passenger Cars/Hour/Lane

Appendix A

Traffic Turning Movement Counts

TRAFFIC TURNING MOVEMENT COUNT
O'OMA TIAR

LOCATION:	Queen K'aahumanu Highway/ Hina Lani Street
DATE:	September 14, 2006
TIME:	6:30a-8:30a / 11:00a-1:00p / 3:30p-5:30p
WEATHER:	Clear
RECORDER:	C. Darby

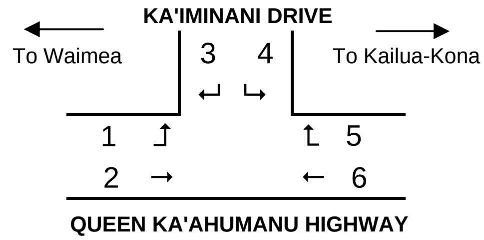


TIME PERIOD	MOVEMENT NUMBER 1	2	3	4	5	6	TOTAL
6:30-6:45a	120	17	79	58	50	207	531
6:45-7:00a	130	35	68	72	90	177	572
7:00-7:15a	134	24	49	44	70	154	475
7:15-7:30a	162	42	64	53	86	147	554
7:30-7:45a	184	36	65	62	106	180	633
7:45-8:00a	171	34	88	82	72	133	580
8:00-8:15a	182	33	63	66	88	170	602
8:15-8:30a	186	35	61	74	82	156	594
6:30-8:30a	1269	256	537	511	644	1324	4541
7:30-8:30a	723	138	277	284	348	639	2409
PHF	0.98				0.86		
11:00-11:15a	149	33	47	109	116	139	593
11:15-11:30a	173	49	59	97	126	138	642
11:30-11:45a	147	43	64	89	94	105	542
11:45-12:00n	174	45	65	107	121	124	636
12:00n-12:15p	130	31	58	91	113	133	556
12:15-12:30p	109	32	58	110	104	113	526
12:30-12:45p	144	28	58	85	123	147	585
12:45-1:00p	145	15	67	96	141	136	600
11:00a-1:00p	1171	276	476	784	938	1035	4680
11:00a-12:00p	643	170	235	402	457	506	2413
3:30-3:45p	150	33	65	64	118	141	571
3:45-4:00p	193	60	90	89	138	155	725
4:00-4:15p	210	52	89	106	128	175	760
4:15-4:30p	95	31	36	42	61	79	344
4:30-4:45p	150	30	63	57	114	141	555
4:45-5:00p	137	36	63	82	119	146	583
5:00-5:15p	122	26	58	73	65	151	495
5:15-5:30p	80	14	84	50	63	110	401
3:30-5:30p	1137	282	548	563	806	1098	4434
3:30-4:30p	648	176	280	301	445	550	2400
PHF	0.79				0.82		

Traffic accident from 5:15-5:30 pm, affected movements 1 & 6
Long traffic queues on movements 1 & 4 from 3:35 to 4:10 pm

TRAFFIC TURNING MOVEMENT COUNT
O'OMA TIAR

LOCATION: Queen Ka'ahumanu Highway/ Ka'iminani Drive
DATE: September 12, 2006
TIME: 6:30a-8:30a / 11:00a-1:00p / 3:30p-5:30p
WEATHER: Clear
RECORDER: C. Darby, R. Miguel



TIME PERIOD	MOVEMENT NUMBER 1	2	3	4	5	6	TOTAL
6:30-6:45a	7	54	92	86	29	184	452
6:45-7:00a	7	89	83	95	36	180	490
7:00-7:15a	13	92	84	114	37	181	521
7:15-7:30a	9	113	73	96	22	152	465
7:30-7:45a	6	124	46	130	26	162	494
7:45-8:00a	6	100	62	126	34	144	472
8:00-8:15a	7	129	37	89	37	135	434
8:15-8:30a	12	139	44	74	23	176	468
6:30-8:30a	67	840	521	810	244	1314	3796
6:45-7:45a	35	418	286	435	121	675	1970
PHF	0.87				0.91		
11:00-11:15a	13	141	21	42	34	141	392
11:15-11:30a	16	147	27	39	35	117	381
11:30-11:45a	13	157	13	26	22	123	354
11:45-12:00n	12	124	20	35	33	143	367
12:00n-12:15p	26	154	16	39	37	141	413
12:15-12:30p	12	130	11	17	35	126	331
12:30-12:45p	9	130	25	32	32	125	353
12:45-1:00p	29	136	17	28	41	143	394
11:00a-1:00p	130	1119	150	258	269	1059	2985
11:15a-12:15p	67	582	76	139	127	524	1515
3:30-3:45p	49	133	15	33	59	122	411
3:45-4:00p	102	171	13	21	69	128	504
4:00-4:15p	99	197	10	21	70	101	498
4:15-4:30p	64	153	19	23	73	115	447
4:30-4:45p	48	155	14	24	69	133	443
4:45-5:00p	44	115	13	25	80	134	411
5:00-5:15p	52	147	13	17	72	122	423
5:15-5:30p	51	117	12	33	92	134	439
3:30-5:30p	509	1188	109	197	584	989	3576
3:45-4:45p	313	676	56	89	281	477	1892
PHF	0.84				0.96		

Appendix B

Signalized Intersection Level of Service (LOS) Calculations

CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst WY
Agency or Company M&E PAC
Analysis Period/Year EX AM #1 2006
Comment 2006 EXISTING 6:30-7:30 AM

Site Information

Jurisdiction/Date 3/26/2008
EB/WB Street KAIMINANI
NB/SB Street QUEEN KAAH

Intersection Data

Area type Other Analysis period .25 h Signal type Actuated-Field % Back of queue 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)				435		285		675	120	35	420	
RTOR volume (veh/h)						30			20			0
Peak-hour factor				.92		.92		.92	.92	.92	.92	
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR							
NB	R		TR					
SB		LT	LT					
Green (s)	20	4	35					
Yellow + All red (s)	5.1	4	5.8					

Cycle (s) 73.9 Lost time per cycle (s) 9.8 Critical v/c Ratio .787

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration				L		R		T	R	L	T	
No. of lanes				1		1		1	1	1	1	
Flow rate (veh/h)				473		277		734	109	38	457	
Capacity (veh/h)				479		429		882	1303	301	1084	
Adjusted saturation flow (veh/h)				1770		1583		1863	1583	1770	1863	
v/c ratio				.987		.647		.832	.083	.126	.421	
g/C ratio				.271		.271		.474	.823	.606	.582	
Average back of queue (veh)				14.1		5.7		15.6	.5	.4	5.7	
Uniform delay (s)				26.8		23.8		16.9	1.2	8.6	8.6	
Incremental delay (s)												
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				26.8		23.8		16.9	1.2	8.6	8.6	
LOS				C		C		B	A	A	A	
Approach delay (s)/LOS		/		25.7	/	C	14.9	/	B	8.6	/	A
Intersection delay (s)/ LOS		17.3				/			B			

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst WY
Agency or Company M&E PAC
Analysis Period/Year EX AM #2 2006
Comment 2006 EXISTING 7:30-8:30 AM

Site Information

Jurisdiction/Date 3/26/2008
EB/WB Street KAIMINANI
NB/SB Street QUEEN KAAH

Intersection Data

Area type Other Analysis period .25 h Signal type Actuated-Field % Back of queue 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)				420		190		615	120	30	490	
RTOR volume (veh/h)						30			20			0
Peak-hour factor				.92		.92		.92	.92	.92	.92	
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR							
NB	R		TR					
SB		LT	LT					
Green (s)	20	4	35					
Yellow + All red (s)	5.1	4	5.8					

Cycle (s) 73.9 Lost time per cycle (s) 9.8 Critical v/c Ratio .732

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration				L		R		T	R	L	T	
No. of lanes				1		1		1	1	1	1	
Flow rate (veh/h)				457		174		668	109	33	533	
Capacity (veh/h)				479		429		882	1303	328	1084	
Adjusted saturation flow (veh/h)				1770		1583		1863	1583	1770	1863	
v/c ratio				.953		.406		.758	.083	.1	.491	
g/C ratio				.271		.271		.474	.823	.606	.582	
Average back of queue (veh)				12.8		3.2		12.9	.5	.3	7	
Uniform delay (s)				26.5		22.1		16	1.2	8.2	9	
Incremental delay (s)												
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				26.5		22.1		16	1.2	8.2	9	
LOS				C		C		B	A	A	A	
Approach delay (s)/LOS		/		25.3	/	C	13.9	/	B	9	/	A
Intersection delay (s)/ LOS		16.1				/			B			

HICAP 2000 ™

CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company:
Analysis Period/Year: AMB AM 2015
Comment: 2015 AMBIENT AM

Site Information

Jurisdiction/Date: 3/26/2008
EB/WB Street: KAIMINANI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other   Analysis period: .25 h   Signal type: Actuated-Field   % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)	15	0	0	575	10	430	46	1307	300	140	815	3
RTOR volume (veh/h)			0			80			60			0
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	2	2	2	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT   T: TH   R: RT   P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB	LTR		R					
WB		LTR	R	R				
NB			L		TR			
SB			L	LT	TR			
Green (s)	5	44	7	20	85			
Yellow + All red (s)	5.1	5.1	1	4	5.8			

Cycle (s): 182   Lost time per cycle (s): 5.8   Critical v/c Ratio: .7

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	TR		L	T	R	L	T	R	L	T	R
No. of lanes	1	1		2	1	1	1	2	1	1	2	1
Flow rate (veh/h)	16	0		625	11	380	50	1421	261	152	886	3
Capacity (veh/h)	49	52		831	450	671	68	1656	739	272	2124	739
Adjusted saturation flow (veh/h)	1770	1885		3437	1863	1583	1770	3547	1583	1770	3547	1583
v/c ratio	.335	0		.752	.024	.567	.735	.858	.353	.559	.417	.004
g/C ratio	.027	.027		.242	.242	.424	.038	.467	.467	.154	.599	.467
Average back of queue (veh)	.9			16.8	.4	15.6	3	38.1	8.9	7.7	13.4	.1
Uniform delay (s)	86.9	86.1		63.9	52.6	39.8	86.6	43.1	30.9	71.3	19.5	25.9
Incremental delay (s)												
Initial queue delay (s)	0			0	0	0	0	0	0	0	0	0
Delay (s)	86.9	86.1		63.9	52.6	39.8	86.6	43.1	30.9	71.3	19.5	25.9
LOS	F	F		E	D	D	F	D	C	E	B	C
Approach delay (s)/LOS	86.9	/	F	54.8	/	D	42.5	/	D	27.1	/	C
Intersection delay (s)/ LOS		41.8				/				D		

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company:
Analysis Period/Year: TOT AM 2015
Comment: 2015 TOTAL AM

Site Information

Jurisdiction/Date: 3/26/2008
EB/WB Street: KAIMINANI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other   Analysis period: .25 h   Signal type: Actuated-Field   % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)	45	8	0	580	15	430	46	1307	300	140	835	3
RTOR volume (veh/h)			0			80			60			0
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	2	2	2	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT   T: TH   R: RT   P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB	LTR		R					
WB		LTR	R	R				
NB			L		TR			
SB			L	LT	TR			
Green (s)	9	44	11	17	85			
Yellow + All red (s)	5.1	5.1	1	4	5.8			

Cycle (s): 187   Lost time per cycle (s): 5.8   Critical v/c Ratio: .72

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	TR		L	T	R	L	T	R	L	T	R
No. of lanes	1	1		2	1	1	1	2	1	1	2	1
Flow rate (veh/h)	49	9		630	16	380	50	1421	261	152	908	3
Capacity (veh/h)	85	89		809	438	661	104	1612	720	274	2010	720
Adjusted saturation flow (veh/h)	1770	1848		3437	1863	1583	1770	3547	1583	1770	3547	1583
v/c ratio	.574	.098		.78	.037	.575	.48	.881	.362	.555	.451	.005
g/C ratio	.048	.048		.235	.235	.418	.059	.455	.455	.155	.567	.455
Average back of queue (veh)	2.8	.5		17.7	.7	16.2	2.8	40.4	9.3	7.9	15.3	.1
Uniform delay (s)	87.1	85.1		67	55.2	41.7	85.2	46.4	33.3	73	23.6	27.9
Incremental delay (s)												
Initial queue delay (s)	0	0		0	0	0	0	0	0	0	0	0
Delay (s)	87.1	85.1		67	55.2	41.7	85.2	46.4	33.3	73	23.6	27.9
LOS	F	F		E	E	D	F	D	C	E	C	C
Approach delay (s)/LOS	86.8	/	F	57.4	/	E	45.6	/	D	30.7	/	C
Intersection delay (s)/ LOS		45.2				/				D		

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company:
Analysis Period/Year: AMB AM 2 — 2020
Comment: 2020 AMBIENT AM W/3 DOUBLE TURNS

Site Information

Jurisdiction/Date: 4/13/2008
EB/WB Street: KAIMINANI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)	18	0	0	577	15	435	50	1324	305	140	820	3
RTOR volume (veh/h)			0			80			60			0
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	2	2	2	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)	0			0			0			0		
Approach bicycle volume (bic/h)	0			0			0			0		
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB	LTR		R					
WB		LTR	R	R				
NB			L		TR			
SB			L	LT	TR			
Green (s)	10	44	7	5	88			
Yellow + All red (s)	5.1	5.1	1	4	5.8			

Cycle (s): 175 — Lost time per cycle (s): 10.9 — Critical v/c Ratio: .704

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	TR		L	T	R	L	T	R	L	T	R
No. of lanes	1	1		2	1	1	1	2	2	2	2	1
Flow rate (veh/h)	20	0		627	16	386	54	1439	266	152	891	3
Capacity (veh/h)	101	108		864	468	562	71	1783	1409	255	1966	796
Adjusted saturation flow (veh/h)	1770	1885		3437	1863	1583	1770	3547	2803	3437	3547	1583
v/c ratio	.193	0		.726	.035	.687	.768	.807	.189	.596	.453	.004
g/C ratio	.057	.057		.251	.251	.355	.04	.503	.503	.074	.554	.503
Average back of queue (veh)	1			15.9	.6	17.5	3.2	34.3	4.2	4.1	14.4	.1
Uniform delay (s)	78.7	77.8		60	49.5	48.2	83.2	36.4	23.9	78.5	23.2	21.7
Incremental delay (s)												
Initial queue delay (s)	0			0	0	0	0	0	0	0	0	0
Delay (s)	78.7	77.8		60	49.5	48.2	83.2	36.4	23.9	78.5	23.2	21.7
LOS	E	E		E	D	D	F	D	C	E	C	C
Approach delay (s)/LOS	78.7	/	E	55.4	/	E	35.9	/	D	31.2	/	C
Intersection delay (s)/ LOS	40.1					/			D			

CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company:
Analysis Period/Year: TOT AM 2 — 2020
Comment: 2020 TOTAL AM W/3 DOUBLE TURNS

Site Information

Jurisdiction/Date: 4/13/2008
EB/WB Street: KAIMINANI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)	121	23	0	610	35	435	50	1324	305	142	910	3
RTOR volume (veh/h)			0			80			60			0
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	2	2	2	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)	0			0			0			0		
Approach bicycle volume (bic/h)	0			0			0			0		
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB	LTR		R					
WB		LTR	R	R				
NB			L		TR			
SB			L	LT	TR			
Green (s)	15	44	9	5	88			
Yellow + All red (s)	5.1	5.1	1	4	5.8			

Cycle (s): 182 — Lost time per cycle (s): 10.9 — Critical v/c Ratio: .77

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	TR		L	T	R	L	T	R	L	T	R
No. of lanes	1	1		2	1	1	1	2	2	2	2	1
Flow rate (veh/h)	132	25		663	38	386	54	1439	266	154	989	3
Capacity (veh/h)	146	152		831	450	558	88	1715	1355	283	1890	766
Adjusted saturation flow (veh/h)	1770	1848		3437	1863	1583	1770	3547	2803	3437	3547	1583
v/c ratio	.902	.164		.798	.084	.692	.621	.839	.197	.545	.523	.004
g/C ratio	.082	.082		.242	.242	.352	.049	.484	.484	.082	.533	.484
Average back of queue (veh)	8.2	1.2		18.3	1.5	18.3	3.1	37.4	4.6	4.2	18.1	.1
Uniform delay (s)	82.8	77.7		64.8	53.4	50.5	84.8	40.9	26.8	80.2	27.5	24.3
Incremental delay (s)												
Initial queue delay (s)	0	0		0	0	0	0	0	0	0	0	0
Delay (s)	82.8	77.7		64.8	53.4	50.5	84.8	40.9	26.8	80.2	27.5	24.3
LOS	F	E		E	D	D	F	D	C	F	C	C
Approach delay (s)/LOS	82	/	F	59.3	/	E	40.1	/	D	34.6	/	C
Intersection delay (s)/ LOS	45.2					/			D			

CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information / Site Information

Analyst: WY
Agency or Company:
Analysis Period/Year: AMB AM 2 — 2029
Comment: 2029 AMB AM W/ 3 DOUBLE TURNS

Jurisdiction/Date: 4/13/2008
EB/WB Street: KAIMINANI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)	20	0	0	607	15	450	50	1390	320	150	855	3
RTOR volume (veh/h)			0			80			60			0
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	2	2	2	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB	LTR		R					
WB		LTR	R	R				
NB			L		TR			
SB			L	LT	TR			
Green (s)	5	44	12	8	95			
Yellow + All red (s)	5.1	5.1	1	4	5.8			

Cycle (s): 185 — Lost time per cycle (s): 10.9 — Critical v/c Ratio: .736

Intersection Performance

	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Lane group configuration	L	TR		L	T	R	L	T	R	L	T	R
No. of lanes	1	1		2	1	1	1	2	2	2	2	1
Flow rate (veh/h)	22	0		660	16	402	54	1511	283	163	929	3
Capacity (veh/h)	48	51		817	443	600	115	1821	1439	390	2051	813
Adjusted saturation flow (veh/h)	1770	1885		3437	1863	1583	1770	3547	2803	3437	3547	1583
v/c ratio	.455	0		.807	.037	.67	.473	.83	.196	.418	.453	.004
g/C ratio	.027	.027		.238	.238	.379	.065	.514	.514	.114	.578	.514
Average back of queue (veh)	1.2			18.6	.7	18.7	2.9	38.7	4.7	4.3	15.2	.1
Uniform delay (s)	88.7	87.6		66.5	54.2	47.8	83.5	38.1	24.3	76.3	22.3	21.9
Incremental delay (s)												
Initial queue delay (s)	0			0	0	0	0	0	0	0	0	0
Delay (s)	88.7	87.6		66.5	54.2	47.8	83.5	38.1	24.3	76.3	22.3	21.9
LOS	F	F		E	D	D	F	D	C	E	C	C
Approach delay (s)/LOS	88.7	/	F	59.4	/	E	37.4	/	D	30.3	/	C
Intersection delay (s)/ LOS			41.6				/			D		

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information / Site Information

Analyst: WY
Agency or Company:
Analysis Period/Year: TOT AM 2 — 2029
Comment: 2029 TOTAL AM W/3 DOUBLE TURN LANE

Jurisdiction/Date: 4/13/2008
EB/WB Street: KAIMINANI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)	285	55	0	655	65	450	50	1390	320	150	1075	3
RTOR volume (veh/h)			0			80			60			0
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	2	2	2	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB	L	TR	R					
WB	L	TR	R	R				
NB			L		TR			
SB			L	LT	TR			
Green (s)	30	10	9	5	95			
Yellow + All red (s)	5.1	5.1	1	4	5.8			

Cycle (s): 170 — Lost time per cycle (s): 10.9 — Critical v/c Ratio: .948

Intersection Performance

	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Lane group configuration	L	TR		L	T	R	L	T	R	L	T	R
No. of lanes	1	1		2	1	1	1	2	2	2	2	1
Flow rate (veh/h)	310	60		712	71	402	54	1511	283	163	1168	3
Capacity (veh/h)	312	109		606	110	280	94	1982	1566	303	2170	885
Adjusted saturation flow (veh/h)	1770	1848		3437	1863	1583	1770	3547	2803	3437	3547	1583
v/c ratio	.992	.55		1.174	.645	1.435	.58	.762	.18	.538	.539	.004
g/C ratio	.176	.059		.176	.059	.177	.053	.559	.559	.088	.612	.559
Average back of queue (veh)	18.9	3.1		26.6	3.7	35.6	2.8	31.8	3.9	4.2	18	.1
Uniform delay (s)	69.9	77.8		70	78.3	70	78.7	28.8	18.4	74.2	19.1	16.6
Incremental delay (s)												
Initial queue delay (s)	0	0		0	0	0	0	0	0	0	0	0
Delay (s)	69.9	77.8		70	78.3	70	78.7	28.8	18.4	74.2	19.1	16.6
LOS	E	E		E	E	E	E	C	B	E	B	B
Approach delay (s)/LOS	71.2	/	E	70.5	/	E	28.7	/	C	25.8	/	C
Intersection delay (s)/ LOS			41.6				/			D		

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PAC
Analysis Period/Year: EX PM #1 2006
Comment: 2006 EXISTING 3:30-4:30 PM

Site Information

Jurisdiction/Date: 3/26/2008
EB/WB Street: KAIMINANI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other Analysis period: .25 h Signal type: Actuated-Field % Back of queue: 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)				90		55		475	280	315	675	
RTOR volume (veh/h)						15			60			0
Peak-hour factor				.92		.92		.92	.92	.92	.92	
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR							
NB	R		TR					
SB		LT	LT					
Green (s)	20	10	40					
Yellow + All red (s)	5.1	4	5.8					

Cycle (s): 84.9 Lost time per cycle (s): 15.6 Critical v/c Ratio: .669

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration				L		R		T	R	L	T	
No. of lanes				1		1		1	1	1	1	
Flow rate (veh/h)				98		43		516	239	342	734	
Capacity (veh/h)				417		373		878	1227	508	1185	
Adjusted saturation flow (veh/h)				1770		1583		1863	1583	1770	1863	
v/c ratio				.235		.117		.588	.195	.673	.619	
g/C ratio				.236		.236		.471	.775	.657	.636	
Average back of queue (veh)				2		.9		9.8	1.7	5.5	11.6	
Uniform delay (s)				26.3		25.5		16.4	2.5	8.9	9.3	
Incremental delay (s)												
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				26.3		25.5		16.4	2.5	8.9	9.3	
LOS				C		C		B	A	A	A	
Approach delay (s)/LOS		/		26	/	C	12	/	B	9.2	/	A
Intersection delay (s)/ LOS				11.5			/			B		

CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PAC
Analysis Period/Year: EX PM #2 2006
Comment: 2006 EXISTING 4:30-5:30 PM

Site Information

Jurisdiction/Date: 3/26/2008
EB/WB Street: KAIMINANI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other Analysis period: .25 h Signal type: Actuated-Field % Back of queue: 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)				100		50		525	315	195	535	
RTOR volume (veh/h)						15			60			0
Peak-hour factor				.92		.92		.92	.92	.92	.92	
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR							
NB	R		TR					
SB		LT	LT					
Green (s)	20	5	40					
Yellow + All red (s)	5.1	4	5.8					

Cycle (s): 79.9 Lost time per cycle (s): 15.6 Critical v/c Ratio: .676

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration				L		R		T	R	L	T	
No. of lanes				1		1		1	1	1	1	
Flow rate (veh/h)				109		38		571	277	212	582	
Capacity (veh/h)				443		396		933	1304	419	1142	
Adjusted saturation flow (veh/h)				1770		1583		1863	1583	1770	1863	
v/c ratio				.245		.096		.612	.213	.506	.509	
g/C ratio				.25		.25		.501	.824	.636	.613	
Average back of queue (veh)				2.1		.7		10.1	1.5	2.7	8	
Uniform delay (s)				23.9		23		14.4	1.5	8.3	8.7	
Incremental delay (s)												
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				23.9		23		14.4	1.5	8.3	8.7	
LOS				C		C		B	A	A	A	
Approach delay (s)/LOS		/		23.7	/	C	10.2	/	B	8.6	/	A
Intersection delay (s)/ LOS				10.6			/			B		

CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company:
Analysis Period/Year: AMB PM 2015
Comment: 2015 AMBIENT PM

Site Information

Jurisdiction/Date: 3/26/2008
EB/WB Street: KAIMINANI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other; Analysis period: .25 h; Signal type: Actuated-Field; % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)	44	5	0	335	5	105	26	1205	755	530	1635	3
RTOR volume (veh/h)			0			80			60			0
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	2	2	2	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB	LTR		R					
WB		LTR	R	R				
NB			L		TR			
SB			L	LT	TR			
Green (s)	10	25	7	25	75			
Yellow + All red (s)	5.1	5.1	1	4	5.8			

Cycle (s): 163; Lost time per cycle (s): 5.8; Critical v/c Ratio: .97

Intersection Performance

	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Lane group configuration	L	TR		L	T	R	L	T	R	L	T	R
No. of lanes	1	1		2	1	1	1	2	1	1	2	1
Flow rate (veh/h)	48	5		364	5	27	28	1310	755	576	1777	3
Capacity (veh/h)	109	113		527	286	613	76	1632	729	358	2263	729
Adjusted saturation flow (veh/h)	1770	1848		3437	1863	1583	1770	3547	1583	1770	3547	1583
v/c ratio	.441	.048		.691	.019	.044	.372	.803	1.037	1.608	.785	.004
g/C ratio	.061	.061		.153	.153	.387	.043	.46	.46	.202	.638	.46
Average back of queue (veh)	2.3	.2		9	.2	.8	1.4	29.8	44.8	54.7	34.3	.1
Uniform delay (s)	73.8	72		65.3	58.6	31.1	75.9	37.7	44	65	21.4	23.8
Incremental delay (s)												
Initial queue delay (s)	0	0		0	0	0	0	0	0	0	0	0
Delay (s)	73.8	72		65.3	58.6	31.1	75.9	37.7	44	65	21.4	23.8
LOS	E	E		E	E	C	E	D	D	E	C	C
Approach delay (s)/LOS	73.6	/	E	62.9	/	E	40.5	/	D	32.1	/	C
Intersection delay (s)/ LOS	38.6				/				D			

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company:
Analysis Period/Year: TOT PM 2015
Comment: 2015 TOTAL PM

Site Information

Jurisdiction/Date: 3/26/2008
EB/WB Street: KAIMINANI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other; Analysis period: .25 h; Signal type: Actuated-Field; % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)	89	14	0	342	12	105	26	1205	755	530	1705	3
RTOR volume (veh/h)			0			80			60			0
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	2	2	2	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB	LTR		R					
WB		LTR	R	R				
NB			L		TR			
SB			L	LT	TR			
Green (s)	10	25	7	25	75			
Yellow + All red (s)	5.1	5.1	1	4	5.8			

Cycle (s): 163; Lost time per cycle (s): 5.8; Critical v/c Ratio: 1.001

Intersection Performance

	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Lane group configuration	L	TR		L	T	R	L	T	R	L	T	R
No. of lanes	1	1		2	1	1	1	2	1	1	2	1
Flow rate (veh/h)	97	15		372	13	27	28	1310	755	576	1853	3
Capacity (veh/h)	109	113		527	286	613	76	1632	729	358	2263	729
Adjusted saturation flow (veh/h)	1770	1848		3437	1863	1583	1770	3547	1583	1770	3547	1583
v/c ratio	.891	.134		.705	.046	.044	.372	.803	1.037	1.608	.819	.004
g/C ratio	.061	.061		.153	.153	.387	.043	.46	.46	.202	.638	.46
Average back of queue (veh)	5.5	.7		9.2	.5	.8	1.4	29.8	44.8	54.7	37.7	.1
Uniform delay (s)	76	72.4		65.5	58.8	31.1	75.9	37.7	44	65	22.4	23.8
Incremental delay (s)												
Initial queue delay (s)	0	0		0	0	0	0	0	0	0	0	0
Delay (s)	76	72.4		65.5	58.8	31.1	75.9	37.7	44	65	22.4	23.8
LOS	E	E		E	E	C	E	D	D	E	C	C
Approach delay (s)/LOS	75.5	/	E	63	/	E	40.5	/	D	32.5	/	C
Intersection delay (s)/ LOS	39.2				/				D			

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company:
Analysis Period/Year: AMB PM 2 — 2020
Comment: 2020 AMBIENT PM W/2LT SB

Site Information

Jurisdiction/Date: 3/26/2008
EB/WB Street: KAIMINANI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)	54	5	0	340	5	106	27	1240	765	537	1656	3
RTOR volume (veh/h)			0			30			110			0
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	2	2	2	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB	LTR		R					
WB		LTR	R	R				
NB			L		TR			
SB			L	LT	TR			
Green (s)	13	25	7	25	90			
Yellow + All red (s)	5.1	5.1	1	4	5.8			

Cycle (s): 181 — Lost time per cycle (s): 5.8 — Critical v/c Ratio: .713

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	TR		L	T	R	L	T	R	L	T	R
No. of lanes	1	1		2	1	1	1	2	2	2	2	1
Flow rate (veh/h)	59	5		370	5	83	29	1348	712	584	1800	3
Capacity (veh/h)	127	133		475	257	552	68	1764	1394	627	2332	787
Adjusted saturation flow (veh/h)	1770	1848		3437	1863	1583	1770	3547	2803	3437	3547	1583
v/c ratio	.462	.041		.779	.021	.15	.429	.764	.511	.932	.772	.004
g/C ratio	.072	.072		.138	.138	.349	.039	.497	.497	.182	.657	.497
Average back of queue (veh)	3.1	.3		10.6	.2	3	1.6	31.8	14.6	18.2	36.7	.1
Uniform delay (s)	80.6	78.2		75.3	67.4	40.5	85	36.9	30.7	72.9	21.6	22.9
Incremental delay (s)	1.9	0		8.1	0	0	2.1	2.1	.3	20.8	1.7	0
Initial queue delay (s)	0	0		0	0	0	0	0	0	0	0	0
Delay (s)	82.5	78.2		83.4	67.4	40.5	87.1	39	31	93.7	23.3	22.9
LOS	F	E		F	E	D	F	D	C	F	C	C
Approach delay (s)/LOS	82.2	/	F	75.5	/	E	36.9	/	D	40.5	/	D
Intersection delay (s)/ LOS			42.7				/			D		

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company:
Analysis Period/Year: TOT PM 2 — 2020
Comment: 2020 TOTAL PM W/2LT SB

Site Information

Jurisdiction/Date: 4/13/2008
EB/WB Street: KAIMINANI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)	164	45	0	355	15	120	27	1230	765	537	1790	3
RTOR volume (veh/h)			0			30			110			0
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	2	2	2	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB	L		TR	R				
WB	L	LTR	TR	R				
NB	R	R		L		TR		
SB	R			L	LTR	TR		
Green (s)	20	2	10	9	28	92		
Yellow + All red (s)	1	4	5.8	1	4	5.8		

Cycle (s): 182.6 — Lost time per cycle (s): 15.6 — Critical v/c Ratio: .925

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	TR		L	T	R	L	T	R	L	T	R
No. of lanes	1	1		2	1	1	1	2	2	2	2	1
Flow rate (veh/h)	178	49		386	16	98	29	1337	712	584	1946	3
Capacity (veh/h)	194	101		433	163	267	87	1787	1854	715	2408	1299
Adjusted saturation flow (veh/h)	1770	1848		3437	1863	1583	1770	3547	2803	3437	3547	1583
v/c ratio	.92	.483		.891	.1	.366	.336	.748	.384	.816	.808	.003
g/C ratio	.11	.055		.126	.088	.169	.049	.504	.662	.208	.679	.82
Average back of queue (veh)	11.1	2.6		12	.8	4.7	1.6	31.1	9.9	16.6	41.3	0
Uniform delay (s)	80.5	83.8		78.6	76.7	67.3	83.9	36.1	14	69	20.8	3
Incremental delay (s)	42.7	3.2		20.1	0	0	0	1.8	0	7.3	2.1	0
Initial queue delay (s)	0	0		0	0	0	0	0	0	0	0	0
Delay (s)	123.2	87		98.7	76.7	67.3	83.9	37.9	14	76.3	22.9	3
LOS	F	F		F	E	E	F	D	B	E	C	A
Approach delay (s)/LOS	115.4	/	F	91.8	/	F	30.4	/	C	35.2	/	D
Intersection delay (s)/ LOS			42				/			D		

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company:
Analysis Period/Year: AMB PM 2 — 2029
Comment: 2029 AMBIENT PM W/2LT SB

Site Information

Jurisdiction/Date: 3/26/2008
EB/WB Street: KAIMINANI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)	67	5	0	355	5	111	32	1283	803	564	1740	3
RTOR volume (veh/h)			0			30			110			0
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	2	2	2	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB	LTR		R					
WB		LTR	R	R				
NB			L		TR			
SB			L	LT	TR			
Green (s)	13	30	5	30	100			
Yellow + All red (s)	5.1	5.1	1	4	5.8			

Cycle (s): 199 — Lost time per cycle (s): 5.8 — Critical v/c Ratio: .747

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	TR		L	T	R	L	T	R	L	T	R
No. of lanes	1	1		2	1	1	1	2	2	2	2	1
Flow rate (veh/h)	73	5		386	5	88	35	1395	753	613	1891	3
Capacity (veh/h)	116	121		518	281	566	44	1782	1408	622	2388	796
Adjusted saturation flow (veh/h)	1770	1848		3437	1863	1583	1770	3547	2803	3437	3547	1583
v/c ratio	.63	.045		.745	.019	.156	.782	.782	.535	.986	.792	.004
g/C ratio	.065	.065		.151	.151	.357	.025	.503	.503	.181	.673	.503
Average back of queue (veh)	4.4	.3		11.8	.3	3.5	2.4	36.6	17.1	21.8	42.7	.1
Uniform delay (s)	90.7	87.2		80.8	72	43.5	96.5	40.6	33.7	81.3	22.7	24.7
Incremental delay (s)	10.5	0		5.8	0	0	59.7	2.3	.4	32.5	1.9	0
Initial queue delay (s)	0	0		0	0	0	0	0	0	0	0	0
Delay (s)	101.2	87.2		86.6	72	43.5	156.2	42.9	34.1	113.8	24.6	24.7
LOS	F	F		F	E	D	F	D	C	F	C	C
Approach delay (s)/LOS	100.2	/	F	78.6	/	E	41.6	/	D	46.4	/	D
Intersection delay (s)/ LOS	48.2				/					D		

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company:
Analysis Period/Year: TOT PM 2 — 2029
Comment: 2029 TOTAL PM W/2LT SB

Site Information

Jurisdiction/Date: 4/13/2008
EB/WB Street: KAIMINANI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)	275	80	0	375	20	111	32	1270	803	564	2005	3
RTOR volume (veh/h)			0			30			110			0
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	2	2	2	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB	L	LTR	TR	R				
WB	L		TR	R				
NB	R			L		TR		
SB	R	R		L	LTR	TR		
Green (s)	30	10	5	9	28	92		
Yellow + All red (s)	1	1	5.8	1	4	5.8		

Cycle (s): 192.6 — Lost time per cycle (s): 10.8 — Critical v/c Ratio: 1.006

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	TR		L	T	R	L	T	R	L	T	R
No. of lanes	1	1		2	1	1	1	2	2	2	2	1
Flow rate (veh/h)	299	87		408	22	88	35	1380	753	613	2179	3
Capacity (veh/h)	377	154		535	48	163	83	1694	1860	678	2283	1404
Adjusted saturation flow (veh/h)	1770	1848		3437	1863	1583	1770	3547	2803	3437	3547	1583
v/c ratio	.793	.566		.761	.45	.541	.421	.815	.405	.904	.954	.002
g/C ratio	.213	.083		.156	.026	.103	.047	.478	.664	.197	.644	.887
Average back of queue (veh)	17.1	4.9		12.1	1.3	4.9	2	36.9	11.2	19.6	66.8	0
Uniform delay (s)	71.8	85		77.9	92.4	82.1	89.3	43	14.9	75.5	31.7	1.2
Incremental delay (s)	11.1	4.8		6.4	4.2	3.6	1.5	3.2	0	15.6	10.2	0
Initial queue delay (s)	0	0		0	0	0	0	0	0	0	0	0
Delay (s)	82.9	89.8		84.3	96.6	85.7	90.8	46.2	14.9	91.1	41.9	1.2
LOS	F	F		F	F	F	F	D	B	F	D	A
Approach delay (s)/LOS	84.4	/	F	85	/	F	36.1	/	D	52.6	/	D
Intersection delay (s)/ LOS	51.5				/					D		

HiCAP 2000 ™

CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst WY
Agency or Company M&E PACIFIC
Analysis Period/Year AMB AM 2015
Comment 2015 AMBIENT AM

Site Information

Jurisdiction/Date 4/13/2008
EB/WB Street KOHANA IKI
NB/SB Street QUEEN KAAH

Intersection Data

Area type Other Analysis period .25 h Signal type Actuated-Field % Back of queue 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)	122	1	147	193	5	129	84	1400	190	126	1150	50
RTOR volume (veh/h)			30			30			30			10
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	5	5	5	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB			LTR					
WB			LTR					
NB	L	TR						
SB	L	TR						
Green (s)	15	80	30					
Yellow + All red (s)	5	5	5					

Cycle (s) 140 Lost time per cycle (s) 10 Critical v/c Ratio .71

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	T	R	L	T	R	L	T	R	L	T	R
No. of lanes	1	1	1	1	1	1	1	2	1	1	2	1
Flow rate (veh/h)	133	1	127	210	5	108	91	1522	174	137	1250	43
Capacity (veh/h)	301	399	339	294	388	330	190	2027	905	190	2027	905
Adjusted saturation flow (veh/h)	1405	1863	1583	1370	1810	1538	1770	3547	1583	1770	3547	1583
v/c ratio	.441	.003	.375	.715	.014	.326	.482	.751	.192	.722	.617	.048
g/C ratio	.214	.214	.214	.214	.214	.214	.107	.571	.571	.107	.571	.571
Average back of queue (veh)	4.8	0	4.5	8.6	.2	3.8	3.6	25.9	3.5	5.9	18.4	.8
Uniform delay (s)	47.7	43.2	47	51	43.3	46.5	58.8	22.5	14.4	60.5	19.9	13.2
Incremental delay (s)	.6	0	.1	8	0	0	1.7	1.6	0	12.7	.6	0
Initial queue delay (s)	0	0	0	0	0	0	0	0	0	0	0	0
Delay (s)	48.3	43.2	47.1	59	43.3	46.5	60.5	24.1	14.4	73.2	20.5	13.2
LOS	D	D	D	E	D	D	E	C	B	E	C	B
Approach delay (s)/LOS	47.7	/	D	54.6	/	D	25	/	C	25.3	/	C
Intersection delay (s)/ LOS			29.2				/			C		

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst WY
Agency or Company M&E PACIFIC
Analysis Period/Year TOT AM 2 2015
Comment 2015 TOTAL AM W/2LT NB

Site Information

Jurisdiction/Date 4/13/2008
EB/WB Street KOHANA IKI
NB/SB Street QUEEN KAAH

Intersection Data

Area type Other Analysis period .25 h Signal type Actuated-Field % Back of queue 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)	122	4	150	193	5	129	122	1400	190	129	1214	50
RTOR volume (veh/h)			30			30			30			10
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	5	5	5	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB			LTR					
WB			LTR					
NB	L	TR						
SB	L	TR						
Green (s)	15	80	30					
Yellow + All red (s)	5	5	5					

Cycle (s) 140 Lost time per cycle (s) 10 Critical v/c Ratio .713

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	T	R	L	T	R	L	T	R	L	T	R
No. of lanes	1	1	1	1	1	1	2	2	1	1	2	1
Flow rate (veh/h)	133	4	130	210	5	108	133	1522	174	140	1320	43
Capacity (veh/h)	301	399	339	293	388	330	368	2027	905	190	2027	905
Adjusted saturation flow (veh/h)	1405	1863	1583	1366	1810	1538	3437	3547	1583	1770	3547	1583
v/c ratio	.441	.011	.384	.717	.014	.326	.36	.751	.192	.74	.651	.048
g/C ratio	.214	.214	.214	.214	.214	.214	.107	.571	.571	.107	.571	.571
Average back of queue (veh)	4.8	.1	4.6	8.6	.2	3.8	2.7	25.9	3.5	6.1	20.1	.8
Uniform delay (s)	47.7	43.3	47.1	51.1	43.3	46.5	58	22.5	14.4	60.6	20.5	13.2
Incremental delay (s)	.6	0	.1	8.2	0	0	0	1.6	0	14.3	.8	0
Initial queue delay (s)	0	0	0	0	0	0	0	0	0	0	0	0
Delay (s)	48.3	43.3	47.2	59.3	43.3	46.5	58	24.1	14.4	74.9	21.3	13.2
LOS	D	D	D	E	D	D	E	C	B	E	C	B
Approach delay (s)/LOS	47.7	/	D	54.7	/	D	25.7	/	C	26	/	C
Intersection delay (s)/ LOS			29.7				/			C		

HiCAP 2000 ™

CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: AMB AM 2020
Comment: 2020 AMBIENT AM

Site Information

Jurisdiction/Date: 4/13/2008
EB/WB Street: KOHANA IKI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)	122	1	147	173	5	129	84	1475	170	126	1261	50
RTOR volume (veh/h)			30			30			30			10
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	5	5	5	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB			LTR					
WB			LTR					
NB	L	TR						
SB	L	TR						
Green (s)	15	80	30					
Yellow + All red (s)	5	5	5					

Cycle (s) 140 — Lost time per cycle (s) 10 — Critical v/c Ratio .718

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	T	R	L	T	R	L	T	R	L	T	R
No. of lanes	1	1	1	1	1	1	1	2	1	1	2	1
Flow rate (veh/h)	133	1	127	188	5	108	91	1603	152	137	1371	43
Capacity (veh/h)	301	399	339	294	388	330	190	2027	905	190	2027	905
Adjusted saturation flow (veh/h)	1405	1863	1583	1370	1810	1538	1770	3547	1583	1770	3547	1583
v/c ratio	.441	.003	.375	.64	.014	.326	.482	.791	.168	.722	.676	.048
g/C ratio	.214	.214	.214	.214	.214	.214	.107	.571	.571	.107	.571	.571
Average back of queue (veh)	4.8	0	4.5	7.4	.2	3.8	3.6	28.8	3	5.9	21.4	.8
Uniform delay (s)	47.7	43.2	47	50.1	43.3	46.5	58.8	23.5	14.2	60.5	21	13.2
Incremental delay (s)	.6	0	.1	4.7	0	0	1.7	2.2	0	12.7	.9	0
Initial queue delay (s)	0	0	0	0	0	0	0	0	0	0	0	0
Delay (s)	48.3	43.2	47.1	54.8	43.3	46.5	60.5	25.7	14.2	73.2	21.9	13.2
LOS	D	D	D	D	D	D	E	C	B	E	C	B
Approach delay (s)/LOS	47.7	/	D	51.6	/	D	26.4	/	C	26.1	/	C
Intersection delay (s)/ LOS		29.6				/				C		

HiCAP 2000 ™

CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM 2020
Comment: 2020 TOTAL AMW/2 LT NB LANES

Site Information

Jurisdiction/Date: 4/13/2008
EB/WB Street: KOHANA IKI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)	122	1	167	173	16	129	230	1475	170	136	1376	50
RTOR volume (veh/h)			30			30			30			10
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	5	5	5	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB			LTR					
WB			LTR					
NB	L	TR						
SB	L	TR						
Green (s)	20	80	40					
Yellow + All red (s)	1	5	5					

Cycle (s) 151 — Lost time per cycle (s) 10 — Critical v/c Ratio .721

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	T	R	L	T	R	L	T	R	L	T	R
No. of lanes	1	1	1	1	1	1	2	2	1	1	2	1
Flow rate (veh/h)	133	1	149	188	17	108	250	1603	152	148	1496	43
Capacity (veh/h)	368	493	419	363	479	407	455	1879	839	234	1879	839
Adjusted saturation flow (veh/h)	1390	1863	1583	1370	1810	1538	3437	3547	1583	1770	3547	1583
v/c ratio	.36	.002	.355	.518	.036	.264	.549	.853	.181	.631	.796	.052
g/C ratio	.265	.265	.265	.265	.265	.265	.132	.53	.53	.132	.53	.53
Average back of queue (veh)	4.8	0	5.4	7.3	.6	3.8	5.5	34.7	3.5	6.5	30	.9
Uniform delay (s)	45.1	40.8	45	47.3	41.2	43.9	61.3	30.5	18.5	62	28.9	17.2
Incremental delay (s)	0	0	0	1.3	0	0	1.4	4	0	5.4	2.5	0
Initial queue delay (s)	0	0	0	0	0	0	0	0	0	0	0	0
Delay (s)	45.1	40.8	45	48.6	41.2	43.9	62.7	34.5	18.5	67.4	31.4	17.2
LOS	D	D	D	D	D	D	E	C	B	E	C	B
Approach delay (s)/LOS	45	/	D	46.6	/	D	36.8	/	D	34.2	/	C
Intersection delay (s)/ LOS		37				/				D		

HiCAP 2000 ™

CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: AMB AM 2 — 2029
Comment: 2029 AMB AM W/2LT NB

Site Information

Jurisdiction/Date: 4/13/2008
EB/WB Street: KOHANA IKI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)	122	1	147	173	5	129	89	1535	170	126	1261	50
RTOR volume (veh/h)			30			30			30			10
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	5	5	5	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB			LTR					
WB			LTR					
NB	L	TR						
SB	L	TR						
Green (s)	15	80	30					
Yellow + All red (s)	5	5	5					

Cycle (s): 140 — Lost time per cycle (s): 10 — Critical v/c Ratio: .738

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	T	R	L	T	R	L	T	R	L	T	R
No. of lanes	1	1	1	1	1	1	2	2	1	1	2	1
Flow rate (veh/h)	133	1	127	188	5	108	97	1668	152	137	1371	43
Capacity (veh/h)	301	399	339	294	388	330	368	2027	905	190	2027	905
Adjusted saturation flow (veh/h)	1405	1863	1583	1370	1810	1538	3437	3547	1583	1770	3547	1583
v/c ratio	.441	.003	.375	.64	.014	.326	.263	.823	.168	.722	.676	.048
g/C ratio	.214	.214	.214	.214	.214	.214	.107	.571	.571	.107	.571	.571
Average back of queue (veh)	4.8	0	4.5	7.4	.2	3.8	1.9	31.3	3	5.9	21.4	.8
Uniform delay (s)	47.7	43.2	47	50.1	43.3	46.5	57.4	24.3	14.2	60.5	21	13.2
Incremental delay (s)	.6	0	.1	4.7	0	0	0	2.9	0	12.7	.9	0
Initial queue delay (s)	0	0	0	0	0	0	0	0	0	0	0	0
Delay (s)	48.3	43.2	47.1	54.8	43.3	46.5	57.4	27.2	14.2	73.2	21.9	13.2
LOS	D	D	D	D	D	D	E	C	B	E	C	B
Approach delay (s)/LOS	47.7	/	D	51.6	/	D	27.7	/	C	26.1	/	C
Intersection delay (s)/ LOS		30.2			/				C			

HiCAP 2000 ™ — 1 of 1

CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM 2 — 2029
Comment: 2029 TOTAL AM W/2 LT NB

Site Information

Jurisdiction/Date: 4/13/2008
EB/WB Street: KOHANA IKI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)	122	17	190	173	20	129	290	1641	170	135	1490	50
RTOR volume (veh/h)			30			30			30			10
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	5	5	5	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB				LTR				
WB				LTR				
NB	L	LTR	TR					
SB	L		TR					
Green (s)	20	10	95	45				
Yellow + All red (s)	1	5	5	5				

Cycle (s): 186 — Lost time per cycle (s): 10 — Critical v/c Ratio: .766

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	T	R	L	T	R	L	T	R	L	T	R
No. of lanes	1	1	1	1	1	1	2	2	1	1	2	1
Flow rate (veh/h)	133	18	174	188	22	108	315	1784	152	147	1620	43
Capacity (veh/h)	335	451	383	326	438	372	573	2097	936	190	1811	809
Adjusted saturation flow (veh/h)	1384	1863	1583	1349	1810	1538	3437	3547	1583	1770	3547	1583
v/c ratio	.396	.041	.454	.576	.05	.289	.55	.85	.163	.771	.894	.054
g/C ratio	.242	.242	.242	.242	.242	.242	.167	.591	.591	.108	.511	.511
Average back of queue (veh)	6.1	.8	8.1	9.3	.9	4.8	8.3	44.9	3.8	8.5	45.5	1.2
Uniform delay (s)	59.1	54	60	62.1	54.1	57.5	71.1	31.2	17.2	80.8	41	22.9
Incremental delay (s)	.2	0	.6	2.5	0	0	1.1	3.6	0	17.5	6.2	0
Initial queue delay (s)	0	0	0	0	0	0	0	0	0	0	0	0
Delay (s)	59.3	54	60.6	64.6	54.1	57.5	72.2	34.8	17.2	98.3	47.2	22.9
LOS	E	D	E	E	D	E	E	C	B	F	D	C
Approach delay (s)/LOS	59.7	/	E	61.5	/	E	38.9	/	D	50.7	/	D
Intersection delay (s)/ LOS		46.4			/				D			

HiCAP 2000 ™ — 1 of 1

CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: AMB PM 2015
Comment: 2015 AMBIENT PM

Site Information

Jurisdiction/Date: 4/13/2008
EB/WB Street: KOHANA IKI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other; Analysis period: .25 h; Signal type: Actuated-Field; % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)	95	1	119	268	1	179	260	1175	98	66	1255	190
RTOR volume (veh/h)			25			30			25			30
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	5	5	5	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB				LTR				
WB				LTR				
NB	L	LTR	TR					
SB	L		TR					
Green (s)	15	20	85	50				
Yellow + All red (s)	1	5	5	5				

Cycle (s): 186; Lost time per cycle (s): 10; Critical v/c Ratio: .8

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	T	R	L	T	R	L	T	R	L	T	R
No. of lanes	1	1	1	1	1	1	1	2	1	1	2	1
Flow rate (veh/h)	103	1	102	291	1	162	283	1277	79	72	1364	174
Capacity (veh/h)	379	501	426	368	486	413	343	2097	936	143	1621	724
Adjusted saturation flow (veh/h)	1410	1863	1583	1370	1810	1538	1770	3547	1583	1770	3547	1583
v/c ratio	.272	.002	.24	.791	.002	.392	.825	.609	.085	.503	.842	.24
g/C ratio	.269	.269	.269	.269	.269	.269	.194	.591	.591	.081	.457	.457
Average back of queue (veh)	4.4	0	4.3	15.8	0	7.2	16.1	23.8	1.9	3.9	36.8	5.8
Uniform delay (s)	53.6	49.7	53.2	63.1	49.8	55.6	72	24.3	16.3	81.9	44.6	30.8
Incremental delay (s)	0	0	0	11.1	0	.1	15.1	.5	0	2.8	4.2	0
Initial queue delay (s)	0	0	0	0	0	0	0	0	0	0	0	0
Delay (s)	53.6	49.7	53.2	74.2	49.8	55.7	87.1	24.8	16.3	84.7	48.8	30.8
LOS	D	D	D	E	D	E	F	C	B	F	D	C
Approach delay (s)/LOS	53.4	/	D	67.6	/	E	35.1	/	D	48.4	/	D
Intersection delay (s)/ LOS		45.3				/			D			

CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM 2 2015
Comment: 2015 TOTAL PM W/2LT NB

Site Information

Jurisdiction/Date: 4/13/2008
EB/WB Street: KOHANA IKI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other; Analysis period: .25 h; Signal type: Actuated-Field; % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)	95	4	144	268	15	179	360	1175	98	71	1300	190
RTOR volume (veh/h)			25			30			25			30
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	5	5	5	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB				LTR				
WB				LTR				
NB	L	LTR	TR					
SB	L		TR					
Green (s)	15	16	87	48				
Yellow + All red (s)	1	5	5	5				

Cycle (s): 182; Lost time per cycle (s): 10; Critical v/c Ratio: .768

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	T	R	L	T	R	L	T	R	L	T	R
No. of lanes	1	1	1	1	1	1	2	2	1	1	2	1
Flow rate (veh/h)	103	4	129	291	16	162	391	1277	79	77	1413	174
Capacity (veh/h)	367	491	418	360	477	406	604	2105	940	146	1695	757
Adjusted saturation flow (veh/h)	1391	1863	1583	1366	1810	1538	3437	3547	1583	1770	3547	1583
v/c ratio	.281	.009	.31	.809	.034	.399	.648	.607	.084	.529	.833	.23
g/C ratio	.264	.264	.264	.264	.264	.264	.176	.593	.593	.082	.478	.478
Average back of queue (veh)	4.4	.2	5.5	15.7	.6	7.1	10.4	23.2	1.8	4.1	36.6	5.4
Uniform delay (s)	53.3	49.4	53.7	62.7	49.8	55.1	69.8	23.5	15.8	80.1	41.2	27.9
Incremental delay (s)	0	0	0	12.9	0	.2	2.4	.5	0	3.6	3.7	0
Initial queue delay (s)	0	0	0	0	0	0	0	0	0	0	0	0
Delay (s)	53.3	49.4	53.7	75.6	49.8	55.3	72.2	24	15.8	83.7	44.9	27.9
LOS	D	D	D	E	D	E	E	C	B	F	D	C
Approach delay (s)/LOS	53.5	/	D	67.7	/	E	34.4	/	C	44.9	/	D
Intersection delay (s)/ LOS		43.6				/			D			

CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: AMB PM 2020
Comment: 2020 AMBIENT PM

Site Information

Jurisdiction/Date: 4/13/2008
EB/WB Street: KOHANA IKI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)	95	1	119	240	1	170	260	1190	88	66	1270	190
RTOR volume (veh/h)			25			30			25			30
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	5	5	5	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB				LTR				
WB				LTR				
NB	L	LTR	TR					
SB	L		TR					
Green (s)	10	18	85	45				
Yellow + All red (s)	1	5	5	5				

Cycle (s) 174 — Lost time per cycle (s) 10 — Critical v/c Ratio .784

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	T	R	L	T	R	L	T	R	L	T	R
No. of lanes	1	1	1	1	1	1	1	2	1	1	2	1
Flow rate (veh/h)	103	1	102	261	1	152	283	1293	68	72	1380	174
Capacity (veh/h)	365	482	409	354	468	398	295	2201	983	102	1733	773
Adjusted saturation flow (veh/h)	1410	1863	1583	1370	1810	1538	1770	3547	1583	1770	3547	1583
v/c ratio	.283	.002	.25	.736	.002	.383	.958	.588	.07	.705	.797	.225
g/C ratio	.259	.259	.259	.259	.259	.259	.167	.621	.621	.057	.489	.489
Average back of queue (veh)	4.2	0	4.1	12.9	0	6.4	17	21.2	1.4	3.9	32.7	5.1
Uniform delay (s)	51.6	47.8	51.1	59.1	47.8	53.1	71.9	19.7	13.1	80.6	37.3	25.6
Incremental delay (s)	0	0	0	7.8	0	.1	41.1	.4	0	19.9	2.7	0
Initial queue delay (s)	0	0	0	0	0	0	0	0	0	0	0	0
Delay (s)	51.6	47.8	51.1	66.9	47.8	53.2	113	20.1	13.1	100.5	40	25.6
LOS	D	D	D	E	D	D	F	C	B	F	D	C
Approach delay (s)/LOS	51.3	/	D	61.8	/	E	35.8	/	D	41.1	/	D
Intersection delay (s)/ LOS		41.6				/			D			

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM 2 2020
Comment: 2020 TOTAL PM W 2LT NB

Site Information

Jurisdiction/Date: 4/13/2008
EB/WB Street: KOHANA IKI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)	95	4	135	240	20	170	430	1180	88	76	1400	190
RTOR volume (veh/h)			50			50			25			50
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	5	5	5	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB				LTR				
WB				LTR				
NB	L	LTR	TR					
SB	L		TR					
Green (s)	18	16	110	55				
Yellow + All red (s)	1	5	5	5				

Cycle (s) 215 — Lost time per cycle (s) 10 — Critical v/c Ratio .793

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	T	R	L	T	R	L	T	R	L	T	R
No. of lanes	1	1	1	1	1	1	2	2	1	1	2	1
Flow rate (veh/h)	103	4	92	261	22	130	467	1283	68	83	1522	152
Capacity (veh/h)	354	477	405	349	463	393	559	2161	965	148	1815	810
Adjusted saturation flow (veh/h)	1384	1863	1583	1366	1810	1538	3437	3547	1583	1770	3547	1583
v/c ratio	.292	.009	.228	.747	.047	.332	.835	.594	.071	.558	.839	.188
g/C ratio	.256	.256	.256	.256	.256	.256	.163	.609	.609	.084	.512	.512
Average back of queue (veh)	5.2	.2	4.6	15.9	1	6.7	16	26.4	1.8	5.2	45.5	5.1
Uniform delay (s)	64.3	59.7	63.2	73.6	60.3	65.1	87.2	25.7	17.2	94.7	44.9	28.4
Incremental delay (s)	0	0	0	8.5	0	0	10.6	.4	0	4.6	3.7	0
Initial queue delay (s)	0	0	0	0	0	0	0	0	0	0	0	0
Delay (s)	64.3	59.7	63.2	82.1	60.3	65.1	97.8	26.1	17.2	99.3	48.6	28.4
LOS	E	E	E	F	E	E	F	C	B	F	D	C
Approach delay (s)/LOS	63.7	/	E	75.6	/	E	44.2	/	D	49.2	/	D
Intersection delay (s)/ LOS		50.3				/			D			

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: AMB PM 2 — 2029
Comment: 2029 AMBIENT PM W/2LT NB

Site Information

Jurisdiction/Date: 4/13/2008
EB/WB Street: KOHANA IKI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)	95	1	119	240	1	170	260	1250	88	66	1335	190
RTOR volume (veh/h)			50			50			25			50
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	5	5	5	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB				LTR				
WB				LTR				
NB	L	LTR	TR					
SB	L		TR					
Green (s)	12	5	85	45				
Yellow + All red (s)	1	5	5	5				

Cycle (s): 163 — Lost time per cycle (s): 10 — Critical v/c Ratio: .726

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	T	R	L	T	R	L	T	R	L	T	R
No. of lanes	1	1	1	1	1	1	2	2	1	1	2	1
Flow rate (veh/h)	103	1	75	261	1	130	283	1359	68	72	1451	152
Capacity (veh/h)	389	514	437	378	500	425	379	2067	923	130	1849	826
Adjusted saturation flow (veh/h)	1410	1863	1583	1370	1810	1538	3437	3547	1583	1770	3547	1583
v/c ratio	.265	.002	.172	.69	.002	.307	.745	.657	.074	.551	.785	.184
g/C ratio	.276	.276	.276	.276	.276	.276	.11	.583	.583	.074	.521	.521
Average back of queue (veh)	3.9	0	2.7	11.7	0	4.9	7.3	23.8	1.4	3.5	31.1	3.8
Uniform delay (s)	46.1	42.7	44.8	52.8	42.7	46.7	70.3	23	14.8	72.9	31.6	20.6
Incremental delay (s)	0	0	0	5.3	0	0	7.8	.8	0	4.9	2.3	0
Initial queue delay (s)	0	0	0	0	0	0	0	0	0	0	0	0
Delay (s)	46.1	42.7	44.8	58.1	42.7	46.7	78.1	23.8	14.8	77.8	33.9	20.6
LOS	D	D	D	E	D	D	E	C	B	E	C	C
Approach delay (s)/LOS	45.5	/	D	54.2	/	D	32.4	/	C	34.6	/	C
Intersection delay (s)/ LOS		36.1				/				D		

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM 8PH — 2029
Comment: 2029 TOTAL PM W 8 PH SIG

Site Information

Jurisdiction/Date: 4/13/2008
EB/WB Street: KOHANA IKI
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)	95	15	175	240	30	170	545	1235	88	86	1540	190
RTOR volume (veh/h)			50			50			25			50
Peak-hour factor	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92	.92
Heavy vehicles (%)	2	2	2	5	5	5	2	2	2	2	2	2
Start-up lost time, l_1 (s)	2	2	2	2	2	2	2	2	2	2	2	2
Extension of effective green, e (s)	2	2	2	2	2	2	2	2	2	2	2	2
Arrival type, AT	3	3	3	3	3	3	3	3	3	3	3	3
Approach pedestrian volume (p/h)		0			0			0			0	
Approach bicycle volume (bic/h)		0			0			0			0	
Left/right parking (Y or N)	N	/	N	N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB	R	R		L		TR		
WB	R			L	LTR	TR		
NB	L	LTR	TR	R	R			
SB	L		TR	R				
Green (s)	15	25	100	15	8	10		
Yellow + All red (s)	1	5	5	1	1	5		

Cycle (s): 191 — Lost time per cycle (s): 10 — Critical v/c Ratio: .853

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration	L	T	R	L	T	R	L	T	R	L	T	R
No. of lanes	1	1	1	2	1	1	2	2	1	1	2	1
Flow rate (veh/h)	103	16	136	261	33	130	592	1342	68	93	1674	152
Capacity (veh/h)	139	98	464	419	180	314	738	2414	1318	139	1857	995
Adjusted saturation flow (veh/h)	1770	1863	1583	3338	1810	1538	3437	3547	1583	1770	3547	1583
v/c ratio	.743	.167	.293	.622	.181	.415	.803	.556	.052	.673	.901	.153
g/C ratio	.079	.052	.293	.126	.099	.204	.215	.681	.832	.079	.524	.628
Average back of queue (veh)	6.2	.9	5.9	7.4	1.7	6.4	17.4	20.8	.7	5.4	48.5	3.5
Uniform delay (s)	86.1	86.5	52.2	79.2	78.9	66.1	71.2	15.7	2.8	85.6	41.1	14.6
Incremental delay (s)	19.2	0	0	2.8	0	.4	6.4	.3	0	12	6.5	0
Initial queue delay (s)	0	0	0	0	0	0	0	0	0	0	0	0
Delay (s)	105.3	86.5	52.2	82	78.9	66.5	77.6	16	2.8	97.6	47.6	14.6
LOS	F	F	D	F	E	E	E	B	A	F	D	B
Approach delay (s)/LOS	75.9	/	E	77	/	E	33.7	/	C	47.4	/	D
Intersection delay (s)/ LOS		45.7				/				D		

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PAC
Analysis Period/Year: EX AM #1 2006
Comment: 2006 EXIST 6:30-7:30AM

Site Information

Jurisdiction/Date: 3/26/2008
EB/WB Street: HINALANI D
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other | Analysis period: .25 h | Signal type: Actuated-Field | % Back of queue: 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)				225		260		685	295	120	545	
RTOR volume (veh/h)						40			80			0
Peak-hour factor				.9	.9	.9	.9	.9	.9	.9	.9	.9
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR							
NB			TR					
SB		LT	LT					
Green (s)	30	11	44					
Yellow + All red (s)	5.1	4.1	5.8					

Cycle (s): 100 | Lost time per cycle (s): 15 | Critical v/c Ratio: .751

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration				L		R		T	R	L	T	
No. of lanes				1		1		1	1	1	1	
Flow rate (veh/h)				250		244		761	239	133	606	
Capacity (veh/h)				531		475		820	697	352	1101	
Adjusted saturation flow (veh/h)				1770		1583		1863	1583	1770	1863	
v/c ratio				.471		.515		.929	.343	.378	.55	
g/C ratio				.3		.3		.44	.44	.608	.591	
Average back of queue (veh)				6.1		6.1		25	4.7	2.1	11.1	
Uniform delay (s)				28.5		29		26.5	18.5	12.9	12.4	
Incremental delay (s)				.5		1		16.7	0	.1	.6	
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				29		30		43.2	18.5	13	13	
LOS				C		C		D	B	B	B	
Approach delay (s)/LOS		/		29.5	/	C	37.3	/	D	13	/	B
Intersection delay (s)/ LOS			27.5				/			C		

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PAC
Analysis Period/Year: EX AM #2 2006
Comment: 2006 EXIST 7:30-8:30AM

Site Information

Jurisdiction/Date: 3/26/2008
EB/WB Street: HINALANI D
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other | Analysis period: .25 h | Signal type: Actuated-Field | % Back of queue: 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)				285		275		640	340	140	725	
RTOR volume (veh/h)						40			80			0
Peak-hour factor				.9	.9	.9	.9	.9	.9	.9	.9	.9
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR							
NB			TR					
SB		LT	LT					
Green (s)	30	11	44					
Yellow + All red (s)	5.1	4.1	5.8					

Cycle (s): 100 | Lost time per cycle (s): 9.9 | Critical v/c Ratio: .72

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration				L		R		T	R	L	T	
No. of lanes				1		1		1	1	1	1	
Flow rate (veh/h)				317		261		711	289	156	806	
Capacity (veh/h)				531		475		820	697	370	1101	
Adjusted saturation flow (veh/h)				1770		1583		1863	1583	1770	1863	
v/c ratio				.596		.55		.868	.415	.42	.732	
g/C ratio				.3		.3		.44	.44	.608	.591	
Average back of queue (veh)				8.2		6.6		21.3	5.9	2.5	18.1	
Uniform delay (s)				29.8		29.3		25.4	19.2	12.7	14.7	
Incremental delay (s)				1.8		1.4		9.8	.2	.3	2.5	
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				31.6		30.7		35.2	19.4	13	17.2	
LOS				C		C		D	B	B	B	
Approach delay (s)/LOS		/		31.2	/	C	30.6	/	C	16.6	/	B
Intersection delay (s)/ LOS			25.4				/			C		

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PAC
Analysis Period/Year: AMB AM 2015
Comment: 2015 AMB AM

Site Information

Jurisdiction/Date: 4/17/2008
EB/WB Street: HINALANI D
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)				434		423		1250	532	211	1280	
RTOR volume (veh/h)						80			100			0
Peak-hour factor				.9	.9	.9	.9	.9	.9	.9	.9	.9
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR	R						
NB	R		TR					
SB		LT	LT					
Green (s)	55	20	65					
Yellow + All red (s)	5.1	4.1	5.8					

Cycle (s) 155 — Lost time per cycle (s) 15.7 — Critical v/c Ratio .917

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration				L		R		T	R	L	T	
No. of lanes				1		1		2	1	1	2	
Flow rate (veh/h)				482		381		1389	480	234	1422	
Capacity (veh/h)				628		818		1487	1285	276	2039	
Adjusted saturation flow (veh/h)				1770		1583		3547	1583	1770	3547	
v/c ratio				.768		.466		.934	.374	.848	.698	
g/C ratio				.355		.517		.419	.812	.586	.575	
Average back of queue (veh)				20.6		11.2		36	6.2	10	25	
Uniform delay (s)				44.3		23.8		42.9	3.9	49.9	23.4	
Incremental delay (s)				5.7		.3		11.1	0	21.2	1.1	
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				50		24.1		54	3.9	71.1	24.5	
LOS				D		C		D	A	E	C	
Approach delay (s)/LOS		/		38.6	/	D	41.2	/	D	31.1	/	C
Intersection delay (s)/ LOS		36.9			/			D				

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PAC
Analysis Period/Year: TOT AM 2015
Comment: 2015 TOT W/PROJ AM

Site Information

Jurisdiction/Date: 4/17/2008
EB/WB Street: HINALANI D
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other — Analysis period: .25 h — Signal type: Actuated-Field — % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)				434		433		1278	532	221	1340	
RTOR volume (veh/h)						80			100			0
Peak-hour factor				.9	.9	.9	.9	.9	.9	.9	.9	.9
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR	R						
NB	R		TR					
SB		LT	LT					
Green (s)	53	20	67					
Yellow + All red (s)	5.1	4.1	5.8					

Cycle (s) 155 — Lost time per cycle (s) 15.7 — Critical v/c Ratio .926

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration				L		R		T	R	L	T	
No. of lanes				1		1		2	1	1	2	
Flow rate (veh/h)				482		392		1420	480	246	1489	
Capacity (veh/h)				605		798		1533	1285	276	2085	
Adjusted saturation flow (veh/h)				1770		1583		3547	1583	1770	3547	
v/c ratio				.797		.492		.926	.374	.888	.714	
g/C ratio				.342		.504		.432	.812	.599	.588	
Average back of queue (veh)				21.2		11.9		36.3	6.2	11.1	26.3	
Uniform delay (s)				46.1		25.4		41.7	3.9	51.3	22.7	
Incremental delay (s)				7.4		.5		10	0	27.6	1.2	
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				53.5		25.9		51.7	3.9	78.9	23.9	
LOS				D		C		D	A	E	C	
Approach delay (s)/LOS		/		41.1	/	D	39.6	/	D	31.7	/	C
Intersection delay (s)/ LOS		36.9			/			D				

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PAC
Analysis Period/Year: AMB AM 2 2020
Comment: 2020 AMB AM W/2 LT WB

Site Information

Jurisdiction/Date: 4/17/2008
EB/WB Street: HINALANI D
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other | Analysis period: .25 h | Signal type: Actuated-Field | % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)				578		443		1266	613	285	1296	
RTOR volume (veh/h)						80			100			0
Peak-hour factor				.9	.9	.9	.9	.9	.9	.9	.9	.9
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR	R						
NB	R		TR					
SB		LT	LT					
Green (s)	40	33	70					
Yellow + All red (s)	5.1	4.1	5.8					

Cycle (s): 158 | Lost time per cycle (s): 15.7 | Critical v/c Ratio: 1.039

Intersection Performance

	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Lane group configuration				L		R		T	R	L	T	
No. of lanes				2		1		2	1	1	2	
Flow rate (veh/h)				642		403		1407	570	317	1440	
Capacity (veh/h)				870		783		1571	1160	417	2404	
Adjusted saturation flow (veh/h)				3437		1583		3547	1583	1770	3547	
v/c ratio				.738		.515		.895	.491	.76	.599	
g/C ratio				.253		.494		.443	.733	.689	.678	
Average back of queue (veh)				14.9		12.9		35	11.4	10.6	19.6	
Uniform delay (s)				54.2		27.1		40.6	8.8	48.1	13.8	
Incremental delay (s)				3.4		.6		7.1	.3	8	.4	
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				57.6		27.7		47.7	9.1	56.1	14.2	
LOS				E		C		D	A	E	B	
Approach delay (s)/LOS		/		46.1	/	D	36.6	/	D	21.8	/	C
Intersection delay (s)/ LOS		33.2			/				C			

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PAC
Analysis Period/Year: TOT AM 2 2020
Comment: 2020 TOT AM W/2 LT WB

Site Information

Jurisdiction/Date: 4/17/2008
EB/WB Street: HINALANI D
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other | Analysis period: .25 h | Signal type: Actuated-Field | % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)				578		465		1305	613	315	1401	
RTOR volume (veh/h)						80			100			0
Peak-hour factor				.9	.9	.9	.9	.9	.9	.9	.9	.9
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR	R						
NB	R		TR					
SB		LT	LT					
Green (s)	45	40	80					
Yellow + All red (s)	5.1	4.1	5.8					

Cycle (s): 180 | Lost time per cycle (s): 15.7 | Critical v/c Ratio: 1.059

Intersection Performance

	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Lane group configuration				L		R		T	R	L	T	
No. of lanes				2		1		2	1	1	2	
Flow rate (veh/h)				642		428		1450	570	350	1557	
Capacity (veh/h)				859		793		1576	1151	435	2445	
Adjusted saturation flow (veh/h)				3437		1583		3547	1583	1770	3547	
v/c ratio				.748		.54		.92	.495	.805	.637	
g/C ratio				.25		.501		.444	.727	.699	.689	
Average back of queue (veh)				16.9		15.7		41.9	13.3	14.1	24.7	
Uniform delay (s)				62.3		30.8		47	10.5	56.9	15.5	
Incremental delay (s)				3.6		.7		9.1	.3	10.6	.6	
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				65.9		31.5		56.1	10.8	67.5	16.1	
LOS				E		C		E	B	E	B	
Approach delay (s)/LOS		/		52.1	/	D	43.3	/	D	25.5	/	C
Intersection delay (s)/ LOS		38.4			/				D			

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information		Site Information	
Analyst	WY	Jurisdiction/Date	4/17/2008
Agency or Company	M&E PAC	EB/WB Street	HINALANI D
Analysis Period/Year	AMB AM 2 2029	NB/SB Street	QUEEN KAAH
Comment	2029 AMB AM W/2 LT WB		

Intersection Data

Area type Other Analysis period .25 h Signal type Actuated-Field % Back of queue 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)				607		443		1330	644	285	1296	
RTOR volume (veh/h)						80			100			0
Peak-hour factor				.9	.9	.9	.9	.9	.9	.9	.9	.9
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR	R						
NB	R		TR					
SB		LT	LT					
Green (s)	40	33	70					
Yellow + All red (s)	5.1	4.1	5.8					

Cycle (s) 158 Lost time per cycle (s) 15.7 Critical v/c Ratio 1.085

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration				L		R		T	R	L	T	
No. of lanes				2		1		2	1	1	2	
Flow rate (veh/h)				674		403		1478	604	317	1440	
Capacity (veh/h)				870		783		1571	1160	417	2404	
Adjusted saturation flow (veh/h)				3437		1583		3547	1583	1770	3547	
v/c ratio				.775		.515		.94	.521	.76	.599	
g/C ratio				.253		.494		.443	.733	.689	.678	
Average back of queue (veh)				16		12.9		39.1	12.6	10.6	19.6	
Uniform delay (s)				54.8		27.1		42	9.1	48.5	13.8	
Incremental delay (s)				4.4		.6		11.5	.4	8	.4	
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				59.2		27.7		53.5	9.5	56.5	14.2	
LOS				E		C		D	A	E	B	
Approach delay (s)/LOS		/		47.4	/	D	40.7	/	D	21.8	/	C
Intersection delay (s)/ LOS	35.5				/				D			

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information		Site Information	
Analyst	WY	Jurisdiction/Date	4/17/2008
Agency or Company	M&E PAC	EB/WB Street	HINALANI D
Analysis Period/Year	TOT AM 2 2029	NB/SB Street	QUEEN KAAH
Comment	2029 TOT AM W/2 LT WB&SB		

Intersection Data

Area type Other Analysis period .25 h Signal type Actuated-Field % Back of queue 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)				607		495		1480	644	340	1515	
RTOR volume (veh/h)						80			100			0
Peak-hour factor				.9	.9	.9	.9	.9	.9	.9	.9	.9
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR	R						
NB	R		TR					
SB		LT	LT					
Green (s)	35	25	75					
Yellow + All red (s)	5.1	4.1	5.8					

Cycle (s) 150 Lost time per cycle (s) 15.7 Critical v/c Ratio 1.067

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration				L		R		T	R	L	T	
No. of lanes				2		1		2	1	2	2	
Flow rate (veh/h)				674		461		1644	604	378	1683	
Capacity (veh/h)				802		687		1773	1222	1833	2461	
Adjusted saturation flow (veh/h)				3437		1583		3547	1583	3437	3547	
v/c ratio				.841		.671		.927	.495	.206	.684	
g/C ratio				.233		.434		.5	.772	.705	.694	
Average back of queue (veh)				16.1		16.8		40	10.3	2.9	23.7	
Uniform delay (s)				54.8		33.9		35	6.3	23.6	13.4	
Incremental delay (s)				8		2.6		9	.3	0	.8	
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				62.8		36.5		44	6.6	23.6	14.2	
LOS				E		D		D	A	C	B	
Approach delay (s)/LOS		/		52.1	/	D	33.9	/	C	15.9	/	B
Intersection delay (s)/ LOS	30.9				/				C			

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: ANALYST
Agency or Company: M&E PAC
Analysis Period/Year: EX PM #1 2006
Comment: 2006 EXIST 3:30-4:30 PM

Site Information

Jurisdiction/Date: 3/26/2008
EB/WB Street: HINALANI D
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other | Analysis period: .25 h | Signal type: Actuated-Field | % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)				300		280		550	445	175	650	
RTOR volume (veh/h)						40			80			0
Peak-hour factor				.9	.9	.9	.9	.9	.9	.9	.9	.9
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR							
NB			TR					
SB		LT	LT					
Green (s)	28	23.1	44					
Yellow + All red (s)	5.1	4	5.8					

Cycle (s) 110 | Lost time per cycle (s) 9.8 | Critical v/c Ratio .688

Intersection Performance

	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Lane group configuration				L		R		T	R	L	T	
No. of lanes				1		1		1	1	1	1	
Flow rate (veh/h)				333		267		611	406	194	722	
Capacity (veh/h)				450		403		745	633	541	1204	
Adjusted saturation flow (veh/h)				1770		1583		1863	1583	1770	1863	
v/c ratio				.74		.662		.82	.64	.36	.6	
g/C ratio				.255		.255		.4	.4	.663	.646	
Average back of queue (veh)				10.6		8.1		19.3	11	2.9	14	
Uniform delay (s)				37.7		36.8		29.5	26.6	11.3	11.2	
Incremental delay (s)				6.4		4		7.3	2.2	0	.8	
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				44.1		40.8		36.8	28.8	11.3	12	
LOS				D		D		D	C	B	B	
Approach delay (s)/LOS		/		42.6	/	D	33.6	/	C	11.9	/	B
Intersection delay (s)/ LOS		27.9				/			C			

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: ANALYST
Agency or Company: M&E PAC
Analysis Period/Year: EX PM #2 2006
Comment: 2006 EXIST 4:30-5:30 PM

Site Information

Jurisdiction/Date: 3/26/2008
EB/WB Street: HINALANI D
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other | Analysis period: .25 h | Signal type: Actuated-Field | % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)				260		270		550	360	105	490	
RTOR volume (veh/h)						40			80			0
Peak-hour factor				.9	.9	.9	.9	.9	.9	.9	.9	.9
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR							
NB			TR					
SB		LT	LT					
Green (s)	28	23.1	44					
Yellow + All red (s)	5.1	4	5.8					

Cycle (s) 110 | Lost time per cycle (s) 9.8 | Critical v/c Ratio .612

Intersection Performance

	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Lane group configuration				L		R		T	R	L	T	
No. of lanes				1		1		1	1	1	1	
Flow rate (veh/h)				289		256		611	311	117	544	
Capacity (veh/h)				450		403		745	633	541	1204	
Adjusted saturation flow (veh/h)				1770		1583		1863	1583	1770	1863	
v/c ratio				.641		.634		.82	.491	.216	.452	
g/C ratio				.255		.255		.4	.4	.663	.646	
Average back of queue (veh)				8.7		7.7		19.3	7.7	1.5	9	
Uniform delay (s)				36.5		36.4		29.5	24.6	10.5	9.7	
Incremental delay (s)				3.1		3.3		7.3	.6	0	.2	
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				39.6		39.7		36.8	25.2	10.5	9.9	
LOS				D		D		D	C	B	A	
Approach delay (s)/LOS		/		39.7	/	D	32.9	/	C	10	/	A
Intersection delay (s)/ LOS		27.5				/			C			

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PAC
Analysis Period/Year: AMB PM 2015
Comment: 2015 AMB PM W/ 1LT WB LANE

Site Information

Jurisdiction/Date: 4/17/2008
EB/WB Street: HINALANI D
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other | Analysis period: .25 h | Signal type: Actuated-Field | % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)				615		360		1174	699	260	1383	
RTOR volume (veh/h)						80			100			0
Peak-hour factor				.9	.9	.9	.9	.9	.9	.9	.9	.9
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR	R						
NB	R		TR					
SB		LT	LT					
Green (s)	65	25	70					
Yellow + All red (s)	5.1	4.1	5.8					

Cycle (s) 175 | Lost time per cycle (s) 9.9 | Critical v/c Ratio .597

Intersection Performance

	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Lane group configuration				L		R		T	R	L	T	
No. of lanes				1		1		2	1	1	2	
Flow rate (veh/h)				683		311		1304	666	289	1537	
Capacity (veh/h)				657		860		1419	1274	295	2008	
Adjusted saturation flow (veh/h)				1770		1583		3547	1583	1770	3547	
v/c ratio				1.04		.362		.919	.522	.978	.765	
g/C ratio				.371		.543		.4	.805	.576	.566	
Average back of queue (veh)				43.3		9.1		37.2	12.2	17.3	33.2	
Uniform delay (s)				55		22.7		49.8	5.8	61.1	29	
Incremental delay (s)				45.8		0		9.9	.4	46.2	1.8	
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				100.8		22.7		59.7	6.2	107.3	30.8	
LOS				F		C		E	A	F	C	
Approach delay (s)/LOS		/		76.4	/	E	41.6	/	D	42.9	/	D
Intersection delay (s)/ LOS				49.3			/			D		

CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PAC
Analysis Period/Year: TOT PM 2015
Comment: 2015 TOT PM W/ 1LT WB LANE

Site Information

Jurisdiction/Date: 4/17/2008
EB/WB Street: HINALANI D
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other | Analysis period: .25 h | Signal type: Actuated-Field | % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)				615		385		1249	699	270	1443	
RTOR volume (veh/h)						80			100			0
Peak-hour factor				.9	.9	.9	.9	.9	.9	.9	.9	.9
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR	R						
NB	R		TR					
SB		LT	LT					
Green (s)	65	25	70					
Yellow + All red (s)	5.1	4.1	5.8					

Cycle (s) 175 | Lost time per cycle (s) 9.9 | Critical v/c Ratio 1.106

Intersection Performance

	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Lane group configuration				L		R		T	R	L	T	
No. of lanes				1		1		2	1	1	2	
Flow rate (veh/h)				683		339		1388	666	300	1603	
Capacity (veh/h)				657		860		1419	1274	295	2008	
Adjusted saturation flow (veh/h)				1770		1583		3547	1583	1770	3547	
v/c ratio				1.04		.394		.978	.522	1.016	.798	
g/C ratio				.371		.543		.4	.805	.576	.566	
Average back of queue (veh)				43.3		10.2		42.8	12.2	19	36.1	
Uniform delay (s)				55		23.2		51.7	5.8	62.2	30	
Incremental delay (s)				45.8		.1		18.8	.4	56.4	2.4	
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				100.8		23.3		70.5	6.2	118.6	32.4	
LOS				F		C		E	A	F	C	
Approach delay (s)/LOS		/		75.1	/	E	49.7	/	D	46	/	D
Intersection delay (s)/ LOS				53.5			/			D		

CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PAC
Analysis Period/Year: AMB PM 2 2020
Comment: 2020 AMB PM W/ 2LT WB LANE

Site Information

Jurisdiction/Date: 4/17/2008
EB/WB Street: HINALANI D
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other Analysis period: .25 h Signal type: Actuated-Field % Back of queue: 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)				559		374		1165	739	392	1247	
RTOR volume (veh/h)						80			100			0
Peak-hour factor				.9	.9	.9	.9	.9	.9	.9	.9	.9
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR	R						
NB	R		TR					
SB		LT	LT					
Green (s)	35	40	70					
Yellow + All red (s)	5.1	4.1	5.8					

Cycle (s) 160 Lost time per cycle (s) 9.9 Critical v/c Ratio .74

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration				L		R		T	R	L	T	
No. of lanes				2		1		2	1	1	2	
Flow rate (veh/h)				621		327		1294	710	436	1386	
Capacity (veh/h)				752		793		1552	1096	495	2529	
Adjusted saturation flow (veh/h)				3437		1583		3547	1583	1770	3547	
v/c ratio				.826		.412		.834	.648	.88	.548	
g/C ratio				.219		.501		.438	.693	.724	.713	
Average back of queue (veh)				15.7		9.7		30.3	19.4	17.8	16.6	
Uniform delay (s)				59.6		25.1		39.9	13.7	48.7	10.8	
Incremental delay (s)				7.6		.1		4.1	1.3	16.5	.3	
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				67.2		25.2		44	15	65.2	11.1	
LOS				E		C		D	B	E	B	
Approach delay (s)/LOS		/		52.7	/	D	33.7	/	C	24	/	C
Intersection delay (s)/ LOS			33.8				/			C		

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PAC
Analysis Period/Year: TOT PM 2 2020
Comment: 2020 TOT PM W/ 2LT WB LANE

Site Information

Jurisdiction/Date: 4/17/2008
EB/WB Street: HINALANI D
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other Analysis period: .25 h Signal type: Actuated-Field % Back of queue: 95

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (veh/h)				559		417		1295	739	425	1355	
RTOR volume (veh/h)						80			100			0
Peak-hour factor				.9	.9	.9	.9	.9	.9	.9	.9	.9
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT T: TH R: RT P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR	R						
NB	R		TR					
SB		LT	LT					
Green (s)	35	45	70					
Yellow + All red (s)	5.1	4.1	5.8					

Cycle (s) 165 Lost time per cycle (s) 9.9 Critical v/c Ratio .761

Intersection Performance

	EB			WB			NB			SB		
Lane group configuration				L		R		T	R	L	T	
No. of lanes				2		1		2	1	1	2	
Flow rate (veh/h)				621		374		1439	710	472	1506	
Capacity (veh/h)				729		817		1505	1063	528	2560	
Adjusted saturation flow (veh/h)				3437		1583		3547	1583	1770	3547	
v/c ratio				.852		.459		.956	.668	.895	.588	
g/C ratio				.212		.516		.424	.672	.732	.722	
Average back of queue (veh)				16.5		11.6		40.7	21.4	20.4	19.2	
Uniform delay (s)				62.5		25.3		46	16.1	51.1	11.1	
Incremental delay (s)				9.6		.3		14.2	1.6	17.7	.4	
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				72.1		25.6		60.2	17.7	68.8	11.5	
LOS				E		C		E	B	E	B	
Approach delay (s)/LOS		/		54.6	/	D	46.2	/	D	25.2	/	C
Intersection delay (s)/ LOS			39.7				/			D		

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PAC
Analysis Period/Year: AMB PM 2 2029
Comment: 2029 AMB PM W/ 2LT WB LANE

Site Information

Jurisdiction/Date: 4/17/2008
EB/WB Street: HINALANI D
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other   Analysis period: .25 h   Signal type: Actuated-Field   % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)				587		412		1328	776	438	1256	
RTOR volume (veh/h)						80			100			0
Peak-hour factor				.9	.9	.9	.9	.9	.9	.9	.9	.9
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT   T: TH   R: RT   P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR	R						
NB	R		TR					
SB		LT	LT					
Green (s)	35	40	70					
Yellow + All red (s)	5.1	4.1	5.8					

Cycle (s): 160   Lost time per cycle (s): 9.9   Critical v/c Ratio: .772

Intersection Performance

	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Lane group configuration				L		R		T	R	L	T	
No. of lanes				2		1		2	1	1	2	
Flow rate (veh/h)				652		369		1476	751	487	1396	
Capacity (veh/h)				752		793		1552	1096	489	2529	
Adjusted saturation flow (veh/h)				3437		1583		3547	1583	1770	3547	
v/c ratio				.868		.465		.951	.685	.995	.552	
g/C ratio				.219		.501		.438	.693	.724	.713	
Average back of queue (veh)				17		11.4		40.2	21.7	27.3	16.8	
Uniform delay (s)				60.3		26		43.3	14.4	53.4	10.9	
Incremental delay (s)				10.6		.3		13.1	1.8	39.4	.3	
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				70.9		26.3		56.4	16.2	92.8	11.2	
LOS				E		C		E	B	F	B	
Approach delay (s)/LOS		/		54.8	/	D	42.9	/	D	32.3	/	C
Intersection delay (s)/ LOS			41.3			/			D			

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CHAPTER 16 - OPERATIONAL ANALYSIS - SUMMARY WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PAC
Analysis Period/Year: TOT PM 2 2029
Comment: 2029 TOT PM W/ 2LT WB &SB LANES

Site Information

Jurisdiction/Date: 4/17/2008
EB/WB Street: HINALANI D
NB/SB Street: QUEEN KAAH

Intersection Data

Area type: Other   Analysis period: .25 h   Signal type: Actuated-Field   % Back of queue: 95

	EB LT	EB TH	EB RT	WB LT	WB TH	WB RT	NB LT	NB TH	NB RT	SB LT	SB TH	SB RT
Volume (veh/h)				587		487		1540	776	505	1450	
RTOR volume (veh/h)						80			100			0
Peak-hour factor				.9	.9	.9	.9	.9	.9	.9	.9	.9
Heavy vehicles (%)				2		2		2	2	2	2	
Start-up lost time, l_1 (s)				2		2		2	2	2	2	
Extension of effective green, e (s)				2		2		2	2	2	2	
Arrival type, AT				3		3		3	3	3	3	
Approach pedestrian volume (p/h)					0			0			0	
Approach bicycle volume (bic/h)					0			0			0	
Left/right parking (Y or N)		/		N	/	N	N	/	N	N	/	N

Signal Phasing Plan

L: LT   T: TH   R: RT   P: Peds

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
EB								
WB	LR	R						
NB	R		TR					
SB		LT	LT					
Green (s)	50	20	105					
Yellow + All red (s)	5.1	4.1	5.8					

Cycle (s): 190   Lost time per cycle (s): 15.7   Critical v/c Ratio: 1.158

Intersection Performance

	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Lane group configuration				L		R		T	R	L	T	
No. of lanes				2		1		2	1	2	2	
Flow rate (veh/h)				652		452		1711	751	561	1611	
Capacity (veh/h)				904		626		1960	1340	1627	2410	
Adjusted saturation flow (veh/h)				3437		1583		3547	1583	3437	3547	
v/c ratio				.721		.723		.873	.561	.345	.669	
g/C ratio				.263		.395		.553	.846	.688	.679	
Average back of queue (veh)				17.7		22.2		46.6	13.2	6.4	28.6	
Uniform delay (s)				63.7		48.6		36.7	4.3	31.1	17.9	
Incremental delay (s)				2.8		4.1		4.7	.5	0	.7	
Initial queue delay (s)				0		0		0	0	0	0	
Delay (s)				66.5		52.7		41.4	4.8	31.1	18.6	
LOS				E		D		D	A	C	B	
Approach delay (s)/LOS		/		60.8	/	E	30.3	/	C	21.8	/	C
Intersection delay (s)/ LOS			33			/			C			

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Appendix C

Unsignalized Intersection Level of Service (LOS) Calculations

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	WY	Jurisdiction/Date	4/16/2008
Agency or Company	M&E PACIFIC	Major Street	QUEEN KAAHUMANU HWY
Analysis Period/Year	EXIST AM 2006	Minor Street	NELHA RD
Comment	2006 EXIST AM		

Input Data

Lane Configuration	SB	NB	EB	WB
Lane 1 (curb)	R	T	R	
Lane 2	T	L	L	
Lane 3				

	SB			NB			EB			WB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		870	40	60	675		12		20			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		967	44	67	750		13		22			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
EB	1	R	22	307	.072	<1	17.6	C	34.9
	2	L	13	74	.177	1	64.2	F	D
	3								
WB	1								
	2								
	3								
		①							
		④	67	709	.094	<1	10.6	B	

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CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	WY	Jurisdiction/Date	4/16/2008
Agency or Company	M&E PACIFIC	Major Street	QUEEN KAAHUMANU HWY
Analysis Period/Year	EXIST PM 2006	Minor Street	NELHA RD
Comment	2006 EXIST PM		

Input Data

Lane Configuration	SB	NB	EB	WB
Lane 1 (curb)	R	T	R	
Lane 2	T	L	L	
Lane 3				

	SB			NB			EB			WB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		615	18	28	840		39		58			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		683	20	31	933		43		64			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
EB	1	R	64	447	.143	<1	14.4	B	35
	2	L	107	187	.572	3	47.3	E	D
	3								
WB	1								
	2								
	3								
		①							
		④	31	905	.034	<1	9.1	A	

HiCAP 2000 ™

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: EXIST AM 2006
Comment: 2006 EXISTING AM

Site Information

Jurisdiction/Date: 4/16/2008
Major Street: QUEEN KAAHUMANU HWY
Minor Street: HULIKOA DR

Input Data

Lane Configuration	SB	NB	EB	WB
Lane 1 (curb)	T	R		R
Lane 2	L	T		L
Lane 3				

	SB			NB			EB			WB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	63	770			820	95				65		97
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	70	856			911	106				72		108
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft   Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
EB	1								
	2								
	3								
WB	1	R	108	331	.326	1	21.1	C	107.3
	2	L	72	67	1.073	6	236.8	F	F
	3								
		①	70	678	.103	<1	10.9	B	
		④							

HiCAP 2000 ™

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: EXIST PM 2006
Comment: 2006 EXISTING PM

Site Information

Jurisdiction/Date: 4/16/2008
Major Street: QUEEN KAAHUMANU HWY
Minor Street: HULIKOA DR

Input Data

Lane Configuration	SB	NB	EB	WB
Lane 1 (curb)	T	R		R
Lane 2	L	T		L
Lane 3				

	SB			NB			EB			WB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	33	460			770	50				134		90
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	37	511			856	56				149		100
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft   Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
EB	1								
	2								
	3								
WB	1	R	100	356	.281	1	19	C	104
	2	L	149	139	1.075	8	161.1	F	F
	3								
		①	37	780	.047	<1	9.8	A	
		④							

HiCAP 2000 ™

Appendix D

On-Ramp
Level of Service (LOS) Calculations

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM — 2029
Comment:

Site Information

Jurisdiction/Date: 4/14/2008
Freeway/Direction of Travel: QKH SOUTHBOUND
Junction: OOMA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp: ☑ Yes ☐ No; ☐ On ☑ Off
L_{up} = 450 ft
V_u = 270 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge; ☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h
S_{FR} = 35 mi/h

Downstream Adjacent Ramp: ☐ Yes ☑ No; ☐ On ☐ Off
L_{down} = ____ ft
V_D = ____ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	16100	.09	1	1449	.9	5	.976	1	1650
v_R	2700	.09		243	.9	5	.976	1	277
v_U		.09		270	.9	5	.976	1	307
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ____ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ____ (Exhibit 25-5)
v_{12} = 1650 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1927	See Exhibit 25-7	
v_{R12}	1927	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$
D_R = 19.5 pc/mi/ln
LOS = B (Exhibit 25-4)

Speed Estimation

M_s = .338 (Exhibit 25-19)
S_R = 60.5 mi/h (Exhibit 25-19)
S_0 = ____ mi/h (Exhibit 25-19)
S = 60.5 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ____ (Equation 25-8 or 25-9)
P_{FD} = ____ using Equation ____ (Exhibit 25-12)
v_{12} = ____ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{FI} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$
D_R = ____ pc/mi/ln
LOS = ____ (Exhibit 25-4)

Speed Estimation

D_s = ____ (Exhibit 25-19)
S_R = ____ mi/h (Exhibit 25-19)
S_0 = ____ mi/h (Exhibit 25-19)
S = ____ mi/h (Equation 25-15)

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM — 2015
Comment: 2015 TOTAL PM ON-RAMP

Site Information

Jurisdiction/Date: 4/9/2008
Freeway/Direction of Travel: QKH SOUTHBOUND
Junction: OOMA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp: ☑ Yes ☐ No; ☐ On ☑ Off
L_{up} = 450 ft
V_u = 77 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge; ☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h
S_{FR} = 35 mi/h

Downstream Adjacent Ramp: ☐ Yes ☑ No; ☐ On ☐ Off
L_{down} = ____ ft
V_D = ____ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	22700	.09	1	2043	.9	5	.976	1	2327
v_R	555	.09		50	.9	5	.976	1	57
v_U		.09		77	.9	5	.976	1	87
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ____ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ____ (Exhibit 25-5)
v_{12} = 2327 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2384	See Exhibit 25-7	
v_{R12}	2384	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$
D_R = 23.2 pc/mi/ln
LOS = C (Exhibit 25-4)

Speed Estimation

M_s = .353 (Exhibit 25-19)
S_R = 60.1 mi/h (Exhibit 25-19)
S_0 = ____ mi/h (Exhibit 25-19)
S = 60.1 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ____ (Equation 25-8 or 25-9)
P_{FD} = ____ using Equation ____ (Exhibit 25-12)
v_{12} = ____ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{FI} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$
D_R = ____ pc/mi/ln
LOS = ____ (Exhibit 25-4)

Speed Estimation

D_s = ____ (Exhibit 25-19)
S_R = ____ mi/h (Exhibit 25-19)
S_0 = ____ mi/h (Exhibit 25-19)
S = ____ mi/h (Equation 25-15)

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM 2020
Comment: 2020 TOTAL PM ON-RAMP

Site Information

Jurisdiction/Date: 4/9/2008
Freeway/Direction of Travel: QKH SOUTHBOUND
Junction: OOMA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp: ☑ Yes ☐ No; ☐ On ☑ Off
L_{up} = 450 ft
V_u = 153 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge
☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h
S_{FR} = 35 mi/h

Downstream Adjacent Ramp: ☐ Yes ☑ No; ☐ On ☐ Off
L_{down} = ____ ft
V_D = ____ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	22850	.09	1	2057	.9	5	.976	1	2342
v_R	1670	.09		150	.9	5	.976	1	171
v_U		.09		153	.9	5	.976	1	174
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ____ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ____ (Exhibit 25-5)
v_{12} = 2342 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2513	See Exhibit 25-7	
v_{R12}	2513	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$
D_R = 24.1 pc/mi/ln
LOS = C (Exhibit 25-4)

Speed Estimation

M_s = .359 (Exhibit 25-19)
S_R = 59.9 mi/h (Exhibit 25-19)
S_0 = ____ mi/h (Exhibit 25-19)
S = 59.9 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ____ (Equation 25-8 or 25-9)
P_{FD} = ____ using Equation ____ (Exhibit 25-12)
v_{12} = ____ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$
D_R = ____ pc/mi/ln
LOS = ____ (Exhibit 25-4)

Speed Estimation

D_s = ____ (Exhibit 25-19)
S_R = ____ mi/h (Exhibit 25-19)
S_0 = ____ mi/h (Exhibit 25-19)
S = ____ mi/h (Equation 25-15)

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM 2029
Comment: 2029 TOTAL PM ON-RAMP

Site Information

Jurisdiction/Date: 4/14/2008
Freeway/Direction of Travel: QKH SOUTHBOUND
Junction: OOMA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp: ☑ Yes ☐ No; ☐ On ☑ Off
L_{up} = 450 ft
V_u = 288 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge
☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h
S_{FR} = 35 mi/h

Downstream Adjacent Ramp: ☐ Yes ☑ No; ☐ On ☐ Off
L_{down} = ____ ft
V_D = ____ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	24000	.09	1	2160	.9	5	.976	1	2460
v_R	2700	.09		243	.9	5	.976	1	277
v_U		.09		288	.9	5	.976	1	328
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ____ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ____ (Exhibit 25-5)
v_{12} = 2460 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2737	See Exhibit 25-7	
v_{R12}	2737	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$
D_R = 25.8 pc/mi/ln
LOS = C (Exhibit 25-4)

Speed Estimation

M_s = .371 (Exhibit 25-19)
S_R = 59.6 mi/h (Exhibit 25-19)
S_0 = ____ mi/h (Exhibit 25-19)
S = 59.6 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ____ (Equation 25-8 or 25-9)
P_{FD} = ____ using Equation ____ (Exhibit 25-12)
v_{12} = ____ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$
D_R = ____ pc/mi/ln
LOS = ____ (Exhibit 25-4)

Speed Estimation

D_s = ____ (Exhibit 25-19)
S_R = ____ mi/h (Exhibit 25-19)
S_0 = ____ mi/h (Exhibit 25-19)
S = ____ mi/h (Equation 25-15)

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM 2015
Comment: 2015 TOTAL AM ON-RAMP

Site Information

Jurisdiction/Date: 4/14/2008
Freeway/Direction of Travel: QKH SOUTHBOUND
Junction: OOMA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp: ☑ Yes ☐ No ☐ On ☑ Off
L_{up} = 450 ft
V_u = 23 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge
☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h
S_{FR} = 35 mi/h

Downstream Adjacent Ramp: ☐ Yes ☑ No ☐ On ☐ Off
L_{down} = ______ ft
V_D = ______ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	15200	.09	1	1368	.9	5	.976	1	1558
v_R	730	.09		66	.9	5	.976	1	75
v_U		.09		23	.9	5	.976	1	26
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ______ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ______ (Exhibit 25-5)
v_{12} = 1558 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1633	See Exhibit 25-7	
v_{R12}	1633	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$

D_R = 17.3 pc/mi/ln
LOS = B (Exhibit 25-4)

Speed Estimation

M_s = .331 (Exhibit 25-19)
S_R = 60.7 mi/h (Exhibit 25-19)
S_0 = ______ mi/h (Exhibit 25-19)
S = 60.7 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ______ (Equation 25-8 or 25-9)
P_{FD} = ______ using Equation ______ (Exhibit 25-12)
v_{12} = ______ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{FI} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$

D_R = ______ pc/mi/ln
LOS = ______ (Exhibit 25-4)

Speed Estimation

D_s = ______ (Exhibit 25-19)
S_R = ______ mi/h (Exhibit 25-19)
S_0 = ______ mi/h (Exhibit 25-19)
S = ______ mi/h (Equation 25-15)

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM 2020
Comment: 2020 TOAL AM ON-RAMP

Site Information

Jurisdiction/Date: 4/14/2008
Freeway/Direction of Travel: QKH SOUTHBOUND
Junction: OOMA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp: ☑ Yes ☐ No ☐ On ☑ Off
L_{up} = 450 ft
V_u = 117 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge
☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h
S_{FR} = 35 mi/h

Downstream Adjacent Ramp: ☐ Yes ☑ No ☐ On ☐ Off
L_{down} = ______ ft
V_D = ______ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	15300	.09	1	1377	.9	5	.976	1	1568
v_R	1400	.09		126	.9	5	.976	1	143
v_U		.09		117	.9	5	.976	1	133
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ______ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ______ (Exhibit 25-5)
v_{12} = 1568 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1712	See Exhibit 25-7	
v_{R12}	1712	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$

D_R = 17.9 pc/mi/ln
LOS = B (Exhibit 25-4)

Speed Estimation

M_s = .333 (Exhibit 25-19)
S_R = 60.7 mi/h (Exhibit 25-19)
S_0 = ______ mi/h (Exhibit 25-19)
S = 60.7 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ______ (Equation 25-8 or 25-9)
P_{FD} = ______ using Equation ______ (Exhibit 25-12)
v_{12} = ______ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{FI} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$

D_R = ______ pc/mi/ln
LOS = ______ (Exhibit 25-4)

Speed Estimation

D_s = ______ (Exhibit 25-19)
S_R = ______ mi/h (Exhibit 25-19)
S_0 = ______ mi/h (Exhibit 25-19)
S = ______ mi/h (Equation 25-15)

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM 2015
Comment: 2015 TOTAL AM ON-RAMP

Site Information

Jurisdiction/Date: 4/19/2008
Freeway/Direction of Travel: QKH SB NELHA
Junction: NELHA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp: ☑ Yes ☐ On ☐ No ☑ Off
L_{up} = 450 ft
V_u = 23 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge ☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h
S_{FR} = 35 mi/h

Downstream Adjacent Ramp: ☐ Yes ☐ On ☑ No ☐ Off
L_{down} = ______ ft
V_D = ______ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	15200	.09	1	1368	.9	5	.976	1	1558
v_R	220	.09		20	.9	5	.976	1	23
v_U		.09		23	.9	5	.976	1	26
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ______ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ______ (Exhibit 25-5)
v_{12} = 1558 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1581	See Exhibit 25-7	
v_{R12}	1581	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$

D_R = 16.9 pc/mi/ln
LOS = B (Exhibit 25-4)

Speed Estimation

M_s = .33 (Exhibit 25-19)
S_R = 60.8 mi/h (Exhibit 25-19)
S_0 = ______ mi/h (Exhibit 25-19)
S = 60.8 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ______ (Equation 25-8 or 25-9)
P_{FD} = ______ using Equation ______ (Exhibit 25-12)
v_{12} = ______ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{FI} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$

D_R = ______ pc/mi/ln
LOS = ______ (Exhibit 25-4)

Speed Estimation

D_s = ______ (Exhibit 25-19)
S_R = ______ mi/h (Exhibit 25-19)
S_0 = ______ mi/h (Exhibit 25-19)
S = ______ mi/h (Equation 25-15)

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM 2020
Comment: 2020 TOAL AM ON-RAMP

Site Information

Jurisdiction/Date: 4/19/2008
Freeway/Direction of Travel: QKH SB NELHA
Junction: NELHA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp: ☑ Yes ☐ On ☐ No ☑ Off
L_{up} = 450 ft
V_u = 117 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge ☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h
S_{FR} = 35 mi/h

Downstream Adjacent Ramp: ☐ Yes ☐ On ☑ No ☐ Off
L_{down} = ______ ft
V_D = ______ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	15700	.09	1	1413	.9	5	.976	1	1609
v_R	220	.09		20	.9	5	.976	1	23
v_U		.09		117	.9	5	.976	1	133
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ______ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ______ (Exhibit 25-5)
v_{12} = 1609 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1632	See Exhibit 25-7	
v_{R12}	1632	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$

D_R = 17.3 pc/mi/ln
LOS = B (Exhibit 25-4)

Speed Estimation

M_s = .331 (Exhibit 25-19)
S_R = 60.7 mi/h (Exhibit 25-19)
S_0 = ______ mi/h (Exhibit 25-19)
S = 60.7 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ______ (Equation 25-8 or 25-9)
P_{FD} = ______ using Equation ______ (Exhibit 25-12)
v_{12} = ______ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{FI} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$

D_R = ______ pc/mi/ln
LOS = ______ (Exhibit 25-4)

Speed Estimation

D_s = ______ (Exhibit 25-19)
S_R = ______ mi/h (Exhibit 25-19)
S_0 = ______ mi/h (Exhibit 25-19)
S = ______ mi/h (Equation 25-15)

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM 2029
Comment:

Site Information

Jurisdiction/Date: 4/19/2008
Freeway/Direction of Travel: QKH SB NELHA
Junction: NELHA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp: ☑ Yes ☐ On ☐ No ☑ Off
L_{up} = 450 ft
V_u = 270 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge ☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h
S_{FR} = 35 mi/h

Downstream Adjacent Ramp: ☐ Yes ☐ On ☑ No ☐ Off
L_{down} = ______ ft
V_D = ______ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	17950	.09	1	1616	.9	5	.976	1	1840
v_R	275	.09		25	.9	5	.976	1	28
v_U		.09		270	.9	5	.976	1	307
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ______ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ______ (Exhibit 25-5)
v_{12} = 1840 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1868	See Exhibit 25-7	
v_{R12}	1868	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$

D_R = 19.2 pc/mi/ln
LOS = B (Exhibit 25-4)

Speed Estimation

M_s = .336 (Exhibit 25-19)
S_R = 60.6 mi/h (Exhibit 25-19)
S_0 = ______ mi/h (Exhibit 25-19)
S = 60.6 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ______ (Equation 25-8 or 25-9)
P_{FD} = ______ using Equation ______ (Exhibit 25-12)
v_{12} = ______ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{FI} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$

D_R = ______ pc/mi/ln
LOS = ______ (Exhibit 25-4)

Speed Estimation

D_s = ______ (Exhibit 25-19)
S_R = ______ mi/h (Exhibit 25-19)
S_0 = ______ mi/h (Exhibit 25-19)
S = ______ mi/h (Equation 25-15)

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM 2015
Comment: 2015 TOTAL PM ON-RAMP

Site Information

Jurisdiction/Date: 4/19/2008
Freeway/Direction of Travel: QKH SB NELHA
Junction: NELHA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp: ☑ Yes ☐ On ☐ No ☑ Off
L_{up} = 450 ft
V_u = 77 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge ☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h
S_{FR} = 35 mi/h

Downstream Adjacent Ramp: ☐ Yes ☐ On ☑ No ☐ Off
L_{down} = ______ ft
V_D = ______ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	22700	.09	1	2043	.9	5	.976	1	2327
v_R	770	.09		69	.9	5	.976	1	79
v_U		.09		77	.9	5	.976	1	87
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ______ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ______ (Exhibit 25-5)
v_{12} = 2327 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2406	See Exhibit 25-7	
v_{R12}	2406	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$

D_R = 23.3 pc/mi/ln
LOS = C (Exhibit 25-4)

Speed Estimation

M_s = .354 (Exhibit 25-19)
S_R = 60.1 mi/h (Exhibit 25-19)
S_0 = ______ mi/h (Exhibit 25-19)
S = 60.1 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ______ (Equation 25-8 or 25-9)
P_{FD} = ______ using Equation ______ (Exhibit 25-12)
v_{12} = ______ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{FI} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$

D_R = ______ pc/mi/ln
LOS = ______ (Exhibit 25-4)

Speed Estimation

D_s = ______ (Exhibit 25-19)
S_R = ______ mi/h (Exhibit 25-19)
S_0 = ______ mi/h (Exhibit 25-19)
S = ______ mi/h (Equation 25-15)

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM 2020
Comment: 2020 TOTAL PM ON-RAMP

Site Information

Jurisdiction/Date: 4/19/2008
Freeway/Direction of Travel: QKH SB NELHA
Junction: NELHA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp: ☑ Yes ☐ On ☐ No ☑ Off
L_{up} = 450 ft
V_u = 153 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge; ☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h
S_{FR} = 35 mi/h

Downstream Adjacent Ramp: ☐ Yes ☐ On ☑ No ☐ Off
L_{down} = ____ ft
V_D = ____ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	23800	.09	1	2142	.9	5	.976	1	2439
v_R	770	.09		69	.9	5	.976	1	79
v_U		.09		153	.9	5	.976	1	174
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ____ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ____ (Exhibit 25-5)
v_{12} = 2439 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2518	See Exhibit 25-7	
v_{R12}	2518	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$

D_R = 24.2 pc/mi/ln
LOS = C (Exhibit 25-4)

Speed Estimation

M_s = .36 (Exhibit 25-19)
S_R = 59.9 mi/h (Exhibit 25-19)
S_0 = ____ mi/h (Exhibit 25-19)
S = 59.9 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ____ (Equation 25-8 or 25-9)
P_{FD} = ____ using Equation ____ (Exhibit 25-12)
v_{12} = ____ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{FI} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$

D_R = ____ pc/mi/ln
LOS = ____ (Exhibit 25-4)

Speed Estimation

D_s = ____ (Exhibit 25-19)
S_R = ____ mi/h (Exhibit 25-19)
S_0 = ____ mi/h (Exhibit 25-19)
S = ____ mi/h (Equation 25-15)

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM 2029
Comment: 2029 TOTAL PM ON-RAMP

Site Information

Jurisdiction/Date: 4/19/2008
Freeway/Direction of Travel: QKH SB NELHA
Junction: NELHA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp: ☑ Yes ☐ On ☐ No ☑ Off
L_{up} = 450 ft
V_u = 288 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge; ☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h
S_{FR} = 35 mi/h

Downstream Adjacent Ramp: ☐ Yes ☐ On ☑ No ☐ Off
L_{down} = ____ ft
V_D = ____ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	26300	.09	1	2367	.9	5	.976	1	2696
v_R	840	.09		76	.9	5	.976	1	86
v_U		.09		288	.9	5	.976	1	328
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ____ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ____ (Exhibit 25-5)
v_{12} = 2696 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2782	See Exhibit 25-7	
v_{R12}	2782	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$

D_R = 26.3 pc/mi/ln
LOS = C (Exhibit 25-4)

Speed Estimation

M_s = .374 (Exhibit 25-19)
S_R = 59.5 mi/h (Exhibit 25-19)
S_0 = ____ mi/h (Exhibit 25-19)
S = 59.5 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ____ (Equation 25-8 or 25-9)
P_{FD} = ____ using Equation ____ (Exhibit 25-12)
v_{12} = ____ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{FI} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$

D_R = ____ pc/mi/ln
LOS = ____ (Exhibit 25-4)

Speed Estimation

D_s = ____ (Exhibit 25-19)
S_R = ____ mi/h (Exhibit 25-19)
S_0 = ____ mi/h (Exhibit 25-19)
S = ____ mi/h (Equation 25-15)

Appendix E

Highway
Level of Service (LOS) Calculations

CHAPTER 20 - DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	WY	Jurisdiction/Date	4/19/2008
Agency or Company	M&E PACIFIC	Highway	Q. KAAHUMANU HWY SB
Analysis Period/Year	EX AM 2006	From/To	KAIMINANI TO KOHANAIKI
Comment	2006 EXISTING AM SB		

☐ Operational (LOS) ☐ Design (v_p) ☑ Planning (LOS) ☐ Planning (v_p)

Input Data

Shoulder width 6 ft
Opposing direction — Lane width 12 ft
Analysis direction — Lane width 12 ft
Shoulder width 6 ft
Segment length, L_t 2 mi

Show North Arrow

☑ Class I highway ☐ Class II highway
Terrain ☐ Level ☐ Rolling
Grade Length ____ mi Up/down ____ %
Peak-hour factor, PHF .95
% Trucks and buses, P_T 3 %
% Recreational vehicles, P_R 0 %
% No-passing zone 50 %
Access points/mi 2 /mi

Analysis direction volume, V_d 865 veh/h Opposing direction volume, V_o 915 veh/h

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalent for trucks, E_T (Exhibit 20-9 or 20-15)	1.1	1.1
Passenger-car equivalent for RVs, E_R (Exhibit 20-9 or 20-17)	1	1
Heavy-vehicle adjustment factor,[5] f_{HV} $f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$	.997	.997
Grade adjustment factor,[1] f_G (Exhibit 20-6 or 20-12)	1	1
Directional flow rate,[2] v_i (pc/h) $v_i = \frac{V_i}{PHF * f_{HV} * f_G}$	913	966

Free-Flow Speed from Field Measurement	Estimated Free-Flow Speed
Field measured speed,[3] S_{FM} 55 mi/h	Base free-flow speed,[3] BFFS ____ mi/h
Observed volume,[3] V_f 865 veh/h	Adj. for lane width and shoulder width,[3] f_{LS} (Exh. 20-5) 0 mi/h
Free-flow speed, FFS_d 61.7 mi/h	Adj. for access points,[3] f_A (Exhibit 20-6) .5 mi/h
$FFS_d = S_{FM} + 0.00776\left(\frac{V_f}{f_{HV}}\right)$	Free-flow speed, FFS_d 61.7 mi/h
	$FFS_d = BFFS - f_{LS} - f_A$

Adjustment for no-passing zones, f_{np} (mi/h) (Exhibit 20-19)	.9
Average travel speed, ATS_d (mi/h) $ATS_d = FFS_d - 0.00776(v_d + v_o) - f_{np}$	46.3

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalent for trucks, E_T (Exhibit 20-10 or 20-16)	1	1
Passenger-car equivalent for RVs, E_R (Exhibit 20-10 or 20-16)	1	1
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$	1	1
Grade adjustment factor,[1] f_G (Exhibit 20-8 or 20-14)	1	1
Directional flow rate,[2] v_i (pc/h) $v_i = \frac{V_i}{PHF * f_{HV} * f_G}$	911	963
Base percent time-spent-following,[4] $BPTSF_d$ (%) $BPTSF_d = 100(1 - e^{av_d^b})$	87.8	
Adjustment for no-passing zone, f_{np} (Exhibit 20-20)	3.6	
Percent time-spent-following, $PTSF_d$ (%) $PTSF_d = BPTSF_d + f_{np}$	91.4	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 or 20-4)	E
Volume to capacity ratio, v/c $v/c = \frac{v_d}{1700}$	.54
Peak 15-min vehicle-miles of travel, VMT_{15} (veh-mi) $VMT_{15} = 0.25L_t\left(\frac{V_d}{PHF}\right)$	455
Peak-hour vehicle-miles of travel, VMT_{60} (veh-mi) $VMT_{60} = V_d * L_t$	1730
Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15} = \frac{VMT_{15}}{ATS_d}$	9.8

Notes

1. If the highway is extended segment (level) or rolling terrain, $f_G = 1.0$
2. If v_i (v_d or v_o) ≥ 1,700 pc/h, terminate analysis—the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

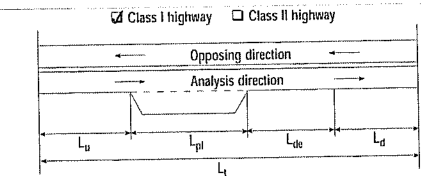
CHAPTER 20 - DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WITH PASSING LANE WORKSHEET

General Information		Site Information	
Analyst	WY	Jurisdiction/Date	4/19/2008
Agency or Company	M&E PACIFIC	Highway	Q. KAAHUMANU HWY SB
Analysis Period/Year	EX AM 2006	From/To	KAIMINANI TO KOHANAIKI
Comment	2006 EXISTING AM SB		

☐ Operational (LOS) ☐ Design (v_p) ☑ Planning (LOS) ☐ Planning (v_p)

Input Data

☑ Class I highway ☐ Class II highway



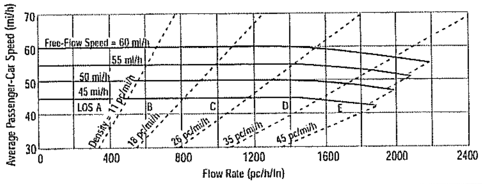
Show North Arrow

Total length of analysis segment, L_t (mi)	2
Length of two-lane highway upstream of the passing lane, L_u (mi)	0
Length of passing lane including tapers, L_{pl} (mi)	
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	46.3
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	91.4
Level of service,[1] LOS_d (from Directional Two-Lane Highway Segment Worksheet)	E
Average Travel Speed	
Downstream length of two-lane highway within effective length of passing lane for average travel speed, L_{de} (mi) (Exhibit 20-23)	1.7
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, L_d (mi) $L_d = L_t - (L_u + L_{pl} + L_{de})$	
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 20-24)	1.11
Average travel speed including passing lane,[2] ATS_{pl} $ATS_{pl} = \frac{ATS_d * L_t}{L_u + L_d + \frac{L_{pl}}{f_{pl}} + \frac{2L_{de}}{1+f_{pl}}}$	
Percent Time-Spent-Following	
Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, L_{de} (mi) (Exhibit 20-23)	5.7
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, L_d (mi) $L_d = L_t - (L_u + L_{pl} + L_{de})$	
Adj. factor for the effect of passing lane on percent time-spent-following, f_{pl} (Exhibit 20-24)	.62
Percent time-spent-following including passing lane,[3] $PTSF_{pl}$ (%) $PTSF_{pl} = \frac{PTSF_d\left[L_u + L_d + f_{pl}L_{pl} + \left(\frac{1+f_{pl}}{2}\right)L_{de}\right]}{L_t}$	
Level of Service and Other Performance Measures[4]	
Level of service including passing lane, LOS_{pl} (Exhibits 20-3 or 20-4)	
Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15} = \frac{VMT_{15}}{ATS_{pl}}$	

Notes

1. If LOS_d = F, passing lane analysis cannot be performed.
2. If L_d < 0, use alternative Equation 20-22.
3. If L_d < 0, use alternative Equation 20-20.
4. v/c, VMT_{15}, and VMT_{60} are calculated on Directional Two-Lane Highway Segment Worksheet.

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: AMB AM 2015
Comment: 2015 AM AMBIENT

Site Information

Jurisdiction/Date: 4/14/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 1370 veh/h
Annual avg. daily traffic, AADT: ____ veh/day
Peak-hour proportion of AADT, K: ____
Peak-hour direction proportion, D: ____
DDHV = AADT * K * D: ____ veh/h
Driver type: ☐ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ____ mi Up/Down ____ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ____ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ____ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ____ mi/h
f_M: 0 mi/h
FFS = BFFS − f_{LW} − f_{LC} − f_A − f_M: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 783 pc/h/ln
S: B mi/h
D = v_p/S: 55 pc/mi/ln
LOS: 14.24

Design (v_p) or Planning (v_p)
LOS: ____
v_p: ____ pc/h/ln
V = v_p * PHF * N * f_{HV} * f_p: ____ veh/h
S: ____ mi/h
D = v_p/S: ____ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____

Design (N) or Planning (N) 2nd Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____
S: ____ mi/h
D = v_p/S: ____ pc/mi/ln

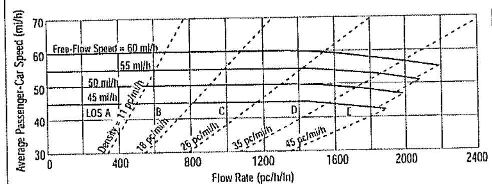
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM 2015
Comment: 2015 AM TOTAL

Site Information

Jurisdiction/Date: 4/14/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 1395 veh/h
Annual avg. daily traffic, AADT: ____ veh/day
Peak-hour proportion of AADT, K: ____
Peak-hour direction proportion, D: ____
DDHV = AADT * K * D: ____ veh/h
Driver type: ☐ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ____ mi Up/Down ____ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ____ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ____ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ____ mi/h
f_M: 0 mi/h
FFS = BFFS − f_{LW} − f_{LC} − f_A − f_M: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 797 pc/h/ln
S: B mi/h
D = v_p/S: 55 pc/mi/ln
LOS: 14.5

Design (v_p) or Planning (v_p)
LOS: ____
v_p: ____ pc/h/ln
V = v_p * PHF * N * f_{HV} * f_p: ____ veh/h
S: ____ mi/h
D = v_p/S: ____ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____

Design (N) or Planning (N) 2nd Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____
S: ____ mi/h
D = v_p/S: ____ pc/mi/ln

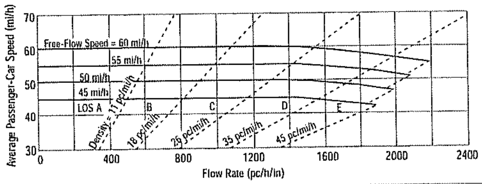
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: AMB AM 2020
Comment: 2020 AM AMBIENT

Site Information

Jurisdiction/Date: 4/14/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 1370 veh/h
Annual avg. daily traffic, AADT: ______ veh/day
Peak-hour proportion of AADT, K: ______
Peak-hour direction proportion, D: ______
DDHV = AADT * K * D: ______ veh/h
Driver type: ☐ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ______ mi Up/Down ______ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ______ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ______ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ______ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 783 pc/h/ln
S: B mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 14.24

Design (v_p) or Planning (v_p)
LOS: ______
v_p: ______ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ______ veh/h
S: ______ mi/h
$D = v_p/S$: ______ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ______ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ______ pc/h/ln
LOS: ______

Design (N) or Planning (N) 2nd Iteration
N: ______ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ______ pc/h/ln
LOS: ______
S: ______ mi/h
$D = v_p/S$: ______ pc/mi/ln

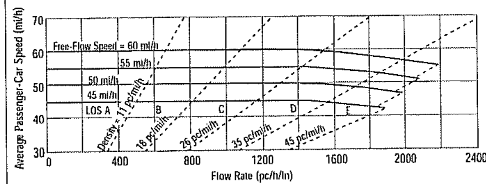
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM 2020
Comment: 2020 AM TOTAL

Site Information

Jurisdiction/Date: 4/14/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 1435 veh/h
Annual avg. daily traffic, AADT: ______ veh/day
Peak-hour proportion of AADT, K: ______
Peak-hour direction proportion, D: ______
DDHV = AADT * K * D: ______ veh/h
Driver type: ☑ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ______ mi Up/Down ______ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ______ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ______ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ______ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 820 pc/h/ln
S: B mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 14.92

Design (v_p) or Planning (v_p)
LOS: ______
v_p: ______ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ______ veh/h
S: ______ mi/h
$D = v_p/S$: ______ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ______ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ______ pc/h/ln
LOS: ______

Design (N) or Planning (N) 2nd Iteration
N: ______ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ______ pc/h/ln
LOS: ______
S: ______ mi/h
$D = v_p/S$: ______ pc/mi/ln

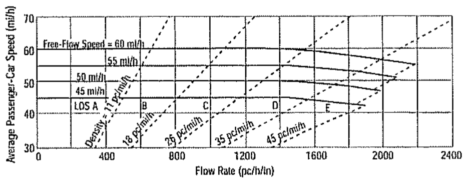
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: AMB AM 2029
Comment: 2029 AM AMBIENT

Site Information

Jurisdiction/Date: 4/9/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 1445 veh/h
Annual avg. daily traffic, AADT: ____ veh/day
Peak-hour proportion of AADT, K: ____
Peak-hour direction proportion, D: ____
DDHV = AADT * K * D: ____ veh/h
Driver type: ☑ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ____ mi Up/Down ____ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ____ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ____ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ____ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 826 pc/h/ln
S: B mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 15.02

Design (v_p) or Planning (v_p)
LOS: ____
v_p: ____ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ____ veh/h
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____

Design (N) or Planning (N) 2nd Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

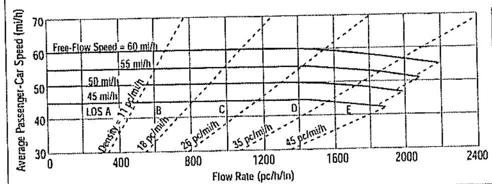
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM 2029
Comment: 2029 AM TOTAL

Site Information

Jurisdiction/Date: 4/14/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 1640 veh/h
Annual avg. daily traffic, AADT: ____ veh/day
Peak-hour proportion of AADT, K: ____
Peak-hour direction proportion, D: ____
DDHV = AADT * K * D: ____ veh/h
Driver type: ☑ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ____ mi Up/Down ____ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ____ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ____ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ____ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 938 pc/h/ln
S: B mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 17.05

Design (v_p) or Planning (v_p)
LOS: ____
v_p: ____ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ____ veh/h
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____

Design (N) or Planning (N) 2nd Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

CHAPTER 20 - DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: EX PM 2006
Comment: 2006 EXISTING PM SB

Site Information

Jurisdiction/Date: 4/19/2008
Highway: Q. KAAHUMANU HWY SB
From/To: KAIMINANI TO KOHANAIKI

☐ Operational (LOS) ☐ Design (v_p) ☑ Planning (LOS) ☐ Planning (v_p)

Input Data

Shoulder width 6 ft
Opposing direction — Lane width 12 ft
Analysis direction — Lane width 12 ft
Shoulder width 6 ft
Segment length, L_t 2 mi

Show North Arrow

☑ Class I highway ☐ Class II highway
Terrain ☐ Level ☐ Rolling
Grade Length ____ mi Up/down ____ %
Peak-hour factor, PHF .95
% Trucks and buses, P_T 3 %
% Recreational vehicles, P_R 0 %
% No-passing zone 50 %
Access points/mi 2 /mi

Analysis direction volume, V_d 825 veh/h
Opposing direction volume, V_o 830 veh/h

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalent for trucks, E_T (Exhibit 20-9 or 20-15)	1.1	1.1
Passenger-car equivalent for RVs, E_R (Exhibit 20-9 or 20-17)	1	1
Heavy-vehicle adjustment factor,5 f_{HV} $f_{HV}=\frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$	.997	.997
Grade adjustment factor,1 f_G (Exhibit 20-6 or 20-12)	1	1
Directional flow rate,2 v_i (pc/h) $v_i=\frac{V_i}{PHF * f_{HV} * f_G}$	871	876

Free-Flow Speed from Field Measurement	Estimated Free-Flow Speed
Field measured speed,3 S_{FM} 55 mi/h	Base free-flow speed,3 BFFS ____ mi/h
Observed volume,3 V_f 865 veh/h	Adj. for lane width and shoulder width,3 f_{LS} (Exh. 20-5) 0 mi/h
Free-flow speed, FFS_d 61.7 mi/h	Adj. for access points,3 f_A (Exhibit 20-6) .5 mi/h
$FFS_d = S_{FM} + 0.00776(\frac{V_f}{f_{HV}})$	Free-flow speed, FFS_d 61.7 mi/h
	$FFS_d = BFFS - f_{LS} - f_A$

Adjustment for no-passing zones, f_{np} (mi/h) (Exhibit 20-19)	1
Average travel speed, ATS_d (mi/h) $ATS_d = FFS_d - 0.00776(v_d + v_o) - f_{np}$	47.2

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalent for trucks, E_T (Exhibit 20-10 or 20-16)	1	1
Passenger-car equivalent for RVs, E_R (Exhibit 20-10 or 20-16)	1	1
Heavy-vehicle adjustment factor, f_{HV} $f_{HV}=\frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$	1	1
Grade adjustment factor,1 f_G (Exhibit 20-8 or 20-14)	1	1
Directional flow rate,2 v_i (pc/h) $v_i=\frac{V_i}{PHF * f_{HV} * f_G}$	868	874
Base percent time-spent-following,4 $BPTSF_d$ (%) $BPTSF_d = 100(1 - e^{av_d^b})$	86.6	
Adjustment for no-passing zone, f_{np} (Exhibit 20-20)	4.5	
Percent time-spent-following, $PTSF_d$ (%) $PTSF_d = BPTSF_d + f_{np}$	91.1	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 or 20-4)	E
Volume to capacity ratio, v/c $v/c = \frac{V_d}{1700}$	.51
Peak 15-min vehicle-miles of travel, VMT_{15} (veh-mi) $VMT_{15} = 0.25L_t(\frac{V_d}{PHF})$	434
Peak-hour vehicle-miles of travel, VMT_{60} (veh-mi) $VMT_{60} = V_d * L_t$	1650
Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15} = \frac{VMT_{15}}{ATS_d}$	9.2

Notes

1. If the highway is extended segment (level) or rolling terrain, $f_G = 1.0$
2. If v_i (v_d or v_o) ≥ 1,700 pc/h, terminate analysis—the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

CHAPTER 20 - DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WITH PASSING LANE WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: EX PM 2006
Comment: 2006 EXISTING PM SB

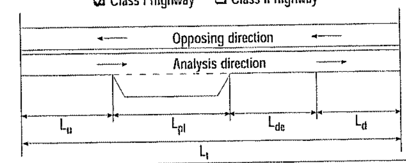
Site Information

Jurisdiction/Date: 4/19/2008
Highway: Q. KAAHUMANU HWY SB
From/To: KAIMINANI TO KOHANAIKI

☐ Operational (LOS) ☐ Design (v_p) ☑ Planning (LOS) ☐ Planning (v_p)

Input Data

☑ Class I highway ☐ Class II highway



Show North Arrow

Total length of analysis segment, L_t (mi)	2
Length of two-lane highway upstream of the passing lane, L_u (mi)	
Length of passing lane including tapers, L_{pl} (mi)	
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	47.2
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	91.1
Level of service,1 LOS_d (from Directional Two-Lane Highway Segment Worksheet)	E

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, L_{de} (mi) (Exhibit 20-23)	1.7
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, L_d (mi) $L_d = L_t - (L_u + L_{pl} + L_{de})$	
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 20-24)	1.11
Average travel speed including passing lane,2 ATS_{pl} $ATS_{pl} = \frac{ATS_d * L_t}{L_u + L_d + \frac{L_{pl}}{f_{pl}} + \frac{2L_{de}}{1+f_{pl}}}$	

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, L_{de} (mi) (Exhibit 20-23)	5.7
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, L_d (mi) $L_d = L_t - (L_u + L_{pl} + L_{de})$	
Adj. factor for the effect of passing lane on percent time-spent-following, f_{pl} (Exhibit 20-24)	.62
Percent time-spent-following including passing lane,3 $PTSF_{pl}$ (%) $PTSF_{pl} = \frac{PTSF_d\left[L_u + L_d + f_{pl}L_{pl} + \left(\frac{1+f_{pl}}{2}\right)L_{de}\right]}{L_t}$	

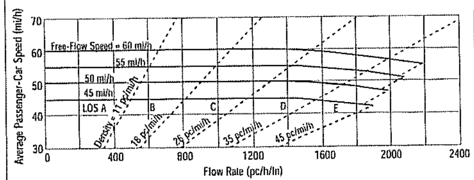
Level of Service and Other Performance Measures 4

Level of service including passing lane, LOS_{pl} (Exhibits 20-3 or 20-4)	
Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15} = \frac{VMT_{15}}{ATS_{pl}}$	

Notes

1. If LOS_d = F, passing lane analysis cannot be performed.
2. If L_d < 0, use alternative Equation 20-22.
3. If L_d < 0, use alternative Equation 20-20.
4. v/c, VMT_{15}, and VMT_{60} are calculated on Directional Two-Lane Highway Segment Worksheet.

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

- Analyst: WY
- Agency or Company: M&E PACIFIC
- Analysis Period/Year: AMB PM / 2015
- Comment: 2015 PM AMBIENT

Site Information

- Jurisdiction/Date: 4/9/2008
- Highway/Direction of Travel: QUEEN KAAHUMANU HWY
- From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

- Volume, V: 2045 veh/h
- Annual avg. daily traffic, AADT: ____ veh/day
- Peak-hour proportion of AADT, K: ____
- Peak-hour direction proportion, D: ____
- DDHV = AADT * K * D: ____ veh/h
- Driver type: ☐ Commuter/Weekday ☐ Recreational/Weekend
- Peak-hour factor, PHF: .9
- % Trucks and buses, P_T: 5
- % RVs, P_R: 2
- General terrain: ☑ Level ☐ Rolling ☐ Mountainous
- Grade: Length ____ mi Up/Down ____ %
- Number of lanes: 2

Calculate Flow Adjustments

- f_p: 1
- E_T: 1.5
- E_R: 1.2
- $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

- Lane width, LW: 10 ft
- Total lateral clearance, TLC: 12 ft
- Access points, A: ____ A/mi
- Median type, M: ☐ Undivided ☑ Divided
- FFS (measured): ____ mi/h
- Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

- f_{LW}: 6.6 mi/h
- f_{LC}: 0 mi/h
- f_A: ____ mi/h
- f_M: 0 mi/h
- $FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)

- $v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 1169 pc/h/ln
- S: C mi/h
- $D = v_p/S$: 55 pc/mi/ln
- LOS: 21.26

Design (v_p) or Planning (v_p)

- LOS: ____
- v_p: ____ pc/h/ln
- $V = v_p * PHF * N * f_{HV} * f_p$: ____ veh/h
- S: ____ mi/h
- $D = v_p/S$: ____ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration

- N: ____ assumed
- $v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
- LOS: ____

Design (N) or Planning (N) 2nd Iteration

- N: ____ assumed
- $v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
- LOS: ____
- S: ____ mi/h
- $D = v_p/S$: ____ pc/mi/ln

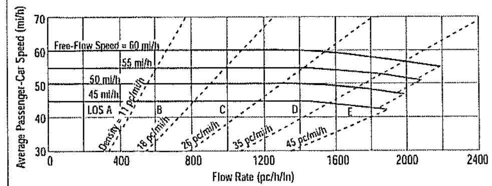
Glossary

- N - Number of lanes
- V - Hourly volume
- v_p - Flow rate
- LOS - Level of service
- DDHV - Directional design-hour volume
- S - Speed
- D - Density
- FFS - Free-flow speed
- BFFS - Base free-flow speed

Factor Location

- E_T - Exhibit 21-8, 21-9, 21-11
- E_R - Exhibit 21-8, 21-10
- f_p - Page 21-11
- LOS, S, FFS, v_p - Exhibit 21-2, 21-3
- f_{LW} - Exhibit 21-4
- f_{LC} - Exhibit 21-5
- f_M - Exhibit 21-6
- f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

- Analyst: WY
- Agency or Company: M&E PACIFIC
- Analysis Period/Year: TOT PM / 2015
- Comment: 2015 PM TOTAL

Site Information

- Jurisdiction/Date: 4/14/2008
- Highway/Direction of Travel: QUEEN KAAHUMANU HWY
- From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

- Volume, V: 2120 veh/h
- Annual avg. daily traffic, AADT: ____ veh/day
- Peak-hour proportion of AADT, K: ____
- Peak-hour direction proportion, D: ____
- DDHV = AADT * K * D: ____ veh/h
- Driver type: ☑ Commuter/Weekday ☐ Recreational/Weekend
- Peak-hour factor, PHF: .9
- % Trucks and buses, P_T: 5
- % RVs, P_R: 2
- General terrain: ☑ Level ☐ Rolling ☐ Mountainous
- Grade: Length ____ mi Up/Down ____ %
- Number of lanes: 2

Calculate Flow Adjustments

- f_p: 1
- E_T: 1.5
- E_R: 1.2
- $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

- Lane width, LW: 10 ft
- Total lateral clearance, TLC: 12 ft
- Access points, A: ____ A/mi
- Median type, M: ☐ Undivided ☑ Divided
- FFS (measured): ____ mi/h
- Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

- f_{LW}: 6.6 mi/h
- f_{LC}: 0 mi/h
- f_A: ____ mi/h
- f_M: 0 mi/h
- $FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)

- $v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 1212 pc/h/ln
- S: C mi/h
- $D = v_p/S$: 55 pc/mi/ln
- LOS: 22.04

Design (v_p) or Planning (v_p)

- LOS: ____
- v_p: ____ pc/h/ln
- $V = v_p * PHF * N * f_{HV} * f_p$: ____ veh/h
- S: ____ mi/h
- $D = v_p/S$: ____ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration

- N: ____ assumed
- $v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
- LOS: ____

Design (N) or Planning (N) 2nd Iteration

- N: ____ assumed
- $v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
- LOS: ____
- S: ____ mi/h
- $D = v_p/S$: ____ pc/mi/ln

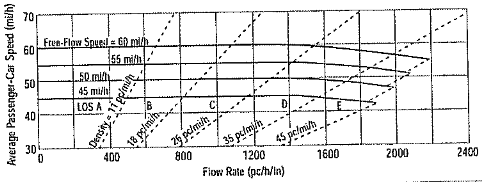
Glossary

- N - Number of lanes
- V - Hourly volume
- v_p - Flow rate
- LOS - Level of service
- DDHV - Directional design-hour volume
- S - Speed
- D - Density
- FFS - Free-flow speed
- BFFS - Base free-flow speed

Factor Location

- E_T - Exhibit 21-8, 21-9, 21-11
- E_R - Exhibit 21-8, 21-10
- f_p - Page 21-11
- LOS, S, FFS, v_p - Exhibit 21-2, 21-3
- f_{LW} - Exhibit 21-4
- f_{LC} - Exhibit 21-5
- f_M - Exhibit 21-6
- f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: AMB PM 2020
Comment: 2020 PM AMBIENT

Site Information

Jurisdiction/Date: 4/9/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 2065 veh/h
Annual avg. daily traffic, AADT: ___ veh/day
Peak-hour proportion of AADT, K: ___
Peak-hour direction proportion, D: ___
DDHV = AADT * K * D: ___ veh/h
Driver type: ☐ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ___ mi Up/Down ___ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ___ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ___ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ___ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 1180 pc/h/ln
S: C mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 21.46

Design (v_p) or Planning (v_p)
LOS: ___
v_p: ___ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ___ veh/h
S: ___ mi/h
$D = v_p/S$: ___ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ___ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ___ pc/h/ln
LOS: ___

Design (N) or Planning (N) 2nd Iteration
N: ___ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ___ pc/h/ln
LOS: ___
S: ___ mi/h
$D = v_p/S$: ___ pc/mi/ln

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

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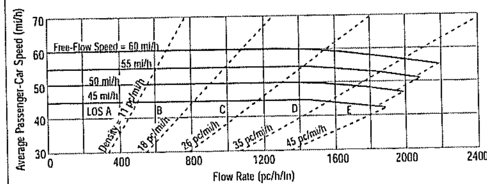
CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM 2020
Comment: 2020 PM TOTAL

Site Information

Jurisdiction/Date: 4/14/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 2200 veh/h
Annual avg. daily traffic, AADT: ___ veh/day
Peak-hour proportion of AADT, K: ___
Peak-hour direction proportion, D: ___
DDHV = AADT * K * D: ___ veh/h
Driver type: ☑ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ___ mi Up/Down ___ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ___ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ___ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ___ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 1258 pc/h/ln
S: C mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 22.87

Design (v_p) or Planning (v_p)
LOS: ___
v_p: ___ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ___ veh/h
S: ___ mi/h
$D = v_p/S$: ___ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ___ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ___ pc/h/ln
LOS: ___

Design (N) or Planning (N) 2nd Iteration
N: ___ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ___ pc/h/ln
LOS: ___
S: ___ mi/h
$D = v_p/S$: ___ pc/mi/ln

Glossary

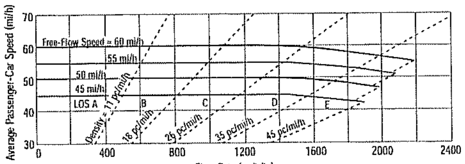
N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

HiCAP 2000 ™

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: AMB PM 2029
Comment: 2029 PM AMBIENT

Site Information

Jurisdiction/Date: 4/9/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 2175 veh/h
Annual avg. daily traffic, AADT: ____ veh/day
Peak-hour proportion of AADT, K: ____
Peak-hour direction proportion, D: ____
DDHV = AADT * K * D: ____ veh/h
Driver type: ☑ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ____ mi Up/Down ____ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ____ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ____ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ____ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 1243 pc/h/ln
S: C mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 22.61

Design (v_p) or Planning (v_p)
LOS: ____
v_p: ____ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ____ veh/h
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____

Design (N) or Planning (N) 2nd Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

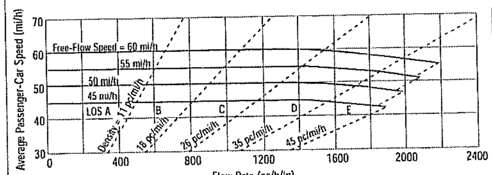
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM 2029
Comment: 2029 PM TOTAL

Site Information

Jurisdiction/Date: 4/14/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 2450 veh/h
Annual avg. daily traffic, AADT: ____ veh/day
Peak-hour proportion of AADT, K: ____
Peak-hour direction proportion, D: ____
DDHV = AADT * K * D: ____ veh/h
Driver type: ☑ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ____ mi Up/Down ____ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ____ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ____ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ____ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 1401 pc/h/ln
S: C mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 25.47

Design (v_p) or Planning (v_p)
LOS: ____
v_p: ____ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ____ veh/h
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____

Design (N) or Planning (N) 2nd Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

Acoustic Study

ACOUSTIC STUDY FOR THE PROPOSED `O`OMA BEACHSIDE VILLAGE PROJECT

NORTH KONA, HAWAII

Prepared for:

`O`OMA BEACHSIDE VILLAGE, LLC

Prepared by:

Y. EBISU & ASSOCIATES
1126 12th Avenue, Room 305
Honolulu, Hawaii 96816

APRIL 2008

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CHAPTER I. SUMMARY

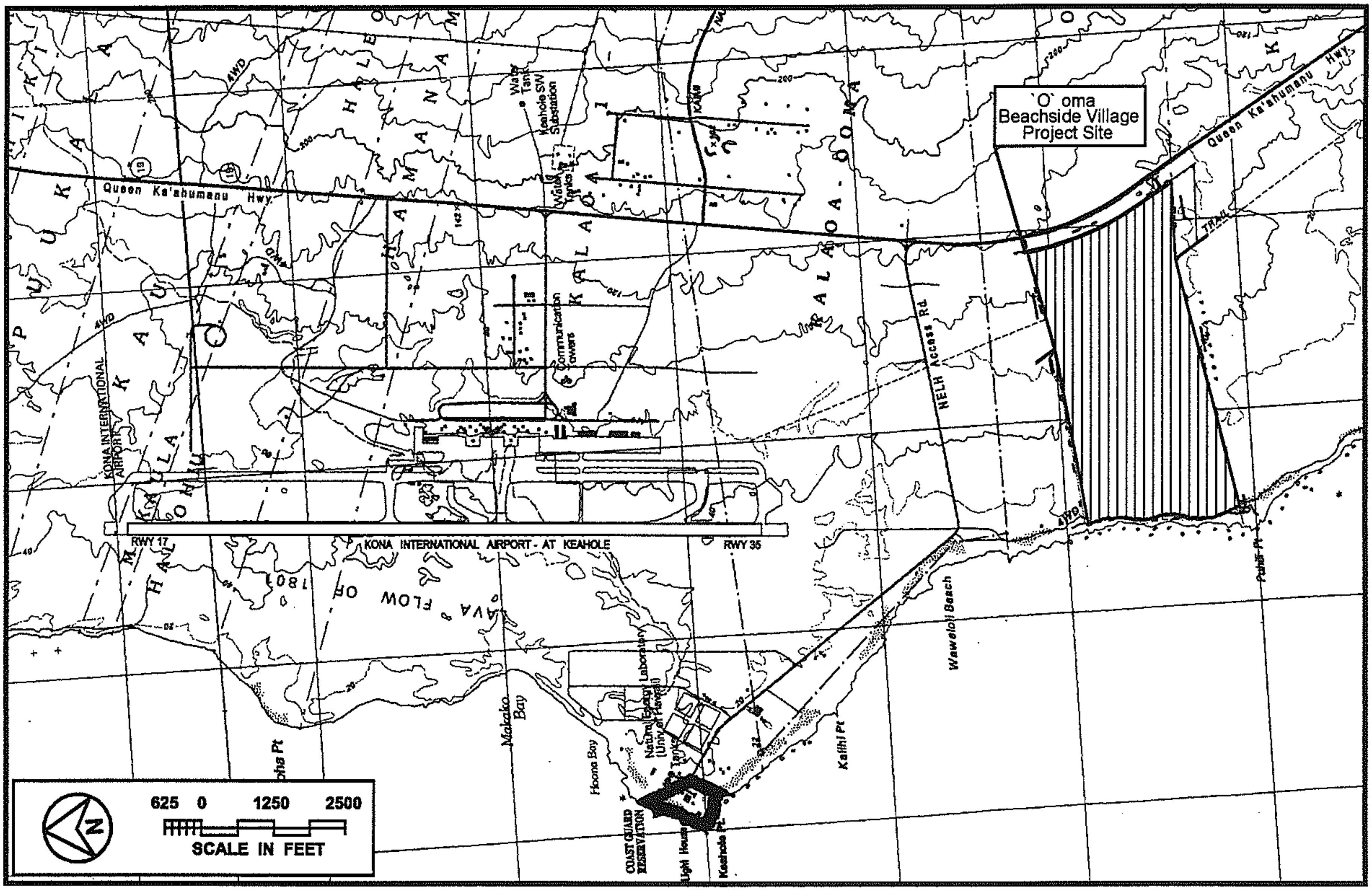
The existing and future traffic noise levels in the vicinity of the proposed `O`oma Beachside Village in North Kona, Hawaii were evaluated for their potential impact on present and future noise sensitive areas. Figure 1 depicts the location of the project site. The future traffic noise levels along the primary access roadways to the project were calculated for the year 2029.

Along Queen Kaahumanu Highway, traffic noise levels are expected to increase by 3.0 to 4.4 DNL (Day-Night Average Sound Level) between CY 2006 and CY 2029 as a result of both project and non-project traffic. Traffic noise increases due to project traffic are predicted to range from 0.2 to 0.7 DNL which is much less than the range of the noise increases caused by non-project traffic on Queen Kaahumanu Highway. These increases in traffic noise levels associated with project traffic are considered to be insignificant. Larger and more significant increases in traffic noise levels of 8.0 to 11.0 DNL are expected to occur along the planned makai Frontage Road as a result of project traffic, but the traffic noise levels from Queen Kaahumanu Highway are expected to control the overall future traffic noise levels along the highway Right-of-Way.

The possible future widening of Queen Kaahumanu Highway toward the project in the makai (west) direction by 2029 was incorporated in this noise study. Predicted future traffic noise levels in CY 2029 for conditions with 4 lanes of Queen Kaahumanu Highway were determined along the `O`oma Beachside Village property Right-of-Way and at the closest buildings of the project. Future traffic noise levels from Queen Kaahumanu Highway should not exceed the FHA/HUD noise standard of 65 DNL or the Hawaii State Department of Transportation, Highways Division (HDOTH) noise abatement criteria level of 66 Leq(h). Project residents should not be impacted by future traffic noise from Queen Kaahumanu Highway since an adequate buffer distance of 150 feet has been provided from the highway Right-of-Way.

The planned makai Frontage Road was assumed to be located within `O`oma Beachside Village, and could cause traffic noise levels to exceed the FHA/HUD noise standard of 65 DNL. At an assumed posted speed limit of 25 miles per hour, with actual speed of 35 miles per hour, the minimum required buffer distance to the 65 DNL noise contour is 22 feet. Future traffic noise mitigation measures may be required along the makai Frontage Road.

Based on previously published CY 2001 14 CFR Part 150 aircraft noise contours for Kona International Airport at Keahole (KOA), the project site is partially affected by the 55 DNL and 60 DNL noise contours, which are located at the western end of the project site. Noise contours for CY 2010 and CY 2020, which were developed during the last Master Plan and 14 CFR Part 150 Study updates for KOA, also indicate that the project site would be partially affected by the airport noise contours, but these contours



PROJECT SITE LOCATION MAP

FIGURE 1

are probably overstating the potential noise impacts due to the prior and future introduction of quieter jet aircraft operations at the airport. The implementation of the airport noise disclosure provisions of Act 208 (see Reference 5) will be necessary over the western portion of project area where the CY 2001 14 CFR Part 150 noise contours cross over the project. The project's proposed land uses have been planned to avoid encroachment into the 60 DNL contour of the 14 CFR Part 150 5-Year (or 2001) Noise Exposure Map for KOA. Based on currently available information, the noise sensitive portions of `O`oma Beachside Village should be outside the 60 DNL contour for 2013 and 2030.

The planned construction of a new runway for C-17 training operations, and the subsequent increase in C-17 operations at KOA were evaluated using information available. As long as the future C-17 training operations remain within the limits described in the current environmental documentation for the new runway, and as long as a large number of those training operations do not extend into the nighttime hours of 2200 to 0700 hours, their effect on the future locations of the 55 DNL and 60 DNL noise contours should be minimal.

During the course of this acoustical impact study for `O`oma Beachside Village, the Hawaii State Department of Transportation, Airports Division (HDOTA) produced two pairs of draft 14 CFR Part 150 noise contours for KOA for years 2007/2008 and 2012/2013. These draft contours were compared to this acoustical impact study's noise contours, and were critiqued via correspondences to the HDOTA. Attempts were made to obtain copies of the noise modeling computer input files used for the HDOTA's draft noise contours, but these attempts were unsuccessful up until the time this noise study report was completed. Attempts will continue to obtain the noise modeling input files in order to verify the reasonableness of the HDOTA's noise modeling assumptions.

Unavoidable, but temporary, noise impacts may occur during the construction of `O`oma Beachside Village. Because construction activities are predicted to be audible at adjoining properties, the quality of the acoustic environment may be degraded during periods of construction. Mitigation measures to reduce construction noise to inaudible levels will not be practical in all cases. For this reason, the use of quiet equipment and construction curfew periods as required under the State Department of Health noise regulations will be implemented to minimize construction noise impacts.

CHAPTER II. PURPOSE

The objectives of this study were to describe the existing and future noise environment in the environs of `O`oma Beachside Village in North Kona on the island of Hawaii. Traffic noise level increases and impacts associated with the proposed community were to be determined within the project site as well as along the public roadways expected to service the project traffic. A specific objective was to determine the future traffic noise level increases associated with both project and non-project traffic, and the potential noise impacts associated with these increases. Assessments of possible impacts from noise resulting from fixed and rotary wing aircraft operations at nearby Kona International Airport at Keahole (KOA), and from short term construction noise at the project site were also included in the noise study objectives. Recommendations for minimizing these noise impacts were also to be provided as required.

CHAPTER III. NOISE DESCRIPTORS AND THEIR RELATIONSHIP TO LAND USE COMPATIBILITY

The noise descriptor currently used by federal agencies to assess environmental noise is the Day-Night Average Sound Level (DNL or Ldn). This descriptor incorporates a 24-hour average of instantaneous A-Weighted sound levels as read on a standard Sound Level Meter. The maximum A-Weighted sound level occurring while a noise source such as a heavy truck or aircraft is moving past a listener (i.e., the maximum sound level from a "single event") is referred to as the "Lmax value". The mathematical product (or integral) of the instantaneous sound level times the duration of the event is known as the "Sound Exposure Level", or Lse, which is analogous to the energy of the time-varying sound levels associated with a single event.

The DNL values represent the average noise during a typical day of the year. DNL exposure levels of 55 or less are typical of quiet rural or suburban areas. DNL exposure levels of 55 to 65 are typical of urbanized areas with medium to high levels of activity and street traffic. DNL exposure levels above 65 are representative of densely developed urban areas and areas fronting high volume roadways.

By definition, the minimum averaging period for the DNL descriptor is 24 hours. Additionally, sound levels which occur during the nighttime hours of 10:00 PM to 7:00 AM are increased by 10 decibels (dB) prior to computing the 24-hour average by the DNL descriptor. Because of the averaging used, DNL values in urbanized areas typically range between 50 and 75 DNL. In comparison, the typical range of intermittent noise events may have maximum Sound Level Meter readings between 75 and 105 dBA. A more complete list of noise descriptors is provided in Appendix B to this report. In Appendix B, the Ldn descriptor symbol is used in place of the DNL descriptor symbol.

Table 1, extracted from Reference 1, categorizes the various DNL levels of outdoor noise exposure with severity classifications. Table 2, also extracted from Reference 1, presents the general effects of noise on people in residential use situations. Figure 2, extracted from Reference 2, presents suggested land use compatibility guidelines for residential and nonresidential land uses. A general consensus among federal agencies has developed whereby residential housing development is considered acceptable in areas where exterior noise does not exceed 65 DNL. This value of 65 DNL is used as a federal regulatory threshold for determining the necessity for special noise abatement measures when applications for federal funding assistance are made.

As a general rule, noise levels of 55 DNL or less occur in rural areas, or in areas which are removed from high volume roadways. In urbanized areas which are shielded from high volume streets, DNL levels generally range from 55 to 65 DNL, and are usually controlled by motor vehicle traffic noise. Residences which front major roadways are generally exposed to levels of 65 DNL, and as high as 75 DNL when the

TABLE 1

EXTERIOR NOISE EXPOSURE CLASSIFICATION (RESIDENTIAL LAND USE)

NOISE EXPOSURE CLASS	DAY-NIGHT SOUND LEVEL	EQUIVALENT SOUND LEVEL	FEDERAL (1) STANDARD
Minimal Exposure	Not Exceeding 55 DNL	Not Exceeding 55 Leq	Unconditionally Acceptable
Moderate Exposure	Above 55 DNL But Not Above 65 DNL	Above 55 Leq But Not Above 65 Leq	Acceptable(2)
Significant Exposure	Above 65 DNL But Not Above 75 DNL	Above 65 Leq But Not Above 75 Leq	Normally Unacceptable
Severe Exposure	Above 75 DNL	Above 75 Leq	Unacceptable

Notes: (1) Federal Housing Administration, Veterans Administration, Department of Defense, and Department of Transportation.

(2) FHWA uses the Leq instead of the Ldn descriptor. For planning purposes, both are equivalent if: (a) heavy trucks do not exceed 10 percent of total traffic flow in vehicles per 24 hours, and (b) traffic between 10:00 PM and 7:00 AM does not exceed 15 percent of average daily traffic flow in vehicles per 24 hours. The noise mitigation threshold used by FHWA for residences is 67 Leq.

TABLE 2

EFFECTS OF NOISE ON PEOPLE
(Residential Land Uses Only)

EFFECTS[1] / DAY-NIGHT AVERAGE SOUND LEVEL IN DECIBELS	Hearing Loss	Speech Interference		Annoyance[2]	Average Community Reaction[4]	General Community Attitude Towards Area
		Indoor	Outdoor			
	Qualitative Description	%Sentence Intelligibility	Distance in Meters for 95% Sentence Intelligibility	% of Population Highly Annoyed[3]		
75 and above	May Begin to Occur	98%	0.5	37%	Very Severe	Noise is likely to be the most important of all adverse aspects of the community environment.
70	Will Not Likely Occur	99%	0.9	25%	Severe	Noise is one of the most important adverse aspects of the community environment.
65	Will Not Occur	100%	1.5	15%	Significant	Noise is one of the important adverse aspects of the community environment.
60	Will Not Occur	100%	2.0	9%	Moderate to Slight	Noise may be considered an adverse aspect of the community environment.
55 and below	Will Not Occur	100%	3.5	4%		Noise considered no more important than various other environmental factors.

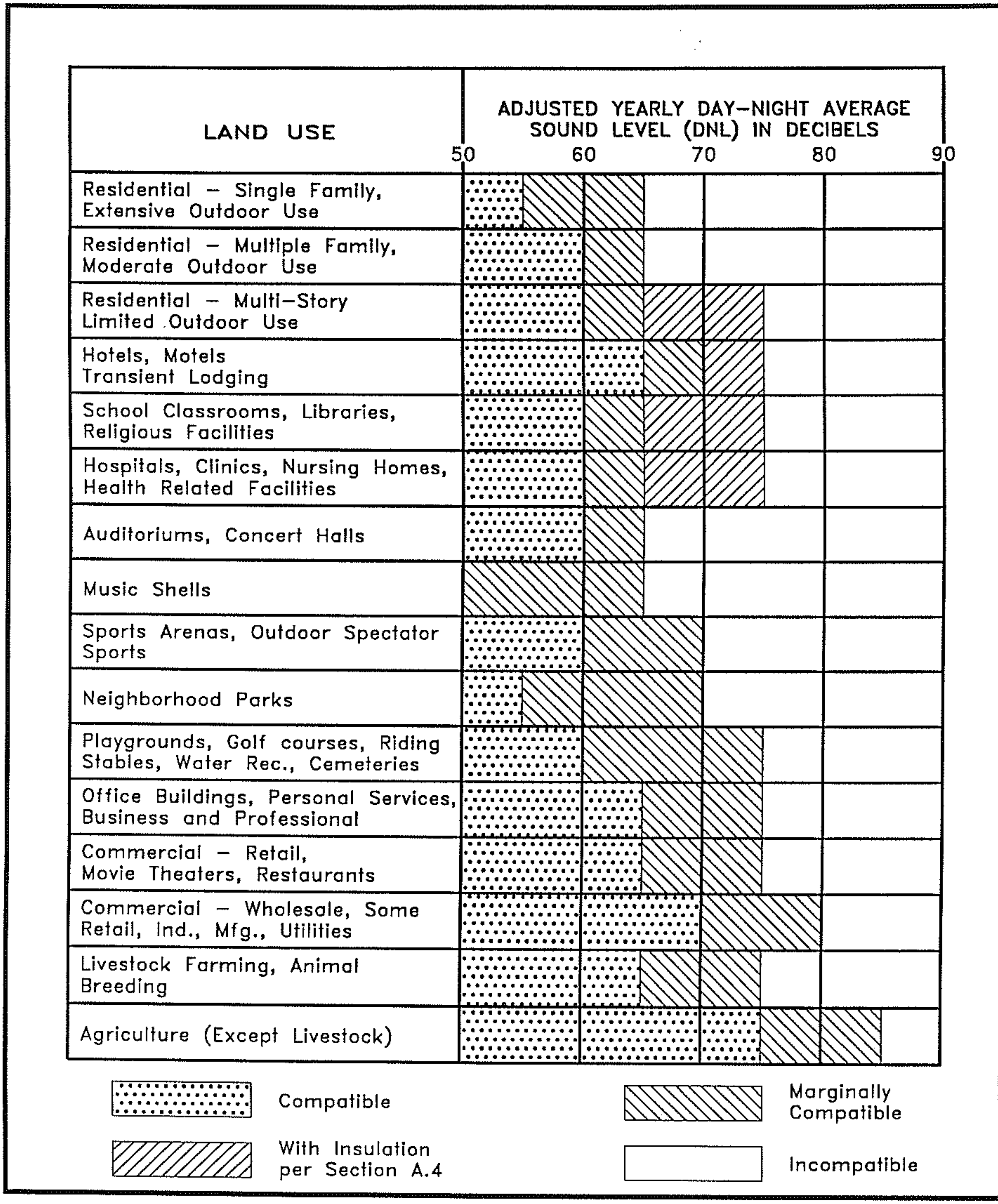
1. "Speech Interference" data are drawn from the following tables in EPA's "Levels Document": Table 3, Fig. D-1, Fig. D-2, Fig. D-3. All other data from National Academy of Science 1977 report "Guidelines for Preparing Environmental Impact Statements on Noise, Report of Working Group 69 on Evaluation of Environmental Impact of Noise."

2. Depends on attitudes and other factors.

3. The percentages of people reporting annoyance to lesser extents are higher in each case. An unknown small percentage of people will report being "highly annoyed" even in the quietest surroundings. One reason is the difficulty all people have in integrating annoyance over a very long time.

4. Attitudes or other non-acoustic factors can modify this. Noise at low levels can still be an important problem, particularly when it intrudes into a quiet environment.

NOTE: Research implicates noise as a factor producing stress-related health effects such as heart disease, high-blood pressure and stroke, ulcers and other digestive disorders. The relationships between noise and these effects, however, have not as yet been quantified.



LAND USE COMPATIBILITY WITH YEARLY AVERAGE DAY-NIGHT AVERAGE SOUND LEVEL (DNL) AT A SITE FOR BUILDINGS AS COMMONLY CONSTRUCTED.
(Source: American National Standards Institute S12.9-1998/Part 5)

FIGURE 2

roadway is a high speed freeway. Due to noise shielding effects from intervening structures, interior lots are usually exposed to 3 to 10 DNL lower noise levels than the front lots which are not shielded from the traffic noise.

For the purposes of determining noise acceptability for funding assistance from federal agencies, an exterior noise level of 65 DNL or lower is considered acceptable. These federal agencies include the Federal Aviation Administration (FAA), Department of Defense (DOD); Federal Housing Administration, Housing and Urban Development (FHA/HUD), and Veterans Administration (VA). This standard is applied nationally (see Reference 3), including Hawaii.

Because of Hawaii's open-living conditions, the predominant use of naturally ventilated dwellings, and the relatively low exterior-to-interior sound attenuation afforded by these naturally ventilated dwellings, an exterior noise level of 65 DNL does not eliminate all risks of noise impacts. Because of these factors, a lower level of 55 DNL is considered as the "Unconditionally Acceptable" (or "Near-Zero Risk") level of exterior noise (see Reference 4). For typical, naturally ventilated structures in Hawaii, an exterior noise level of 55 DNL results in an interior level of approximately 45 DNL, which is considered to be the "Unconditionally Acceptable" (or "Near-Zero Risk") level of interior noise. However, after considering the cost and feasibility of applying the lower level of 55 DNL, government agencies such as FHA/HUD and VA have selected 65 DNL as a more appropriate regulatory standard.

For aircraft noise, the Hawaii State Department of Transportation, Airports Division (HDOTA), has recommended that 60 DNL be used as the common level for determining land use compatibility in respect to noise sensitive uses near its airports. Table 3 summarizes the recommendations for compatible land uses at various levels of aircraft noise. For those noise sensitive land uses which are exposed to aircraft noise greater than 55 DNL, the division has recommended that disclosure of the aircraft noise levels be provided prior to any real property transactions. Reference 5 requires that such disclosure be provided prior to real property transactions concerning properties located within Air Installation Compatibility Use Zones (AICUZ) or located within airport noise maps developed under Federal Aviation Regulation (FAR) Part 150 - Airport Noise Compatibility Planning (14 CFR Part 150). The most recent 14 CFR Part 150 noise contours for KOA were completed in 1996 and reflect conditions through 2001. Additional airport noise contours for 2010 and 2020 were developed by the HDOTA for information purposes only during the 1996 to 1997 time frame. The HDOTA is currently updating the airport noise contours for 2008 and 2013, in conjunction with the 14 CFR Part 150 update for KOA (Reference 13). The HDOTA's draft noise contours for 2008, 2013, and 2030 are included in this report for comparison with the estimated noise contours developed for this acoustical impact study for `O`oma Beachside Village.

For commercial, industrial, and other non-noise sensitive land uses, exterior noise levels as high as 75 DNL are generally considered acceptable. Exceptions to this occur when naturally ventilated office and other commercial establishments are exposed to exterior levels which exceed 65 DNL.

TABLE 3

HAWAII STATE DEPARTMENT OF TRANSPORTATION RECOMMENDATIONS FOR LOCAL LAND USE COMPATIBILITY WITH YEARLY DAY-NIGHT AVERAGE SOUND LEVELS (DNL)

TYPE OF LAND USE	**** Yearly Day-Night Average Sound Level ****					
	< 60	60-65	65-70	70-75	75-80	80-85
RESIDENTIAL						
Low density residential, resorts, and hotels (outdoor facil.)	Y(a)	N(b)	N	N	N	N
Low density apartment with moderate outdoor use	Y	N(b)	N	N	N	N
High density apartment with limited outdoor use	Y	N(b)	N(b)	N	N	N
Transient lodgings with limited outdoor use	Y	N(b)	N(b)	N	N	N
PUBLIC USE						
Schools, day-care centers, libraries, and churches	Y	N(c)	N(c)	N(c)	N	N
Hospitals, nursing homes, clinics, and health facilities	Y	Y(d)	Y(d)	Y(d)	N	N
Indoor auditoriums and concert halls	Y(c)	Y(c)	N	N	N	N
Government services and office buildings serving the general public	Y	Y	Y(d)	Y(d)	N	N
Transportation and Parking	Y	Y	Y(d)	Y(d)	Y(d)	Y(d)
COMMERCIAL AND GOVERNMENT USE						
Offices - government, business, and professional	Y	Y	Y(d)	Y(d)	N	N
Wholesale and retail - building materials, hardware and heavy equipment	Y	Y	Y(d)	Y(d)	Y(d)	Y(d)
Airport businesses - car rental, tours, lei stands, ticket offices, etc.	Y	Y	Y(d)	Y(d)	N	N
Retail, restaurants, shopping centers, financial institutions, etc.	Y	Y	Y(d)	Y(d)	N	N
Power plants, sewage treatment plants, and base yards	Y	Y	Y(d)	Y(d)	Y(d)	N
Studios without outdoor sets, broadcasting, production facilities, etc.	Y(c)	Y(c)	N	N	N	N
MANUFACTURING, PRODUCTION, AND STORAGE						
Manufacturing, general	Y	Y	Y(d)	Y(d)	Y(d)	N
Photographic and optical	Y	Y	Y(d)	Y(d)	N	N
Agriculture (except livestock) and forestry	Y	Y(e)	Y(e)	Y(e)	Y(e)	Y(e)
Livestock farming and breeding	Y	Y(e)	Y(e)	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
RECREATIONAL						
Outdoor sports arenas and spectator sports	Y	Y(f)	Y(f)	N	N	N
Outdoor music shells, amphitheaters	Y(f)	N	N	N	N	N
Nature exhibits and zoos, neighborhood parks	Y	Y	Y	N	N	N
Amusements, beach parks, active playgrounds, etc.	Y	Y	Y	Y	N	N
Public golf courses, riding stables, cemeteries, gardens, etc.	Y	Y	N	N	N	N
Professional/resort sport facilities, locations of media events, etc.	Y(f)	N	N	N	N	N
Extensive natural wildlife and recreation areas	Y(f)	N	N	N	N	N

Numbers in parentheses refer to notes.

KEY TO TABLE 3:

Y(Yes) = Land Use and related structures compatible without restrictions.
N(No) = Land Use and related structures are not compatible and should be prohibited.

TABLE 3 (CONTINUED)

HAWAII STATE DEPARTMENT OF TRANSPORTATION RECOMMENDATIONS FOR LOCAL LAND USE COMPATIBILITY WITH YEARLY DAY-NIGHT AVERAGE SOUND LEVELS (DNL)

NOTES FOR TABLE 3:

(a) A noise level of 60 DNL does not eliminate all risks of adverse noise impacts from aircraft noise. However, the 60 DNL planning level has been selected by the State Airports Division as an appropriate compromise between the minimal risk level of 55 DNL and the significant risk level of 65 DNL.

(b) Where the community determines that these uses must be allowed, Noise Level Reduction (NLR) measures to achieve interior levels of 45 DNL or less should be incorporated into building codes and be considered in individual approvals. Normal local construction employing natural ventilation can be expected to provide an average NLR of approximately 9 dB. Total closure plus air conditioning may be required to provide additional outdoor to indoor NLR, and will not eliminate outdoor noise problems.

(c) Because the DNL noise descriptor system represents a 24-hour average of individual aircraft noise events, each of which can be unique in respect to amplitude, duration, and tonal content, the NLR requirements should be evaluated for the specific land use, interior acoustical requirements, and properties of the aircraft noise events. NLR requirements should not be based solely upon the exterior DNL exposure level.

(d) Measures to achieve required NLR must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

(e) Residential buildings require NLR. Residential buildings should not be located where noise is greater than 65 DNL.

(f) Impact of amplitude, duration, frequency, and tonal content of aircraft noise events should be evaluated.

In the State of Hawaii, the State Department of Health (DOH) regulates noise from on-site activities. State DOH noise regulations are expressed in maximum allowable property line noise limits rather than DNL (see Reference 6). The noise limits apply on all islands of the State, including the island of Hawaii. Although they are not directly comparable to noise criteria expressed in DNL, State DOH noise limits for preservation/residential, apartment/commercial, and agricultural/industrial lands equate to approximately 55, 60, and 76 DNL, respectively.

Because the `O`oma Beachside Village site is located on lands proposed for single family and multifamily residential, and commercial uses, various DOH noise limits would be applicable along the lot boundary lines or at receptor locations for the noise originating from any stationary machinery, or equipment related to commercial or construction activities. These property line limits are 60 dBA and 50 dBA during the daytime and nighttime periods, respectively, for commercial lots or receptors. For multifamily or apartment use, the State DOH limits are also 60 dBA and 50 dBA during the daytime and nighttime periods, respectively. For single family residential and public facility uses, the State DOH limits are 55 dBA and 45 dBA during the daytime and nighttime periods, respectively. These noise limits cannot be exceeded for more than 2 minutes in any 20-minute time period under the State DOH noise regulations. The State DOH noise regulations do not apply to aircraft or motor vehicles.

CHAPTER IV. GENERAL STUDY METHODOLOGY

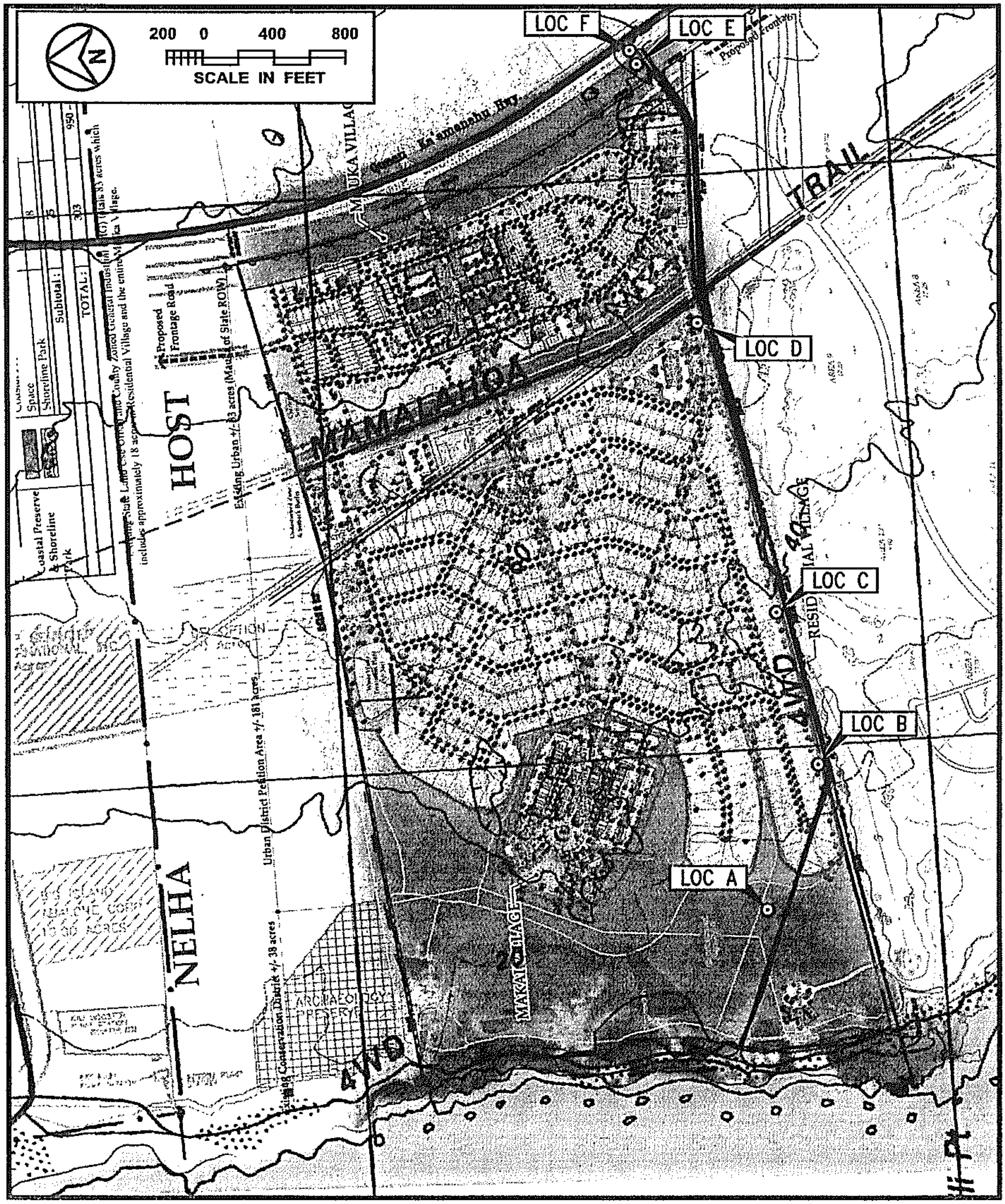
Noise Measurements. Existing traffic, aircraft, and background ambient noise levels were measured at six locations in the project environs to provide a basis for developing the traffic noise contours along Queen Kaahumanu Highway, which will service `O`oma Beachside Village, and for determining the existing background ambient noise levels in the project area. In addition, aircraft noise measurements were also obtained at the southern and western ends of the project site to validate the aircraft noise model used to develop the aircraft noise contours over the project site.

The locations of the measurement sites (Locations A through F) are shown in Figure 3. Noise measurements were performed during a six day period from March 19 to 24, 2007. The traffic noise measurement results, and their comparisons with computer model predictions of existing traffic noise levels are summarized in Table 4. The results of the traffic noise measurements were compared with calculations of existing traffic noise levels to validate the highway traffic noise computer model used. The single event aircraft noise measurement results are summarized in Tables 5 through 8, and were used to validate the aircraft noise computer model used. Comparisons of the measured DNL values at the four aircraft noise measurement sites with the various computer modeled scenarios and their aircraft noise contour values are shown in Tables 9A and 9B.

Road Traffic Noise Analysis. Traffic noise calculations for the existing conditions as well as noise predictions for the future conditions with and without the project were performed using the Federal Highway Administration (FHWA) Noise Prediction Model (Reference 8). Traffic data entered into the noise prediction model were: hourly traffic volumes, average vehicle speeds, estimates of traffic mix, and loose soil propagation loss factor. The traffic assignments for the project (Reference 9) and Hawaii State Department of Transportation counts on Queen Kaahumanu Highway (Reference 10) were the primary sources of data inputs to the model. For existing and future traffic, it was assumed that the 24-hour DNL along the highway was one unit greater than the larger of the AM or PM peak hour Leq(h). This assumption was based on computations of both the hourly Leq and the 24-hour DNL of traffic noise on Queen Kaahumanu Highway (see Figure 4).

Traffic noise calculations for both the existing and future conditions in the project environs were developed for ground level receptors without the benefit of shielding effects. Traffic assignments with and without the project were obtained from the project's traffic turning movements (Reference 9). The forecasted increases in traffic noise levels over existing levels were calculated for both scenarios, and noise impact risks evaluated. The relative contributions of non-project and project related traffic to the total noise levels were also calculated, and an evaluation was made of possible traffic noise impacts resulting from the project.

The widening of Queen Kaahumanu Highway by CY 2029 was also assumed.



NOISE MEASUREMENT LOCATIONS ON PROJECT SITE

FIGURE 3

TABLE 4
TRAFFIC NOISE MEASUREMENT RESULTS

	LOCATION	Time of Day (HRS)	Ave. Speed (MPH)	------ Hourly Traffic Volume ------ AUTO	M.TRUCK	H.TRUCK	Measured Leq (dB)	Predicted Leq (dB)
E	150 FT from centerline of Q. Kaahumanu Hwy. (3/20/07)	0645 TO 0745	65	1,650	36	45	66.6	65.9
F	50 FT from centerline of Q. Kaahumanu Hwy. (3/20/07)	0645 TO 0745	65	1,650	36	45	74.8	74.9
E	150 FT from centerline of Q. Kaahumanu Hwy. (3/20/07)	1645 TO 1745	55	1,633	18	12	58.4	62.8
F	50 FT from centerline of Q. Kaahumanu Hwy. (3/20/07)	1645 TO 1745	55	1,633	18	12	72.0	71.9

TABLE 5

SUMMARY OF INDIVIDUAL AIRCRAFT NOISE MEASUREMENTS AT LOCATION "A"

AIRCRAFT TYPE	MAXIMUM SOUND LEVELS Lmax (in dB)	SOUND EXPOSURE LEVELS Lse (in dB)
B-737(700) (RWY 17) (TAKE OFF)	72.7; 70.7; 70.8; 76.5; 66.2; 69.3; 65.8; (AVE.=70.3)	80.1; 81.8; 81.6; 87.0; 77.5; 80.9; 77.5; (ENERGY AVE.=82.1; PRED.=83.9)
B-737(200) (RWY 17) (TAKE OFF)	85.5; 76.7; 76.8; 79.2; 77.3; 79.2; 78.1; 77.9; 85.0; 85.2; 81.2; 78.5; 82.2; 81.4; 78.0; 87.8; 81.7; 79.3; 78.5; 80.4; 92.5; 85.6; 81.4; 89.0; 83.5; 75.6; 93.1; 90.5; 81.4; 87.7; 76.7; 72.9; 79.5; 80.7; 73.1; 72.1; 84.5; 82.4; 81.5; 87.9; 76.6; 72.9; 82.6; 84.7; 88.9; 80.4; 80.0; 62.6; 76.9; 66.5; 77.2; 82.3; 77.1; 80.2; 82.5; 84.5; 75.9; 82.0; 77.8; 82.8; 86.9; 84.5; 79.9; 68.7; 81.0; 83.2; 78.3; 83.0; 78.0; 78.1; 79.6; 77.8; 79.5; 78.8; 80.8; 92.1; 80.2; 75.3; 81.2; 80.0; 76.2 (AVE.=81.0)	90.9; 87.5; 87.4; 88.4; 87.2; 89.0; 88.9; 86.0; 93.5; 95.3; 90.9; 88.1; 90.4; 89.5; 89.4; 97.0; 91.1; 89.6; 88.9; 91.4; 99.2; 94.3; 92.3; 98.4; 93.7; 85.3; 100.6; 96.9; 91.2; 96.2; 85.5; 92.6; 88.2; 90.3; 80.9; 84.1; 93.9; 91.9; 92.2; 96.5; 86.5; 85.0; 92.7; 94.6; 97.4; 89.3; 90.0; 75.5; 87.2; 73.0; 85.9; 92.0; 88.5; 89.5; 88.5; 94.5; 85.8; 91.8; 88.5; 92.5; 95.7; 93.3; 88.3; 78.4; 88.9; 92.4; 90.1; 92.6; 87.8; 88.6; 86.1; 87.5; 89.2; 88.2; 91.2; 101.9; 90.0; 86.7; 91.5; 89.5; 86.5; (ENERGY AVE.=92.1; PRED.=91.2)
B-717(200) (RWY 17) (TAKE OFF)	67.8; 75.9; 65.1; 66.2; 69.0; 67.9; 68.1; 74.0; 68.3; 66.2; 65.1; 69.9; 66.6; 69.4; 64.1; 69.6; 59.8; 65.5; 68.6; 68.0; 66.0; 65.7; 67.5; 66.4; 59.0; 72.0; 64.1; 62.2; 70.8; 64.5; 70.2; 68.6; 76.9; 66.5; 70.7; 64.1; 64.0; 66.7; 63.8; 69.4; 63.2; 63.4; 65.9; 65.9; 68.5; 66.2; 67.7; 66.5; 64.4; 63.5; 67.0; 67.7; 67.6; 68.1; 71.5; 67.4; 65.5; 65.3; 69.5; 71.3; 68.0; 67.6; 67.7; 67.7; (AVE.=67.2)	77.3; 85.2; 75.1; 77.7; 80.3; 77.2; 79.8; 83.8; 77.4; 76.5; 75.5; 78.1; 77.0; 80.4; 75.0; 78.7; 70.0; 77.0; 79.4; 77.9; 75.9; 75.9; 76.4; 76.3; 70.7; 81.1; 75.0; 73.8; 81.4; 74.9; 78.2; 77.5; 87.2; 73.0; 78.9; 74.0; 74.5; 76.6; 74.4; 80.4; 74.6; 74.5; 76.5; 76.2; 79.4; 76.5; 79.0; 76.5; 75.2; 71.3; 77.6; 77.7; 77.9; 78.7; 80.6; 77.4; 77.6; 75.3; 76.8; 80.2; 75.6; 77.3; 77.4; 77.2; (ENERGY AVE.=78.4; PRED.=80.3)
CRJ 200 (RWY 17) (TAKE OFF)	63.2; 62.7; 63.4; 66.5; 57.5; 64.9; 67.2; 65.7; 63.0; 66.7; 60.9; 55.2; 60.5; 66.2; 66.9; 61.5; 63.7; 62.1; 68.5; 61.1; 77.8; 69.2; 61.4; 62.7; 63.2; 64.4; 66.9; 64.1; 60.0; 60.5; (AVE.=63.9)	73.4; 69.9; 73.7; 76.0; 68.0; 72.8; 78.3; 76.9; 73.7; 78.4; 70.1; 68.3; 71.1; 76.8; 75.6; 73.1; 73.0; 73.4; 78.8; 70.6; 88.5; 79.2; 71.8; 74.0; 72.5; 73.0; 75.2; 73.9; 73.0; 68.3; (ENERGY AVE.=77.1; PRED.=76.1)

TABLE 5 (CONTINUED)

SUMMARY OF INDIVIDUAL AIRCRAFT NOISE MEASUREMENTS AT LOCATION "A"

AIRCRAFT TYPE	MAXIMUM SOUND LEVELS Lmax (in dB)	SOUND EXPOSURE LEVELS Lse (in dB)
C-17 (RWY 17) (TAKE OFF)	75.2; 67.5; 72.8; 78.2; 73.5; 79.8; 77.6; 79.2; (AVE.=75.5)	86.7; 78.9; 83.7; 88.9; 84.2; 89.6; 86.7; 85.2; (ENERGY AVE.=86.4; PRED.=88.3)
P-3C (RWY 17) (TOUCH &GO)	64.4; 67.8; 67.6; 68.9; 70.4; 67.6; 66.6; 69.0; 72.3; 78.4; 68.6; 70.7; 66.2; 69.4; 65.9; 68.7; 73.5; 67.9; 68.1; 71.1; 65.8; 65.3; 61.4; 60.5; 63.8; (AVE.=68.0)	76.2; 76.9; 76.3; 78.5; 78.7; 77.2; 76.2; 77.4; 82.8; 83.6; 76.0; 79.3; 76.0; 76.1; 75.7; 77.5; 82.5; 78.4; 77.7; 78.8; 74.2; 74.0; 71.2; 68.8; 73.3; (ENERGY AVE.=78.1; PRED.=80.5)
B-757/767 (RWY 17) (TAKE OFF)	66.2; 75.8; 67.8; 78.7; 73.6; 72.8; 74.2; 68.2; 64.6; 68.6; 72.4; 66.4; 72.5; 73.5; 66.9; 66.0; 71.4; 73.6; 77.8; 69.3; 74.6; 73.8; 71.7; 70.9; 75.1; 77.3; 80.4; 76.1; 67.8; 73.6; (AVE.=72.1)	76.3; 84.3; 76.0; 87.4; 83.6; 80.0; 83.8; 77.0; 76.1; 77.3; 81.6; 78.3; 83.7; 84.6; 78.3; 76.2; 81.7; 84.0; 87.5; 80.0; 85.7; 82.3; 79.1; 80.2; 84.8; 87.5; 85.8; 84.6; 75.6; 83.3; (ENERGY AVE.=83.0; PRED.=86.5)
KC-135R (RWY 17) (TOUCH &GO)	71.8; 81.1; 78.8; 77.7; 73.0; 79.9; 75.7; 73.5; 74.9; 72.9; 70.4; 73.3; 75.9; 74.2; 67.0; 70.2; 73.6; 63.5; 79.1; 72.2; 77.7; (AVE.=74.1)	81.9; 89.2; 87.7; 86.2; 82.1; 88.8; 84.8; 82.5; 82.5; 79.5; 79.3; 81.2; 84.5; 83.5; 77.4; 80.0; 81.6; 74.0; 86.8; 81.5; 85.8; (ENERGY AVE.=84.3; PRED.=86.6)

TABLE 6

SUMMARY OF INDIVIDUAL AIRCRAFT NOISE MEASUREMENTS AT LOCATION "B"

AIRCRAFT TYPE	MAXIMUM SOUND LEVELS Lmax (in dB)	SOUND EXPOSURE LEVELS Lse (in dB)
B-737(700) (RWY 17) (TAKE OFF)	68.1; 69.2; 68.4; (AVE.=68.6)	76.9; 78.2; 74.0; (ENERGY AVE.=76.7; PRED.=79.9)
B-737(200) (RWY 17) (TAKE OFF)	79.5; 77.6; 78.7; 79.4; 73.8; 80.6; 77.0; 81.6; 80.2; 82.0; 84.6; 76.8; 80.9; 78.1; 87.8; 84.4; 81.4; 85.0; 76.9; 71.9; 77.3; 79.6; 75.2; 76.0; 83.6; 80.8; 79.6; 84.1; 75.8; 72.4; 77.4; 78.4; 78.4; 79.4; 79.8; 80.2; 90.0; 80.3; 77.7; 82.2; 78.4; 76.6; 78.6; (AVE.=79.8)	88.6; 85.8; 85.0; 86.7; 83.5; 86.5; 84.9; 84.3; 89.3; 90.3; 88.2; 85.2; 89.4; 84.0; 94.6; 92.7; 83.6; 91.7; 84.9; 79.9; 84.8; 87.9; 84.0; 84.3; 90.8; 89.3; 88.3; 92.4; 84.3; 82.9; 85.5; 85.7; 86.4; 85.6; 86.0; 88.4; 98.2; 86.9; 84.9; 86.1; 87.9; 86.2; 85.6; (ENERGY AVE.=88.7; PRED.=88.8)
B-717(200) (RWY 17) (TAKE OFF)	66.0; 73.2; 63.4; 66.9; 77.4; 65.0; 68.5; 66.1; 74.1; 66.8; 66.2; 67.9; 68.3; 65.5; 64.0; 64.5; 69.0; 59.5; 68.5; 64.0; 67.4; 68.2; 67.5; 71.0; 66.2; 67.8; 64.6; 67.8; 67.0; 63.2; 68.2; 65.4; 65.6; (AVE.=67.1)	73.8; 81.7; 73.3; 76.3; 78.4; 74.8; 75.9; 76.1; 79.7; 74.0; 73.8; 75.8; 75.3; 74.0; 73.6; 74.0; 73.7; 69.3; 75.9; 73.1; 75.1; 74.2; 75.1; 75.8; 76.0; 76.8; 74.9; 76.1; 74.0; 72.6 73.6; 74.0; 74.2; (ENERGY AVE.=75.6; PRED.=70.9)
CRJ 200 (RWY 17) (TAKE OFF)	63.4; 59.6; 62.1; 65.4; 71.6; 58.1; 59.4; 64.1; 61.3; 62.5; 62.8; 58.2; 63.7 (AVE.=62.5)	70.7; 69.8; 71.1; 73.5; 74.9; 66.0; 68.5; 68.9; 67.0; 71.8; 70.2; 68.5; 66.1 (ENERGY AVE.=70.6; PRED.=70.9)
C-17 (RWY 17) (TAKE OFF)	73.0; 68.8; 75.0; 70.7; (AVE.=71.9)	83.4; 77.9; 85.6; 81.0; (ENERGY AVE.=82.8; PRED.=84.5)
P-3C (RWY 17) (TOUCH &GO)	63.8; 65.8; 64.6; 67.1; (AVE.=65.3)	73.9; 72.9; 73.5; 73.8; (ENERGY AVE.=73.5; PRED.=76.7)
B-757/767 (RWY 17) (TAKE OFF)	65.1; 75.1; 64.2; 75.4; 67.6; 70.2; 69.2; 75.6; 71.0; 66.9; 64.1; 72.6; 74.7; 76.2; 74.4; 68.5; 72.7; (AVE.=70.8)	75.1; 82.2; 73.4; 84.0; 78.1; 78.3; 77.5; 84.1; 81.4; 77.3; 74.5; 81.4; 83.4; 83.2; 81.2; 72.8; 81.2; (ENERGY AVE.=80.7; PRED.=82.8)

TABLE 7

SUMMARY OF INDIVIDUAL AIRCRAFT NOISE MEASUREMENTS AT LOCATION "C"

AIRCRAFT TYPE	MAXIMUM SOUND LEVELS Lmax (in dB)	SOUND EXPOSURE LEVELS Lse (in dB)
B-737(700) (RWY 17) (TAKE OFF)	70.7; 69.6; (AVE.=70.2)	78.1; 76.9; (ENERGY AVE.=77.5; PRED.=77.4)
B-737(200) (RWY 17) (TAKE OFF)	78.6; 80.9; 79.4; 80.5; 79.3; 77.7; 75.8; 78.0; 85.0; 83.0; 77.5; 81.9; 76.8; 82.6; 82.5; 79.3; 79.9; 70.8; 79.5; 76.3; 67.2; 76.4; 61.4; 74.0; 80.2; 80.4; 77.9; 76.4; 82.4; (AVE.=78.0)	85.0; 87.1; 85.5; 89.5; 86.8; 85.4; 84.3; 86.9; 91.3; 90.4; 87.2; 90.6; 87.5; 89.3; 89.2; 85.0; 85.3; 80.1; 85.8; 84.4; 75.0; 82.9; 67.3; 81.1; 86.9; 84.7; 85.9; 83.0; 88.8; (ENERGY AVE.=86.8; PRED.=88.3)
B-717(200) (RWY 17) (TAKE OFF)	66.4; 68.6; 67.8; 69.2; 61.8; 68.1; 66.6; 65.5; 65.4; 71.1; 69.5; 64.6; 68.0; 70.0; 66.2; 66.8; 64.9; 64.5; 65.1; 61.8; 64.5; (AVE.=66.5)	75.9; 75.8; 73.4; 75.0; 70.8; 75.8; 68.4; 73.2; 73.9; 77.5; 76.6; 72.7; 74.3; 77.5; 75.8; 75.2; 71.6; 71.5; 71.4; 68.5; 74.7; (ENERGY AVE.=74.5; PRED.=76.2)
CRJ 200 (RWY 17) (TAKE OFF)	66.0; 65.6; 62.8; 59.7; 66.0; 59.0; 63.2; 62.5; 64.3; 59.7; 61.4; 60.7; (AVE.=62.6)	73.0; 77.2; 72.8; 66.9; 68.6; 69.4; 74.0; 73.2; 72.5; 69.1; 69.4; 69.0; (ENERGY AVE.=72.2; PRED.=70.6)
C-17 (RWY 17) (TAKE OFF)	71.8; 74.9; 75.4; (AVE.=74.0)	81.2; 83.9; 81.8; (ENERGY AVE.=82.5; PRED.=84.4)
P-3C (RWY 17) (TOUCH &GO)	66.3; 66.1; 63.4; 62.8; 66.3; 68.7; 70.4; 70.9; 65.6; 66.6; 65.2; (AVE.=66.6)	74.3; 74.7; 74.5; 70.5; 72.6; 76.9; 74.0; 78.9; 70.7; 73.8; 72.1; (ENERGY AVE.=73.9; PRED.=75.0)
B-757/767 (RWY 17) (TAKE OFF)	71.1; 72.8; 67.8; 70.7; 67.7; 71.8; 67.8; 69.3; 72.0; 75.2; 67.8; 71.3; 74.0; 68.5; (AVE.=70.6)	79.2; 76.8; 77.6; 79.4; 76.5; 79.0; 73.2; 74.0; 78.8; 78.5; 76.2; 79.2; 81.6; 75.7; (ENERGY AVE.=78.1; PRED.=80.4)
KC-135R (RWY 17) (TOUCH &GO)	70.8; 74.6; 73.0; 74.5; 68.7; 74.1; 71.1; 70.3; 70.6; 69.0; 70.9; 68.1; 71.1; 73.8; (AVE.=71.5)	79.5; 82.6; 82.1; 80.9; 76.9; 82.4; 76.7; 77.5; 75.0; 75.5; 76.3; 77.9 78.8; (ENERGY AVE.=79.3; PRED.=79.2)

TABLE 8

SUMMARY OF INDIVIDUAL AIRCRAFT NOISE MEASUREMENTS AT LOCATION "D"

AIRCRAFT TYPE	MAXIMUM SOUND LEVELS Lmax (in dB)	SOUND EXPOSURE LEVELS Lse (in dB)
B-737(700) (RWY 17) (TAKE OFF)	70.7; 63.2; (AVE.=67.0)	78.4; 71.9; (ENERGY AVE.=76.3; PRED.=73.5)
B-737(200) (RWY 17) (TAKE OFF)	72.1; 76.3; 76.3; 79.3; 81.1; 81.7; 77.8; 74.3; 69.4; 75.8; 76.0; 77.0; 80.0; (AVE.=76.7)	81.7; 84.5; 85.1; 85.3; 87.1; 87.9; 85.9; 81.7; 75.1; 82.7; 83.7; 83.1; 85.6; (ENERGY AVE.=84.6; PRED.=83.5)
B-717(200) (RWY 17) (TAKE OFF)	60.3; 64.8; 63.1; 64.6; 66.2; 62.2; 65.2; 61.3; 59.9; 64.1; 61.2; (AVE.=63.0)	69.7; 70.6; 72.2; 73.7; 73.5; 70.3; 75.8; 67.7; 68.1; 68.8; 69.2; (ENERGY AVE.=71.6; PRED.=67.5)
CRJ 200 (RWY 17) (TAKE OFF)	60.2; 60.6; 64.4; 61.2; 61.4; (AVE.=61.6)	71.0; 68.4; 74.5; 68.4; 69.4; (ENERGY AVE.=71.0; PRED.=66.9)
P-3C (RWY 17) (TOUCH &GO)	62.4; 63.5; 63.0; 61.3; 66.4; 64.6; 64.5; 66.8; 64.5;; 59.2; 63.7; 61.2; 67.1; (AVE.=63.7)	70.3; 73.3; 71.0; 71.0; 74.4; 73.4; 72.5; 71.5; 70.2; 69.7; 73.9; 68.8; 72.1; (ENERGY AVE.=71.7; PRED.=73.5)
B-757/767 (RWY 17) (TAKE OFF)	70.4; 73.5; 67.3; 69.0; (AVE.=70.1)	79.2; 78.0; 74.4; 75.8; (ENERGY AVE.=77.2; PRED.=77.1)
KC-135R (RWY 17) (TOUCH &GO)	66.3; 68.2; 66.8; 62.0; 68.5; 68.4; 66.7; 73.7; (AVE.=67.6)	74.6; 77.0; 73.9; 71.4; 74.1; 77.0; 74.5; 78.2; (ENERGY AVE.=75.6; PRED.=75.0)

TABLE 9A
COMPARISONS OF MEASURED AND PREDICTED EXISTING AIRCRAFT NOISE LEVELS

NOISE MODELING CONDITIONS	-- DNL @ MEASUREMENT LOCATION ---- A	B	C	D
1. March 2007 On-Site A/C Noise Measurements	55.8	52.0	50.8	49.4
2. FAR Part 150 5-Year (2001) Noise Contours	57.2	53.6	51.9	50.2
3a. INM 6.1 Estimated 2007/2008 Noise Contours	58.2	53.6	51.1	48.8
3b. INM 7.0 Estimated 2007/2008 Noise Contours	59.0	55.0	52.7	50.1
4. Draft 14 CFR Part 150 2008 Noise Contours	61.0	--- (Not possible to determine) ---		

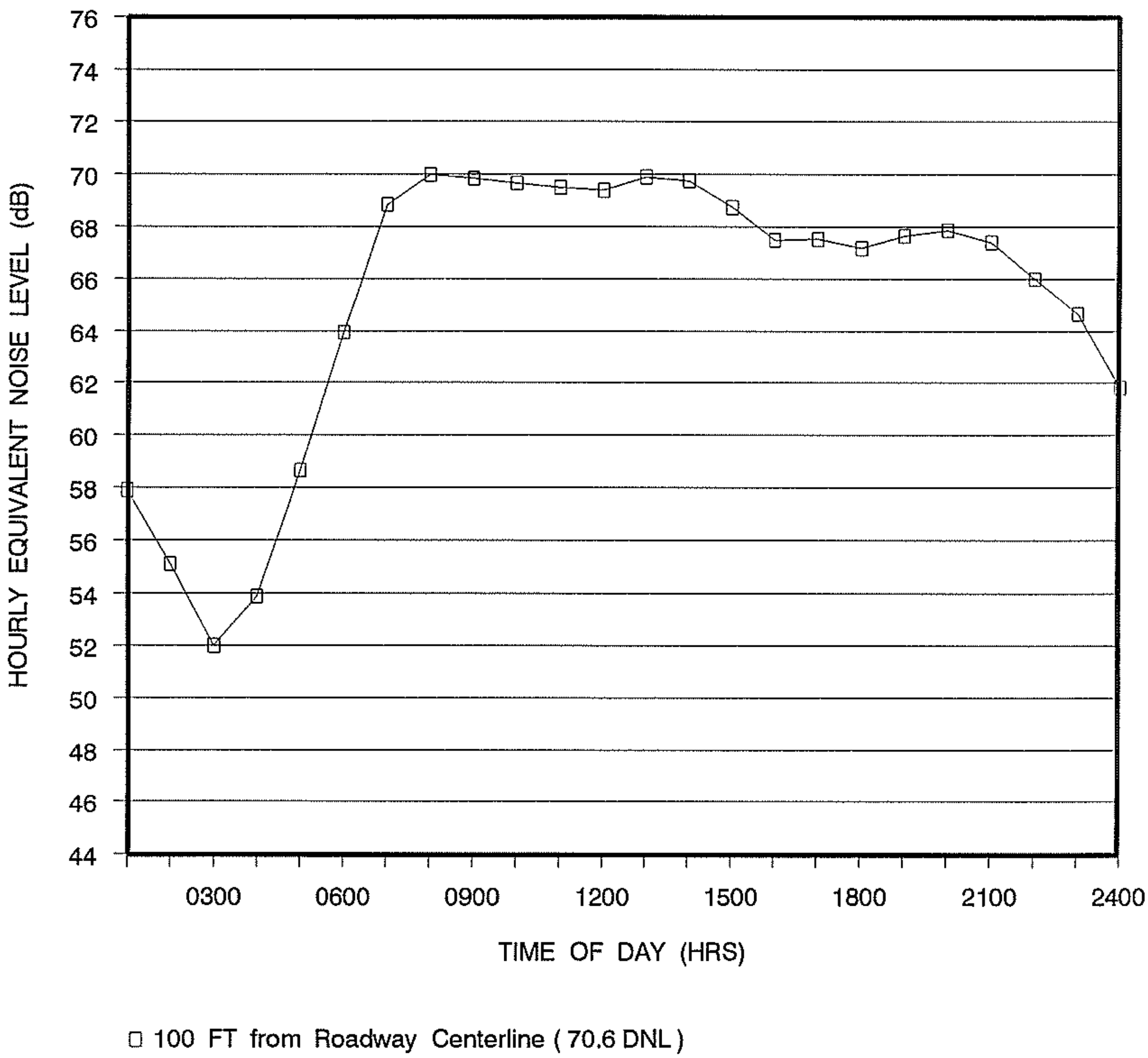
TABLE 9B
COMPARISONS OF MEASURED EXISTING AND PREDICTED FUTURE AIRCRAFT NOISE LEVELS

NOISE MODELING CONDITIONS	-- DNL @ MEASUREMENT LOCATION ---- A	B	C	D
1. March 2007 On-Site A/C Noise Measurements	55.8	52.0	50.8	49.4
5a. INM 6.1 Estimated 2013 Noise Contours	60.0	55.6	53.1	51.9
5b. INM 7.0 Estimated 2013 Noise Contours	60.4	56.1	53.5	50.6
6. Draft 14 CFR Part 150 2013 Noise Contours	62.0	--- (Not possible to determine) ---		
7. HDOTA 2020 Noise Contours (1997 Study)	56.8	53.3	51.4	49.8
8. Draft 14 CFR Part 150 2030 Noise Contours	61.0	--- (Not possible to determine) ---		
9. INM 6.1 Estimated 2030 Noise Contours	60.5	56.3	53.9	52.9

FIGURE 4

HOURLY VARIATIONS OF TRAFFIC NOISE AT 100 FT SETBACK DISTANCE FROM THE CENTERLINE OF QUEEN KAAHUMANU HWY. BETWEEN OTEC ACCESS RD. AND HULIKOA ST. AT 95 MILEPOST

(Sta. B71001909280, 5/31/06)

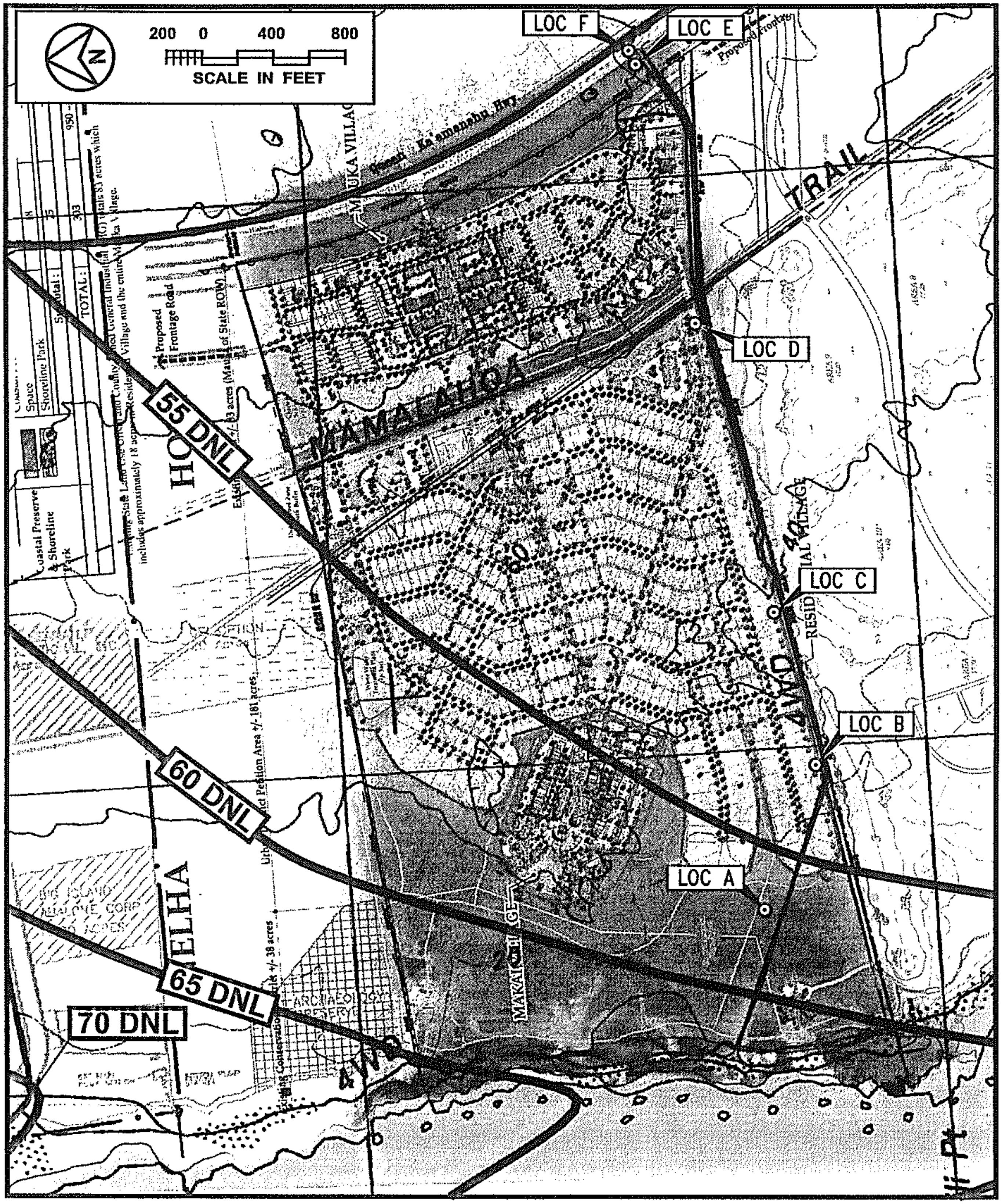


Future traffic noise levels with and without the project were calculated for conditions with 2 northbound and 2 southbound lanes, with the 2 southbound lanes located west of the existing highway pavement, and with a 72 foot wide median separating the northbound and southbound lanes.

Aircraft Noise Analysis. The potential aircraft noise impacts at the O'oma Beachside Village project site from existing and forecasted operations at KOA were evaluated. In addition, aircraft noise measurements on the project site were obtained in March 2007 to validate the reasonableness of the aircraft noise model used to develop the noise contours, and to quantify the expected noise levels from various aircraft flybys at noise sensitive locations on the project site. The potential noise impacts from additional C-17 training operations with the proposed Austere Runway at KOA were also investigated. Future 2013 noise contours with C-17, F-22A, and P-8A training operations included were developed. For the 2030 period, it was assumed that military training operations would remain the same as 2013 operations, and that the noisier B-737(200) aircraft (passenger only) would be replaced with quieter Stage 3 aircraft. The data sources for these evaluations were the current official 14 CFR Part 150 Noise Compatibility Study for KOA (Reference 7), which was completed in 1997; the Environmental Assessment for the site selection of the C-17 Short Austere Airfield (Reference 11), which was completed in 2004; the Environmental Assessment for the replacement of the F-15 aircraft with F-22A aircraft (Reference 12), which was completed in 2007; and the information provided by HDOTA from the ongoing 14 CFR Part 150 study (Reference 13).

The current and official noise contours for KOA were developed during the 14 CFR Part 150 Airport Noise Compatibility Study and Master Plan Update in the late 1900's and do not include C-17, F-22A, or P-8A operations. Figure 5 depicts the 2001 14 CFR Part 150 aircraft noise contours for the airport, which are the contours used for noise disclosure purposes during land ownership transactions near the airport. The aircraft noise contours fall over the western (makai) portions of the \`O\`oma Beachside Village project site. For noise sensitive land uses such as residential development, areas outside the 60 DNL contour are considered to be acceptable by the State of Hawaii Department of Transportation, Airports Division (HDOTA) land use compatibility recommendations. Any land ownership transactions which occur within the 55 DNL contour typically required disclosure of the aircraft noise levels prior to the transactions. Whenever State Land Use district boundary amendments or rezoning of noise sensitive lands is proposed within the 60 DNL contour, the HDOTA has recommended that sound attenuation measures be included with the noise sensitive structures and that a noise and avigation easement be provided to the HDOTA in exchange for the higher State Land Use or zoning reclassification. As indicated in Figure 5, the proposed noise sensitive residential land uses of the \`O\`oma Beachside Village project are located outside the 60 DNL contour, and were located to comply with the HDOTA land use compatibility recommendations shown in Table 3.

Estimates of current aircraft noise levels over the project site were made using



LOCATIONS OF CY 2001 AIRCRAFT NOISE CONTOURS (FROM FAR PART 150 REPORT FOR KOA)

FIGURE 5

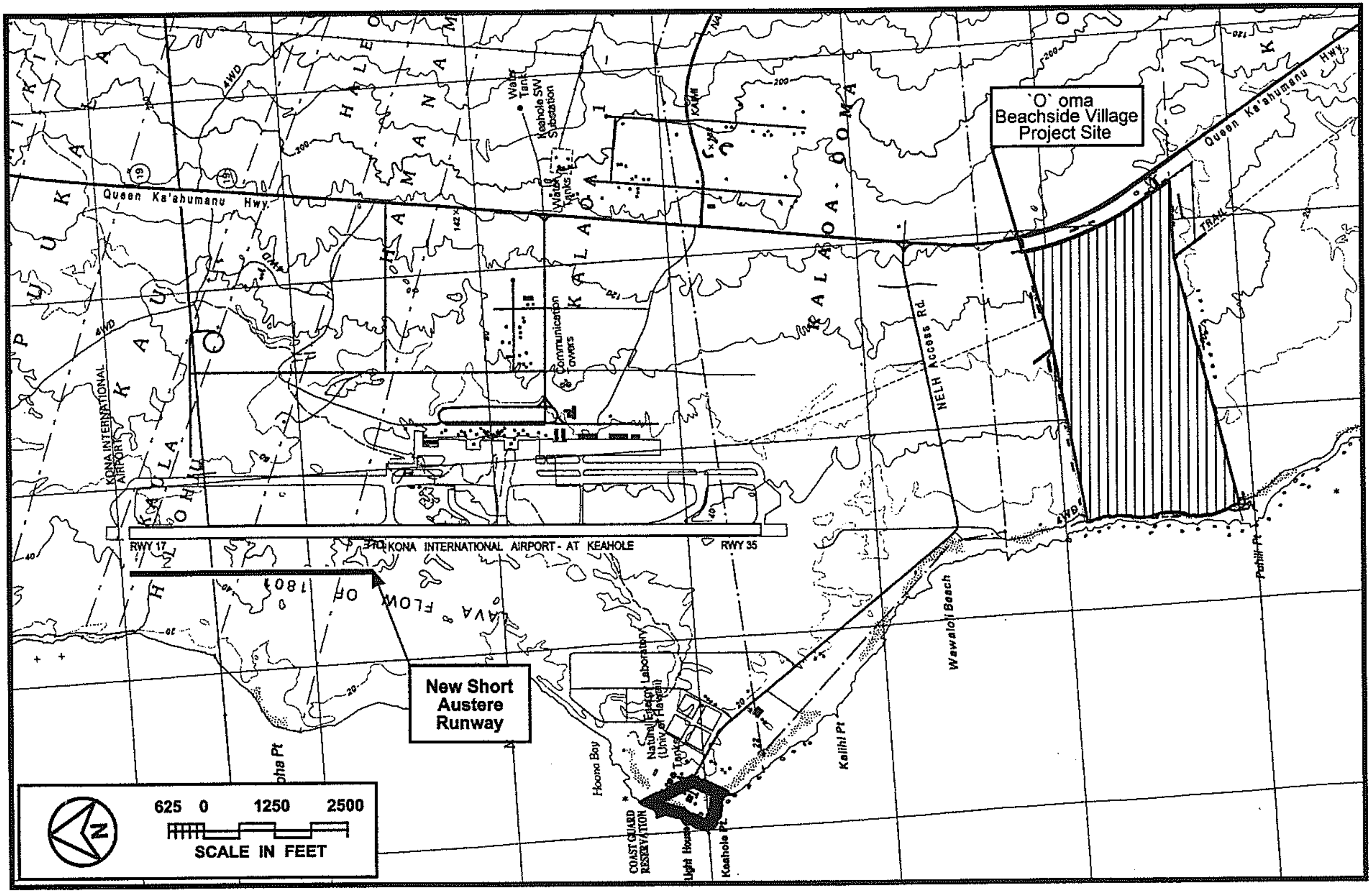
aircraft operation information contained in Reference 13 for the 2007/2008 period, and are described in Chapter V - Existing Noise Environment. Chapter V also includes the results of the aircraft noise measurements on the project site. Since this study's existing aircraft noise contours are not the "official" 14 CFR Part 150 noise contours for KOA, they should not be used for determining the aircraft noise disclosure boundaries by Reference 5.

The FAA Integrated Noise Model, Version 6.1 (FAA INM) was used to develop the aircraft noise contours for this study. In addition, the more recent Version 7.0 of the FAA INM was also used to identify any significant differences in the modeling results between Versions 6.1 and 7.0. After comparing the results from the two versions with the noise measurement data, it was concluded that the differences in results from the two FAA INM versions were insignificant when compared to the differences between measured noise levels and the predicted noise levels from both INM versions.

For the purposes of this study, estimates of the 2013 noise contours at KOA were developed in Chapter VI - Future Noise Environment. By 2013, it was assumed that the proposed Austere Runway for the C-17 would be completed, the F-15 would be replaced with the F-22A, and the P-3C would be replaced by the P-8A. These assumptions are consistent with the forecast contained in Reference 13, except for the replacement of the P-3C with the P-8A.

The proposed C-17 operations at KOA were estimated from information provided in the 2004 Environmental Assessment for the site selection of the C-17 Short Austere Airfield, which recommended KOA as the preferred airport (Reference 11), and information contained in Reference 13. The required funding for the new runway has not been secured, and the Hawaii State environmental documentation for the proposed runway has not been completed. Nevertheless, it was assumed that an additional parallel and shorter (4,250 feet long x 90 feet wide) runway will be constructed makai of and at the north end of the existing airfield where shown in Figure 6. The assumed C-17 operations at KOA with the new runway completed by 2013 were modeled using the following assumptions:

- 92 landings and 92 takeoffs per month on the new 4,250' runway;
- 92 landings and 92 takeoffs per month on the existing runway;
- 480 landings and 480 takeoffs (touch and go operations) per month on the existing runway; and
- 41 nighttime operations per month during the DNL noise penalty hours from 10:00 PM to 7:00 AM.



LOCATION OF PROPOSED NEW SHORT AUSTERE RUNWAY FOR C-17 TRAINING OPERATIONS

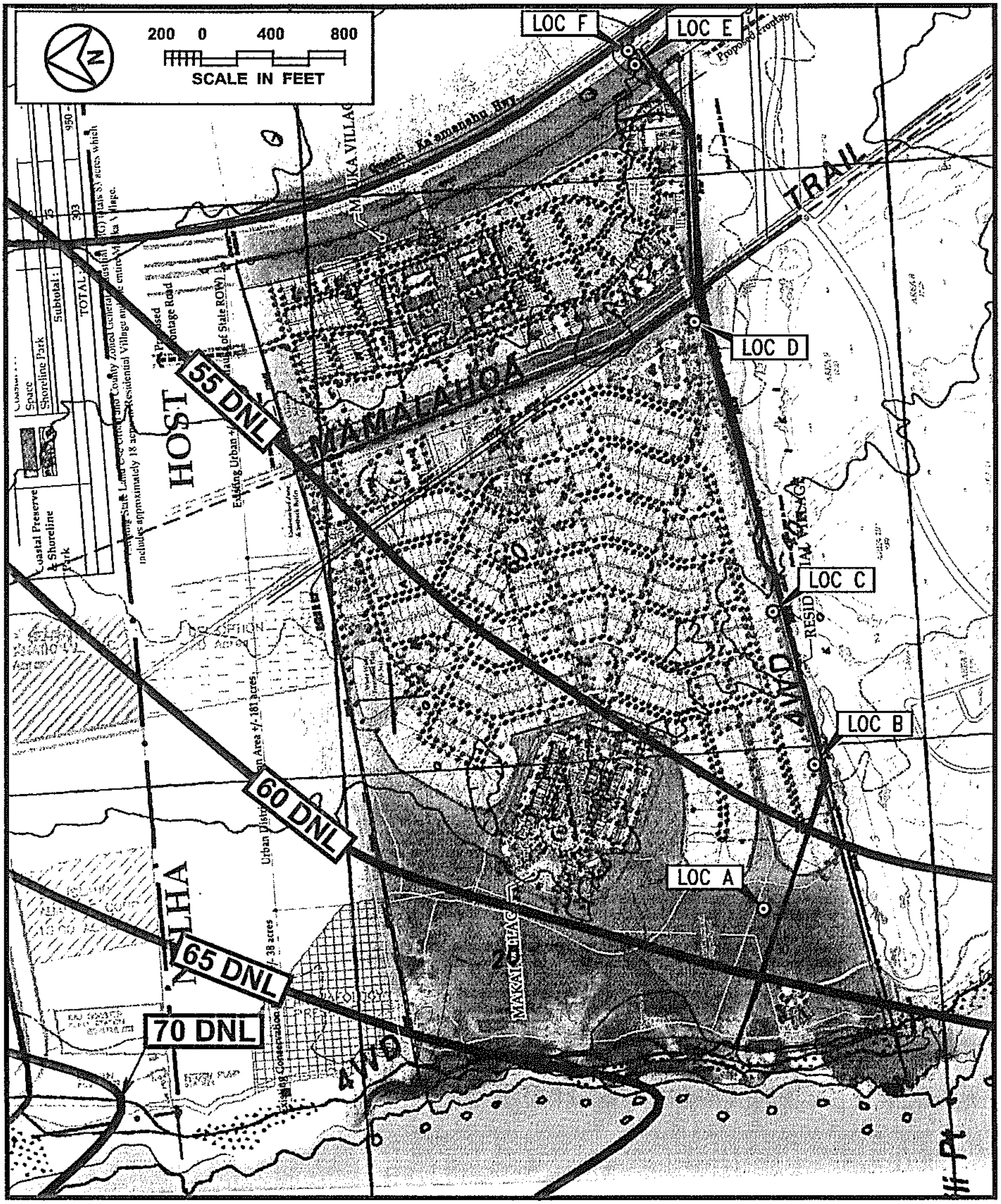
FIGURE 6

Forecasted airport noise contours for 2020 at KOA were developed during the 1997 14 CFR Part 150 Airport Noise Compatibility Study and Master Plan Update in the late 1900's and are shown in Figure 7. It should be noted that the forecasted noise contours were very similar to the 2001 contours shown in Figure 5. Both the 2001 and 2020 noise contours are in the process of being updated by the HDOTA, with the updated contours scheduled for completion within 1 year. Estimated noise contours for 2030 were developed in conjunction with this study using the available aircraft operations forecast from Reference 13.

The locations of the aircraft flight tracks and estimated airport noise contours for 2008, 2013, and 2030 were compared with the locations of the proposed noise sensitive land uses on the project site, and risks of noise impacts were evaluated. The need for special aircraft noise attenuation measures or disclosures of aircraft noise level at the project site was determined by comparing the relationship of the official 2001 14 CFR Part 150 airport noise contours with the locations of proposed land uses on the project site. In addition, noise monitoring data and the study's estimated 2008, 2013, and 2030 noise contours were also used to validate the conclusions regarding existing and future aircraft noise impacts over the project site.

Comparisons of Draft 14 CFR Part 150 Update Noise Contours with \`O\`oma Beachside Village Development Plans. During the course of this acoustical impact study for the \`O\`oma Beachside Village, the Hawaii State Department of Transportation, Airports Division (HDOTA) published its draft 14 CFR Part 150 Noise Study and contours for KOA (see Reference 13). The draft noise contours were compared with the aircraft noise contours developed for this acoustical impact study for \`O\`oma Beachside Village. Because of original modeling assumptions which were considered to be questionable or arbitrary, a request for a copy of the HDOTA's consultant's modeling input file was made via Reference 14. Because the request for the FAA INM modeling input file was denied, a second letter describing the concerns regarding the modeling input assumptions (see Reference 15) was also sent as comments regarding the draft 14 CFR Part 150 study results. These concerns involved the:

- incorrect assumption that daytime and nighttime winds and runway use at KOA are identical;
- lack of correlation between the departure tracks of the B-737(200) aircraft and the seaward extension of the noise contours south of the airport;
- use of a 3% increase in airport operations to account for nighttime flights;
- use of identical itinerant operations for the C-130, P-3, KC-135, and C-17 aircraft;
- apparent lack of authoritative input from the military when forecasting future military operations at KOA;



LOCATIONS OF CY 2020 AIRCRAFT NOISE CONTOURS (FROM 1997 MASTER PLAN UPDATE FOR KOA)

FIGURE 7

- lack of the new seaward runway planned for the C-17;

- continuing use of B-737(200) aircraft through 2030, when their replacement was assumed elsewhere;

- and inclusion of questionable noise monitoring data, which if deleted, would contradict the study conclusion that the south side of the airport is noisier than the north side of the airport.

Because the initial draft 14 CFR Part 150 contours for 2007 and 2012 did not cross into the planned noise sensitive developments of the `O`oma Beachside Village project site, and because the noise measurement data obtained in March 2007 also confirmed that the 60 DNL contour is probably west of the planned noise sensitive developments, the original `O`oma Beachside Village project noise analysis was considered to be adequate. A new set of draft noise contours were developed by HDOTA in 2008 which were larger than the original draft contours. Both the existing and forecast 14 CFR Part 150 contours increased in size, and these latest draft contours have been included with this study report. Continued monitoring and review of the HDOTA's 14 CFR Part 150 Update noise modeling assumptions will be performed to determine the causes of the differences between the study noise contours and the draft 14 CFR Part 150 contours.

Other Noise Analysis. Risks of adverse noise impacts from short term construction noise over the project site were also evaluated. Recommendations for mitigation of construction noise impacts were provided.

CHAPTER V. EXISTING NOISE ENVIRONMENT

Traffic Noise. The existing traffic noise levels in the project environs vary from levels of approximately 64 DNL along the mauka (east) property boundary, to less than 45 DNL at the makai (west) property boundary and interior locations of the project site. Traffic noise levels along Queen Kaahumanu Highway are less than 65 DNL at 180 FT or greater setback distances from the highway centerline. At the west boundary of the project which adjoins the shoreline, existing traffic noise levels are very low and less than 45 DNL.

Calculations of existing traffic noise levels during the AM and PM peak traffic hours are presented in Table 10. Existing traffic noise levels at the project site are typically higher during the AM peak traffic hour rather than the PM peak traffic hour. This is due to the traffic congestion on Queen Kaahumanu Highway in the southbound direction and the lower number of heavy vehicles during the PM peak hour. The hourly Leq (or Equivalent Sound Level) contribution from each roadway section in the project environs were calculated for comparison with forecasted traffic noise levels with and without the project. The existing setback distances from the roadways' centerlines to their associated 65 and 75 DNL contours were also calculated as shown in Table 11. The contour line setback distances do not take into account noise shielding effects or the additive contributions of traffic noise from intersecting street sections. Based on the results of Table 11, it was concluded that the existing 65 DNL traffic noise contour is located approximately 179 FT from the centerline of Queen Kaahumanu Highway in the immediate vicinity of the project site.

Existing traffic noise levels at the interior portions of the project site are low (less than 45 DNL) due to their large setback distances from Queen Kaahumanu Highway. At these interior locations on the project site, aircraft noise and the natural sounds of surf, birds, and winds in foliage are the dominant noise sources. A discussion of existing aircraft noise levels on the project site is provided in the following section. Between aircraft noise events, background ambient noise levels drop to a range of 35 to 49 dB. During calm wind periods, background ambient noise levels decrease to levels less than 35 dB. The minimum background ambient noise levels at these interior locations are controlled by distant traffic, surf, and wind noise.

Aircraft Noise. Aircraft noise sources in the project environs are associated with fixed and rotary wing aircraft operations at KOA. Figures 8 through 10, obtained from Reference 7, depict aircraft flight tracks in the project environs. Occasionally, depending on weather, visibility, or air traffic conditions, helicopter and light, fixed wing aircraft may cross over the project site as indicated by the departure and arrival tracks shown in Figures 8 and 9, respectively. In Figures 8 through 10, flight tracks G7, HT2, H3D, H3A, T16, T17, T19, and T21 represent overflights over the project site by light fixed wing propellor and rotary wing aircraft. The flight tracks of the noisier jet aircraft typically remain west of the project site and are aligned with KOA's single runway.

TABLE 10

EXISTING (CY 2006) TRAFFIC VOLUMES AND NOISE LEVELS ALONG VARIOUS ROAD SECTIONS (AM AND PM PEAK HOURS)

LOCATION	SPEED (MPH)	TOTAL VPH	********* VOLUMES (VPH) **********			** Leq(h) @ Dist. from B.L. **		
			AUTOS	M TRUCKS	H TRUCKS	50' Leq	100' Leq	200' Leq
AM Peak Hour:								
Q. Kaahumanu Hwy. - N. of Entrance Rd.	65	1,780	1,697	37	46	75.1	69.4	63.0
Q. Kaahumanu Hwy. - S. of Entrance Rd.	65	1,780	1,697	37	46	75.1	69.4	63.0
PM Peak Hour:								
Q. Kaahumanu Hwy. - N. of Entrance Rd.	55	1,655	1,625	18	12	74.2	68.4	61.8
Q. Kaahumanu Hwy. - S. of Entrance Rd.	55	1,655	1,625	18	12	74.2	68.4	61.8

Notes:

1. Traffic mix during AM Peak Hour: 95.3% Autos; 2.1% Medium Trucks; and 2.6% Heavy Trucks and Buses.
2. Traffic mix during PM Peak Hour: 98.2% Autos; 1.1% Medium Trucks; and 0.7% Heavy Trucks and Buses.
3. Loose Soil propagation loss factor used.
4. Receptor elevation of 4.92 feet above ground level was assumed.

TABLE 11

YEAR 2006 AND 2029 DISTANCES TO 65 AND 75 DNL CONTOURS

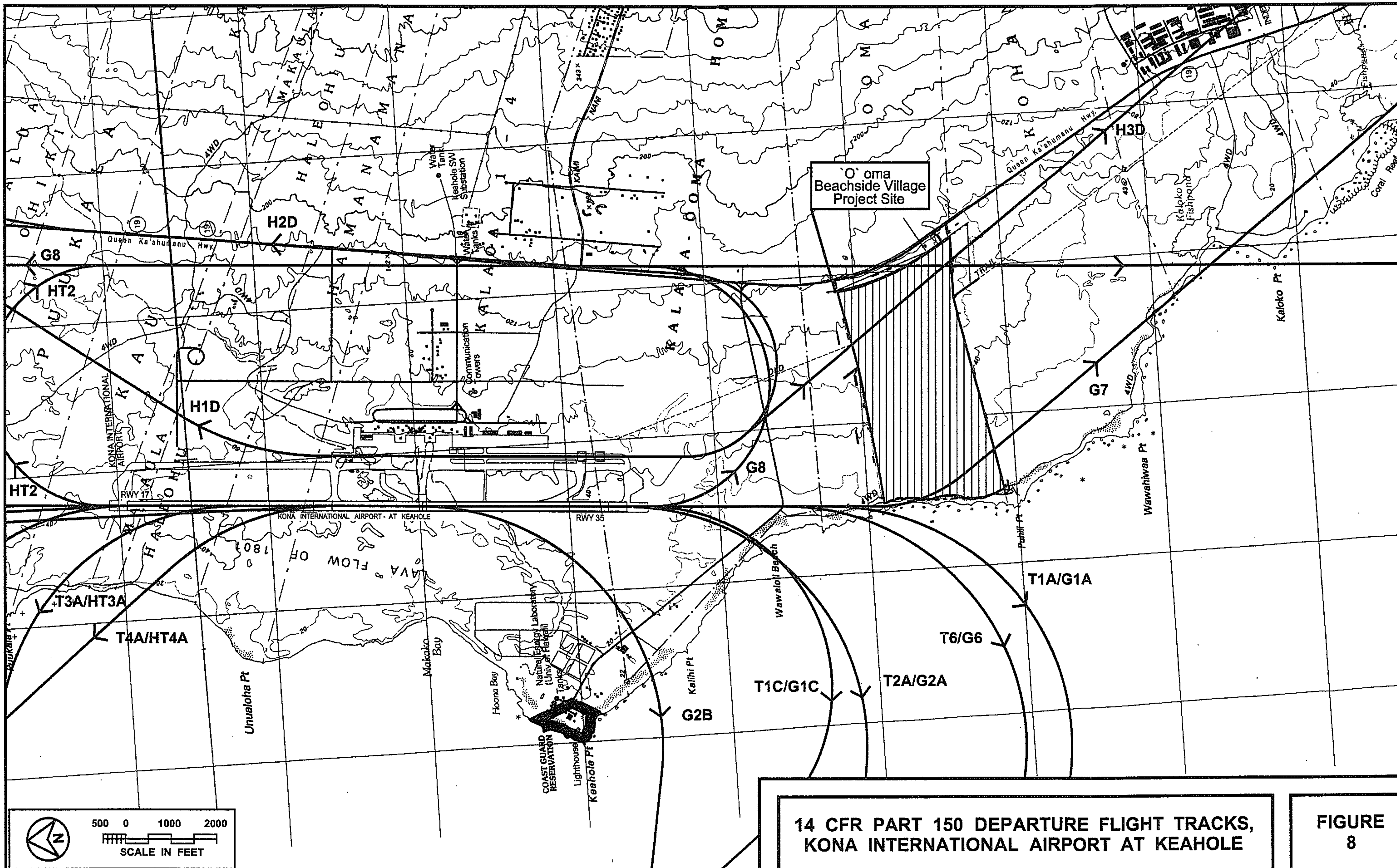
STREET SECTION	65 DNL SETBACK (FT)		75 DNL SETBACK (FT)	
	CY 2006	CY 2029	CY 2006	CY 2029
Q. Kaahumanu Hwy. - N. of Entrance Rd.	179	218	57	97
Q. Kaahumanu Hwy. - S. of Entrance Rd.	179	218	57	97
Project Entrance Rd. At Q. Kaahumanu	N/A	29	N/A	< 12
Frontage Rd. North of Proj. Entrance Rd.	N/A	22	N/A	< 12
Frontage Rd. South of Proj. Entrance Rd.	N/A	24	N/A	< 12
Project Entrance Rd. W. of Frontage Rd.	N/A	50	N/A	< 12

Notes:

(1) Setback distances are from the roadways' centerlines or baselines. For existing Q. Kaahumanu Hwy., Frontage Road, and Project Entrance Road, setback distances are from roadways' centerlines. For widened Q. Kaahumanu Hwy., setback distances are from new highway baseline, midway between northbound and new southbound lanes.

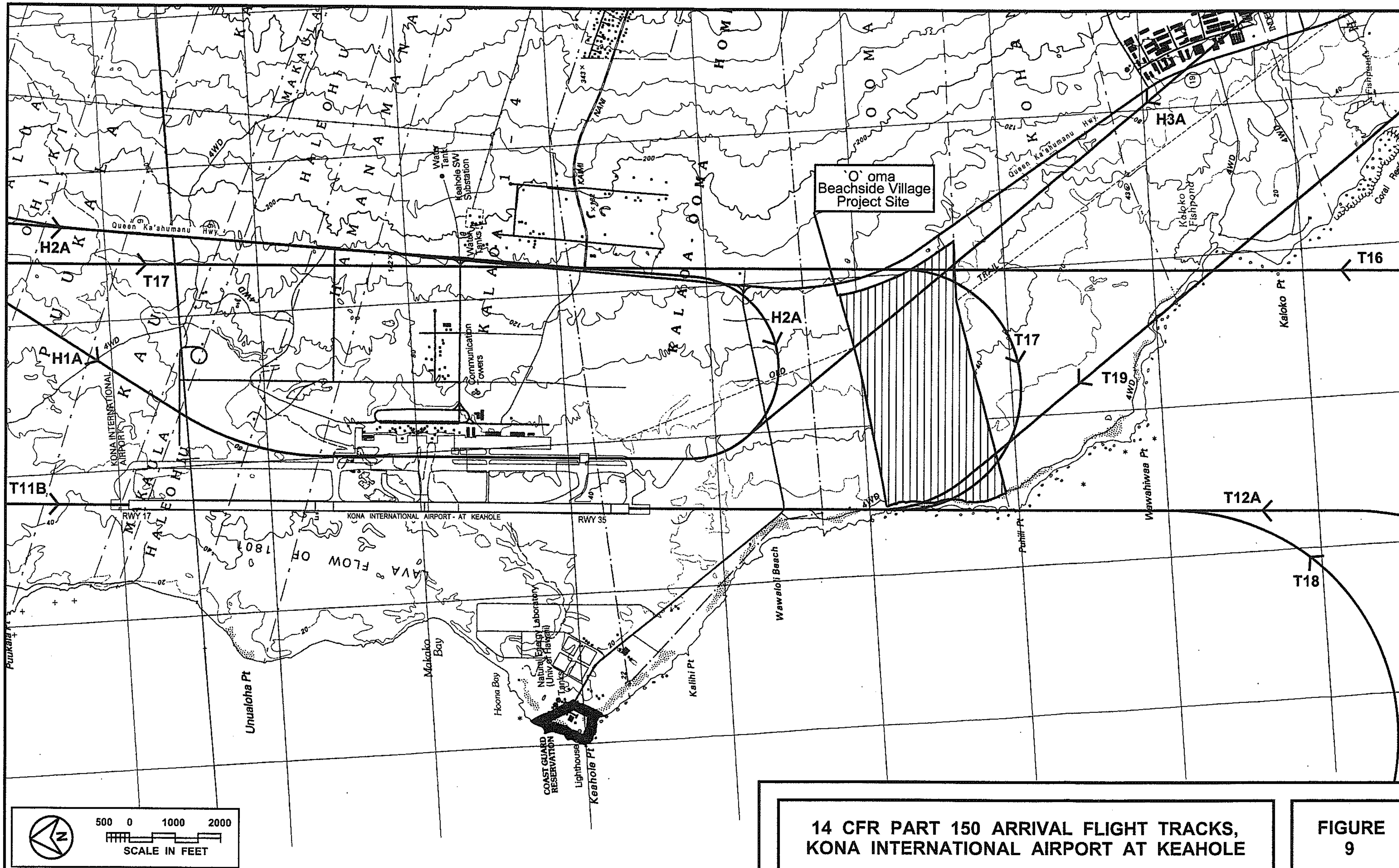
(2) See Tables 10 and 12 for traffic volume, speed, and mix assumptions.

(3) Setback distances are for unobstructed line-of-sight conditions.



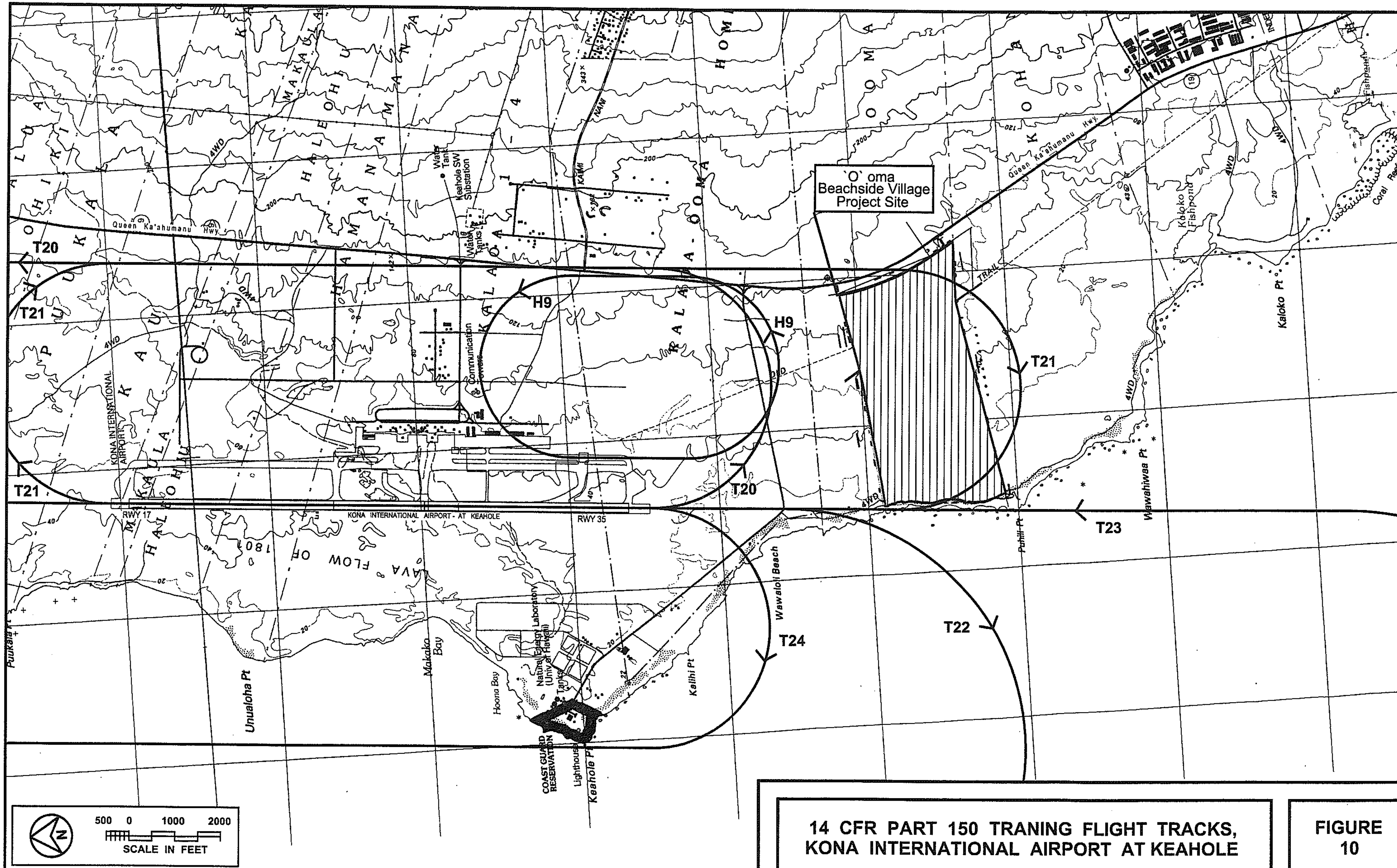
14 CFR PART 150 DEPARTURE FLIGHT TRACKS, KONA INTERNATIONAL AIRPORT AT KEAHOLE

FIGURE 8



14 CFR PART 150 ARRIVAL FLIGHT TRACKS, KONA INTERNATIONAL AIRPORT AT KEAHOLE

FIGURE 9



14 CFR PART 150 TRANING FLIGHT TRACKS, KONA INTERNATIONAL AIRPORT AT KEAHOLE

FIGURE 10

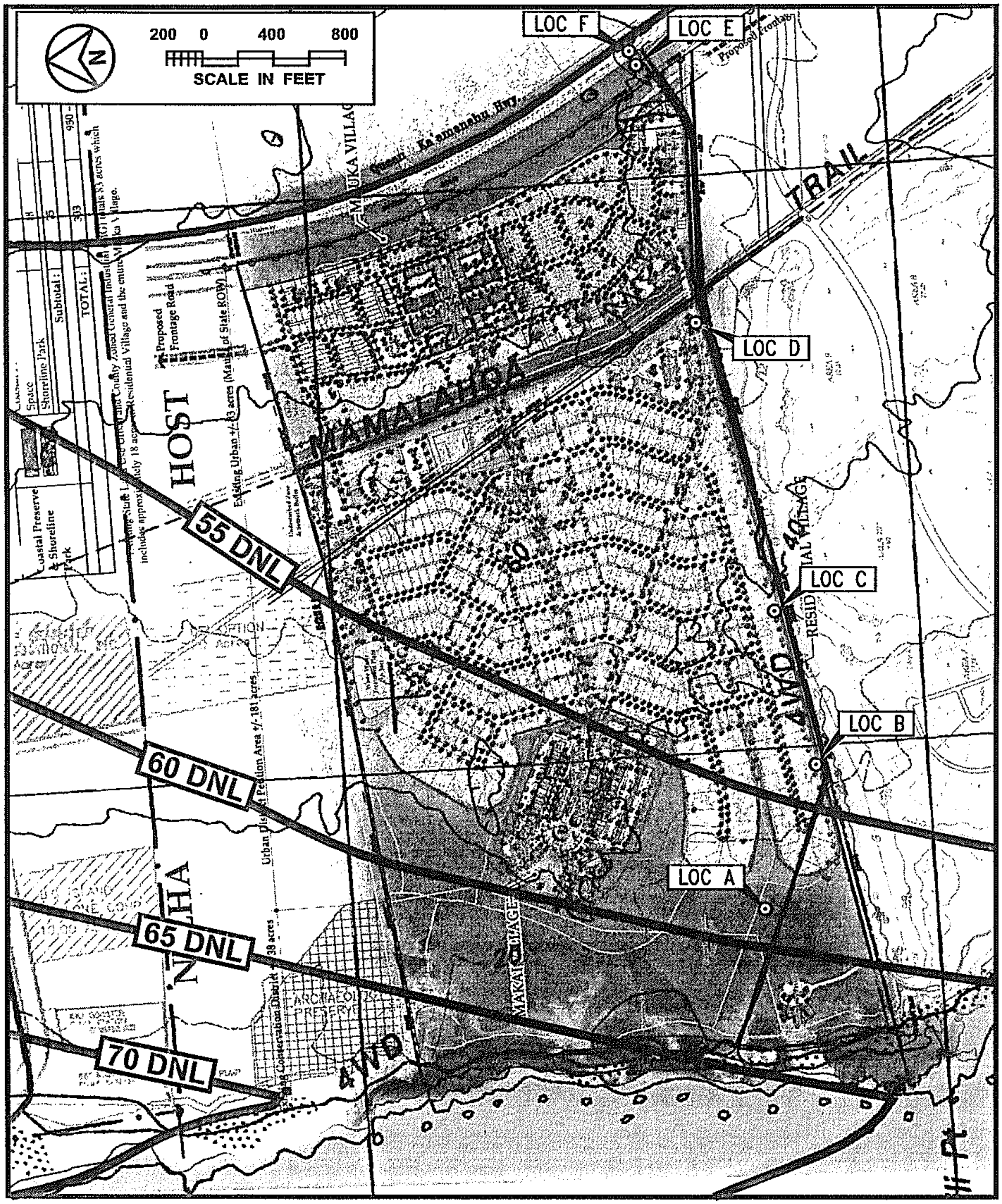
Because of their relatively low altitudes when crossing over the project site, the light fixed and rotary wing aircraft noise levels can be higher than those of the noisier jet aircraft which fly offshore. At measurement Location D, for instance, measured maximum A-Weighted (Lmax) noise levels of helicopter and single engine propeller aircraft overflights ranged from 60 to 83 dB, while the noise levels of offshore aircraft ranged from 60 to 82 dB.

Figure 11 depicts the estimated locations of the 55 through 65 DNL aircraft noise contours over the project site during the CY 2007 period. These noise contours were developed from the 2007/2008 airport operations contained in draft Table 3B of Reference 13. Only the noise from the noisier interisland, overseas, and military aircraft were included in the 2007 study noise contours, since the noise contributions from the general aviation and helicopter aircraft were not significant contributors to the noise contours. From Figure 11, aircraft noise levels over portions of the project site are above 60 DNL, and as such, place some constraints on any noise sensitive land uses on the western portions of the project site. The locations of the 2001 14 CFR Part 150 55 DNL and 60 DNL contours are shown in Figure 5, and their locations are similar to those of the 2007/2008 contours shown in Figure 11.

Figure 12 depicts the HDOTA's latest draft 14 CFR Part 150 Update noise contours for 2007/2008, which were reproduced from Reference 13. It should be noted that it is larger than the estimated study contours shown in Figure 11, and do not cross into the noise sensitive development areas of the `O`oma Beachside Village project site. The differences in the existing noise contour values at noise monitoring Location A between the study contours and the latest draft 14 CFR Part 150 contours are shown in Table 9A, and range from 2 to 3 DNL.

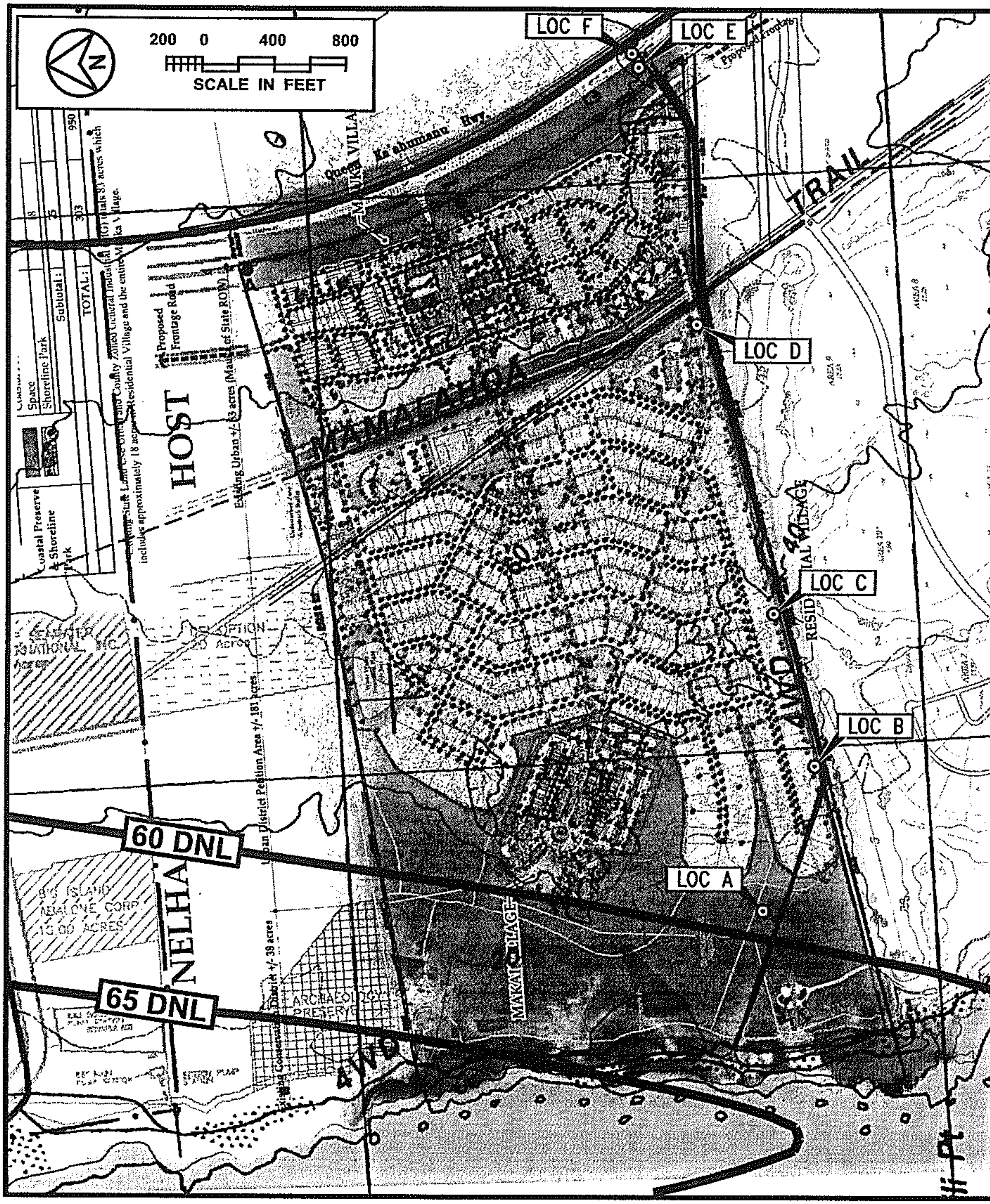
In order to validate the modeled aircraft noise levels over the western portions of the project site, measurements of aircraft noise levels were obtained during the period from March 19 to March 25, 2007. Tables 5 through 8 summarize the results of recent aircraft single event noise measurements on the project site. The locations of the aircraft noise measurement sites are shown in Figure 3. Maximum A-Weighted jet aircraft noise levels (Lmax) were typically between 60 to 88 dB at the aircraft noise measurement sites shown in Figure 3. For the purposes of comparison, typical maximum noise levels of heavy trucks are in the order of 80 to 85 dB at 50 FT distance.

Table 9A compares the measured DNL values (Line #1) at Locations "A" through "D" with those developed by the noise contour models in Figure 5 (Line #2), Figure 11 (Line #3a), and Figure 12 (Line #4). Agreement between the measured and computer model generated DNL values was considered to be good, and reinforced the conclusion that the planned noise sensitive areas of `O`oma Beachside Village are not located within the 60 DNL airport noise contour. The measured 55.8 DNL value shown for Location A represented the 6 day average of all aircraft flyby events which occurred during the monitoring period. Table 5 lists the louder aircraft noise events which occurred during the monitoring period. Based on the comparisons of the measured data with the computer modeled noise levels at Location A, it was concluded that both



ESTIMATED 2007/2008 AIRCRAFT NOISE CONTOURS OVER PROJECT SITE

FIGURE 11



HDOTA'S DRAFT 14 CFR PART 150 UPDATE NOISE CONTOURS FOR 2007/2008 OVER PROJECT SITE

FIGURE 12

this study's modeling results and the HDOTA's modeling results are probably overestimating the actual aircraft noise levels in the vicinity of Location A. These differences are approximately 2.4 DNL for this study's contour modeling, and 5.3 DNL for the HDOTA's modeling. These differences in noise modeling will probably carry forward in the noise modeling of the future noise levels by the FAA INM.

Unusually louder (by as much as 14 dB) aircraft noise events can occur during the nighttime and early morning hours due to thermal ducting effects. Examples of these aircraft noise events are engine thrust reversals during landings on Runways 17 or 35, and start-to-roll takeoff noise during departures on Runway 35. These noise events are typically inaudible during the daytime hours, but can be audible during the nighttime and early morning hours due to thermal ducting effects. An unusually loud noise event (at 70 to 71 dB), which was probably amplified by thermal ducting effects, was measured at Locations "A" and "B" during an early morning north flow departure of the noisier B-737(200) aircraft at 6:34 AM on March 24, 2007.

High, single event, aircraft noise levels over the coastal areas of the project site will occur during north wind conditions when aircraft land from the south onto the airport's Runway 35. Typical maximum noise levels from the noisier B-737(200) jet aircraft are expected to range from 75 to 80 dB. The newer, and quieter B-717(200) jet aircraft are typically quieter, and less than 75 dB. Noise levels from helicopters, fixed wing air taxi, and general aviation aircraft are generally less than 70 dB. Higher noise levels of helicopter and light fixed wing aircraft which exceed 70 dB are also possible during flyovers over the project site.

In the 1997 14 CFR Part 150 program for KOA, those noise sensitive land uses within the 60 DNL contour were considered to be exposed to incompatible levels of aircraft noise. The degree of adverse health and welfare impacts resulting from aircraft noise depends upon the sound attenuation properties of the structures containing the noise sensitive uses. For the purposes of this acoustical impact study, it was assumed that all noise sensitive properties can be considered to be adversely impacted by aircraft noise if they are located within the 60 DNL aircraft noise contour and if they are not specially treated to reduce interior noise levels to 45 DNL or less. Total closure and air conditioning is generally required for structures located within the 60 DNL contour in order to achieve the 45 DNL interior noise criteria.

As shown in Figures 5 and 11, the existing aircraft noise levels over the project site are generally compatible with the proposed land uses. Noise sensitive residential land uses are located outside the 60 DNL contour. By current HDOTA and 14 CFR Part 150 planning guidelines, sound attenuation treatment need not be incorporated into the planned residences of the project because of aircraft noise.

CHAPTER VI. FUTURE NOISE ENVIRONMENT

Traffic Noise. Predictions of future traffic noise levels were made using the traffic volume assignments of Reference 9 for CY 2029 with and without the proposed project. The future assignments of project plus non-project traffic along Queen Kaahumanu Highway, the planned makai Frontage Road, and the project's Entrance Road are shown in Table 12 for the AM and PM peak hours of traffic.

Table 11 summarizes the predicted increases in the future setback distances to the 65 and 75 DNL traffic noise contour lines along Queen Kaahumanu Highway in the project environs and attributable to both project plus non-project traffic in CY 2029. The setback distances in Table 11 do not include the beneficial effects of noise shielding from terrain features and highway cuts, or the detrimental effects of additive contributions of noise from intersecting streets. The setback distances in Table 11 for CY 2029 include the additive effects of the planned highway widening from 2 to 4 lanes. As shown in Table 11, the setback distance to the 65 DNL contour is predicted to be 218 FT from the new baseline of Queen Kaahumanu Highway following project build-out in CY 2029. Along the planned Frontage Road and project Entrance Road, future traffic noise levels are predicted to not exceed 65 DNL at distances of 22 to 50 FT from the roadways' centerlines. Posted and average vehicle speeds of 25 and 35 miles per hour, respectively, were assumed for the Frontage Road and project Entrance Road.

Table 13 presents the predicted increases in traffic noise levels associated with non-project and project traffic along Queen Kaahumanu Highway by CY 2029, and as measured by the Leq descriptor system. As indicated in Table 13, by CY 2029 and following complete project build-out, traffic noise levels on Queen Kaahumanu Highway in the areas fronting the project are predicted to increase by 3.0 to 3.8 Leq(h). This range of increases in traffic noise levels is considered to be moderate, and reflects the growth in forecasted project and non-project traffic in the project environs by CY 2029. As indicated in Table 13, the increases in traffic noise along Queen Kaahumanu Highway due to project traffic are relatively small when compared to those resulting from non-project traffic. Overall, the increases in noise levels associated with project traffic are considered to be insignificant along Queen Kaahumanu Highway. These conclusions apply to sections of Queen Kaahumanu Highway fronting the project as well as to those sections of the highway north and south of the project.

Aircraft Noise. The future aircraft noise contours for the CY 2013 period were developed using the aircraft operational forecasts of Reference 13, existing aircraft flight tracks for the existing runway, and assumed C-17 flight tracks for the new Austere Runway. Because information on the C-17 flight tracks for the new runway were not available from References 11 or 13, and because of the special spiral approach flight tracks mentioned in Reference 11, the C-17 flight tracks assumed for the new runway may not be accurate. However, for noise modeling purposes, the special spiral flight tracks should not result in significant contributions to the aircraft noise contours since

TABLE 12

FUTURE (CY 2029) TRAFFIC VOLUMES AND NOISE LEVELS ALONG VARIOUS ROADWAY SECTIONS (AM AND PM PEAK HOURS, WITH PROJECT)

LOCATION	SPEED (MPH)	TOTAL VPH	********* VOLUMES (VPH) ********** AUTOS	M TRUCKS	H TRUCKS	** Leq(h) @ Dist. from B.L. ** 85' Leq	150' Leq	300' Leq
AM Peak Hour:								
Q. Kaahumanu Hwy. - N. of Entrance Rd.	55	3,530	3,364	74	92	75.7	68.1	60.5
Q. Kaahumanu Hwy. - S. of Entrance Rd.	55	3,575	3,407	75	93	75.8	68.1	60.5
PM Peak Hour:								
Q. Kaahumanu Hwy. - N. of Entrance Rd.	55	3,950	3,879	43	28	75.5	67.7	59.7
Q. Kaahumanu Hwy. - S. of Entrance Rd.	55	3,900	3,830	43	27	75.5	67.7	59.7
						** Leq(h) @ Dist. from B.L. ** 25' Leq	50' Leq	100' Leq
AM Peak Hour:								
Project Entrance Rd. At Q. Kaahumanu	35	435	427	5	3	63.8	60.3	54.8
Frontage Rd. North of Proj. Entrance Rd.	35	380	373	4	3	63.3	59.7	54.2
Frontage Rd. South of Proj. Entrance Rd.	35	335	329	4	2	62.6	59.0	53.6
Project Entrance Rd. W. of Frontage Rd.	35	1,040	1,022	11	7	67.6	64.0	58.5
PM Peak Hour:								
Project Entrance Rd. At Q. Kaahumanu	35	530	520	6	4	64.7	61.1	55.7
Frontage Rd. North of Proj. Entrance Rd.	35	385	378	4	3	63.3	59.7	54.3
Frontage Rd. South of Proj. Entrance Rd.	35	430	422	5	3	63.8	60.2	54.7
Project Entrance Rd. W. of Frontage Rd.	35	965	947	11	7	67.3	63.7	58.2

Notes:

1. Traffic mix during AM Peak Hour on Queen Kaahumanu Hwy.: 95.3% Autos; 2.1% Medium Trucks; and 2.6% Heavy Trucks and Buses.
2. Traffic mix during PM Peak Hour on Queen Kaahumanu Hwy.: 98.2% Autos; 1.1% Medium Trucks; and 0.7% Heavy Trucks and Buses.
3. Traffic mix on Project Entrance and Frontage Road: 98.2% Autos; 1.1% Medium Trucks; and 0.7% Heavy Trucks and Buses.
4. Loose Soil propagation loss factor used.
5. Receptor elevation of 4.92 feet above ground level was assumed.
6. Queen Kaahumanu Highway widened from two to four lanes by 2029.

TABLE 13

CALCULATIONS OF PROJECT AND NON-PROJECT TRAFFIC NOISE CONTRIBUTIONS (CY 2029) (AM AND PM PEAK HOURS)

STREET SECTION	NOISE LEVEL (DB) INCREASE DUE TO: NON-PROJECT TRAFFIC	PROJECT TRAFFIC
AM Peak Hour:		
Q. Kaahumanu Hwy. - N. of Entrance Rd.	2.6	0.4
Q. Kaahumanu Hwy. - S. of Entrance Rd.	2.6	0.4
Q. Kaahumanu Hwy. - N. of Kaiminani Dr.	3.3	0.6
Q. Kaahumanu Hwy. - S. of Kohanaiki	2.8	0.7
PM Peak Hour:		
Q. Kaahumanu Hwy. - N. of Entrance Rd.	3.5	0.3
Q. Kaahumanu Hwy. - S. of Entrance Rd.	3.5	0.2
Q. Kaahumanu Hwy. - N. of Kaiminani Dr.	3.9	0.5
Q. Kaahumanu Hwy. - S. of Kohanaiki	3.0	0.6

they are expected to occur at much larger distances from the ground than the final approach tracks prior to landing.

The future aircraft flight tracks near and over the project site for operations using the existing runway are expected to be similar to the existing flight tracks shown in Figures 8 through 10. Figures 13 and 14 depict the departure and arrival flight tracks, respectively, assumed for the C-17 operations on the proposed new runway. Touch and Go flight tracks T22 and T23 on the existing Runway 17/35 and shown in Figure 10 were assumed for the C-17 military aircraft.

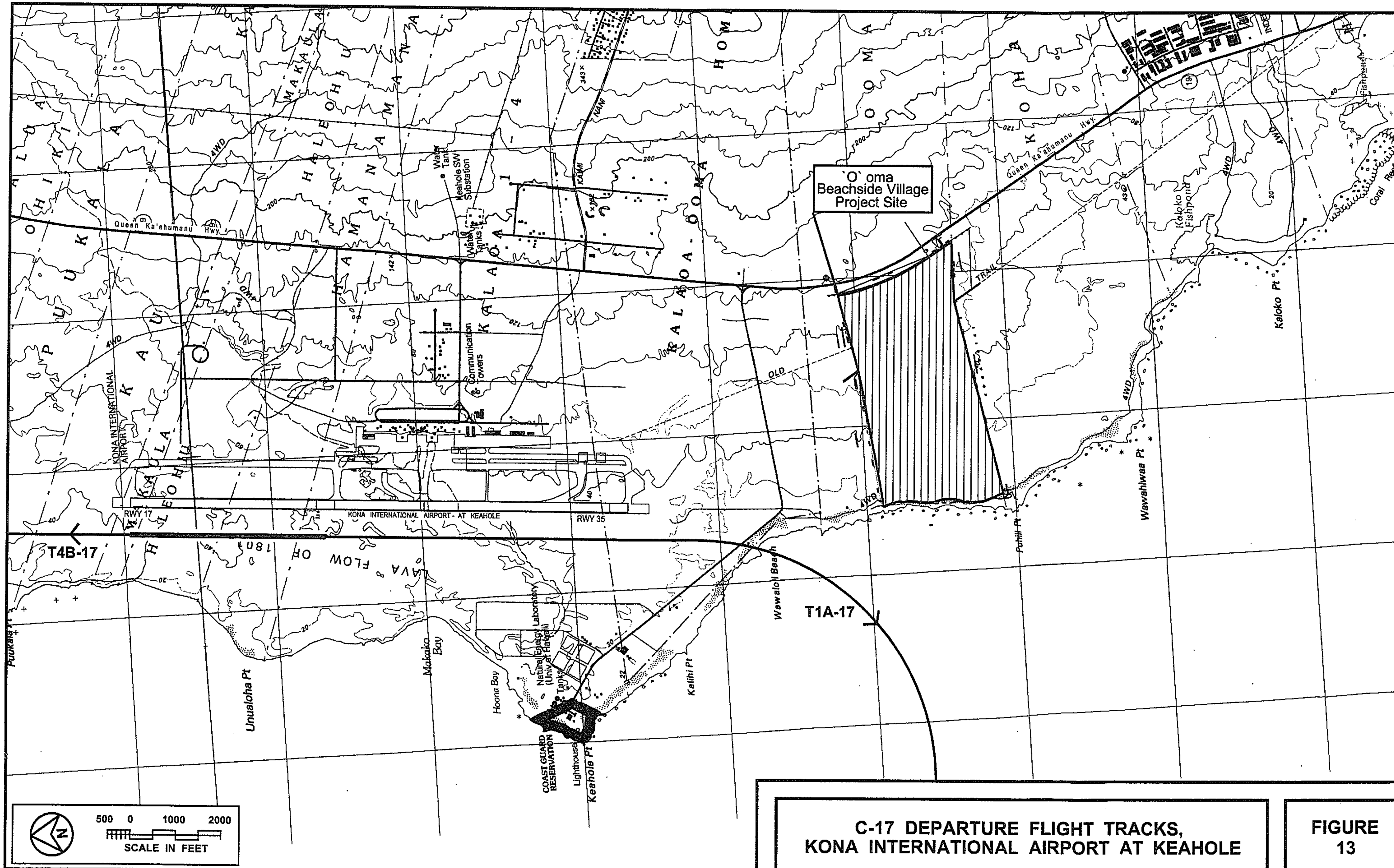
The proposed C-17 operations at KOA were estimated from information provided in the 2004 Environmental Assessment for the site selection of the C-17 Short Austere Airfield, which recommended KOA as the preferred airport (Reference 11). An additional parallel and shorter (4,250 feet long x 90 feet wide) runway is proposed for construction makai of and at the north end of the existing airfield where shown in Figure 6. In addition, forecasts of C-17 operations at KOA with and without the new runway were obtained from Reference 13.

Figure 15 and Line #5a of Table 9B depict this study's estimated 2013 DNL contours and levels associated with the assumed C-17 operations at KOA, which were modeled using the following assumptions:

- 92 landings and 92 takeoffs per month on the new 4,250' runway;
- 92 landings and 92 takeoffs per month on the existing runway;
- 480 landings and 480 takeoffs (touch and go operations) per month on the existing runway; and
- 41 nighttime operations per month during the DNL noise penalty hours from 10:00 PM to 7:00 AM.

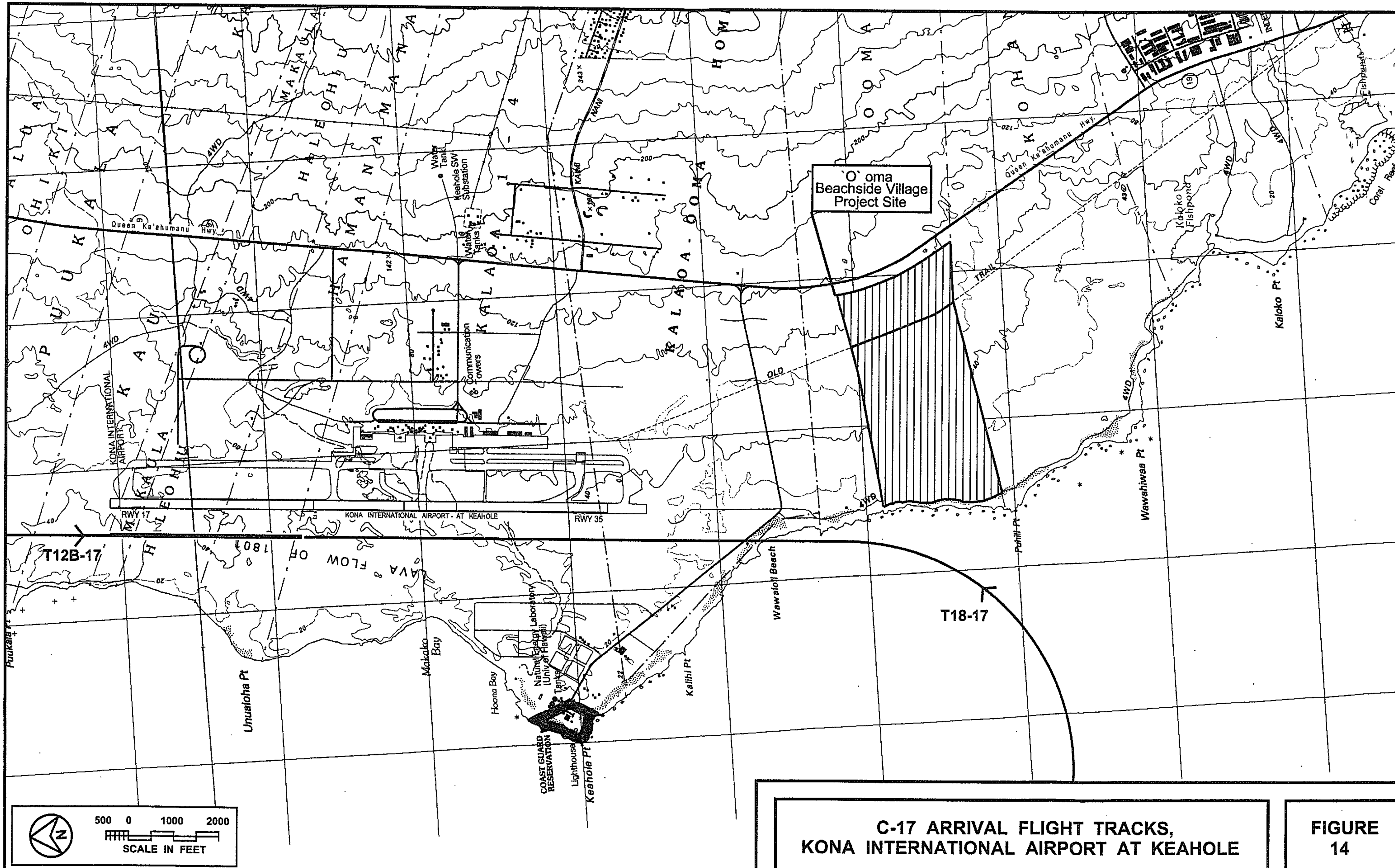
The 480 touch and go operations per month on the existing runway represent worst case assumptions for C-17 noise levels over the `O`oma Beachside Village project site. Figure 15 and Line #5a of Table 9B also include forecast operations of the new F-22A and P-8A aircraft, with the P-8A aircraft operations replacing the P-3C operations on a one-for- one basis. As shown in Figure 15, the 60 DNL contour is expected to remain outside the noise sensitive development area of `O`oma Beachside Village. It should be noted that the noise monitoring data shown in Table 9A indicates that the study's 2007/2008 noise contours of Figure 15 may be overstating actual aircraft noise levels at Location A by 2 DNL units.

Figure 16 and Line #6 of Table 9B depict the HDOTA's latest draft 14 CFR Part 150 Update noise contours for 2013, which were reproduced from Reference 13. It should be noted that it is larger than the estimated study contours shown in Figure 15



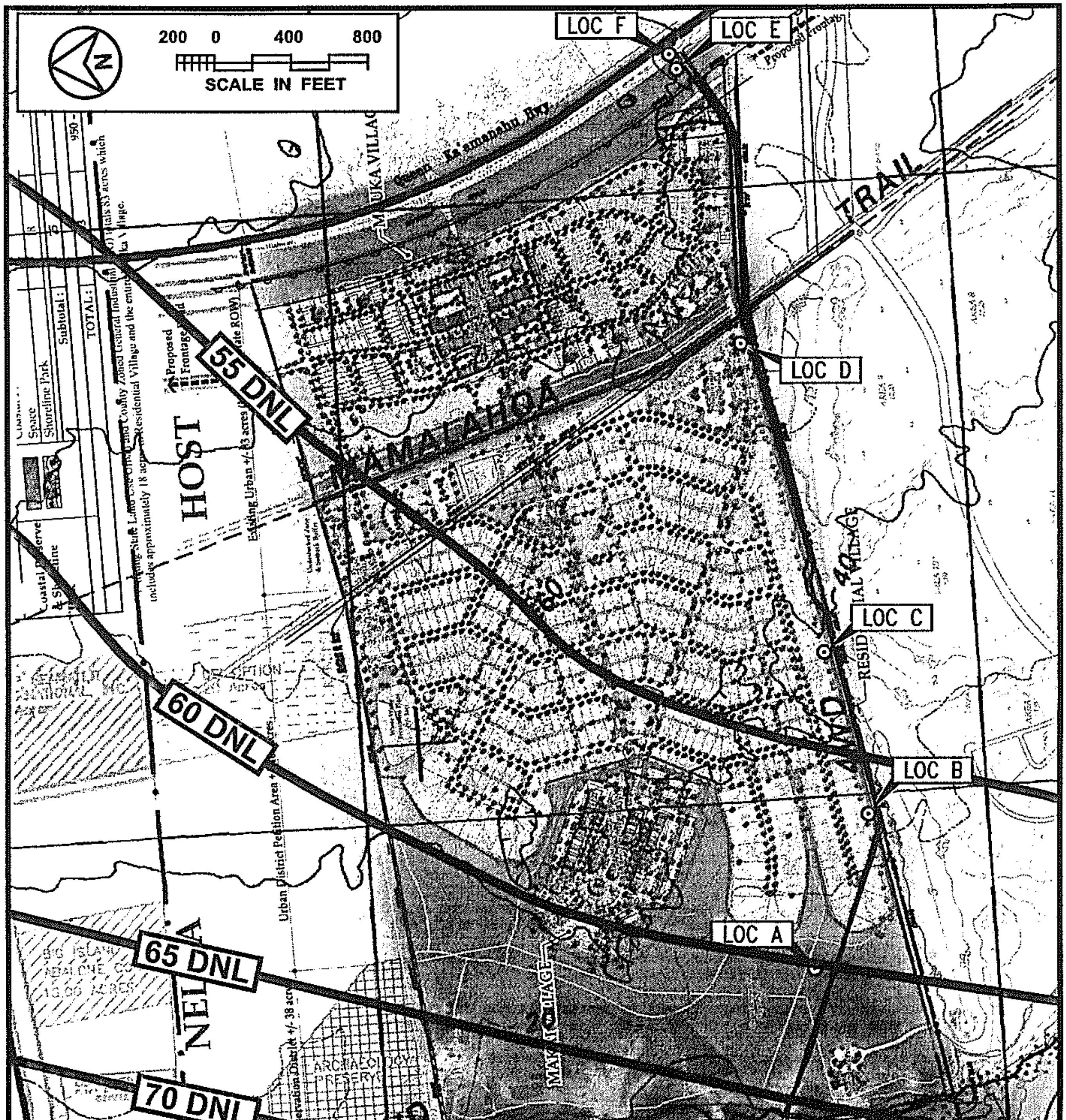
C-17 DEPARTURE FLIGHT TRACKS, KONA INTERNATIONAL AIRPORT AT KEAHOLE

FIGURE 13



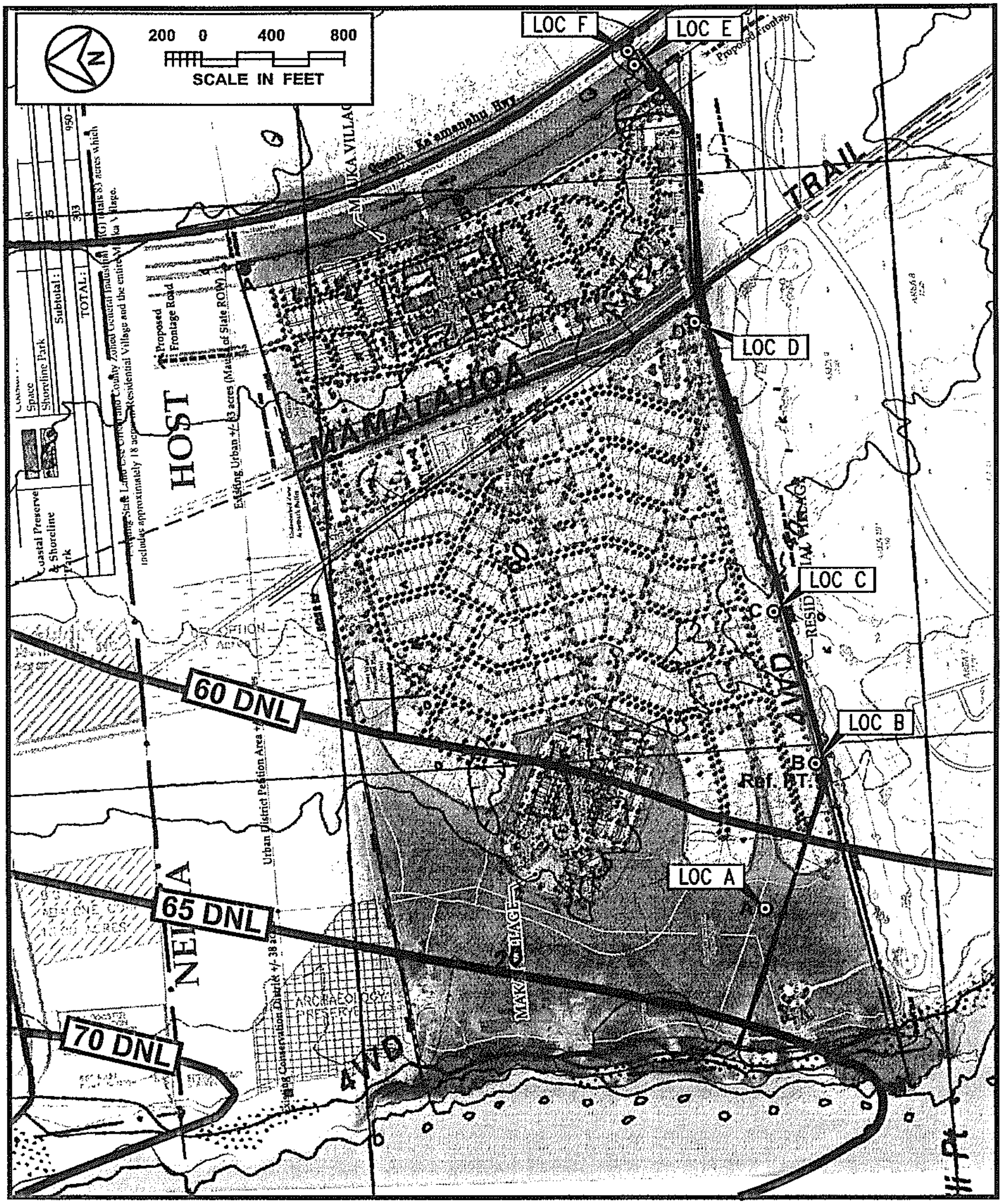
C-17 ARRIVAL FLIGHT TRACKS, KONA INTERNATIONAL AIRPORT AT KEAHOLE

FIGURE 14



LOCATIONS OF CY 2013 ESTIMATED STUDY CONTOURS

FIGURE 15



HDOTA'S DRAFT 14 CFR PART 150 UPDATE NOISE CONTOURS FOR 2013 OVER PROJECT SITE

FIGURE 16

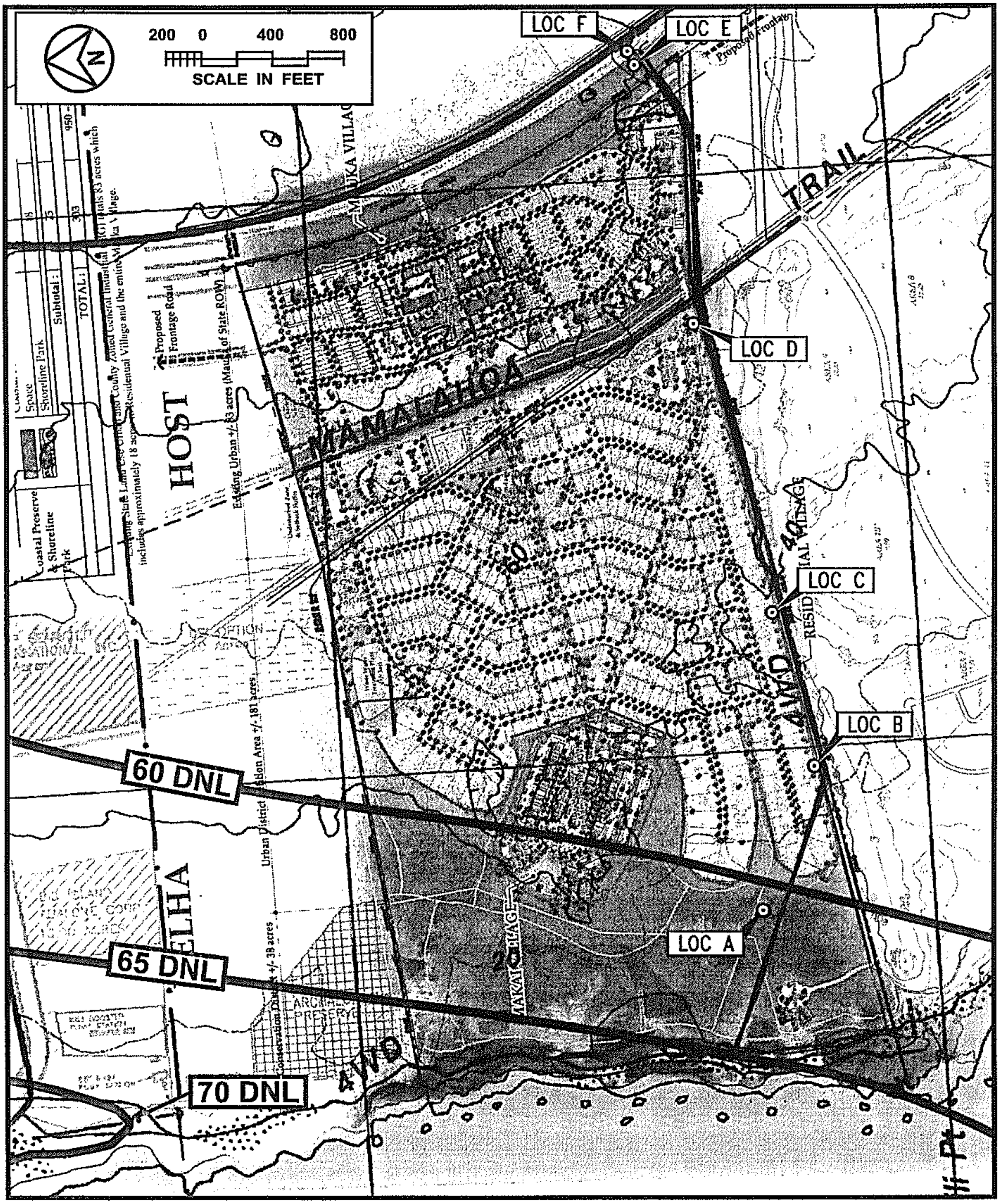
by approximately 2 DNL units, and do cross into the noise sensitive development areas of the `O`oma Beachside Village site. It should be noted, however, that the noise monitoring data shown in Table 9A indicates that the HDOTA's 2007/2008 noise contours may be overstating actual aircraft noise levels at Location A by 5 DNL units.

The future aircraft noise contours in the project environs for the CY 2020 period were developed in 1997 during the prior Master Plan and 14 CFR Part 150 Study Updates for KOA. These airport noise contours are shown in Figure 7, with DNL values at measurement Locations "A" through "D" shown on Line #7 of Table 9B. They do not include the C-17, F-22A, or P-8A operations. These noise contours may still overstate the forecasted aircraft noise levels since they do not include the 100 percent replacement of the noisier DC-9(50) aircraft with the quieter B-717(200) aircraft by Hawaiian Airlines. In addition, the anticipated replacement of all of the noisier B-737(200) aircraft with quieter aircraft by 2020 would also reduce the size of the contours shown in Figure 7. It should be noted that the forecasted 2020 noise contours of Figure 7 were very similar to the 2001 contours shown in Figure 5.

The 2020 noise contours are in the process of being updated by the HDOTA, with the updated contours scheduled for completion within 1 year. Figure 17 is a draft of the 2030 noise contours for KOA from Reference 13, with estimated DNL value shown on Line #8 of Table 9B. The planned noise sensitive developments of `O`ma Beachside Village appear to be clear of the 60 DNL contour except for a few lots in the vicinity of Location A. Figure 18 depicts this study's estimated 2030 noise contours over the project site, which was developed from aircraft operations forecast contained in Reference 13. All aircraft flight tracks were assumed to be identical to those assumed for 2013. Line #9 of Table 9B presents this study's DNL values for 2030 at measurement Locations A through D.

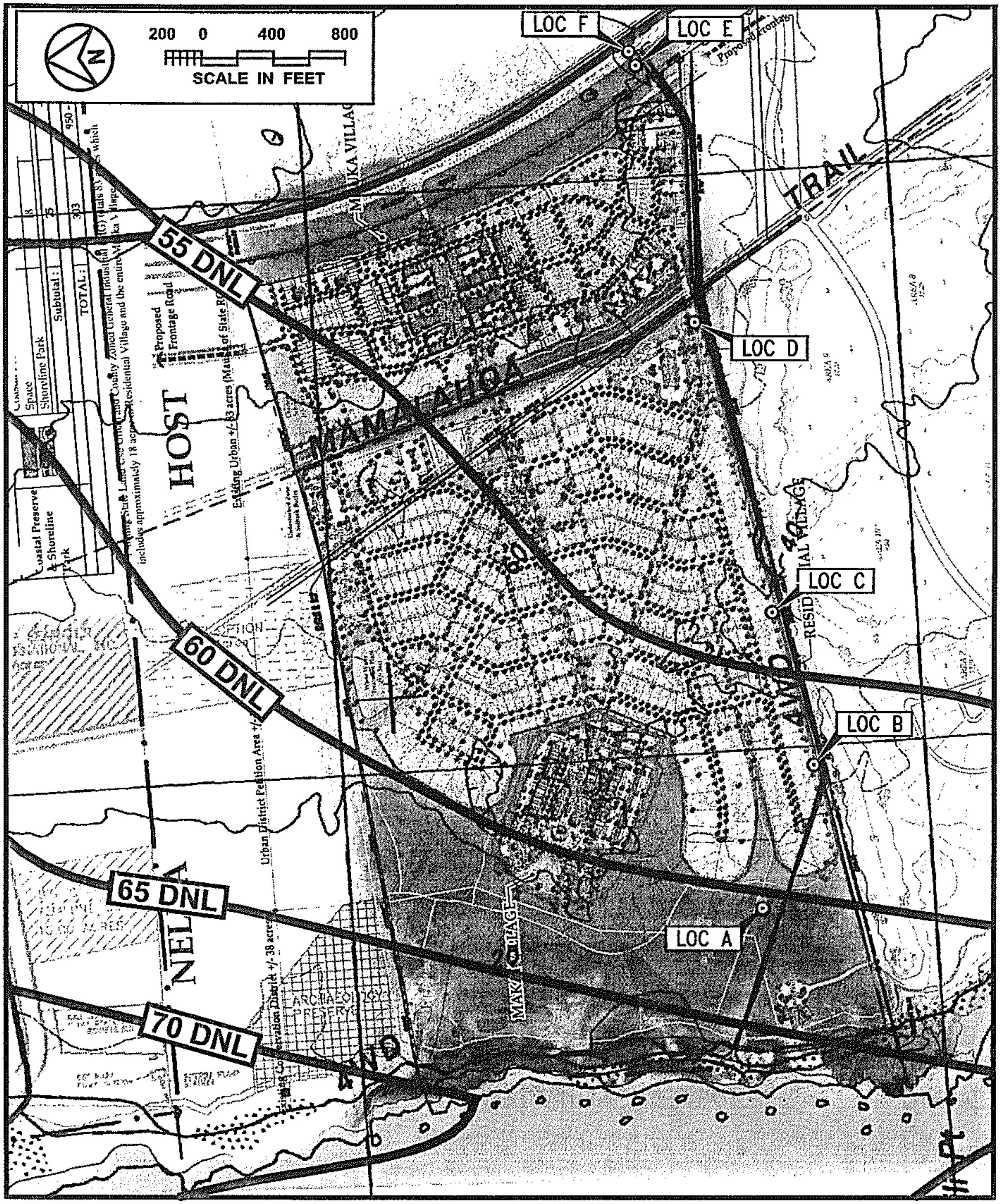
Measurements of C-17 flyby events at Location "A" (see Table 5), Location "B" (see Table 6), and Location "C" (see Table 7) indicate that it is 4 to 6 dB quieter during departures than the B-737(200), 2 to 4 dB noisier than the B-757/B-767 and KC-135R, 4 to 12 dB noisier than the B-717(200) and CRJ 200, and 8 to 9 dB noisier than the P-3C. So, in summary, the C-17 may not be noisiest aircraft operating at KOA and the DNL contours over the `O`oma Beachside Village project site did not increase significantly following inception of C-17 operations at KOA. No noise measurement data were available for the F-22A aircraft, which is similar to the F-15 during departure but approximately 20 dBA noisier during landing. The base conditions for the noise sensitive receptor on the `O`oma Beachside Village project site will worsen in the future in respect to the increased number of audible flyby events, and the greater number of these audible flyby events which occur during the hours of darkness. This will become more significant in 2030 if the noisier B-737(200) are replaced with quieter Stage 3 aircraft, and the C-17 and F-22A may then be included with the noisiest aircraft operating at KOA.

The current forecasts for aircraft noise over the project site indicate that the 60



HDOTA'S DRAFT MASTER PLAN UPDATE NOISE CONTOURS FOR 2030 OVER PROJECT SITE

FIGURE 17



LOCATIONS OF CY 2030 ESTIMATED STUDY CONTOURS	FIGURE 18

DNL contour will not extend into the proposed residential areas of the project site by CY 2030 (see Figures 6, 7, 15, and 18). The draft HDOTA contours (Figures 16 and 17) indicate that the 60 DNL contour crosses into the planned noise sensitive areas of `O`oma Beachside Village. However, the aircraft noise measurement data on the project site indicates that the HDOTA's draft noise contours are overstating the actual noise levels over the project site. Therefore, unless significant changes occur in the operational activity and HDOTA forecasts for KOA, the proposed `O`oma Beachside Village project is expected to be compatible with the aircraft noise levels associated with operations at KOA.

The HDOTA's future noise contours may change as the 14 CFR Part 150 Update Report is finalized because of issues related to the assumed aircraft flight tracks, the nighttime runway use frequencies, the proposed austere runway for the C-17, and the forecast methodology used for military operations.

CHAPTER VII. DISCUSSION OF PROJECT RELATED NOISE IMPACTS AND POSSIBLE NOISE MITIGATION MEASURES

Traffic Noise. The increases in traffic noise levels attributable to the project from the present to CY 2029 are predicted to range from 0.2 to 0.7 DNL along Queen Kaahumanu Highway, where traffic noise levels are expected to be above 65 DNL along the highway Right-of-Way. These increases in traffic noise levels along Queen Kaahumanu Highway which are attributable to the project are considered to be in the insignificant category, and are much smaller than the traffic noise increases expected as a result of non-project traffic. These increases will be difficult to measure or perceive over the duration of the 23 year forecast period. In addition, the lands along the highway Right-of-Way are generally vacant in the project environs. For these reasons, traffic noise impacts along Queen Kaahumanu Highway and resulting from project traffic are not considered to be serious. However, setback distances to the 65 DNL contour are expected to increase as a result of both project and non-project traffic.

Because of the relatively high noise levels along Queen Kaahumanu Highway and the planned widening of the highway toward the makai direction, a 150 foot wide buffer is planned for `O`oma Beachside Village. This buffer will be an effective traffic noise mitigation measure, and will keep future traffic noise levels from exceeding the 65 DNL FHA/HUD noise standard in 2029. Predicted traffic noise levels in 2029 along the first row of project structures fronting the highway are expected to range from approximately 60 DNL for ground level receptors to approximately 59 to 63 DNL for 2nd and 3rd floor receptors. Closure and air conditioning of the structures is a typical means of sound attenuation for traffic noise, and particularly at the upper floors, which are difficult to sound attenuate with berms or exterior sound walls. The first row of structures will provide 5 to 10 dB of sound attenuation for receptors along the second row and beyond, as long as they block the visual lines of sight between the highway lanes and the receptors' ears.

Traffic noise levels along the makai Frontage Road could exceed the FHA/HUD standard of 65 DNL. Setback distances to the 65 DNL traffic noise contour are predicted to be between 22 and 24 FT from the centerline of the Frontage Road in the vicinity of the `O`oma Beachside Village entrance road from Queen Kaahumanu Highway. Future traffic noise mitigation measures may be required at noise sensitive dwellings along the Frontage Road.

Because traffic noise along public roadways such as Queen Kaahumanu Highway are generated by non-project as well as project traffic, mitigation of offsite traffic noise impacts are generally performed by individual property owners along the roadways' Rights-of-Way or by public agencies during roadway improvement projects. These mitigation measures generally take the form of increased setbacks, sound attenuating walls, total closure and air conditioning, or the use of sound attenuating windows. Where adequate setbacks beyond the 65 DNL noise contour are not available, the construction of 6 FT high sound walls is generally effective for attenuating traffic noise at single story structures, or at the ground floors of multistory structures.

Whenever mitigation of traffic noise at the upper floors are required, the use of closure and air conditioning, or the use of sound attenuating windows are the more appropriate sound attenuation measures.

Aircraft Noise. Based on existing and forecasted aircraft noise contours (when adjusted for measured aircraft noise levels) over the project site, special aircraft noise attenuation measures are not considered mandatory on the project site. The implementation of the airport noise disclosure provisions of Reference 5 will be required because the existing and forecasted 14 CFR Part 150 noise contours do enter into the project area.

The siting of future noise sensitive developments within the 60 DNL airport noise contour is not recommended by HDOTA. Residences, schools, churches, health centers, day-care centers, and hotels are included within the noise sensitive land use category. The rationale for selection of the 60 DNL threshold is more fully discussed in Reference 7. By the rationale expressed in the current 14 CFR Part 150 study update (Reference 13), HDOTA has shifted its 14 CFR Part 150 aircraft noise mitigation threshold upward to 65 DNL, while retaining its prior recommendation for noise sensitive development outside the 60 DNL contour. Therefore, the HDOTA is essentially applying a double noise standard, which is 5 DNL units more stringent for the land side community (such as the `O`oma Beachside Village project) than it is for the air side community (such as the airport proprietor).

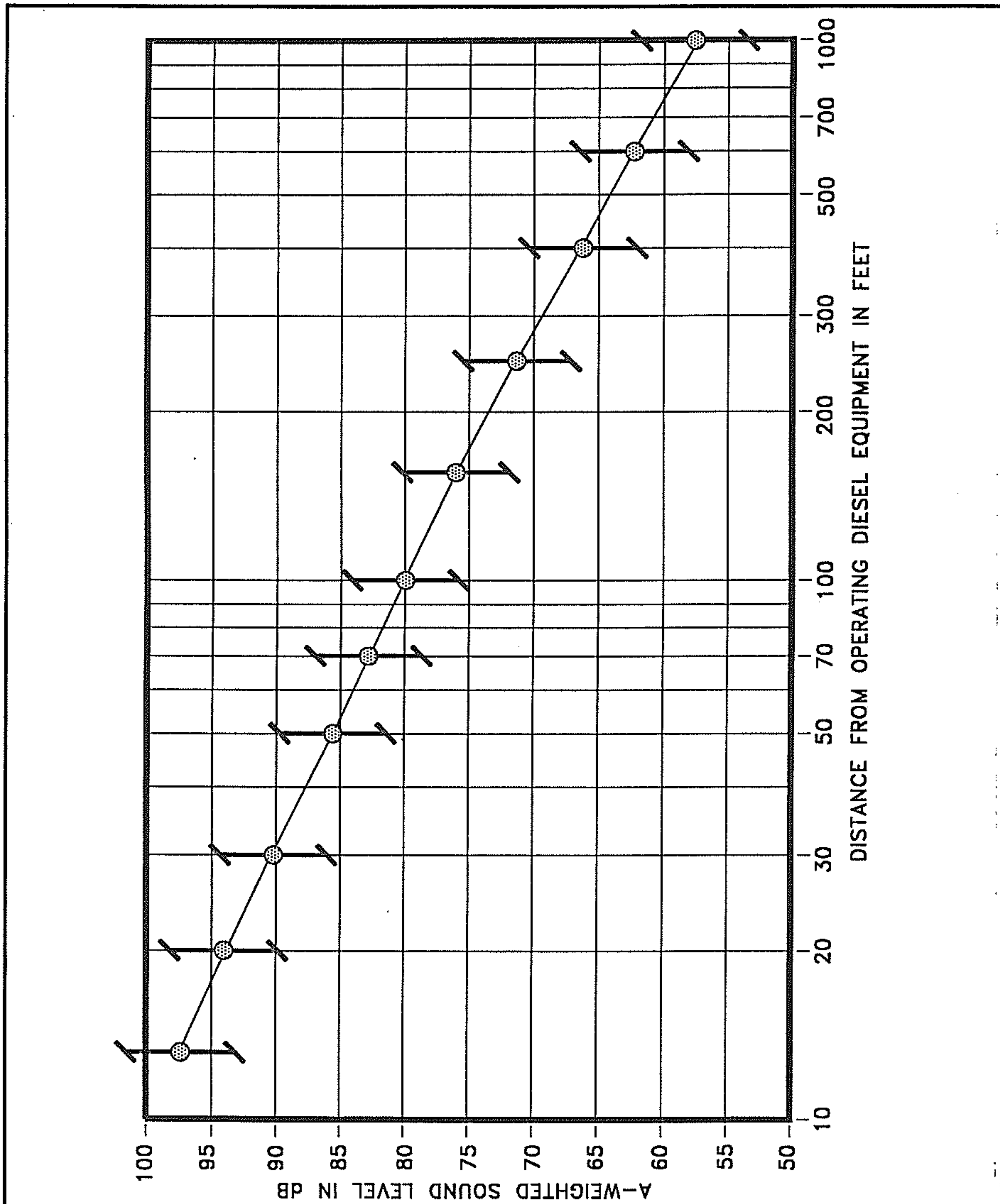
The siting of commercial uses within the 60 DNL contour is acceptable, since closure and air conditioning of commercial spaces is the rule rather than an exception. The siting of recreational uses within the 60 DNL contour is also acceptable. The siting of these types of uses within the high noise areas around an airport is usually encouraged, since it tends to preclude future development of noise sensitive uses on the same lands.

By siting planned noise sensitive uses outside the existing and forecasted 60 DNL noise contours for KOA, risks of adverse aircraft noise impacts have been reduced to acceptable levels. The noise contour disclosure provisions of Reference 5 must be applied over all project lands which are located within the aircraft noise contours developed by HDOTA during a 14 CFR Part 150 Noise Compatibility Program. Currently, and until they are officially updated, the 2001 contours (see Figure 5) are the applicable noise contours for disclosure purposes in accordance with Reference 5. Because the draft 14 CFR Part 150 noise contours (see Figure 16) do not include the outermost 55 DNL contour, the lands subject to aircraft noise disclosure will be less than those shown in the 2001 contours (see Figure 5).

Combined Traffic and Aircraft Noise. When applying for FHA/HUD financial assistance on residential developments, sound attenuation measures are normally required if total exterior noise levels exceed 65 DNL. Traffic noise levels may exceed 65 DNL along the highway corridors and major thoroughfares which service the project. If the traffic noise level equals 65 DNL and the aircraft noise level equals 60 DNL at a project dwelling, the total noise level will be 66 DNL, which exceeds the FHA/HUD standard of 65 DNL. However, existing and forecasted aircraft noise levels over the project site should not exceed 60 DNL. Under these more favorable conditions with aircraft noise levels less than 60 DNL, combined traffic and aircraft noise levels should not exceed 65 DNL when traffic noise levels are less than 63.3 DNL. With aircraft noise levels less than 55 DNL, combined traffic and aircraft noise levels should not exceed 65 DNL when traffic noise levels are less than 64.5 DNL. At the first row of structures fronting Queen Kaahumanu Highway, where predicted future traffic noise levels do not exceed 63 DNL, the combined traffic and aircraft noise levels will not exceed 65 DNL as long as the aircraft noise level at these front row structures does not exceed 60.7 DNL. As shown in Figures 11, 15, and 18, the aircraft noise level at these front row structures does not exceed 60.7 DNL, so the combined traffic plus aircraft noise levels should not exceed the 65 DNL FHA/HUD standard along the first row of homes which front Queen Kaahumanu Highway.

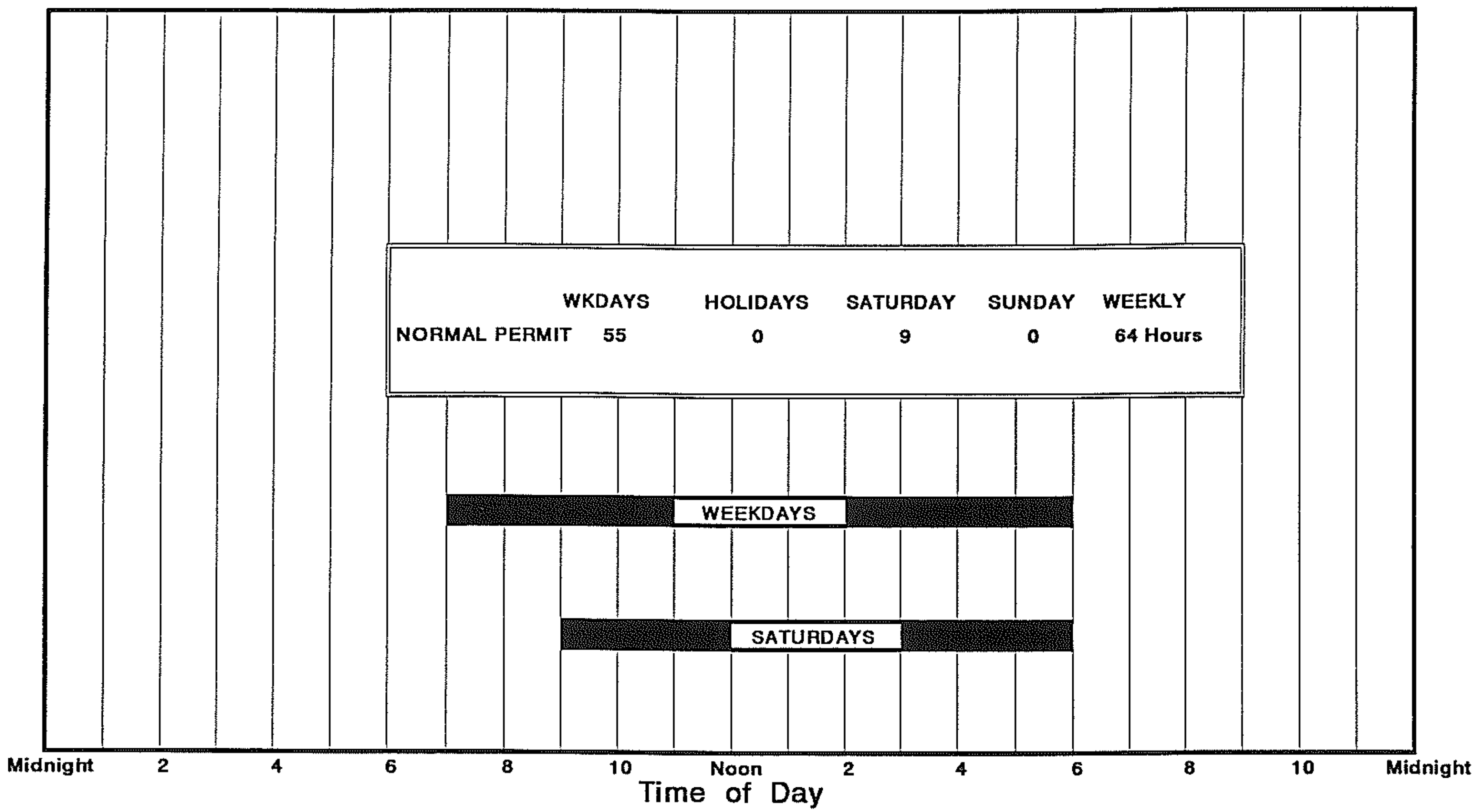
Construction Noise. Audible construction noise will probably be unavoidable during the entire project construction period. It is anticipated that the actual work will be moving from one location on the project site to another during the construction period. Actual length of exposure to construction noise at any receptor location will probably be less than the total construction period for the entire project. Typical levels of noise from construction activity (excluding pile driving activity) are shown in Figure 19. The noise sensitive properties which are predicted to experience the highest noise levels during construction activities on the project site are the future residences south of the project site. Adverse impacts from construction noise are not expected to be in the "public health and welfare" category due to the temporary nature of the work and due to the administrative controls available for its regulation. Instead, these impacts will probably be limited to the temporary degradation of the quality of the acoustic environment in the immediate vicinity of the project site.

Mitigation of construction noise to inaudible levels will not be practical in all cases due to the intensity of construction noise sources (80 to 90+ dB at 50 FT distance), and due to the exterior nature of the work (grading and earth moving, trenching, concrete pouring, hammering, etc.). The use of properly muffled construction equipment should be required on the job site. The incorporation of State Department of Health construction noise limits and curfew times, which are applicable on the island of Hawaii (Reference 6), is another noise mitigation measure which will be applied to this project. Figure 20 depicts the normally permitted hours of construction for normal construction noise as well as the curfew periods for construction noise. Noisy construction activities are not allowed on Sundays and holidays under the DOH permit procedures.



ANTICIPATED RANGE OF CONSTRUCTION NOISE LEVELS VS. DISTANCE

FIGURE 19



AVAILABLE WORK HOURS UNDER DOH PERMIT PROCEDURES FOR CONSTRUCTION NOISE

FIGURE 20

APPENDIX A. REFERENCES

(1) "Guidelines for Considering Noise in Land Use Planning and Control;" Federal Interagency Committee on Urban Noise; June 1980.

(2) American National Standard, "Sound Level Descriptors for Determination of Compatible Land Use," ANSI S12.9-1998/ Part 5; Acoustical Society of America.

(3) "Environmental Criteria and Standards, Noise Abatement and Control, 24 CFR, Part 51, Subpart B;" U.S. Department of Housing and Urban Development; July 12, 1979.

(4) "Information on Levels of Environmental Noise Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety;" U.S. Environmental Protection Agency; EPA 550/9-74- 004; March 1974.

(5) "Mandatory Seller Disclosures in Real Estate Transactions;" Chapter 508D, Hawaii Revised Statutes; July 1, 1996.

(6) "Title 11, Administrative Rules, Chapter 46, Community Noise Control;" Hawaii State Department of Health; September 23, 1996.

(7) "FAR Part 150 Noise Compatibility Program Report; Kona International Airport At Keahole" State Department of Transportation, Airports Division; December 1997.

(8) "FHWA Highway Traffic Noise Model User's Guide;" FHWA-PD-96-009, Federal Highway Administration; Washington, D.C.; January 1998 and Version 2.5 Upgrade (April 14, 2004).

(9) "Draft Traffic Impact Analysis Report; O`oma Beachside Village;" M & E Pacific, Inc.; April 2008.

(10) 24-Hour Traffic Counts, Station B71001909280, Queen Kaahumanu Highway Between OTEC Access Road and Hulikoa Street at 95 Milepost; State Department of Transportation; May 30, 2006.

(11) "Final Environmental Assessment for the C-17 Short Austere Airfield, Hickam Air Force Base, Hawaii;" Department of the Air Force, USA; October 2004.

(12) "Environmental Assessment for the Replacement of F-15 Aircraft with F-22A Aircraft, Hickam AFB, Hawaii; Hawaii Air National Guard; September 2007.

(13) Drafts of 14 CFR Part 150 Noise Compatibility Study Update, KOA; Hawaii State Department of Transportation, Airports Division; July 2007 to March 2008.

APPENDIX A. REFERENCES (CONTINUED)

(14) July 19, 2007 letter to Hawaii State Department of Transportation, Airports Division from Y. Ebisu & Associates requesting copy of draft INM 7.0 modeling input file for KOA 2007.

(15) August 10, 2007 letter to Hawaii State Department of Transportation, Airports Division from Y. Ebisu & Associates with critiques of Draft 14 CFR Part 150 noise study report for KOA.

APPENDIX B

EXCERPTS FROM EPA'S ACOUSTIC TERMINOLOGY GUIDE

Descriptor Symbol Usage

The recommended symbols for the commonly used acoustic descriptors based on A-weighting are contained in Table I. As most acoustic criteria and standards used by EPA are derived from the A-weighted sound level, almost all descriptor symbol usage guidance is contained in Table I.

Since acoustic nomenclature includes weighting networks other than "A" and measurements other than pressure, an expansion of Table I was developed (Table II). The group adopted the ANSI descriptor-symbol scheme which is structured into three stages. The first stage indicates that the descriptor is a level (i.e., based upon the logarithm of a ratio), the second stage indicates the type of quantity (power, pressure, or sound exposure), and the third stage indicates the weighting network (A, B, C, D, E.....). If no weighting network is specified, "A" weighting is understood. Exceptions are the A-weighted sound level and the A-weighted peak sound level which require that the "A" be specified. For convenience in those situations in which an A-weighted descriptor is being compared to that of another weighting, the alternative column in Table II permits the inclusion of the "A". For example, a report on blast noise might wish to contrast the LCdn with the LAdn.

Although not included in the tables, it is also recommended that "Lpn" and "LepN" be used as symbols for perceived noise levels and effective perceived noise levels, respectively.

It is recommended that in their initial use within a report, such terms be written in full, rather than abbreviated. An example of preferred usage is as follows:

The A-weighted sound level (LA) was measured before and after the installation of acoustical treatment. The measured LA values were 85 and 75 dB respectively.

Descriptor Nomenclature

With regard to energy averaging over time, the term "average" should be discouraged in favor of the term "equivalent". Hence, Leq, is designated the "equivalent sound level". For Ld, Ln, and Ldn, "equivalent" need not be stated since the concept of day, night, or day-night averaging is by definition understood. Therefore, the designations are "day sound level", "night sound level", and "day-night sound level", respectively.

The peak sound level is the logarithmic ratio of peak sound pressure to a reference pressure and not the maximum root mean square pressure. While the latter is the maximum sound pressure level, it is often incorrectly labelled peak. In that sound level meters have "peak" settings, this distinction is most important.

"Background ambient" should be used in lieu of "background", "ambient", "residual", or "indigenous" to describe the level characteristics of the general background noise due to the contribution of many unidentifiable noise sources near and far.

With regard to units, it is recommended that the unit decibel (abbreviated dB) be used without modification. Hence, DBA, PNdB, and EPNdB are not to be used. Examples of this preferred usage are: the Perceived Noise Level (Lpn was found to be 75 dB. Lpn = 75 dB). This decision was based upon the recommendation of the National Bureau of Standards, and the policies of ANSI and the Acoustical Society of America, all of which disallow any modification of bel except for prefixes indicating its multiples or submultiples (e.g., deci).

Noise Impact

In discussing noise impact, it is recommended that "Level Weighted Population" (LWP) replace "Equivalent Noise Impact" (ENI). The term "Relative Change of Impact" (RCI) shall be used for comparing the relative differences in LWP between two alternatives.

Further, when appropriate, "Noise Impact Index" (NII) and "Population Weighed Loss of Hearing" (PHL) shall be used consistent with CHABA Working Group 69 Report Guidelines for Preparing Environmental Impact Statements (1977).

APPENDIX B (CONTINUED)

TABLE I

A-WEIGHTED RECOMMENDED DESCRIPTOR LIST

	TERM	SYMBOL
1.	A-Weighted Sound Level	L_A
2.	A-Weighted Sound Power Level	L_{WA}
3.	Maximum A-Weighted Sound Level	L_{max}
4.	Peak A-Weighted Sound Level	L_{Apk}
5.	Level Exceeded x% of the Time	L_x
6.	Equivalent Sound Level	L_{eq}
7.	Equivalent Sound Level over Time (T) (1)	$L_{eq(T)}$
8.	Day Sound Level	L_d
9.	Night Sound Level	L_n
10.	Day-Night Sound Level	L_{dn}
11.	Yearly Day-Night Sound Level	$L_{dn(Y)}$
12.	Sound Exposure Level	L_{SE}

(1) Unless otherwise specified, time is in hours (e.g. the hourly equivalent level is $L_{eq(1)}$). Time may be specified in non-quantitative terms (e.g., could be specified a $L_{eq(WASH)}$ to mean the washing cycle noise for a washing machine).

SOURCE: EPA ACOUSTIC TERMINOLOGY GUIDE, BNA 8-14-78,

APPENDIX B (CONTINUED)

TABLE II

RECOMMENDED DESCRIPTOR LIST

	TERM	A-WEIGHTING	ALTERNATIVE[1] A-WEIGHTING	OTHER[2] WEIGHTING	UNWEIGHTED
1.	Sound (Pressure)[3] Level	L_A	L_{pA}	L_B, L_{pB}	L_p
2.	Sound Power Level	L_{WA}		L_{WB}	L_W
3.	Max. Sound Level	L_{max}	L_{Amax}	L_{Bmax}	L_{pmax}
4.	Peak Sound (Pressure) Level	L_{Apk}		L_{Bpk}	L_{pk}
5.	Level Exceeded x% of the Time	L_x	L_{Ax}	L_{Bx}	L_{px}
6.	Equivalent Sound Level	L_{eq}	L_{Aeq}	L_{Beq}	L_{peq}
7.	Equivalent Sound Level Over Time(T) [4]	$L_{eq(T)}$	$L_{Aeq(T)}$	$L_{Beq(T)}$	$L_{peq(T)}$
8.	Day Sound Level	L_d	L_{Ad}	L_{Bd}	L_{pd}
9.	Night Sound Level	L_n	L_{An}	L_{Bn}	L_{pn}
10.	Day-Night Sound Level	L_{dn}	L_{Adn}	L_{Bdn}	L_{pdn}
11.	Yearly Day-Night Sound Level	$L_{dn(Y)}$	$L_{Adn(Y)}$	$L_{Bdn(Y)}$	$L_{pdn(Y)}$
12.	Sound Exposure Level	L_S	L_{SA}	L_{SB}	L_{Sp}
13.	Energy Average Value Over (Non-Time Domain) Set of Observations	$L_{eq(e)}$	$L_{Aeq(e)}$	$L_{Beq(e)}$	$L_{peq(e)}$
14.	Level Exceeded x% of the Total Set of (Non-Time Domain) Observations	$L_{x(e)}$	$L_{Ax(e)}$	$L_{Bx(e)}$	$L_{px(e)}$
15.	Average L_x Value	L_x	L_{Ax}	L_{Bx}	L_{px}

(1) "Alternative" symbols may be used to assure clarity or consistency.

(2) Only B-weighting shown. Applies also to C,D,E,.....weighting.

(3) The term "pressure" is used only for the unweighted level.

(4) Unless otherwise specified, time is in hours (e.g., the hourly equivalent level is Leq(1). Time may be specified in non-quantitative terms (e.g., could be specified as Leq(WASH) to mean the washing cycle noise for a washing machine.

APPENDIX C

SUMMARY OF BASE YEAR AND FUTURE YEAR TRAFFIC VOLUMES

ROADWAY LANES	**** CY 2006 *****		CY 2029 (NO BUILD)		CY 2029 (BUILD)	
	AM VPH	PM VPH	AM VPH	PM VPH	AM VPH	PM VPH
Q. Kaahumanu Hwy. - N. of Entrance Rd. (NB)	915	830	1,785	1,515	1,890	1,500
Q. Kaahumanu Hwy. - N. of Entrance Rd. (SB)	865	825	1,445	2,175	1,640	2,450
Two-Way	1,780	1,655	3,230	3,690	3,530	3,950
Q. Kaahumanu Hwy. - S. of Entrance Rd. (NB)	915	830	1,785	1,515	1,890	1,500
Q. Kaahumanu Hwy. - S. of Entrance Rd. (SB)	865	825	1,445	2,175	1,685	2,400
Two-Way	1,780	1,655	3,230	3,690	3,575	3,900
Proj. Entrance Road At Q. Kaahumanu Hwy. (EB)	N/A	N/A	N/A	N/A	240	240
Proj. Entrance Road At Q. Kaahumanu Hwy. (WB)	N/A	N/A	N/A	N/A	195	290
Two-Way	N/A	N/A	N/A	N/A	435	530
Makai Frontage Rd. - N. of Entrance Rd. (NB)	N/A	N/A	45	25	345	335
Makai Frontage Rd. - N. of Entrance Rd. (SB)	N/A	N/A	10	20	35	50
Two-Way	N/A	N/A	55	45	380	385
Makai Frontage Rd. - S. of Entrance Rd. (NB)	N/A	N/A	45	25	265	340
Makai Frontage Rd. - S. of Entrance Rd. (SB)	N/A	N/A	10	20	70	90
Two-Way	N/A	N/A	55	45	335	430
Proj. Entrance Road W. of Frontage Rd. (EB)	N/A	N/A	N/A	N/A	600	620
Proj. Entrance Road W. of Frontage Rd. (SB)	N/A	N/A	N/A	N/A	440	345
Two-Way	N/A	N/A	N/A	N/A	1,040	965
Q. Kaahumanu Hwy. - N. of Kaiminani Dr. (NB)	805	530	1,860	1,460	2,100	1,665
Q. Kaahumanu Hwy. - N. of Kaiminani Dr. (SB)	520	990	1,005	2,305	1,185	2,570
Two-Way	1,325	1,520	2,865	3,765	3,285	4,235
Q. Kaahumanu Hwy. - S. of Kohanaiki (NB)	915	830	1,795	1,600	2,100	1,870
Q. Kaahumanu Hwy. - S. of Kohanaiki (SB)	865	825	1,580	1,695	1,855	1,955
Two-Way	1,780	1,655	3,375	3,295	3,955	3,825

Air Quality Study

AIR QUALITY STUDY

FOR

O'OMA BEACHSIDE VILLAGE

NORTH KONA, HAWAII

Prepared for:

O'oma Beachside Village, LLC

May 2008

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1.0 SUMMARY

O'oma Beachside Village, LLC is proposing to develop the O'oma Beachside Village in the North Kona District on the island of Hawaii. The proposed project will include up to 1,200 residential units, commercial space, a school, a park and other associated amenities and facilities. Development of the project is expected to commence in 2011 and be completed and fully occupied by 2029. This study examines the potential short- and long-term air quality impacts that could occur as a result of construction and use of the proposed facilities and suggests mitigative measures to reduce any potential air quality impacts where possible and appropriate.

Both federal and state standards have been established to maintain ambient air quality. At the present time, seven parameters are regulated including: particulate matter, sulfur dioxide, hydrogen sulfide, nitrogen dioxide, carbon monoxide, ozone and lead. Hawaii 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 climate together with the amount and type of human activity generally dictate the air quality of a given location. The climate of the project area is very much affected by its near coastal situation and by nearby mountains. Winds are predominantly light and variable, although kona storms generate occasional strong winds from the south or southwest during winter. Temperatures in the project area are generally very consistent and moderate with average daily temperatures ranging from about 65°F to 85°F. The extreme minimum temperature recorded at the nearby Old Kona Airport is 47°F, while the extreme maximum temperature is 93°F. Average annual rainfall in the area amounts to about 25 inches with each month typically contributing about 2 inches.

Except for periodic impacts from volcanic emissions (vog) and possibly occasional localized impacts from traffic congestion, the present air quality of the project area is believed to be relatively good. The limited air quality data that are available for the area from the Department of Health indicate that (despite the vog) concentrations are well within state and national air quality standards.

If the proposed project is given the necessary approvals to proceed, it may be inevitable that some short- and/or long-term impacts on air quality will occur either directly or indirectly as a consequence of project construction and use. Short-term impacts from fugitive dust will likely occur during the project construction phase. To a lesser extent, exhaust emissions from stationary and mobile construction equipment, from the disruption of traffic, and from workers' vehicles may also affect air quality during the period of construction. State air pollution control regulations require that there be no visible fugitive dust emissions at the property line. Hence, an effective dust control plan must be implemented to ensure compliance with state regulations. Fugitive dust emissions can be controlled to a large extent by watering of active work areas, using wind screens, keeping adjacent paved roads clean, and by covering of open-bodied trucks. Other dust control measures could include limiting the area that can be disturbed at any given time and/or mulching or chemically stabilizing inactive areas that have been worked. Paving and landscaping of project areas early in the construction schedule will also reduce dust emissions. Monitoring dust at the project boundary during the period of construction could be considered as a means to evaluate the effectiveness of the project dust control program. Exhaust emissions can be mitigated by moving construction equipment and workers to and from the project site during off-peak traffic hours.

After construction, motor vehicles coming to and from the proposed development will result in a long-term increase in air pollution emissions in the project area. To assess the impact of emissions from these vehicles, a computerized air quality modeling study was undertaken to estimate current ambient concentrations of carbon monoxide at roadway intersections in the project vicinity and to predict future levels both with and without the proposed project. During worst-case conditions, model results indicated that present 1-hour and 8-hour carbon monoxide concentrations are within both the state and the national ambient air quality standards. In the year 2029 without the project, carbon monoxide concentrations were predicted to increase in the project area, but concentrations should remain within state and federal standards. With the project in the year 2029, carbon monoxide concentrations were estimated to increase by about 10 to 20 percent compared to the without-project case, but worst-case concentrations should remain within both national and state standards. Implementing mitigation measures for traffic-related air quality impacts is probably unnecessary and unwarranted.

Depending on the demand levels, long-term impacts on air quality are also possible due to indirect emissions associated with a development's electrical power and solid waste disposal requirements. Quantitative estimates of these potential impacts were not made, but based on the estimated demand levels and emission rates involved, any significant impacts are unlikely. Nevertheless, incorporating energy conservation design features and promoting conservation and recycling programs within the proposed development could serve to further reduce any associated impacts and conserve the island's resources.

2.0 INTRODUCTION

O’oma Beachside Village, LLC is proposing to develop the O’oma Beachside Village on approximately 303 acres of undeveloped lands in the North Kona District on the island of Hawaii (see Figure 1 for project location). The project site is makai of Queen Kaahumanu Highway and south of and adjacent to the Natural Energy Lab of Hawaii Authority (NELHA). The proposed development includes 950 to 1,200 multi- and single-family residential units, commercial space for stores and services, a charter school, park and open-space areas, a canoe club, a wastewater treatment plant, and other associated facilities and infrastructure. Full development and occupancy of the development is planned by 2029.

The purpose of this study is to describe existing air quality in the project area and to assess the potential short- and long-term direct and indirect air quality impacts that could result from construction and use of the proposed facilities as planned. Measures to mitigate project impacts are suggested where possible and appropriate.

3.0 AMBIENT AIR QUALITY STANDARDS

Ambient concentrations of air pollution are regulated by both national and state ambient air quality standards (AAQS). National AAQS are specified in Section 40, Part 50 of the Code of Federal Regulations (CFR), while State of Hawaii AAQS are defined in Chapter 11-59 of the Hawaii Administrative Rules. Table 1 summarizes both the national and the state AAQS that are specified in the cited documents. As indicated in the table, national and state AAQS have been established for particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and lead. The state has also set a standard for hydrogen sulfide. National AAQS are stated in terms of both primary and secondary standards for most of the regulated air pollutants. National primary standards are designed to protect the public health with an "adequate margin of safety". National secondary standards, on the other hand, define levels of air quality necessary to protect the public welfare from "any known or anticipated adverse effects of a pollutant". Secondary public welfare impacts may include such effects as decreased visibility, diminished comfort levels, or other potential injury to the natural or man-made environment, e.g., soiling of materials, damage to vegetation or other economic damage. In contrast to the national AAQS, Hawaii State AAQS are given in terms of a single standard that is designed "to protect public health and welfare and to prevent the significant deterioration of air quality".

Each of the regulated air pollutants has the potential to create or exacerbate some form of adverse health effect or to produce environmental degradation when present in sufficiently high concentration for prolonged periods of time. The AAQS specify a maximum allowable concentration for a given air pollutant for one or more averaging times to prevent harmful effects. Averaging times vary from one hour to one year depending on the pollutant and type of exposure necessary to cause adverse effects. In the case of the short-term (i.e., 1- to 24-hour) AAQS, both national and state standards allow a specified number of exceedances each year.

The Hawaii AAQS are in some cases considerably more stringent than the comparable national AAQS. In particular, the Hawaii 1-hour AAQS for carbon monoxide is four times more stringent than the comparable national limit. The U.S. Environmental Protection Agency (EPA) is currently working on a plan to phase out the national 1-hour ozone standard in favor of the new (and more stringent) 8-hour standard.

The Hawaii AAQS for sulfur dioxide were relaxed in 1986 to make the state standards essentially the same as the national limits. In 1993, the state also revised its particulate standards to follow those set by the federal government. During 1997, the federal government again revised its standards for particulate, but the new standards were challenged in federal court. A Supreme Court ruling was issued during February 2001, and as a result, the new standards for particulate were implemented during 2005. To date, the Hawaii Department of Health has not updated the state particulate standards. In September 2001, the state vacated the state 1-hour standard for ozone and an 8-hour standard was adopted.

4.0 REGIONAL AND LOCAL CLIMATOLOGY

Regional and local climatology significantly affect the air quality of a given location. Wind, temperature, atmospheric turbulence, mixing height and rainfall all influence air quality. Although the climate of Hawaii is relatively moderate throughout most of the state, significant differences in these parameters may occur from one location to another. Most differences in regional and local climates within the state are caused by the mountainous topography.

The site of the proposed project is located near the midpoint of the western coast of the island of Hawaii. The topography of Hawaii Island is dominated by the great volcanic masses of Mauna Loa (13,653 feet), Mauna Kea (13,796 feet), and of Hualalai, the Kohala Mountains and Kilauea. The island consists entirely of the slopes of these mountains and of the broad saddles between them. Mauna Loa and Kilauea, located on the southern half of the island, are still active volcanoes.

Hawaii lies well within the belt of northeasterly trade winds generated by the semi-permanent Pacific high pressure cell to the north and east. Nearly the entire western coast of the island of Hawaii, however, is sheltered from the trade winds by high mountains, except when unusually strong trade winds sweep through the saddle between the Kohala Mountains and Mauna Kea and reach some areas to the lee. Due to wind shadow effects caused by the terrain, winds in the project area are predominantly light and variable. Local winds such as land/sea breezes and/or upslope/downslope winds dominate the wind pattern for the area. During the daytime, winds typically move onshore because of seabreeze and/or upslope effects. At night, winds generally are land breezes and/or drainage winds that move downslope and out to sea. During winter, occasional strong winds from the south or southwest occur in association with the passage of winter storm systems.

Air pollution emissions from motor vehicles, the formation of photochemical smog and smoke plume rise all depend in part on air temperature. Colder temperatures tend to result in higher emissions of contaminants from automobiles but lower concentrations of photochemical smog and ground-level concentrations of air pollution from elevated plumes. In Hawaii, the annual and daily variation of temperature depends to a large degree on elevation above sea level, distance inland and exposure to the trade winds. Average temperatures at locations near sea level generally are warmer than those at higher elevations.

Areas exposed to the trade winds tend to have the least temperature variation, while inland and leeward areas often have the most. The project site's leeward location results in a larger temperature profile compared to windward locations at the same elevation. At the Old Kona Airport, located a few miles south of the project site, average daily minimum and maximum temperatures are 67°F and 83°F, respectively [1]. The extreme minimum temperature on record at this location is 47°F, and the extreme maximum is 93°F. Temperatures at the project site are similar.

Small scale, random motions in the atmosphere (turbulence) cause air pollutants to be dispersed as a function of distance or time from the point of emission. Turbulence is caused by both mechanical and thermal forces in the atmosphere. It is often measured and described in terms of Pasquill-Gifford stability class. Stability class 1 is the most turbulent and class 6 is the least. Thus, air pollution dissipates the best during stability class 1 conditions and the worst when stability class 6 prevails. In the Kona area, stability classes 5 or 6 typically occur during the nighttime or early morning hours when temperature inversions form due to radiational cooling or to drainage flow from the mountainous interior of the island. Stability classes 1 through 4 occur during the daytime, depending mainly on the amount of cloud cover and incoming solar radiation and the onset and extent of the sea breeze.

Mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Low mixing heights can result in high ground-level air pollution concentrations because contaminants emitted from or near the surface can become trapped within the mixing layer. In Hawaii, minimum mixing heights tend to be high because of mechanical mixing caused by the trade winds and because of the temperature moderating effect of the surrounding ocean. Low mixing heights may sometimes occur, however, at inland locations and even at times along coastal areas early in the morning following a clear, cool, windless night. Coastal areas also may experience low mixing levels during sea breeze conditions when cooler ocean air rushes in over warmer land. Mixing heights in Hawaii typically are above 3000 feet (1000 meters).

Rainfall can have a beneficial affect on the air quality of an area in that it helps to suppress fugitive dust emissions, and it also may "washout" gaseous contaminants that are water soluble. Rainfall in Hawaii is highly variable depending on elevation and on location with respect to the trade wind. The climate of the project area is wetter than might be expected for a leeward location. This is due to the persistent onshore and upslope movement of marine air caused by both eddie and seabreeze or mountain slope effects. Some of the rainfall occurs during summer afternoons and evenings as a result of this onshore and upslope movement of moisture-laden marine air, and some occurs in conjunction with winter storms. At the Old Kona Airport, average annual rainfall amounts to about 25 inches with each month registering about 2 inches [1]. Rainfall at the project site is probably about the same.

5.0 PRESENT AIR QUALITY

Present air quality in the project area is mostly affected by air pollutants from vehicular, industrial, natural and/or agricultural sources. Table 2 presents an air pollutant emission summary for the island of Hawaii for calendar year 1993. The emission rates shown in the table pertain to manmade emissions only, i.e., emissions from natural sources are not included. As suggested in the table, much of the manmade particulate emissions on Hawaii originate from area sources, such as the mineral products industry and agriculture. Manmade sulfur oxides are emitted almost exclusively by point sources, such as power plants and other fuel-burning industries. Nitrogen oxides emissions emanate predominantly from area sources (mostly motor vehicle traffic), although industrial point sources contribute a significant share. The majority of carbon monoxide emissions occur from area sources (motor vehicle traffic), while hydrocarbons are emitted mainly from point sources.

It should be noted that Hawaii Island is unique from the other islands in the state in terms of the natural volcanic air pollution emissions that occur. Volcanic emissions periodically plague the project area. This is especially so since the latest eruption phase of the Kilauea Volcano began in 1983. Air pollution emissions from the Hawaiian volcanoes consist primarily of sulfur dioxide. After entering the atmosphere, these sulfur dioxide emissions are carried away by the wind and either washed out as acid rain or gradually transformed into particulate sulfates or acid aerosols. Although emissions from Kilauea are vented on the other side of a mountain barrier more than 50 miles east of the project site, the prevailing wind patterns eventually carry some of the emissions into the Kona area. These emissions can be seen in the form of the volcanic haze (vog) which persistently hangs over the area.

The major industrial source of air pollution in the project vicinity is Hawaii Electric Light Company’s Keahole Power Plant, which is located about 2 miles to the north. Air pollution emissions from Keahole Power Plant consist mostly of sulfur dioxide and oxides of nitrogen.

The project site is situated adjacent to Queen Kaahumanu Highway on the makai side. Queen Kaahumanu Highway is a regional arterial roadway that often carries substantial volumes of traffic. Downslope winds during the evening and nighttime hours will tend to carry emissions from motor vehicles traversing this roadway toward the project site.

The State Department of Health operates a network of air quality monitoring stations at various locations around the state. Unfortunately, very limited data are available for Hawaii Island, and even less data are available for the Kona area specifically. During the most recent 5-year period for which data have been reported (2001-2005), the Department of Health operated an air quality monitoring site in the Kealakekua area for measuring sulfur dioxide. Particulate was also monitored at this site, but monitoring for this parameter was discontinued during 2000. As indicated in Table 3, measurements of sulfur dioxide concentrations at this location during the 2001-2005 monitoring period were consistently low with annual average concentrations of 8 to 13 $\mu g/m^3$, which represents about 10 to 15 percent of the state and national standard. The highest annual second-highest 3-hour and 24-hour concentrations (which are most relevant to the standards) for these five years were 82 and 42 $\mu g/m^3$, respectively; these are about 6 to 12 percent of the applicable standards. No exceedances of the state/national 3-hour and 24-hour AAQS for sulfur dioxide were recorded.

Although not shown in the table, the annual average particulate concentration for the year 2000 was 18 $\mu g/m^3$, which equates to about 36 percent of the state/national standard. The second-highest 24-hour concentration of particulate matter, 23 $\mu g/m^3$, was about 15 percent of the state/national standard, and there were no violations of the state/national AAQS during the 2000 monitoring period. Monitoring of particulate matter was discontinued at this site during June 2000.

At this time, there are no reported measurements of lead, ozone, nitrogen dioxide or carbon monoxide in the project vicinity. These are primarily motor vehicle related air pollutants. Lead, ozone and nitrogen dioxide typically are regional scale problems. Concentrations of lead and nitrogen dioxide generally have not been found to exceed AAQS elsewhere in the state. Ozone concentrations, on the other hand, have been found to exceed the state standard at times at Sand Island on Oahu. Carbon monoxide air pollution typically is a microscale problem caused by congested motor vehicular traffic. In traffic congested areas such as urban Honolulu, carbon monoxide concentrations have been found to occasionally exceed the state AAQS. Present concentrations of carbon monoxide in the project area are estimated later in this study based on computer modeling of motor vehicle emissions.

6.0 SHORT-TERM IMPACTS OF PROJECT

Short-term direct and indirect impacts on air quality could potentially occur due to project construction. For a project of this nature, there are two potential types of air pollution emissions that could directly result in short-term air quality impacts during project construction: (1) fugitive dust from vehicle movement and soil excavation; and (2) exhaust emissions from on-site construction equipment. Indirectly, there also could be short-term impacts from slow-moving construction equipment traveling to and from the project site, from a temporary increase in local traffic caused by commuting construction workers, and from the disruption of normal traffic flow caused by lane closures of adjacent roadways.

Fugitive dust emissions may arise from the grading and dirt-moving activities associated with site clearing and preparation work. The emission rate for fugitive dust emissions from construction activities is difficult to estimate accurately. This is because of its elusive nature of emission and because the potential for its generation varies greatly depending upon the type of soil at the construction site, the amount and type of dirt-disturbing activity taking place, the moisture content of exposed soil in work areas, and the wind speed. The EPA [2] has provided a rough estimate for uncontrolled fugitive dust emissions from construction activity of 1.2 tons per acre per month under conditions of "medium" activity, moderate soil silt content (30%), and precipitation/evaporation (P/E) index of 50. Uncontrolled fugitive dust emissions at the project site would likely be somewhere near that level, depending on the amount of rainfall that occurs. In any case, State of Hawaii Air Pollution Control Regulations [3] prohibit visible emissions of fugitive dust from construction activities at the property line. Thus, an effective dust control plan for the project construction phase is essential.

Adequate fugitive dust control can usually be accomplished by the establishment of a frequent watering program to keep bare-dirt surfaces in construction areas from becoming significant sources of dust. In dust-prone or dust-sensitive areas, other control measures such as limiting the area that can be disturbed at any given time, applying chemical soil stabilizers, mulching and/or using wind screens may be necessary. Control regulations further stipulate that open-bodied trucks be covered at all times when in motion if they are transporting materials that could be blown away. Haul trucks tracking dirt onto paved streets from unpaved areas is often a significant source of dust in construction areas. Some means to alleviate this problem, such as road cleaning or tire washing, may be appropriate. Paving of parking areas and/or establishment of landscaping as early in the construction schedule as possible can also lower the potential for fugitive dust emissions. Monitoring dust at the project property line could be considered to quantify and document the effectiveness of dust control measures.

On-site mobile and stationary construction equipment also will emit air pollutants from engine exhausts. The largest of this equipment is usually diesel-powered. Nitrogen oxides emissions from diesel engines can be relatively high compared to gasoline-powered equipment, but the standard for nitrogen dioxide is set on an annual basis and is not likely to be violated by short-term construction equipment emissions. Carbon monoxide emissions from diesel engines, on the other hand, are low and should be relatively insignificant compared to vehicular emissions on nearby roadways.

Project construction activities will also likely obstruct the normal flow of traffic at times to such an extent that overall vehicular emissions in the project area will temporarily increase. The only means to alleviate this problem will be to attempt to keep roadways open during peak traffic hours and to move heavy construction equipment and workers to and from construction areas during periods of low traffic volume. Thus, most potential short-term air quality impacts from project construction can be mitigated.

7.0 LONG-TERM IMPACTS OF PROJECT

7.1 Roadway Traffic

After construction is completed, use of the proposed facilities will result in increased motor vehicle traffic in the project area, potentially causing long-term impacts on ambient air quality. Motor vehicles with gasoline-powered engines are significant sources of carbon monoxide. They also emit nitrogen oxides and other contaminates.

Federal air pollution control regulations require that new motor vehicles be equipped with emission control devices that reduce emissions significantly compared to a few years ago. In 1990, the President signed into law the Clean Air Act Amendments. This legislation requires further emission reductions, which have been phased in since 1994. More recently, additional restrictions were signed into law during the Clinton administration, which will begin to take effect during the next decade. The added restrictions on emissions from new motor vehicles will lower average emissions each year as more and more older vehicles leave the state's roadways. It is estimated that carbon monoxide emissions, for example, will go down by an average of about 30 to 40 percent per vehicle during the next 10 years due to the replacement of older vehicles with newer models.

To evaluate the potential long-term indirect ambient air quality impact of increased roadway traffic associated with a project such as this, computerized emission and atmospheric dispersion models can be used to estimate ambient carbon monoxide concentrations along roadways leading to and from the project. Carbon monoxide is selected for modeling because it is both the most stable and the most abundant of the pollutants generated by motor vehicles. Furthermore, carbon monoxide air pollution is generally considered to be a microscale problem that can be addressed locally to some extent, whereas nitrogen oxides air pollution most often is a regional issue that cannot be addressed by a single new development.

For this project, three scenarios were selected for the carbon monoxide modeling study: (1) year 2006 with present conditions, (2) year 2029 without the project, and (3) year 2029 with the project. To begin the modeling study of the three scenarios, critical receptor areas in the vicinity of the project were identified for analysis. Generally speaking, roadway intersections are the primary concern because of traffic congestion and because of the increase in vehicular emissions associated with traffic queuing. For this study, the same key intersections identified in the traffic study were also selected for air quality analysis. These included the following intersections:

- Queen Kaahumanu Highway at Kaiminani Drive
- Queen Kaahumanu Highway at Hulikoa Drive
- Queen Kaahumanu Highway at Hina Lani Street

The traffic impact report for the project [4] describes the projected future traffic conditions and laneage configurations of these intersections in detail. In performing the air quality impact analysis, it was assumed that all recommended traffic mitigation measures would be implemented.

The main objective of the modeling study was to estimate maximum 1-hour average carbon monoxide concentrations for each of the three scenarios studied. To evaluate the significance of the estimated concentrations, a comparison of the predicted values for each scenario can be made. Comparison of the estimated values to the national and state AAQS was also used to provide another measure of significance.

Maximum carbon monoxide concentrations typically coincide with peak traffic periods. The traffic impact assessment report evaluated morning and afternoon peak traffic periods. These same periods were evaluated in the air quality impact assessment.

The EPA computer model MOBILE6 [5] was used to calculate vehicular carbon monoxide emissions for each year studied. One of the key inputs to MOBILE6 is vehicle mix. Unless very detailed information is available, national average values are typically assumed, which is what was used for the present study. Based on national average vehicle mix figures, the present vehicle mix in the project area was estimated to be 40.9% light-duty gasoline-powered automobiles, 46.2% light-duty gasoline-powered trucks and vans, 3.6% heavy-duty gasoline-powered vehicles, 0.2% light-duty diesel-powered vehicles, 8.5% heavy-duty diesel-powered trucks and buses, and 0.6% motorcycles. For the future scenarios studied, the vehicle mix was estimated to change slightly with fewer light-duty gasoline-powered automobiles and more light-duty gasoline-powered trucks and vans.

Ambient temperatures of 59 and 68 degrees F were used for morning and afternoon peak-hour emission computations, respectively. These are conservative assumptions since morning/afternoon ambient temperatures will generally be warmer than this, and emission estimates given by MOBILE6 generally have an inverse relationship to the ambient temperature.

After computing vehicular carbon monoxide emissions through the use of MOBILE6, these data were then input to an atmospheric dispersion model. EPA air quality modeling guidelines [6] currently recommend that the computer model CAL3QHC [7] be used to assess carbon monoxide concentrations at roadway intersections, or in areas where its use has previously been established, CALINE4 [8] may be used. Until a few years ago, CALINE4 was used extensively in Hawaii to assess air quality impacts at roadway intersections. In December 1997, the California Department of Transportation recommended that the intersection mode of CALINE4 no longer be used because it was thought the model has become outdated. Studies have shown that CALINE4 may tend to over-predict maximum concentrations in some situations. Therefore, CAL3QHC was used for the subject analysis.

CAL3QHC was developed for the U.S. EPA to simulate vehicular movement, vehicle queuing and atmospheric dispersion of vehicular emissions near roadway intersections. It is designed to predict 1-hour average pollutant concentrations near roadway intersections based on input traffic and emission data, roadway/receptor geometry and meteorological conditions.

Although CAL3QHC is intended primarily for use in assessing atmospheric dispersion near signalized roadway intersections, it can also be used to evaluate unsignalized intersections. This is accomplished by manually estimating queue lengths and then applying the same techniques used by the model for signalized intersections. Currently, one of the study intersections, Queen Kaahumanu Highway at Hulikoa Drive, is unsignalized. In the future, in accordance with the traffic report, this intersection was assumed to be signalized.

Input peak-hour traffic data were obtained from the traffic study cited previously. This included vehicle approach volumes, saturation capacity estimates, intersection laneage and signal timings (where applicable). All emission factors that were input to CAL3QHC for free-flow traffic on roadways were obtained from MOBILE6 based on assumed free-flow vehicle speeds corresponding to the posted speed limits (25 to 45 mph depending on location).

Model roadways were set up to reflect roadway geometry, physical dimensions and operating characteristics. Concentrations predicted by air quality models generally are not considered valid within the roadway-mixing zone. The roadway-mixing zone is usually taken to include 3 meters on either side of the traveled portion of the roadway and the turbulent area within 10 meters of a cross street. Model receptor sites were thus located at the edges of the mixing zones near all intersections that were studied for all three scenarios. This implies that pedestrian sidewalks either already exist or are assumed to exist in the future. All receptor heights were placed at 1.8 meters above ground to simulate levels within the normal human breathing zone.

Input meteorological conditions for this study were defined to provide "worst-case" results. One of the key meteorological inputs is atmospheric stability category. For these analyses, atmospheric stability category 6 was assumed for the morning cases, while atmospheric stability category 4 was assumed for the afternoon cases. These are the most conservative stability categories that are generally used for estimating worst-case pollutant dispersion within suburban areas for these periods. A surface roughness length of 100 cm and a mixing height of 1000 meters were used in all cases. Worst-case wind conditions were defined as a wind speed of 1 meter per second with a wind direction resulting in the highest predicted concentration. Concentration estimates were calculated at wind directions of every 5 degrees.

Existing background concentrations of carbon monoxide in the project vicinity are believed to be at low levels. Thus, background contributions of carbon monoxide from sources or roadways not directly considered in the analysis were accounted for by adding a background concentration of 0.5 ppm to all predicted concentrations for 2006. Although increased traffic is expected to occur within the project area during the next several years with or without the project, background carbon monoxide concentrations may not change significantly since individual emissions from motor vehicles are forecast to decrease with time. Hence, a background value of 0.5 ppm was assumed to persist for the future scenarios studied.

Predicted Worst-Case 1-Hour Concentrations

Table 4 summarizes the final results of the modeling study in the form of the estimated worst-case 1-hour morning and afternoon ambient carbon monoxide concentrations. These results can be compared directly to the state and the national AAQS. Estimated worst-case carbon monoxide concentrations are presented in the table for three scenarios: year 2006 with existing traffic, year 2029 without the project and year 2029 with the project. The locations of these estimated worst-case 1-hour concentrations all occurred at or very near the indicated intersections.

As indicated in the table, the highest estimated 1-hour concentration within the project vicinity for the present (2006) case was 5.5 mg/m^3. This was projected to occur during the morning peak traffic hour near the intersection of Queen Kaahumanu Highway and Kaiminani Drive. Concentrations at other locations and times studied were 5.2 mg/m^3 or lower. All predicted worst-case 1-hour concentrations for the 2006 scenario were within both the national AAQS of 40 mg/m^3 and the state standard of 10 mg/m^3.

In the year 2029 without the proposed project, the highest worst-case 1-hour concentration was predicted to continue to occur during the morning at the intersection of Queen Kaahumanu Highway and Kaiminani Drive. A value of 6.2 mg/m^3 was predicted to occur at this location and time. Peak-hour worst-case values at the other locations and times studied for the 2029 without project scenario ranged between 3.2 and 5.8 mg/m^3. Compared to the existing case, concentrations increased, but all projected worst-case concentrations for this scenario remained within the state and national standards.

In the year 2029 with the proposed project and with the recommended traffic mitigation measures, the predicted highest worst-case 1-hour concentration continued to occur during the morning at the intersection of Queen Kaahumanu Highway and Kaiminani Drive with a value of 7.7 mg/m^3, which is about 24 percent higher compared to the without project case. Other concentrations for this scenario ranged between 3.8 and 6.4 mg/m^3. With the project and with the recommended traffic mitigation measures, concentrations would increase about 10 to 20 percent compared to the without project scenario. All concentrations would remain within the state and federal standards.

Predicted Worst-Case 8-Hour Concentrations

Worst-case 8-hour carbon monoxide concentrations were estimated by multiplying the worst-case 1-hour values by a persistence factor of 0.5. This accounts for two factors: (1) traffic volumes averaged over eight hours are lower than peak 1-hour values, and (2) meteorological conditions are more variable (and hence more favorable for dispersion) over an 8-hour period than they are for a single hour. Based on monitoring data, 1-hour to 8-hour persistence factors for most locations generally vary from 0.4 to 0.8 with 0.6 being the most typical. One study based on modeling [9] concluded that 1-hour to 8-hour persistence factors could typically be expected to range from 0.4 to 0.5. EPA guidelines [10] recommend using a value of 0.7 unless a locally derived persistence factor is available. Recent monitoring data for locations on Oahu reported by the Department of Health [11] suggest that this factor may range between about 0.2 and 0.6 depending on location and traffic variability. Considering the location of the project and the traffic pattern for the area, a 1-hour to 8-hour persistence factor of 0.5 will likely yield reasonable estimates of worst-case 8-hour concentrations.

The resulting estimated worst-case 8-hour concentrations are indicated in Table 5. For the 2006 scenario, the estimated worst-case 8-hour carbon monoxide concentrations for the five locations studied ranged from 2.2 mg/m^3 at Queen Kaahumanu Highway and Hulikoa Drive to 2.8 mg/m^3 at Queen Kaahumanu Highway and Kaiminani Drive. The estimated worst-case concentrations were within both the state standard of 5 mg/m^3 and the national limit of 10 mg/m^3.

For the year 2029 without project scenario, worst-case concentrations ranged between 2.6 and 3.1 mg/m^3, with the highest concentration at the Queen Kaahumanu Highway and Kaiminani Drive intersection. Concentrations at all locations studied increased slightly compared to the existing case, but all predicted concentrations were within the standards.

For the 2029 with project scenario (assuming traffic mitigation measures), concentrations ranged from 3.0 mg/m^3 at Queen Kaahumanu Highway and Hina Lani Street to 3.8 mg/m^3 at Queen Kaahumanu Highway and Kaiminani Drive. Worst-case concentrations increased compared to the without project case, but all predicted 8-hour concentrations for this scenario were well within both the national and the state AAQS.

Conservativeness of Estimates

The results of this study reflect several assumptions that were made concerning both traffic movement and worst-case meteorological conditions. One such assumption concerning worst-case meteorological conditions is that a wind speed of 1 meter per second with a steady direction for 1 hour will occur. A steady wind of 1 meter per second blowing from a single direction for an hour is extremely unlikely and may occur only once a year or less. With wind speeds of 2 meters per second, for example, computed carbon monoxide concentrations would be only about half the values given above. The 8-hour estimates are also conservative in that it is unlikely that anyone would occupy the assumed receptor sites (within 3 m of the roadways) for a period of 8 hours.

7.2 Electrical Demand

The proposed project also will cause indirect air pollution emissions from power generating facilities as a consequence of electrical power usage. The annual electrical demand of the project when fully developed is expected to reach a maximum of approximately 71 million kilowatt-hours [12]. Electrical power for the project will most probably be provided mainly by oil-fired generating facilities, but some of the project power may also be derived from geothermal energy, photovoltaic systems, wind power or other sources. In order to meet the electrical power needs of the proposed project, power generating facilities will likely be required to burn more fuel and hence more air pollution will be emitted at these facilities. Given in Table 6 are estimates of the indirect air pollution emissions that would result from the project electrical demand assuming all power is provided by burning more fuel oil at local power plants. These values can be compared to the island-wide emission estimates for 1993 given in Table 2. The estimated indirect emissions from project electrical demand amount to 2 percent or less of the present (manmade) air pollution emissions occurring on Hawaii Island even if all power is assumed to be derived from oil.

7.3 Solid Waste Disposal

Solid waste generated by the proposed development when fully completed and occupied is not expected to exceed about 2,568 tons per year [12]. Currently, all solid waste on the island is buried at solid waste landfills. Thus, assuming this continues to be the method for solid waste disposal, the only associated air pollution emissions that will occur will be from trucking the waste to the landfill and burying it. These emissions should be relatively minor.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The major potential short-term air quality impact of the project will occur from the emission of fugitive dust during construction. Uncontrolled fugitive dust emissions from construction activities are estimated to amount to about 1.2 tons per acre per month, depending on rainfall. To control dust, active work areas and any temporary unpaved work roads should be watered at least twice daily on days without rainfall. Use of wind screens and/or limiting the area that is disturbed at any given time will also help to contain fugitive dust emissions. Wind erosion of inactive areas of the site that have been disturbed could be controlled by mulching or by the use of chemical soil stabilizers. Dirt-hauling trucks should be covered when traveling on roadways to prevent windage. A routine road cleaning and/or tire washing program will also help to reduce fugitive dust emissions that may occur as a result of trucks tracking dirt onto paved roadways in the project area. Paving of parking areas and establishment of landscaping early in the construction schedule will also help to control dust. Monitoring dust at the project boundary during the period of construction could be considered as a means to evaluate the effectiveness of the project dust control program and to adjust the program if necessary.

During construction phases, emissions from engine exhausts (primarily consisting of carbon monoxide and nitrogen oxides) will also occur both from on-site construction equipment and from vehicles used by construction workers and from trucks traveling to and from the project. Increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers can be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

After construction of the proposed project is completed and it is fully occupied, carbon monoxide concentrations in the project area due to motor vehicle emissions will likely increase, but worst-case concentrations should remain within both the state and the national ambient air quality standards. Implementing any air quality mitigation measures for long-term traffic-related impacts is probably unnecessary and unwarranted.

Any long-term impacts on air quality due to indirect emissions from supplying the project with electricity and from the disposal of solid waste materials generated by the project will likely be small based on the relatively small magnitudes of these emissions. Nevertheless, indirect emissions from project electrical demand could likely be reduced somewhat by incorporating energy-saving features into project design requirements. This might include the use of solar water heaters; designing building space so that window positions maximize indoor light without unduly increasing indoor heat; using landscaping where feasible to provide afternoon shade to cut down on the use of air conditioning; installation of insulation and double-glazed doors to reduce the effects of the sun and heat; providing movable, controlled openings for ventilation at opportune times; and possibly installing automated room occupancy sensors.

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Figure 1 - Project Location

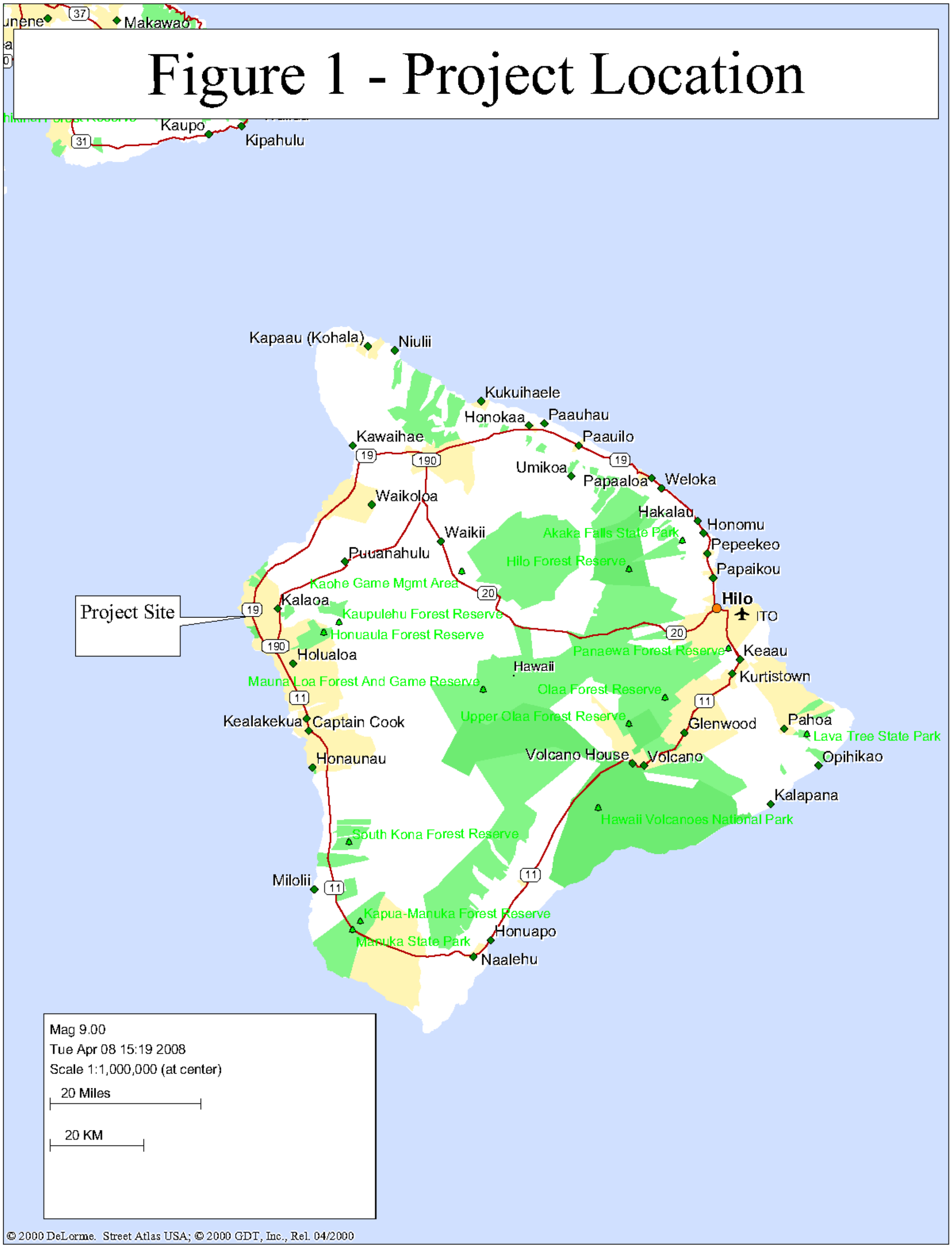

Table 1

SUMMARY OF STATE OF HAWAII AND NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Units	Averaging Time	Maximum Allowable Concentration		
			National Primary	**National Secondary**	**State of Hawaii**
Particulate Matter (<10 microns)	µg/m³	Annual 24 Hours	50[a] 150[b]	50[a] 150[b]	50 150[c]
Particulate Matter (<2.5 microns)	µg/m³	Annual 24 Hours	15[a] 65[d]	15[a] 65[d]	- -
Sulfur Dioxide	µg/m³	Annual 24 Hours 3 Hours	80 365[c] -	- - 1300[c]	80 365[c] 1300[c]
Nitrogen Dioxide	µg/m³	Annual	100	100	70
Carbon Monoxide	mg/m³	8 Hours 1 Hour	10[c] 40[c]	- -	5[c] 10[c]
Ozone	µg/m³	8 Hours 1 Hour	157[e] 235[f]	157[e] 235[f]	157[e] -
Lead	µg/m³	Calendar Quarter	1.5	1.5	1.5
Hydrogen Sulfide	µg/m³	1 Hour	-	-	35[c]

[a] Three-year average of annual arithmetic mean.

[b] 99th percentile value averaged over three years.

[c] Not to be exceeded more than once per year.

[d] 98th percentile value averaged over three years.

[e] Three-year average of fourth-highest daily 8-hour maximum.

[f] Standard is attained when the expected number of exceedances is less than or equal to 1.

Table 2

AIR POLLUTION EMISSIONS INVENTORY FOR ISLAND OF HAWAII, 1993

Air Pollutant	Point Sources (tons/year)	Area Sources (tons/year)	Total (tons/year)
Particulate	30,311	9,157	39,468
Sulfur Oxides	9,345	nil	9,345
Nitrogen Oxides	4,054	8,858	12,912
Carbon Monoxide	3,357	23,934	27,291
Hydrocarbons	1,477	203	1,680

Source: Final Report, “Review, Revise and Update of the Hawaii Emissions Inventory Systems for the State of Hawaii”, prepared for Hawaii Department of Health by J.L. Shoemaker & Associates, Inc., 1996

Table 3

ANNUAL SUMMARIES OF AIR QUALITY MEASUREMENTS FOR MONITORING STATIONS NEAREST O'OMA BEACHSIDE VILLAGE

Parameter / Location	2001	2002	2003	2004	2005
Sulfur Dioxide / Kealakekua, Kona					
3-Hour Averaging Period:					
No. of Samples	2869	2877	2886	2513	2341
Highest Concentration (μg/m^3)	38	50	91	55	83
2nd Highest Concentration (μg/m^3)	37	37	58	54	82
No. of State AAQS Exceedances	0	0	0	0	0
24-Hour Averaging Period:					
No. of Samples	360	362	364	317	296
Highest Concentration (μg/m^3)	22	19	39	21	47
2nd Highest Concentration (μg/m^3)	20	18	22	19	42
No. of State AAQS Exceedances	0	0	0	0	0
Annual Average Concentration (μg/m^3)	8	8	10	8	13

Source: State of Hawaii Department of Health, "Annual Summaries, Hawaii Air Quality Data, 2001 - 2005"

Table 4

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR O'OMA BEACHSIDE VILLAGE (milligrams per cubic meter)

Roadway Intersection	Year/Scenario					
	2006/Present		2029/Without Project		2029/With Project[a]	
	AM	PM	AM	PM	AM	PM
Queen Kaahumanu Hwy at Kaimiani Drive	5.5	2.6	6.2	3.9	7.7	4.4
Queen Kaahumanu Hwy at Hulikoa Drive	4.4	2.6	5.3	3.2	6.4	3.8
Queen Kaahumanu Hwy at Hina Lani Street	5.2	4.0	5.8	4.0	6.1	4.3

Hawaii State AAQS: 10
National AAQS: 40

[a]Includes mitigation measures given in project traffic report.

Table 5

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR O'OMA BEACHSIDE VILLAGE (milligrams per cubic meter)

Roadway Intersection	Year/Scenario		
	2006/Present	2029/Without Project	2029/With Project[a]
Queen Kaahumanu Hwy at Kaimiani Drive	2.8	3.1	3.8
Queen Kaahumanu Hwy at Hulikoa Drive	2.2	2.6	3.2
Queen Kaahumanu Hwy at Hina Lani Street	2.6	2.9	3.0

Hawaii State AAQS: 5
National AAQS: 10

[a]Includes mitigation measures given in project traffic report.

Table 6

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM O’OMA BEACHSIDE VILLAGE ELECTRICAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	18
Sulfur Dioxide	184
Carbon Monoxide	18
Volatile Organics	<1
Nitrogen Oxides	79

[a]Based on U.S. EPA emission factors for utility boilers [2]. Assumes demand of 71 million kw-hrs per year of electrical power use. Estimated emission rates assume low-sulfur oil used to generate power.

Civil & Electrical Infrastructure Assessment

Civil & Electrical Infrastructure Assessment Report ‘O‘oma Beachside Village

‘O‘oma, North Kona, Island of Hawai‘i, Hawai‘i

Tax Map Key Number (3)7-3-009: 004 & 022

MAY 2008

Prepared for:
‘O‘oma Beachside Village, LLC

Prepared by:

M&E Pacific, Inc.

METCALF & EDDY | AECOM

Davies Pacific Center, 841 Bishop Street
Suite 1900, Honolulu, Hawai‘i 96813

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APPENDICES

1.0 INTRODUCTION

‘O‘oma Beachside Village, a 302.38 acre residential and commercial mixed-use community, is being planned at ‘O‘oma, North Kona, Hawai‘i. This report assesses existing conditions, future demands, and future infrastructure requirements for the community.

1.0.1 Project Description

‘O‘oma Beachside Village, LLC intends to develop a 302.383 acre property (hereinafter referred to as the Property) at ‘O‘oma, North Kona, Hawai‘i. The Property is comprised of a:

- 217.566-acre parcel identified by TMK (3)7-3-009: 004 (Parcel 4);
- 83-acre parcel identified by TMK (3)7-3-009: 022 (Parcel 22); and
- 1.814-acre portion of the State-owned Right-of-Way (ROW) located on by TMK (3)7-3-009: (State ROW).

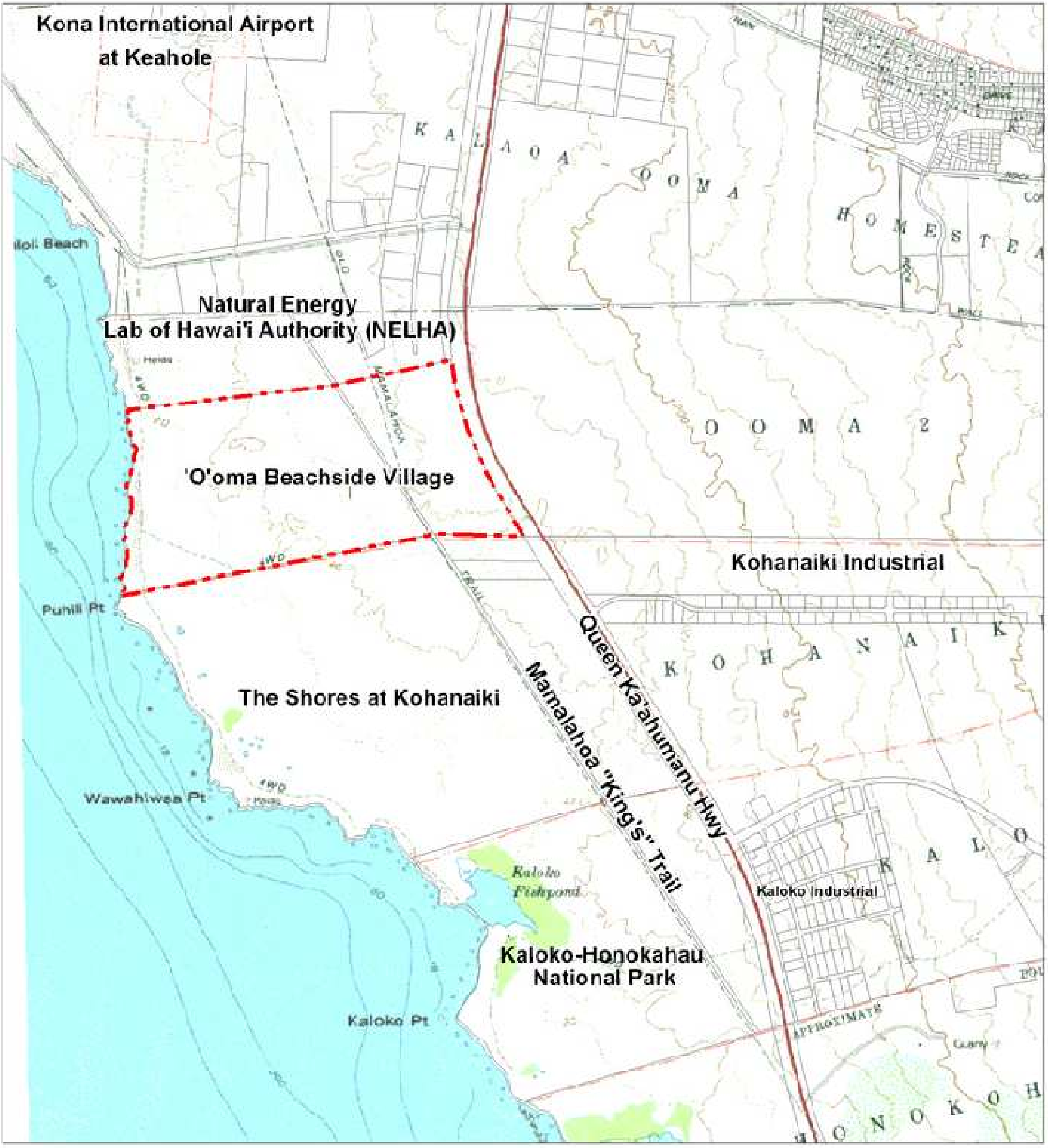
The Property is bordered by Queen Ka‘ahumanu Highway to the east, Kohanaiki Shores to the south and the Natural Energy Laboratory of Hawai‘i Authority (NELHA) to the north. The Property is located *makai* of Queen Ka‘ahumanu Highway and runs toward the shoreline (Ref **Figure 1**).

The Conceptual Plan provides for single family homes, multi-family homes, mixed-use villages combining commercial and residential uses, parks public coastal open space, and a coastal preserve area (Ref **Figure 2**).

‘O‘oma Beachside Village is planned to include:

- Approximately 950 to 1,200 homes, including:
  - Single family units,
  - Multi-family units, and
  - “Live-work” units with commercial uses on the ground floor and residential uses above.
- 200,000 square feet of commercial space, including:
  - Space for a small grocery store,
  - Restaurants, and
  - Retail and office space.
- A private or charter school site.
- A public beach park, including a community pavilion.

Construction of ‘O‘oma Beachside Village is expected to begin in 2011 and will continue through approximately 2029. For the purpose of infrastructure development and demand projection, ‘O‘oma Beachside Village is roughly divided into three (3) areas: Area A, Area B, and Area C as shown on **Figure 3**.



Legend

'O'oma Beachside Village

Source: U.S. Geological Survey

Disclaimer: This graphic has been prepared for general planning purposes only.

FIGURE 1
Regional Location Map

'O'oma Beachside Village

North Kona Village, LLC — ISLAND OF HAWAII

NORTH — LINEAR SCALE (FEET) 0 500 1,000 2,000 4,000

PBR HAWAII & ASSOCIATES, INC.
4/03/2008

PATH/FILENAME: P:\Projects\Hawaii\60012984 NKV Ooma\500 Deliverables\Draft Civil Assessment\Figure 1 Location.dwg LAST UPDATE: May 05, 2008 @ 05:46:34 pm PLOT DATE: May 05, 2008 @ 05:46:44 pm

FIGURE 2
Conceptual Plan
`O`OMA BEACHSIDE VILLAGE

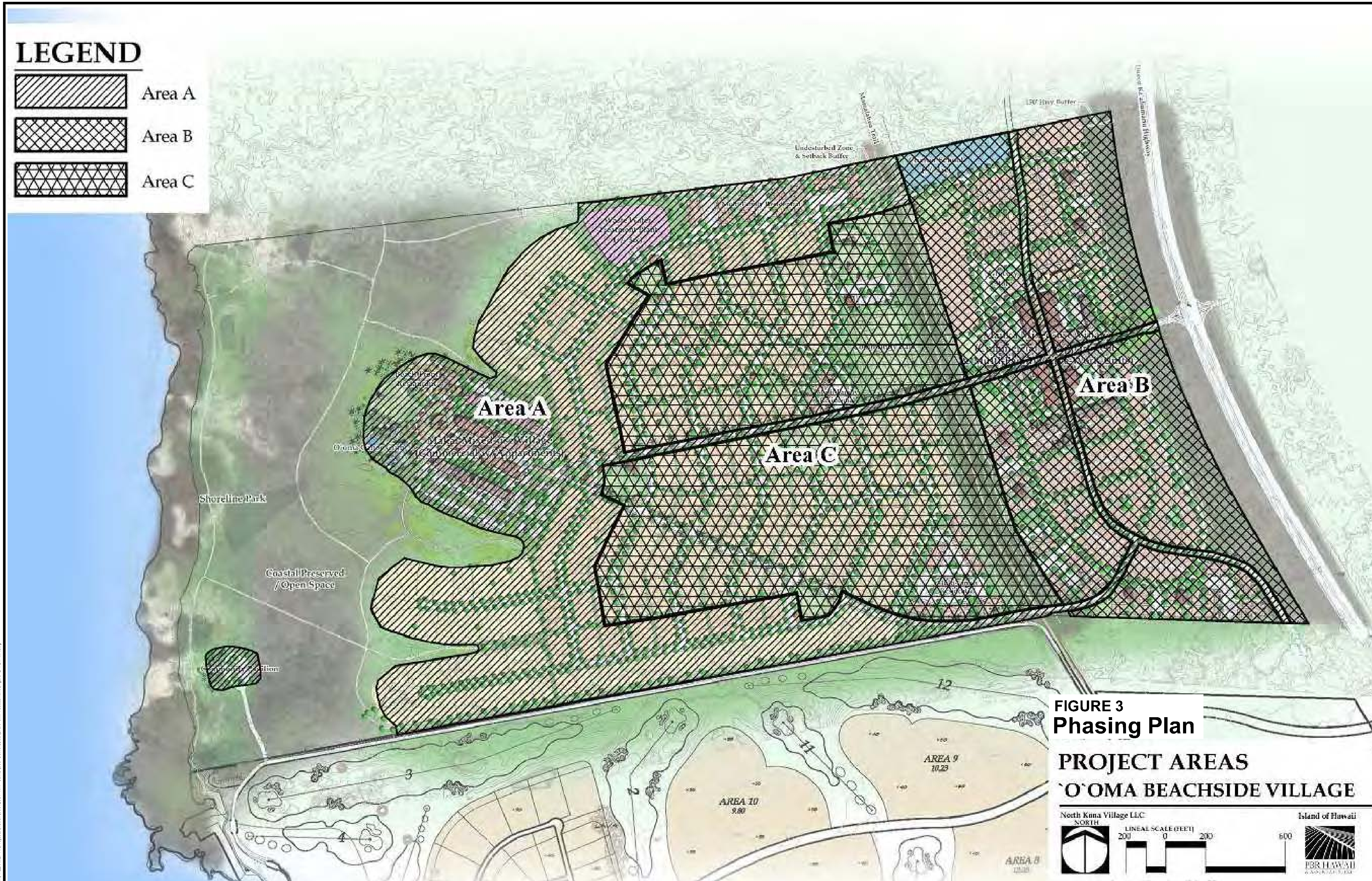


FIGURE 3
Phasing Plan

1.1 ROADWAY

1.1.1 Existing Conditions

Presently, an unpaved jeep road intersects with Queen Ka‘ahumanu Highway at an unsignalized junction on the southern Property boundary. This connection is a State of Hawai‘i Department of Transportation (SDOT) recognized access point for the Property. There are no other existing roadways into the Property.

The State ROW, erroneously referred to on survey maps as “King’s Highway,” is located between Parcels 4 and 22 and extends north-south, paralleling Queen Ka‘ahumanu Highway. At the southern boundary of the Property, the State ROW and the Mamalahoa Trail share the same alignment; however, approximately one-third of the way into the Property, the two separate, with the historic Mamalahoa Trail veering slightly *mauka* and the State ROW coming to a dead end north of ‘O‘oma Beachside Village. It is understood that the portion of the State ROW not aligned with the Mamalahoa Trail is the result of a mapping error.

The Queen Ka‘ahumanu Highway is the primary arterial highway on the west side of Hawai‘i. The highway passes through the North Kona and South Kohala districts and connects Kailua Village with the Kona International Airport at Keahole, the Kohala resort areas, and Kawaihae. It is a two-lane Class I State Highway with limited access and a design speed of 70 miles per hour.

1.1.2 Development Demand

The SDOT and County of Hawai‘i have many roadway improvements planned to meet the expected growth of the West Hawai‘i area. The “Keahole to Honaunau Regional Circulation Plan County Action Plan” (August 2006) prepared by the County of Hawai‘i Planning Department (hereinafter referred to as the RCP) identifies nine (9) specific improvements pertinent to this study. Those improvements include the widening of Queen Ka‘ahumanu Highway to the airport and the development of an extensive roadway network *mauka* of the highway

The SDOT is presently constructing a widening project on Queen Ka‘ahumanu Highway to four lanes between Henry Street and Kealakehe Parkway (Phase I). Phase I began in 2005 and is expected to continue through 2008. Continued widening to the Kona International Airport at Keahole (Phase II) is scheduled to begin in 2008. Existing and new intersections within the corridor will be signalized when warranted.

A separate Traffic Impact Assessment Report (TIAR) has been prepared for ‘O‘oma Beachside Village that assesses access to Queen Ka‘ahumanu Highway and traffic conditions along Queen Ka‘ahumanu Highway.

While this section focuses on the interior roads within ‘O‘oma Beachside Village, the RCP does impact the circulation of the private lands as well. As part of the RCP, a new network of roadways *mauka* of Queen Ka‘ahumanu Highway is planned to alleviate some of the north/south congestion. This new roadway network will be County-managed and will serve the local traffic in the Kona region. A timetable for the development of the new roadways has not been established. This *mauka* road will involve many individual land owners/developers and is not anticipated to be fully completed for another ten years.

In concert with a *mauka* road, the Draft Kona Community Development Plan (CDP) dated 6/21/07 describes a frontage road *makai* of Queen Ka‘ahumanu Highway between the airport and Huliko‘a Drive. This frontage street will consolidate vehicular access points to Queen Ka‘ahumanu for the developments *makai* of the highway is intended to serve as a secondary transit route.

1.1.3 Proposed Infrastructure

The internal roadways of ‘O‘oma Beachside Village are being planned for private ownership and maintenance. However, for future consideration of County dedication, the roads will be built to County of Hawai‘i standards with curb, gutter, and sidewalks. The roadway will act as an access and maintenance easement for the County of Hawaii and utility companies. Landscaping at the entrance and along the main drive will enhance the ambience of ‘O‘oma Beachside Village. Reference **Figure 2** for the Conceptual Master Plan.

As noted above the internal roadways will follow the County of Hawai‘i Department of Public Works and Subdivision standards. The surface, base course, and subbase requirements will be determined during the preliminary design phase with the recommendations of a geotechnical engineer. The following schemes are made for the roadway pavement widths (not including sidewalks and landscaping):

Main Driveway:	50 feet	(including planting median)
Roadway Loop:	50 feet	
Alleyways (Minor Streets)	25 feet	

1.2 WATER

1.2.1 Existing Conditions

The Kona area receives minimal trade wind rainfall due to the high elevation land masses of Mauna Loa, Mauna Kea, and Hualalai.

Total annual rainfall estimated for the Kona area is approximately 1,200 mgd, with most of the activity occurring at the higher elevations of 1,200 to 3,500 feet msl. Most of this rainfall, over two thirds, is lost through evapotranspiration.

Water resources in the Kona area are groundwater based. The County of Hawai‘i Department of Water Supply (DWS) is the major purveyor for potable water. Four (4) major wells serve the North Kona System, running from Keahole International Airport south to Kealakekua.

Presently there are no public or private water transmission lines within the Property. An existing 12” waterline runs along Queen Ka‘ahumanu Highway from the Keahole Tank mauka of the Kona International Airport at Keahole, and presently terminates along the frontage of National Energy Laboratory of Hawai‘i Authority (NELHA) before reaching the ‘O’oma property. This waterline provides service to the Airport and NELHA.

There are currently 92 DWS water commitments available for Parcel 22. Each commitment is based on a 400 gallon per day per unit residence. The Water Standards categorize a standard Single Family unit with a consumption rate of 400 gallons per day.

There are considerations for a higher per residence usage on the West side of the island as the area is arid and the residence lots tend to be larger than a typical 5,000 square foot plot, thereby requiring more water usage for irrigation of landscaping. In addition, homes on the West side tend to be more than three bedrooms and thus the potential domestic use of potable water is increased.

DWS has informed us that since there are no similar type developments existing in the area, they would use an adjacent area’s water usage as a gage on what gallon per day per unit amount that they would accept. The nearest developments with similar water usage are Keauhou to the South and Waikoloa to the North. DWS recognizes that these are two separate regions, as well as development types, and neither matches the ‘O‘oma Beachside Village.

Section 1.2.2 provides the estimated demand for ‘O‘oma Beachside Village and presents the assumed consumption rates for single family, multi-family, and non-residential uses.

Discussion with the DWS also confirms that while the credits are due to a customer, the use of the credits depends on the availability of source water. At this time, the Kona district water systems are reaching their current limits and DWS is looking at other source wells.

1.2.2 Development Demand

Due to the availability of R-1 effluent from the private wastewater treatment plant to be installed with ‘O‘oma Beachside Village as described in **Section 1.3** of this report, non-potable recycled water will be used for general irrigation of common landscaping features within the community. Potable water demand will be limited to that used for consumption, general household/commercial use, and irrigation of landscaping within individual residential lots.

The DWS determines water use demand based on land use converted to a capita per unit or capita per acre basis. For ‘O‘oma Beachside Village, the potable water demands have been calculated for the varying uses, as summarized in **Table 1** – Potable Water Consumption.

The irrigation (non-potable) water use demand is based on the acreages of general landscaped areas within ‘O‘oma Beachside Village, with an applied DWS demand rate for parks in the County of Hawai‘i. The estimated non-potable water demands are summarized in **Table 2** – Non-Potable Water Consumption.

Table 1 - Potable Water Consumption Estimate

Land Use Description	Area A (mgd)	Area B (mgd)	Area C (mgd)	Total (mgd)
Single Family Residential – Large Lots	0.077	---	---	**0.077**
Single Family Residential – Regular Lots	0.055	---	0.165	**0.220**
Multi-Family Residential	0.024	0.100	0.030	**0.154**
Mixed Use Residential	0.024	0.080	---	**0.104**
Multi-Family & Mixed Use Common Landscaping	0.014	0.027	0.006	**0.047**
Live-Work Residential	---	0.028	---	**0.028**
Commercial/Public Use	0.019	0.045	---	**0.064**
Total (mgd)	**0.213**	**0.280**	**0.201**	**0.694**

Table 2 - Non-Potable Water Consumption Estimate

Land Use Description	Area A (mgd)	Area B (mgd)	Area C (mgd)	Total (mgd)
Commercial/Public Use	0.006	0.009	---	**0.015**
Roads & Parking	0.078	0.030	0.048	**0.156**
Parks & Trails	0.036	0.018	0.084	**0.144**
Mamalahoa Trail Buffer	0.003	0.021	0.036	**0.060**
Other	---	---	---	**0.036**
Total (mgd)	**0.123**	**0.078**	**0.168**	**0.405**

The support calculations for these potable and irrigation water demand estimates can be found in **Appendix A**.

1.2.3 Proposed Infrastructure

There are several systems that can be considered for potable water infrastructure. The conventional potable water system within the area is comprised of a groundwater well *mauka* of Mamalahoa Highway with the DWS Kona Water System. Consideration for a private well, a joint-venture, or County well has been investigated; however, due to various reasons potable well water is not a feasible alternative for ‘O‘oma Beachside Village at this time.

To ensure a potable water source and a reliable self-sufficient system for ‘O‘oma Beachside Village, an on-site desalination facility feeding a private transmission, storage, and distribution system is proposed.

Several desalination processes are available and include Reverse Osmosis (RO), Multi-Stage Flash (MSF) Distillation, Ion Exchange, and Electrodialysis Reversal, among others. These processes were evaluated on the basis of feed and product water requirements, energy consumption, performance, operation and maintenance (O&M) requirements, and cost.

For operations and conditions in Hawai‘i, RO is a preferred process as it requires less energy compared to distillation techniques and it removes a wider range of minerals than electrodialysis reversal. RO has a higher water product recovery rate than distillation, reducing the volume of brine disposal.

The RO process uses a membrane filter that is highly permeable to water and only slightly permeable to dissolved solids. The membranes are subjected to high-pressure seawater, allowing only pure (potable) water through the membrane and leaving a brine solution as a filter reject solution. The major steps are:

- Intake Screening
- Pretreatment (removal of silts & solids)
- Desalination (removal of salts and dissolved constituents)
- Post-treatment (conditioning of water for potable use)
- Disposal of Byproducts (solids & brine by-products)

<u>INTAKE SCREENING</u>

Two possible sources of feedwater supply considered for desalinization are: 1) the NELHA deep (cold) or shallow (warm) systems; or 2) onsite deep wells that would tap saline groundwater at a depth beneath the brackish lens. A study conducted by Tom Nance Water Resource Engineering (under separate cover), concludes that feedwater received from NELHA or drawn from wells at depths below the basal lens will not impact the existing basal groundwater source. The desalination alternative is self-sufficient and environmentally sound, as it will not impact the basal lens or draw from the high groundwaters within the Kona water system.

<u>PRE-TREATMENT</u>

Prior to RO, the feedwater will undergo pre-treatment. The pre-treatment process improves the RO process by removing particles and compounds that can negatively impact RO membranes. During pretreatment, the feedwater is conditioned and filtered. This process adjusts the acidity of the feedwater, and prevents formation of scales on RO membranes thereby maximizing the RO performance and life span.

<u>DESALINATION</u>

After pre-treatment, the feedwater is sent through the RO membranes at a pressure of up to 1,200 psi. During the RO process, total dissolved solids (TDS) in the filtrate will be reduced from approximately 37,700 mg/l to 300 mg/l. The salinity of the resulting reject brine (filtrates) solution is at a concentration of about twice that of the intake seawater.

POST TREATMENT

The RO product water will be conditioned by: 1) a small amount of sodium hydroxide for pH adjustment that will have no impact on the safety of the water for human consumption, and 2) sodium hypochlorite in small quantities for disinfection. This water is then the final product water and available for storage and distribution as “potable” (or “drinkable”) water.

DISPOSAL OF BYPRODUCTS

The proposed desalination facility will produce four (4) waste streams as listed below:

- Reject water from the ultrafiltration process (UF)
- Backwash water from the UF membrane cleaning process
- Reject water from the RO process (brine solution)
- Wasted membrane cleaning solution (WMCS)

Reject water from the pre-treatment process will contain compounds used for water conditioning. This waste stream will also include material rejected by the filter. Backwash water from the UF membrane cleaning process will be similar to the UF reject water. Disposal options include pretreatment and diffusing it into the nearby proposed wastewater treatment facility for processing. Another option would be through pretreatment and disposal into injection wells into the underground injection control area. A permit for injection wells will have to be filed with the State of Hawai‘i Department of Health for this disposal option

Reject water from the RO process will be a brine solution as mentioned above. The brine solution will be disposed of in onsite wells that will deliver the solution into the saltwater zone below the basal lens. The brine solution would have a salinity of approximately 60 percent, which is substantially denser than either open coastal seawater (salinity of 35 percent) or saline groundwater (salinity of 33-35 percent). Owing to the greater density, as well as the horizontal-to-vertical anisotropy of the subsurface lava flows, the concentrate will flow seaward without rising into and impacting basal groundwater. Discharge into the marine environment would be offshore at a substantial distance and depth.

For maintenance purposes, the process membranes will need more cleaning than can be provided by backwashing. Continuous monitoring of water quality and adjusting dosage of conditioning compounds can avoid this. Membrane cleaning solution (MCS), which will contain citric acid, can be used to help remove biological and precipitated inorganic buildup on the membranes. Most of the MCS will be recirculated; however, a part of the solution will be discarded after its cleaning ability is diminished. The MCS will be neutralized through basic additive prior to disposal. Disposal options for the MCS are same as the filter reject and backwash waters, i.e. pretreatment prior to proposed wastewater treatment facility or underground injection.

A 1.0 mgd desalination plant is proposed on the NELHA border of ‘O‘oma Beachside Village, *makai* of the proposed wastewater treatment plant. This location will allow efficient use of NELHA drawn waters (if provided) by minimizing the length of salt water transmission. Should deep saltwater wells be required, the lower ground elevation will also help in minimizing the well depth. A pressurized transmission system will be installed to pump the ‘potable’ water into a storage facility and be gravity fed into an on-site distribution system.

The storage facility is proposed to be a new 0.5 million gallon tank at the existing DWS Keahole Tank site as the area has been previously developed and is already being used for water storage. Presently, the DWS does not have a policy or regulations for the infusing of desalinated water into the distribution systems. Therefore, at this time a separate tank and transmission system for ‘O‘oma development is proposed. As mentioned previously, this would make the treatment, storage, transmission and distribution system independently operated from DWS’ system.

A pressurized 8-inch forcemain will run along the NELHA/‘O‘oma boundary (on the Property), enter a utility corridor on Queen Ka‘ahumanu Highway and proceed up to the Keahole Tank Site. Subsequently, a gravity fed 12-inch main will run back along the pressurized line and enter the Property at the Northern most point. Reference **Figure 4 and 4a** for water treatment, transmission, storage, and distribution.

This system will also provide fire protection for the development. During fire flow usage, the domestic meter is bypassed and flows are provided for fire protection. The proposed system and storage is sized accordingly and will accommodate fire flow requirements for the ‘O’oma Beachside Village.

Should the Keahole Tank site and *mauka* transmission lines prove unfeasible, the alternative is an on-site pressurization system to provide a direct distribution system with ‘O‘oma Beachside Village. A storage tank and pressurized system would originate at the desalination facility and feed the distribution system for the community. A system of check valves and pressure reducing valves would regulate water pressure for domestic, commercial and fire protection use. This method of distribution, although kept within the Property, would incur higher operational costs.

Based on the availability of higher elevations on the *mauka* side of the highway, a gravity fed distribution system is being pursued by the ‘O‘oma Beachside Village. However, a mechanically pressurized system is commonly operated in lower lying areas around the Country such as the mid-western plains, and level topographic municipalities found in Florida, Texas, among others.

ALTERNATE SYSTEM

An alternate source of potable water continues to be discussed with the DWS utilizing the existing County Kona Water System as described in Section 1.2.1. The alternative requires use of the existing DWS 12” line along the Queen Ka‘ahumanu Highway that presently terminates along the frontage of NELHA. This line is planned to be extended south to the Kohanaiki Shores development (South of the Property) as part of the Queen Ka‘ahumanu Widening Phase II project.

The present DWS infrastructure is able to accommodate the increase in demand on the water system as additional source wells become available. Future well sites to be dedicated to the DWS are being negotiated with other developers and land owners. A proposed well into high level waters can be located south of Ka‘iminani Drive down to the Honokohau Tanks South of Hina Lani Street. The Kona Water System ties all the wells shown on **Figure 4b** (Obtained from DWS Kona Water Mater Plan), and with the addition of source waters, this alternatives provides minimal construction of offsite infrastructure.

PROPOSED UTILITY PLAN
OVERALL LAYOUT

SCALE: NOT TO SCALE

M&E Pacific, Inc.

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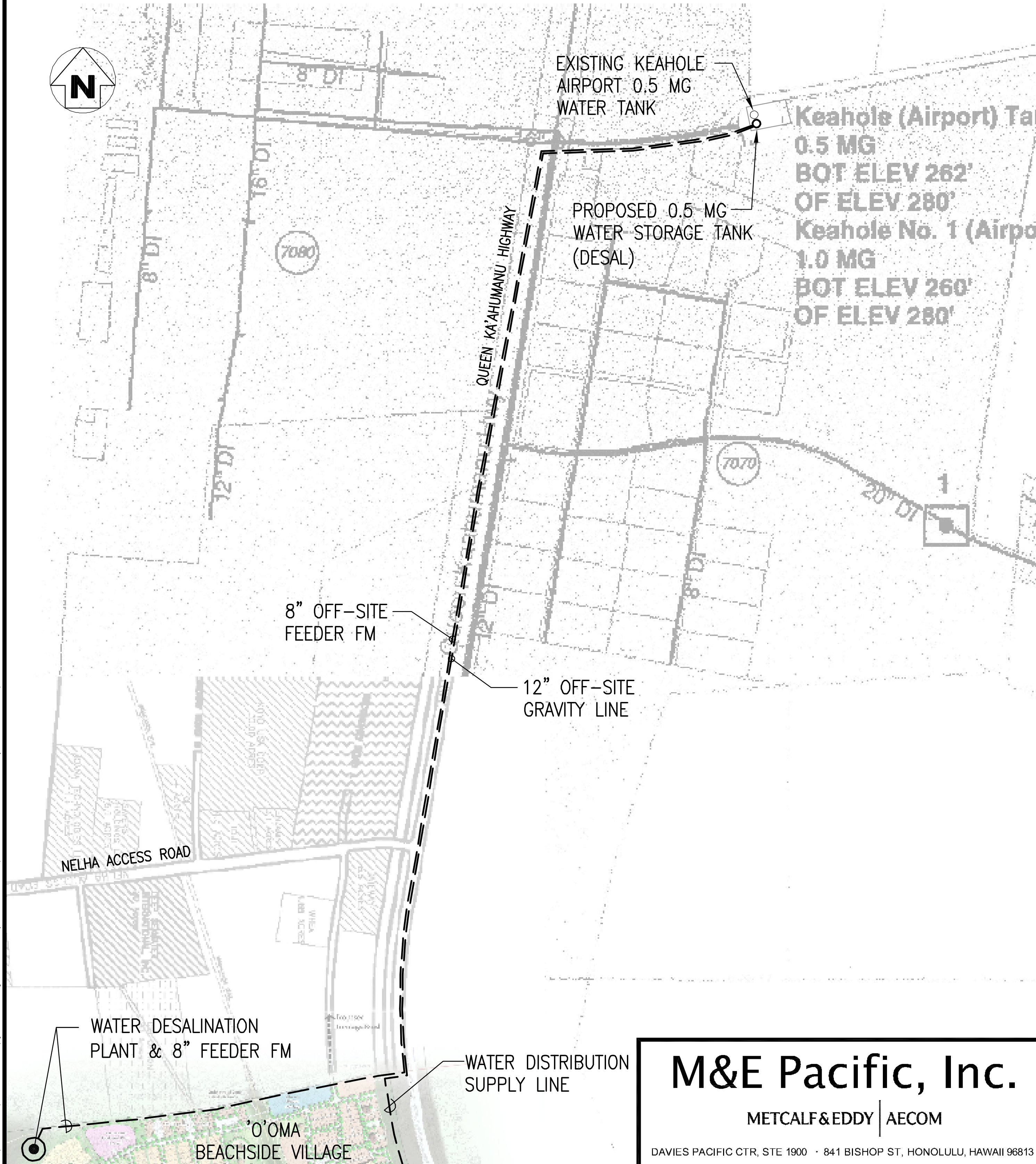
Figure 4
Proposed Utility Plan
Overall Layout
Infrastructure Report
'O'oma Beachside Villages
May 2008



PROPOSED UTILITY PLAN
OFF-SITE WATER LAYOUT

SCALE: NOT TO SCALE

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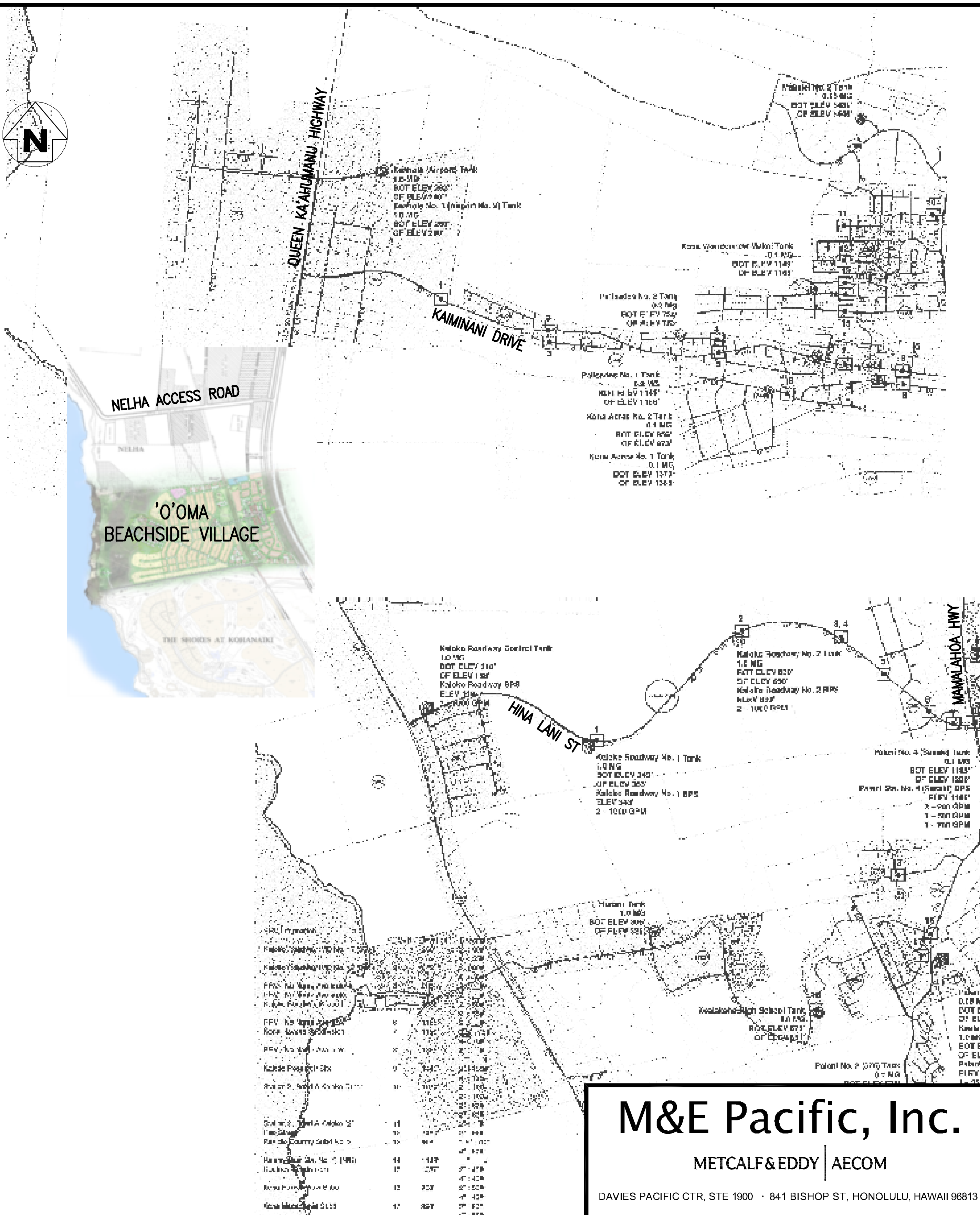
Figure 4A
Proposed Utility Plan
Off-Site Water Layout
Infrastructure Report
'O'oma Beachside Village
May 2008



DWS KONA WATER SYSTEM

SCALE: NOT TO SCALE

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Figure 4B
Department of Water Supply
Kona Water System

Infrastructure Report
'O'oma Beachside Village
May 2008

ON-SITE DISTRIBUTION

For either of the proposed potable water systems (desalination or potable well source), an on-site water distribution main will run along the ‘O‘oma Beachside Village access road from Queen Ka‘ahumanu Highway (however this would not be necessary if a on-site pressurization system is utilized). A 12” loop is recommended with 8” lines running into each development cluster. This system will be comprised of all new infrastructure, and will be design and constructed to meet DWS Design Standards. The total length of the on-site water infrastructure from the highway is approximately 9,300 linear feet. A preliminary layout of this on-site water system is also shown as part of **Figure 4**.

1.3 WASTEWATER

1.3.1 Existing Conditions

Wastewater treatment and disposal in the Kona area is mainly through individual wastewater systems (IWS) and private treatment facilities. Many single family residential units and public parks and facilities still utilize cesspool systems. However, the State Department of Health is presently governed by a consent decree to eliminate the use of such systems. For smaller facilities, a minimum treatment of a septic tank with disposal through leaching is required. For a community the size of ‘O‘oma Beachside Village, treatment by a private package plant or transmission to a larger treatment facility is necessary.

The three (3) closest treatment facilities to the Property are located at the Crown Lands of Keauhou and Kealakehe to the South and Kona International Airport at Keahole to the North.

The wastewater collection, treatment, and disposal system of the Keauhou Resorts area is a privately owned system that is maintained by the resort developers; mainly Kamehameha Investment Corporation (KIC). The wastewater from the resort’s lands is transported through a system of gravity lines and force mains to a 3.6 mgd sequencing batch reactors (SBR) facility. Effluent from the treatment facility is discharged into series of basins and used for irrigation at the resort golf courses.

This wastewater system is the farthest from the Property which makes this connection to this system an unfeasible alternative. Whereas there is currently some capacity available at the facility, this volume is reserved for KIC development.

A municipal wastewater treatment facility is located in the Kealakehe area south of Kealakehe Parkway. The 2.8 mgd wastewater treatment facility utilizes aerated lagoons for achieving secondary treated wastewater generated from the Kailua town area and along Ali‘i drive southward to Disappearing Sands. The excess capacity at this facility is reserved for its adjacent planned area.

The newly constructed tertiary treatment facility at the Kona International Airport at Keahole treats the wastewater generated from the airport and support facilities. This facility has expansion capabilities, however, past efforts to have the plant expanded for non-airport use by the County of Hawai‘i and others have been denied by the State of Hawai‘i, Department of Transportation, Airports Division. Effluent from this treatment facility is used for irrigation of the landscape at the airport entrance and main roadway.

Presently there are no public or private wastewater transmission lines fronting the Property. In December 2003, the County of Hawai‘i adopted Resolution 129-03 for the preparation of a North Kona Regional Sewerage Master Plan and a North Kona District Implementation Study for wastewater and recycled water system improvements for the Kealakehe, Honokohau, Kaloko, and Kohanaiki regions. The areas included in the implementation study are located adjacent to and just below the Property. As of April 2008, the sewer master plan for this implementation plan is in a draft stage.

A related resolution (Resolution 70-01) to initiate the extension of the municipal sewer system from Kealakehe Wastewater Treatment Plant to Kohanaiki was filed in December 2003, after a deferral in May 2001. The Kealakehe WWTP is currently slated for an upgrade and expansion (Hawai‘i County 2007). In addition, DEM will be installing infrastructure from Kealakehe Parkway to Kohanaiki in conjunction with Phase II of the DOT’s Queen Ka‘ahumanu widening project[1]. Plans for installing additional sewer and reuse infrastructure to service the North Kona Area and upgrades of the Kealakehe WWTP to provide R-1 reuse water are to be performed in additional phases. The DEM has indicated they may be able to supplement the irrigation supply for ‘O‘oma Beachside Village with effluent reuse from the Kealakehe WWTP.

There have been preliminary discussions between the County and DOT Highways to include a collection line and an effluent transmission line in Queen Ka‘ahumanu Highway as part of the second phase of the Highway expansion project. Along with the issues of including utility lines in the Highway expansion, the DOT, County, and other land owners are in discussion regarding the scope of the improvements.

1.3.2 Development Demand

The County of Hawai‘i Department of Public Works determines wastewater requirements on the basis of acreage, residential unit counts, and inflow/infiltration for dry and wet weather conditions. For design purposes, three (3) wastewater requirements are considered: the Design Average Flow, the Design Maximum Flow, and the Design Peak Flow. For ‘O‘oma Beachside Village, the demands have been calculated based on the County standards and are summarized in **Table 3** – Wastewater Demand Estimate. The wastewater system will be designed for the estimated Design Average Flow shown below.

Table 3 - Wastewater Demand Estimate

Flow Description	Area A (mgd)	Area B (mgd)	Area C (mgd)	Total (mgd)
Design Average Flow	0.132	0.219	0.128	**0.479**
Design Maximum Flow	0.627	1.036	0.608	**2.271**
Design Peak Flow	0.701	1.113	0.659	**2.473**

The support calculations for these demand estimates can be found in **Appendix B**.

[1] DEM letter dated May 30, 2007; letter included in Section 11.0 of this EIS.

1.3.3 Proposed Infrastructure

1.3.3.1 Wastewater Treatment

A private package wastewater treatment plant (WWTP) is recommended for ‘O‘oma Beachside Village. With the State Department of Health (DOH) and County of Hawai‘i Department of Water Supply (DWS) advocating the use of recycled water for non-potable purposes, a secondary facility that produces R-2 effluent is a minimal requirement. The production and use of R-1 effluent is preferred as it allows for the widest range of irrigation uses with the least amount of regulation and restrictions. Therefore, the WWTP for ‘O‘oma Beachside Village will be designed to produce an R-1 quality effluent for non-potable reuse throughout the community.

The proposed WWTP will utilize a membrane bioreactor (MBR) system to treat the wastewater from ‘O‘oma Beachside Village to produce R-1 recycled water. A MBR process is a biological treatment process (activated sludge process) combined with a separation process (membrane system). MBR systems are widely used throughout the world and are considered an industry standard for the production of reliable R-1 recycled water. An additional benefit of the MBR system is that is has a smaller facility footprint than other systems to allow for a minimal visual impact on the surrounding environment. The WWTP is currently sited in an area in the center of the Property just along the north boundary.

On-site sewer mains will run along the roadways wherever possible for the ease of maintenance. The majority of the collection system will be designed as a gravity system for discharge to the planned WWTP. However, due to the location of the WWTP a portion of the wastewater flow from Area A will be pumped to the WWTP via a package pump station and force main following primary collection by gravity flow.

The interior sewer mains will be a system of 8” gravity sewer lines with a 6” force main that discharges to the WWTP. The total length of the on-site wastewater infrastructure is approximately 32,200 linear feet. A preliminary layout of this on-site collection system is also shown as a part of **Figure 4**.

As previously mentioned, Resolution 70-01 was filed in 2001. The related Resolution 129-03, Draft 2, was adopted by the Hawai‘i County Council in December 2003. The adopted resolution proposed to initiate the preparation and submission of an Improvement District Implementation Study for the construction of wastewater system improvements for Kealakehe, Honokohau, Kaloko, and Kohanaiki. The Kona Community Development Plan (CDP) includes conceptual plans which may result in a new decentralized WWTP mauka of the Property. Thus, public wastewater treatment facilities to serve ‘O‘oma Beachside Village and the surrounding area may be available in the future. Under this scenario, a pump station and force main transmission line would replace the need for a private, on-site wastewater treatment facility. However, as the above resolution has already been adopted, it would be the responsibility of the ‘O‘oma Beachside Village, LLC to introduce a new resolution to the Council to include the Project area as a part of the study.

While a new County WWTP as noted in the CDP would be a viable alternative, without confirmation on schedule and redefining of the improvement district, ‘O‘oma Beachside Village will move forward with plans of developing its own treatment facility and R1 reuse system.

1.3.3.2 Effluent Disposal / Reuse

There are essentially three (3) methods for effluent disposal including surface discharge (ocean outfall or stream discharge), reuse especially for crop/turf irrigation, and ground disposal (injection wells, seepage pits/trenches, percolation ponds). The alternative for effluent disposal via an ocean outfall is not feasible for various reasons including cost ($4,600 per linear foot) and environmental requirements and therefore will not be considered for this project. Effluent reuse and ground disposal will be considered in this section.

Effluent Reuse

Over the last decade, the recycling of treated wastewater has gained public acceptance and is highly promoted as the preferred means of effluent disposal by the State of Hawai‘i as well as the Environmental Protection Agency (EPA).

Effluent reuse is governed by the DOH Chapter 11-62 and the Guidelines for the Treatment and Use of Recycled Water. The proposed effluent reuse areas are determined based on a water budget calculation that uses the following input variables:

- Rainfall.
- Evapotranspiration rate.
- Irrigation application.

In ‘O‘oma, and throughout the Kona coast, the climate is generally dry, with seasonal precipitation. Rainfall in this area is generally heaviest from October through March, and the average annual rainfall is approximately 25 inches. Less irrigation is needed to sustain plant growth during this “wet” period. From April to September, especially during the dry summer months, irrigation would be essential for proper plant growth.

For all reuse alternatives, DOH requires zero runoff of recycled water and zero percolation to the ground water aquifer during irrigation. During rainfall events, the DOH guidelines require that the effluent be stored or be discharged through a backup disposal system.

The DOH *Guidelines for the Treatment and Use of Recycled Water* (May 2002), state that R-1 quality water is suitable for any form of irrigation for food crops, with the stipulation that there will be no effluent irrigation within 50 feet of any drinking water supply well.

Another common use of R-1 water is for landscape irrigation. O‘oma Beachside Village is envisioned to be a sustainable and environmentally conscientious community, and recycling the effluent by means of landscape irrigation of parks and other common areas is part of this vision.

The effluent reuse system for ‘O‘oma Beachside Village would require an effluent storage facility for at least two (2) days storage, recycled water pumps, and recycled water transmission mains. As mentioned previously, little irrigation is expected during the “wet” period of October through March. Therefore, a 1.2 million gallon effluent storage reservoir is recommended for the effluent reuse system.

Injection wells will be utilized as a backup means of effluent disposal to the primary method of effluent reuse. If it occurs, the overflow from the proposed irrigation reservoir would discharge into the standby injection wells.

Ground Disposal

The proposed WWTP site is below the Underground Injection Control (UIC) line and therefore injection wells within the Property are theoretically allowed. In accordance with the City and County of Honolulu *Design Standards, Volume 2* (as used by the County of Hawai‘i, per HRS §11-62-25), “the total injection capacity of the injection system shall be equal to or greater than 200 percent of the design peak flow rate.”

However, due to its proximity to the shoreline and its location within the Special Maintenance Area (SMA) the stand-by injection wells may potentially affect the ground water and shoreline water resources. The impacts of the proposed stand-by injection wells to the ground water resources or shoreline water quality are addressed in separate reports prepared by Tom Nance Water Resources Engineering and Marine Research Consultants. These reports conclude that ‘O‘oma Beachside Village will not have any significant negative effect on ground water or ocean water quality.

It is expected that the stand-by injection well capacity may deteriorate over time. Therefore, the standby injection wells will be periodically maintained and cleaned per DOH requirements. The proposed stand-by injection wells will be monitored for water depth, flow rate, and amount entering wells, as well as chemical usage during cleaning operations.

1.4 STORM WATER DRAINAGE

1.4.1 Existing Conditions

Kona’s dry weather and very porous surface conditions support the design of a stream-lined, non-extravagant storm drain system.

During wet weather conditions, the typical drainage pattern due to the topography of the area would direct storm water runoff from the mountains flows down to Queen Ka‘ahumanu Highway. However, due to high permeability of the natural ground surface across the Property and on the upland slopes mauka of the Property, surface runoff rarely occur even during heavy rainfalls. At present, about half of the annual rainfall that occurs on the Property percolates to the underlying groundwater. The balance is evaporated or transpired into the atmosphere.

During extreme storm conditions, such as design 50 or 100 years storms, storm water sheet flow is cut off by the highway and diverted parallel-wise to a series of culverts that run under the roadway. The nearest highway culverts to the Property are located at milepost (MP) 94.43 and MP 95.25.

The existing 30” Corrugated Metal Pipe (CMP) at MP 94.43 is located closer to the airport and is over 1,000 feet north of the Property. A 14’-10” by 9’-1” culvert located at MP 95.25 is situated approximately 950 feet south of the existing access road. This runoff should continue to the south and not impact the Property.

Presently there are no other recorded storm drain culverts nearby or within the Property.

The area downstream of the Property is open to the ocean. The existing drainage pattern allows for any on-site storm water runoff that has not evaporated back into the atmosphere or detained by natural topography to discharge into the ocean. As mentioned previously, these storm conditions are based on theoretical design storms as a significant majority of storm waters do not reach the ocean front.

The ocean waters along the coastline in the area of the development are classified as Class AA. The DOH requires that marine waters with this classification “remain in their natural pristine state as nearly possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions,” (Ref. HAR §11-54-3(c)). Therefore, any additional storm water runoff generated by O‘oma Beachside Village will be collected and effectively discharged or treated to maintain the integrity of the shoreline waters.

1.4.2 Development Runoff Flow

The County of Hawai‘i Department of Public Works determines stormwater discharge flows based on acreage, ground cover conditions, rainfall intensity (by locale), and a design storm condition. For drainage areas of 100 acres or less, a 10-year recurrence interval design storm is considered.

The drainage area considered for the Property is bounded on the north, south, by the Property’s boundary, to the West by the limits of the Area A (as shown on **Figure 3**), and to the east by Queen Ka‘ahumanu Highway. As discussed in Section 1.4.1, stormwater from the *mauka* side of the highway runs parallel to the highway and discharges *makai* of the highway through a series of culverts none of which are located within the Property.

Based on these drainage limits and design conditions, the following discharge flows have been calculated using County standards for the existing conditions.

Total Area:	303 acres
Total Flow (10-year storm):	228.5 cfs

As the area is developed, the amount of open, porous ground surface is replaced by impervious rooftops and roadway pavement. This increases the amount of runoff produced by the same area under the same storm conditions. The primary design criterion for storm water runoff used by County Public Works is containment of any net increase in flow within the source’s property. Thus, all increase in flow has to be retained by the developed property via retention basins or drywells.

Based upon the conceptual plan for the future development, an approximate future flow condition has been calculated for the master-planned areas.

Area A	143.5	cfs
Area B	115.5	cfs
Area C	152.5	cfs

A preliminary layout of the described on-site storm water collection system is shown as a part of **Figure 4**. The support calculations for existing and future flows can be found in **Appendix C**.

1.4.3 Proposed Infrastructure

For ‘O‘oma Beachside Village, a storm drain system consisting of drain inlets and/or catch basins (where there may be roadway curb) and drywells is recommended. An underground injection control (UIC) permit must be obtained from the DOH Safe Drinking Water Branch for the use of drywell discharge.

The minimum storm drain line size is 18” diameter per County requirements. However, if the system is maintained as a private system, there may be local areas where 8” and 12” lines may be installed. The typical drywell design will be 6-foot diameter and 20 foot depth, with an average capacity of 6 cfs per well.

The design of the storm drain system shall be done to eliminate any on-site flooding and ponding conditions. For smaller confined areas where low flows make it impractical to construct a 20-foot deep drywell, a shorter 8-foot wide by 8-foot deep drywell can be utilized. These smaller wells have a lesser capacity for storm drain discharge of 2 cfs.

In September 2002, a proposed development nearby in the Kaloko district called for a pilot system where storm drain filtration devices are used in drainage structures. (Ref **Appendix C**, TSA Rezoning Ordinance No. 02-114, Section F.) However, in discussions with the County of Hawai‘i, Department of Public Works, the implementation of this program is being re-evaluated in light of maintenance issues. During design of ‘O‘oma Beachside Village, the status of the pilot system will be acknowledged and the storm drain system shall be designed in conjunction with County requirements.

Based on the runoff quantities calculated in Section 1.4.2 and the delineation of estimated drainage areas, a minimum of 42 drywells (6 cfs capacity) for Area A, 45 for Area B, and 34 for Area C will be required. At this stage, actual grading of the Property has not been conducted; therefore, the future flow runoff may be affected by flatter slopes, additional pavement areas, intermediate low spots or sump conditions, etc. To minimize any impacts from non-point source discharge, ‘O‘oma Beachside Village will be designed with paved roadway swales and/or curb and gutters. As stated earlier, under all conditions, containment of any net increase in flow to the downstream parcels is required to obtain County approval.

The safeguarding of ground water and shoreline water quality is not just a temporary issue but also requires the consideration and inclusion of permanent Best Management Practices (BMPs) to assure continuous protection of the State’s water bodies. The County of Hawai‘i is planning to establish a Storm Water Management Plan (SWMP) and may potentially add water quality measures as part of the County drainage standards. The City and County of Honolulu is currently implementing such a program and is in the process of updating their drainage standards to include various water quality protection requirements. While the formulation of a County of Hawai‘i SWMP is not yet contracted as of April 2008, additional consideration should be given to the addition of more detention ponds, grassing, and other permanent BMPs.

Similar to the wastewater reuse and disposal concerns, the storm water discharge may potentially affect the ground water and shoreline water in the area. As previously mentioned, Tom Nance Water Resources Engineering and Marine Research Consultants conducted separate reports analyzing storm drain infiltration, potential effluent reuse, and other issues that may impact the quality of groundwater and shoreline waters. These reports conclude that ‘O‘oma Beachside Village will not have any significant negative effect on ground water or ocean water quality.

1.5 SOLID WASTE

1.5.1 Existing Conditions

The County of Hawai‘i currently maintains two (2) active landfills on the island of Hawai‘i. One landfill is located in Hilo, and the other is located north of the Property at Pu‘uanahulu. Island residents collect their solid waste trash and transport it to any one of the 21 solid waste transfer stations located around the island. In some areas of the island, residents may hire a private collection company to pick-up their solid waste for disposal at a landfill.

The nearest transfer station to the Property is the Kailua Transfer Station, located approximately 2.7 miles to the southeast of the Property. According to the latest County of Hawai‘i *Integrated Solid Waste Management Plan* (December 2002), this transfer station collects approximately 22% of the total solid waste that is eventually transported to the Pu‘uanahulu landfill, which is anticipated to reach full capacity in about 40 years.

1.5.2 Development Waste Generation

The County of Hawai‘i Department of Environmental Management Solid Waste Division (DEM-SWD) does not have a means of estimating the anticipated solid waste that will be generated for a new development. To obtain an estimate for master-planning purposes, the rates used for a recent preliminary solid waste management plan prepared for an existing Kauai residential and commercial development were applied to ‘O‘oma Beachside Village on the basis of residential unit counts, residential area acreages, commercial area acreages, and an estimated population.

For ‘O‘oma Beachside Village it is estimated that approximately 2,160 to 2,568 tons of solid waste will be generated each year. The solid waste generation estimate is summarized in **Table 4** - Solid Waste Generation. The support calculations for these generation estimates can be found in **Appendix D**.

Table 4 - Solid Waste Generation

Land Use Description	Area A (tons/year)	Area B (tons/year)	Area C (tons/year)	Total (tons/year)
Single Family Residential – Large Lots	123 – 149	---	---	**123 – 149**
Single Family Residential – Regular Lots	158 – 175	---	455 – 525	**613 – 700**
Multi-Family Residential	67.5 – 90	293 – 375	82.5 – 113	**443 – 455**
Mixed Use Residential	61.3 – 105	263 – 350	---	**324.3 – 455**
Live-Work Residential	---	75 – 105	---	**75 – 105**
Commercial/Public Use	135	446	---	**689**
Total (tons/year)	**545 – 654**	**1,077 – 1,276**	**538 – 638**	**2,160 – 2,568**

1.6 POWER AND COMMUNICATIONS INFRASTRUCTURE

1.6.1 Electrical System – Existing Conditions

The Property is not currently served by any existing HELCo facilities. The nearest source of existing power is the 69 KV transmission overhead line on the *mauka* (east) side of Queen Ka‘ahumanu Highway. The next available source of power is the existing substation serving the NELHA. However, HELCo has determined that the substation does not have the spare capacity to accommodate our 18.6 MVA maximum projected loads. Reference power calculations and HELCo letter dated September 12, 2006 **Appendix E**.

1.6.2 Electrical System – Proposed Infrastructure

HELCo will require a new fenced 150’ x 150’ lot for the substation’s 69 KV tower and pad-mounted transformer, preferably adjacent to the existing 69 KV overhead line. If creating a substation *mauka* of the Queen Ka‘ahumanu Highway right-of-way is problematic, the alternate choice would be to construct the substation *makai* of the highway within the Property. HELCo would install an overhead 69 KV crossing of the highway to the new substation, with underground distribution to the Property. An underground 69 KV line extension in lieu of an overhead drop may be considered, however this would need to be coordinated with the Department of Transportation, Highways Division.

Previous discussions with the County Planning Department have suggested the 150’ highway setback area along Queen Ka‘ahumanu Highway may be used for the HELCo substation. This solution shall be pursued, as submission of this portion of the Property would not impact the overall developable land area that is planned. Whereas the substation is not housed in a building, solid fences and landscaping may be necessary to soften the visual impact of the substation

HELCo estimates a $1.2 million basic overhead service cost and a 2-year design/ construction schedule for the substation. The $1.2 million Advance will be refunded to the payee over the next 5 years as load is added to the substation and meter revenue is generated.

The electrical consumption demand is summarized in **Tables 5 & 6** – Electrical Consumption Estimate in MVA and kW-hr/yr, respectively. The support calculations for these consumption estimates can be found in **Appendix E**.

Table 5 - Electrical Consumption Estimate (MVA)

Land Use Description	**Area A (MVA)**	**Area B (MVA)**	**Area C (MVA)**	**Total (MVA)**
Single Family Residential – Large Lots	0.85	---	---	**0.85**
Single Family Residential – Regular Lots	1.00	---	3.00	**4.00**
Multi-Family Residential	0.60	2.50	0.75	**3.85**
Mixed Use Residential	0.60	2.00	---	**2.60**
Live-Work Residential	---	0.70	---	**0.70**
Commercial/Public Use	2.17	3.55	---	**5.72**
Street Lighting & Incidentals	0.26	0.44	0.19	**0.89**
Total (MVA)	**5.48**	**9.19**	**3.94**	**18.6**

Table 6 - Electrical Consumption Estimate (10^6 kW-hr/yr)

Land Use Description	**Area A (10^6 kW-hr/yr)**	**Area B (10^6 kW-hr/yr)**	**Area C3 (10^6 kW-hr/yr)**	**Total (10^6 kW-hr/yr)**
Single Family Residential – Large Lots	1.77 – 7.70	---	---	**1.77 – 7.70**
Single Family Residential – Regular Lots	2.08 – 2.81	---	6.24 - 8.42	**8.32 – 11.23**
Multi-Family Residential	1.25 – 1.68	5.20 - 7.02	1.56 - 2.11	**8.01 – 10.81**
Mixed Use Residential	1.25 – 1.68	4.16 - 5.62	---	**5.41 – 7.30**
Live-Work Residential	---	1.46 - 1.96	---	**1.46 - 1.96**
Commercial/Public Use	11.60 – 12.42	10.49 – 12.75	---	**22.09 – 25.17**
Street Lighting & Incidentals	1.87 – 2.21	2.93 - 3.46	0.755 - 0.892	**5.56 – 6.56**
Total (10^6 kW-hr/yr)	**19.8 - 28.5**	**24.2 - 30.8**	**8.56 - 11.4**	**52.6 - 70.7**

1.6.3 Telephone System – Existing Conditions

The Property has no existing Hawaiian Telcom (HTCO) telephone facilities. The nearest source of telecommunications service is HTCO’s fiber optic lines on HELCo’s 69 KV pole line *mauka* of Queen Ka‘ahumanu Highway. The next available source of telephone service is a small equipment hut serving a small agricultural subdivision to the north of the Property. However, HTCO has determined that source to be too small and too far away to serve the ‘O‘oma Beachside Village. Refer to HTCO letter to ECS, Inc., **Appendix E**.

1.6.4 Telephone System – Proposed Infrastructure

HTCO tentatively plans to construct a new “mini-hut” or “pair-gain” on the Property to provide telecommunications service. A pair-gain or mini-hut is a packaged, self-contained metal enclosed ±10’W x 15’L x 6’H, equipment rack on a concrete pad which is fed with fiber optic lines and generates thousands of telephone copper pairs. The pair-gain requires a 30’ x 30’ lot or it may be placed in a developer-provided building. The pair-gain lot may be fenced and landscaped to soften visual impact. Similar to the HELCo substation, this “pair-gain” unit may be developed in the highway setback area thereby not impacting the current development plan.

As there are no existing ducts across Queen Ka‘ahumanu Highway within the project limits, new telephone ductlines will have to be added at the highway intersection.

The telephone load demand is summarized in **Table 7** – Telephone Load Estimate. The support calculations for these load estimates can be found in **Appendix E**.

Table 7 - Telephone Load Estimate

Land Use Description	**Area A (PR)**	**Area B (PR)**	**Area C (PR)**	**Total (PR)**
Single Family Residential – Large Lots	255	---	---	**255**
Single Family Residential – Regular Lots	300	---	900	**1,200**
Multi-Family Residential	180	750	225	**1,155**
Mixed Use Residential	180	600	---	**780**
Live-Work Residential	---	210	---	**210**
Commercial/Public Use	274.2	321.4	---	**595.6**
Total (PR)	**1,189**	**1,882**	**1,125**	**4,192**

1.6.5 CATV System – Existing Conditions

The Property currently has no CATV facilities on site. The nearest source of CATV service is Oceanic Cablevision’s fiber optic lines on HELCo’s 69 KV pole line *mauka* of Queen Ka‘ahumanu Highway. Although the existing agricultural subdivision to the north of the Property has CATV service, that is not a desirable source of CATV service, as fiber lines are available directly across the highway. There is an existing node located directly across of the NELHA entrance that serves the agricultural lots on the *mauka* side of the highway. See Oceanic Time Warner’s letter dated August 30, 2006, **Appendix E**.

1.6.6 CATV System – Proposed Infrastructure

Oceanic will require at least one “node” within the Property. This node is a free-standing cabinet located within a 6’ x 6’ easement. It is anticipated that Oceanic’s system will also provide high-speed data connectivity. The capacity of each node is approximately 250 service accounts, therefore several nodes will be needed to extend service to the proposed commercial and residential units in the development.

Cost of the CATV system is negotiable, as estimated revenue must be balanced against installed construction cost. An estimated cost of $20,000 per mile of line extension has been provided by Oceanic. As there are no existing ducts across Queen Ka‘ahumanu Highway within the Property, new CATV ductlines will have to be added at the highway intersection.

1.7 ORDER OF MAGNITUDE COSTS

Table 8 - Order of Magnitude Cost Comparison

Component Description	Area A	Area B	Area C	Total
Site Preparation*	$350,000	$250,000	$400,000	**$1,000,000**
Roadway	$8,000,000	$3,000,000	$3,000,000	**$14,000,000**
Storm Drain	$2,500,000	$450,000	$2,000,000	**$4,950,000**
Wastewater System	$21,500,000	$3,500,000	$9,500,000	**$34,500,000**
Water System	$12,000,000	$1,500,000	$2,500,000	**$16,000,000**
Electrical/Telephone/Cable	$11,500,000	$2,500,000	$10,000,000	**$24,000,000**
Mobilization & Contingencies	$10,000,000	$3,000,000	$6,500,000	**$19,500,000**
Total	**$67,850,000**	**$14,200,000**	**$33,900,000**	**$115,950,000**

*Site Preparation estimate does not include mass grading or earthwork costs.

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APPENDICES

Appendix A—Water System: Calculation and Reference Documents
Appendix B—Wastewater System: Calculation and Reference Documents
Appendix C—Storm Drain System: Calculation and Reference Documents
Appendix D—Solid Waste Generation: Calculation and Reference Documents
Appendix E—Power and Communication System: Calculation and Reference Documents

APPENDIX A

Water System: Calculation and Reference Documents

Potable Water Consumption Estimate

Land Uses by Area	Total Approx. Acreage	Approx. Units Count	Potable Demand Area	Landscape / Common Area	Approx. Commercial Floor Area	Estimated Potable Water Demand Rate	Estimated Average Daily Potable Water Demand	Estimated Maximum Daily Potable Water Demand
	(acres)		(acres)	(acres)	(sq.ft.)		(gpd)	(gpd)
Area A								
Single Family Lot (9,000 - 15,000 sf)	22	70 - 85	22	0	-	900 GPD/DU*	76,500	114,750
Single Family Lot (5,000 - 6,000 sf)	12	90 - 100	12	0	-	550 GPD/DU**	55,000	82,500
Multi-Family Residential	5	45 - 60	3.5	1.5	-	400 GPD/DU	24,000	36,000
Makai Mixed-Use Village & Beachfront Restaurant	7		4	3	40,000	3,000 GPD/AC	12,000	18,000
Multi-Family & Mixed-Use Common Landscaping	(4.5)	-	4.5	-	-	3,000 GPD/AC	13,500	20,250
Residential Apartment on top of Commercial	-	35 - 60	-	-	-	400 GPD/DU	24,000	36,000
Ooma Canoe Club	2	-	1	1	10,000	3,000 GPD/AC	3,000	4,500
Road & Parking	26	-	-	13	-	-	–	-
Parks and Trails	6	-	-	6	-	-	–	-
Waste Water Treatment Plant	2	-	10 people	0	-	20 GPD/CAPITA	200	300
Mamalahoa Trail Undisturbed Zone / Setback Buffer	1	-	-	0.5	-	-	–	-
Community Pavilion	1	-	1	0.5	-	4,000 GPD / AC	4,000	6,000
Subtotal :	**84**	**240 – 305**	**48**	**25.5**	**50,000**		**212,200**	**318,300**
Area B								
Mauka Mixed-Use (Commercial below Residential)	14	-	12	2	135,000	3,000 GPD/AC	36,000	54,000
Mauka Mixed-Use (Residential Apartment on top of Commercial)	-	150 - 200	-	-	-	400 GPD/DU	80,000	120,000
Mauka Mixed-Use (Live-Work Units***)	4	50 - 70	2.8	1.2	-	400 GPD/DU	28,000	42,000
Multi-Family & Mixed-Use Common Landscaping	(9)	-	9	-	-	3,000 GPD/AC	27,000	40,500
Grocery Store	1	-	1	0	15,000	3,000 GPD/AC	3,000	4,500
Multi-Family Residential	19	195 - 250	13.2	5.8	-	400 GPD/DU	100,000	150,000
Charter School	3	-	1.5	1.5	-	4,000 GPD/AC	6,000	9,000
Road & Parking	10	-	-	5	-	-	-	-
Parks	3	-	-	3	-	-	-	-
Mamalahoa Highway Buffer	9	-	-	3.5	-	-	-	-
Subtotal :	**63**	**395 – 520**	**39.5**	**22.0**	**150,000**		**280,000**	**420,000**
Area C								
Single Family Lot (5,000 - 6,000 sf)	35	260 - 300	35	0	-	550 GPD/DU**	165,000	247,500
Multi-Family Residential	6	55 - 75	4	2	-	400 GPD/DU	30,000	45,000
Multi-Family Common Landscaping	(2)	-	2	-	-	3,000 GPD/AC	6,000	9,000
Community Park	7	-	-	7	-	-	-	-
Parks & Trails	7	-	-	7	-	-	-	-
Road & Parking	16	-	-	8	-	-	-	-
Mamalahoa Trail Undisturbed Zone / Setback Buffer	11	-	-	6	-	-	-	-
Subtotal :	**82**	**315 – 375**	**41**	**30.0**	**0**		**201,000**	**301,500**
Others								
Costal Preserved / Open Space	57	-		0	-	-	-	-
Shoreline Park (Excluding the Public Canoe Club)	17	-		6	-	-	-	-
Subtotal :	**74**	**0**		**6.0**	**0**			
TOTAL :	**303**	**950 - 1,200**		**84**	**200,000**		**693,200**	**1,039,800**

* Single Family Lot (9,000 - 15,000 sf) - assumes 30% of lot irrigated. 12,000sf x .30 = 3,600 / 43,560 = 0.083 acre x 6,000 gpd = 498 gpd + 400 gpd = 898 say 900 gpd/unit

** Single Family Lot (5,000 - 6,000 sf) - assumes 20% of lot irrigated. 5,500sf x .20 = 1,100 / 43,560 = 0.025 acre x 6,000 gpd = 150 gpd + 400 gpd = 550 gpd/unit

*** Live-Work units use multi-family standard (400 gpd/unit); No commercial areas included.

Nonpotable Water Consumption Estimate

Land Uses by Phase	Total Approx. Acreage	Approx. Units Count	Non-Potable Landscape / Common Area	Estimated Nonpotable Water Demand Rate	Estimated Average Daily Non potable Water Demand	Estimated Maximum Daily Nonpotable Water Demand
	(acres)		(acres)	(gpd/acre)	(gpd)	(gpd)
Area A						
Single Family Lot (9,000 - 15,000 sf)	22	70 - 85	0	-	-	-
Single Family Lot (5,000 - 6,000 sf)	12	90 - 100	0	-	-	-
Multi-Family Residential	5	45 - 60	1.5**	-	-	-
Makai Mixed-Use Village & Beachfront Restaurant	7	-	3**	-	-	-
Multi-Family & Mixed-Use Common Landscaping*	(4.5)	-	-	-	-	-
Residential Apartment on top of Commercial	-	35 - 60	-	-	-	-
Ooma Canoe Club	2	-	1	6,000	6,000	9,000
Road & Parking	26	-	13	6,000	78,000	117,000
Parks and Trails	6	-	6	6,000	36,000	54,000
Waste Water Treatment Plant	2	-	0	-	-	-
Mamalahoa Trail Undisturbed Zone / Setback Buffer	1	-	0.5	6,000	3,000	4,500
Community Pavilion	1	-	0.5***	-	-	-
Subtotal :	**84**	**240 – 305**	**20.5**		**123,000**	**184,500**
Area B						
Mauka Mixed-Use (Commercial below Residential)	14	-	2**	-	-	-
Mauka Mixed-Use (Residential Apartment on top of Commercial)	-	150 - 200	-	-	-	-
Mauka Mixed-Use (Live-Work Units)	4	50 - 70	1.2**	-	-	-
Multi-Family & Mixed-Use Common Landscaping*	(9)	-	-	-	-	-
Grocery Store	1	-	0	-	-	-
Multi-Family Residential	19	195 - 250	5.8**	-	-	-
Charter School	3	-	1.5	6,000	9,000	13,500
Road & Parking	10	-	5	6,000	30,000	45,000
Parks	3	-	3	6,000	18,000	27,000
Mamalahoa Highway Buffer	9	-	3.5	6,000	21,000	31,500
Subtotal :	**63**	**395 – 520**	**13.0**		**78,000**	**117,000**
Area C						
Single Family Lot (5,000 - 6,000 sf)	35	260 - 300	0	-	-	-
Multi-Family Residential	6	55 - 75	2**	-	-	-
Multi-Family Common Landscaping*	(2)	-	-	-	-	-
Community Park	7	-	7	6,000	42,000	63,000
Parks & Trails	7	-	7	6,000	42,000	63,000
Road & Parking	16	-	8	6,000	48,000	72,000
Mamalahoa Trail Undisturbed Zone / Setback Buffer	11	-	6	6,000	36,000	54,000
Subtotal :	**82**	**315 – 375**	**28.0**		**168,000**	**252,000**
Others						
Costal Preserved / Open Space	57	-	0	-	-	-
Shoreline Park (Excluding the Public Canoe Club)	17	-	6	6,000	36,000	54,000
Subtotal :	**74**	**–**	**6.0**		**36,000**	**54,000**
TOTAL :	**303**	**950 - 1,200**	**68**		**405,000**	**607,500**

* Multi-Family & Mixed Use common area landscaping separated into this line item. These areas will be irrigated with potable water.

** Landscape/Common Areas removed and reallocated into "Multi-Family & Mixed-Use Common Landscaping.

*** Community Pavilion to be irrigated with potable water.

APPENDIX B
Wastewater System: Calculation and Reference Documents

'O'OMA BEACHSIDE VILLAGE

Wastewater Calculations

DESCRIPTION	Units	Area (acres)	Ave Flow (gpd)	Max Flow Factor	Dry I/I (gpd)	Design Ave (gpd)	Design Max (gpd)	Wet I/I (gpd)	Design Peak (gpd)	Reported Dsn. Peak (gpd)	Design Peak (cfs)
AREA A											
Single Family	185	34	59,200	5	3,700	**62,900**	299,700	42,500	342,200	343,000	0.53
Multi-Family	60	5	19,200	5	1,200	**20,400**	97,200	6,250	103,450	104,000	0.16
Mixed Use (R)	60	7	13,440	5	1,200	**14,640**	68,400	8,750	77,150	78,000	0.12
Mixed Use (C)	---	7	22,400	5	1,400	**23,800**	113,400	8,750	122,150	123,000	0.19
Commercial	---	3	9,600	5	600	**10,200**	48,600	3,750	52,350	53,000	0.08
TOTAL DEMAND (AREA A)						**131,940**	**627,300**			**701,000**	**1.08**
AREA B											
Single Family	0	0	0	5	0	**0**	0	0	0	0	0.00
Multi-Family	250	19	80,000	5	5,000	**85,000**	405,000	23,750	428,750	429,000	0.66
Mixed Use (R)	270	18	60,480	5	5,400	**65,880**	307,800	22,500	330,300	331,000	0.51
Mixed Use (C)	---	18	57,600	5	3,600	**61,200**	291,600	22,500	314,100	315,000	0.49
Commercial	---	1	3,200	5	200	**3,400**	16,200	1,250	17,450	18,000	0.03
School	---	3	3,000	5	600	**3,600**	15,600	3,750	19,350	20,000	0.03
TOTAL DEMAND (AREA B)						**219,080**	**1,036,200**			**1,113,000**	**1.72**
AREA C											
Single Family	300	35	96,000	5	6,000	**102,000**	486,000	43,750	529,750	530,000	0.82
Multi-Family	75	6	24,000	5	1,500	**25,500**	121,500	7,500	129,000	129,000	0.20
TOTAL DEMAND (AREA C)						**127,500**	**607,500**			**659,000**	**1.02**
OVERALL*											
Single Family	485	69	155,200	5	9,700	**164,900**	785,700	86,250	871,950	872,000	1.35
Multi-Family	385	30	123,200	5	7,700	**130,900**	623,700	37,500	661,200	662,000	1.02
Mixed Use (R)	330	25	73,920	5	6,600	**80,520**	376,200	31,250	407,450	408,000	0.63
Mixed Use (C)	---	25	80,000	5	5,000	**85,000**	405,000	31,250	436,250	437,000	0.68
Commercial	---	4	12,800	5	800	**13,600**	64,800	5,000	69,800	70,000	0.11
School	---	3	3,000	5	600	**3,600**	15,600	3,750	19,350	20,000	0.03
TOTAL DEMAND (OVERALL)						**478,520**	**2,271,000**			**2,469,000**	**3.82**

__*NOTE:__ The Overall sewer calculations are based upon the overall unit and area counts. These totals may differ from the sum of the three areas due to rounding.

__Design Flows based on Average Daily Per Capita Flow__

- 80 gallons per capita per day
- 4 persons per single family home
- 2.8 persons per apartment units (used for Mixed-Use)
- 4 persons per townhome/duplex unit
  (assumption on townhomes/duplex based on larger size units)
- 40 persons per acre for commercial and business areas

Pipe Hydraulics will be based on peak flow.
Design peak flow is the sum of the design maximum flow and wet weather infiltratio
Design maximum flow is the sum of the maximum flow and dry weather infiltration.
Maximum flow is based on the average flow multiplied by a flow factor.

__Example Calculation: 185 single family units__

Average Flow:	185 units * 4 persons/unit * 80 gal/capita/day	
	59,200	gallons/day
Max flow factor:	5	
Max flow:	296,000	gallons/day
Dry I/I:	185 units * 4 persons/unit * 5 gal/capita/day	
	3,700	gallons/day
Design Ave:	62,900	gallons/day
Design Max:	299,700	gallons/day
Wet I/I:	34 acres * 1250 gallons/acre/day	
	42,500	gallons/day
Design Peak:	342,200	gallons/day
say:	343,000	gallons/day
=	0.53	cfs

APPENDIX C

Storm Drain System: Calculation and Reference Documents

'O'OMA BEACHSIDE VILLAGE

Storm Drain Calculations

Sample Calculations for 10 year design storm (See Attached Tables)
PAVED AREA - Sample Area 1A

A = Q / CI

"C" based on Table 1 (County of Hawaii Storm Drainage Standards)
C = infiltration + relief + vegetal cover + development type
infiltration is negligible: 0.2
relief is flat: 0.00
vegetal cover is none: 0.0
development type is residential: 0.40
C = 0.6

I = rainfall intensity
one hour rainfall from Plate 1 is ~1.9 inches
inlet concentration is ~12 min from Plate 3
I = 3.75in/hr (from Plate 4)

Q = 6 cfs (based on average capacity of 6' deep drywell)

A = 2.67 acres / drywell

'O'OMA BEACHSIDE VILLAGE

Existing Drainage Calculations

C values:			
Infiltration	0.0	high	From Table 1
Relief	0.0	flat	From Table 1
Vegetal Cover	0.05	poor	From Table 1
Development	0.15	agricultural	From Table 1
TOTAL C:	**0.20**		

Area ID	**Length (ft)**	**Slope (%)**	**Tc (min)**	**I (in/hr)**	**C**	**Planimeter (si)**	**Meas. Area (acres)**	**Q=CIA (cfs)**
1	800	3.75	8.8	4.75	0.2	17.84	19.7	**18.8**
2	1,450	2.41	11.6	3.65	0.2	11.53	12.7	**9.3**
3	2,050	2.44	38	2.6	0.2	32.22	35.5	**18.5**
4a	2,000	1.875	17.25	---	---	---	---	**---**
4b	2,000	1.875	17.25	2.5	0.2	105.34	115.8	**57.9**
5	500	1	27.8	2.75	0.2	2.93	3.3	**1.9**
6	2,150	1.75	17.3	3.35	0.2	54.92	60.5	**40.6**
7	2,400	2.71	20.25	3.08	0.5	48.03	52.9	**81.5**
							TOTAL:	**228.5**

'O'OMA BEACHSIDE VILLAGE

Developed Drainage Calculations

Area ID	Area Name	Area (acres)	Length (feet)	Slope %	Tc (min)	I (in/hr)	C	Area/Inlet (acres)	Q (cfs)	# CB or drywells
1A	A	7.5	1,375	1.96%	12.5	3.75	0.6	2.67	16.9	3
1B	A	4.4	1,265	1.82%	12.5	3.75	0.6	2.67	9.9	2
2	A	7.1	660	3.79%	8.4	3.85	0.6	2.60	16.5	3
3	A	6.2	353	4.82%	6.75	4.5	0.6	2.22	16.8	3
4	A	5.3	202	2.48%	6	4.65	0.6	2.15	14.8	6
5	A	5.7	385	3.12%	7.3	4.45	0.6	2.25	15.3	4
6	A	11.4	820	2.20%	10.25	3.85	0.6	2.60	26.4	9
7	A	2.1	406	2.96%	7.5	4.4	0.6	2.27	5.6	0
8	A	4.8	220	2.27%	6	4.65	0.6	2.15	13.4	3
9	A	2.9	245	1.63%	6.8	4.5	0.6	2.22	7.9	2
10	B	1.6	355	2.54%	7.4	4.4	0.6	2.27	4.3	1
11	B	1.9	478	3.77%	7.75	4.35	0.6	2.30	5	2
12	B	3.0	100	5.00%	5	4.9	0.6	2.04	8.9	2
13	B	2.1	145	3.45%	5	4.9	0.6	2.04	6.2	2
14	B	2.8	318	2.83%	7.2	4.45	0.6	2.25	7.5	3
15	B	3.7	435	2.76%	6.5	4.55	0.6	2.20	10.2	3
16	B	0.9	141	7.09%	6	4.65	0.6	2.15	2.6	1
17	B	7.3	573	2.97%	8.5	3.85	0.6	2.60	16.9	3
18	B	1.6	116	4.31%	5	4.9	0.6	2.04	4.8	2
19	B	5.1	596	3.02%	8.5	3.85	0.6	2.60	11.8	5
20	B	1.8	455	0.88%	10.2	3.85	0.6	2.60	4.2	1
21	B	1.3	240	3.33%	6	4.65	0.6	2.15	3.7	1
22	B	0.9	218	1.83%	6.5	4.55	0.6	2.20	2.5	1
23	B	2.0	387	2.07%	7.7	4.35	0.6	2.30	5.3	1
24	B	1.1	170	2.94%	5.2	4.85	0.6	2.06	3.3	1
25	B	2.1	240	0.83%	7.8	4.35	0.6	2.30	5.5	1
26	B	1.3	170	4.71%	5	4.9	0.6	2.04	3.9	1
27	B	3.3	363	3.03%	7.2	4.45	0.6	2.25	8.9	3
28	C	14.9	930	1.51%	11.9	3.75	0.6	2.67	33.6	6
29	C	4.6	336	1.49%	8	4.25	0.6	2.35	11.8	2
30	C	8.3	942	1.17%	12.9	3.65	0.6	2.74	18.2	5
31	C	13.6	1,087	1.84%	15.1	3.5	0.6	2.86	28.6	6
32	C	13.6	655	1.83%	10	3.9	0.6	2.56	31.9	8
33	C	7.7	752	1.86%	10.4	3.8	0.6	2.63	17.6	4
34	C	4.2	474	2.74%	7.8	4.35	0.6	2.30	11	3
	TOTAL	**168.1**							**411.7**	**103**

SUMMARY	Area A	Area B	Area C	TOTAL
CB/Drywell by Area	0	0	0	0
Additional for Rdwy	7	11	0	18
TOTAL CB/Drywell	**7**	**11**	**0**	**18**

APPENDIX D

Solid Waste Generation: Calculation and Reference Documents

Solid Waste Generation Estimate

Land Uses by Area	Total Approx. Acreage	Approx. Commercial Floor Area	Approx. Units Count	Solid Waste Multiplier	Approx. Solid Waste Generation
	(acres)	(sq.ft.)		(per year)	(tons/yr)
AREA A					
Single Family Lot (9,000 - 15,000 sf)	22	-	70 - 85	1.75 tons/unit	123 - 149
Single Family Lot (5,000 - 6,000 sf)	12	-	90 - 100	1.75 tons/unit	158 - 175
Multi-Family Residential	5	-	45 - 60	1.5 tons/unit	67.5 - 90
Makai Mixed-Use Village & Beachfront Restaurant	7	40,000		2.7 tons/1000 sq.ft.	108
Multi-Family & Mixed-Use Common Landscaping	(4.5)	-	-	-	-
Residential Apartment on top of Commercial	-	-	35 - 60	1.75 tons/unit	61.3 - 105
Ooma Canoe Club	2	10,000	-	2.7 tons/1000 sq.ft.	27
Road & Parking	26	-	-	-	-
Parks and Trails	6	-	-	-	-
Waste Water Treatment Plant	2	-	-	-	-
Mamalahoa Trail Undisturbed Zone / Setback Buffer	1	-	-	-	-
Community Pavilion	1	-	-	-	-
Subtotal :	**84**	**50,000**	**240 – 305**		**545 - 654**
AREA B					
Mauka Mixed-Use (Commercial below Residential)	14	150,000	-	2.7 tons/1000 sq.ft.	405
Mauka Mixed-Use (Residential Apartment on top of Commercial)	-	-	150 - 200	1.75 tons/unit	263 - 350
Mauka Mixed-Use (Live-Work Units***)	4	-	50 - 70	1.5 tons/unit	75 - 105
Multi-Family & Mixed-Use Common Landscaping	(9)	-	-	-	-
Grocery Store	1	15,000	-	2.7 tons/1000 sq.ft.	41
Multi-Family Residential	19	-	195 - 250	1.5 tons/unit	293 - 375
Charter School	3	-	-	-	-
Road & Parking	10	-	-	-	-
Parks	3	-	-	-	-
Mamalahoa Highway Buffer	9	-	-	-	-
Subtotal :	**63**	**165,000**	**395 – 520**		**1077 - 1276**
AREA C					
Single Family Lot (5,000 - 6,000 sf)	35	-	260 - 300	1.75 tons/unit	455 - 525
Multi-Family Residential	6	-	55 - 75	1.5 tons/unit	82.5 - 113
Multi-Family Common Landscaping	(2)	-	-	-	-
Community Park	7	-	-	-	-
Parks & Trails	7	-	-	-	-
Road & Parking	16	-	-	-	-
Mamalahoa Trail Undisturbed Zone / Setback Buffer	11	-	-	-	-
Subtotal :	**82**	**0**	**315 – 375**		**538 - 638**
OTHERS					
Costal Preserved / Open Space	57	-	-		-
Shoreline Park (Excluding the Public Canoe Club)	17	-	-		-
Subtotal :	**74**	**0**	**0**		
TOTAL :	**303**	**215,000**	**950 - 1,200**		**2160 - 2568**

*** Live-Work units use multi-family standard (1.5 tons/unit); No commercial areas included.

APPENDIX E

Power and Communication System: Calculation and Reference Documents

Electrical Consumption Estimate

Land Uses by Phase	Total Approx. Acreage	Approx. Commercial Floor Area	Approx. Units Count	Power Unit Load	Power Demand	Power Demand	Hours of Power Usage per Day		Daily Energy Consumption		Energy Consumption per Year	Telephone Unit Load	Telephone Demand
	(acres)	(sq.ft.)			(MVA)	(kW)	Weekdays	Weekends	(kW-hr)	(kW-hr)	(10^6 kW-hr/yr)		(PR)
AREA A													
Single Family Lot (9,000 - 15,000 sf)	22	-	70 - 85	10,000 VA/Unit	0.85	850	4 - 6[1]	10 - 12	3,400 - 5,100	8,500 - 61,200	1.77 - 7.70	3 PR/Unit	255
Single Family Lot (5,000 - 6,000 sf)	12	-	90 - 100	10,000 VA/Unit	1.00	1000	4 - 6[1]	10 - 12	4,000 - 6,000	10,000 - 12,000	2.08 - 2.81	3 PR/Unit	300
Multi-Family Residential	5	-	45 - 60	10,000 VA/Unit	0.60	600	4 - 6[1]	10 - 12	2,400 - 3,600	6,000 - 7,200	1.25 - 1.68	3 PR/Unit	180
Makai Mixed-Use Village & Beachfront Restaurant	7	40,000	-	12 VA/SF	0.48	480	10 - 12[2]		4,800 - 5,760		1.75 - 2.10	1 PR/500 SF	80
Multi-Family & Mixed-Use Common Landscaping	(4.5)	-	-	-	-	-	-	-	-	-	-	-	-
Residential Apartment on top of Commercial	-	-	35 - 60	10,000 VA/Unit	0.60	600	4 - 6[1]	10 - 12	2,400 - 3,600	6,000 - 7,200	1.25 - 1.68	3 PR/Unit	180
Ooma Canoe Club	2	10,000	-	12 VA/SF	0.12	120	3 - 5[3]		360 - 600		.131 - .219	1 PR/500 SF	20
Road & Parking	26	-	-	-	-	-	-	-	-	-	-	-	-
Parks and Trails	6	-	-	-	-	-	-	-	-	-	-	-	-
Waste Water Treatment Plant	2	-	-	12 VA/SF	1.05	1045	24		25,080		9.15	1 PR/500 SF	174
Mamalahoa Trail Undisturbed Zone / Setback Buffer	1	-	-	-	-	-	-	-	-	-	-	-	-
Community Pavilion	1	-	-	12 VA/SF	0.52	523	3 - 5[3]		1,569 - 2,615		.573 - .954	-	
Street Lighting and Incidentals (5%)		-			0.26	261	11 - 13[4]		5,126 - 6,058		1.87 - 2.21		
Subtotal :	**84**	**50,000**	**240 – 305**		**5.48**	**5,479**					**19.8 - 28.5**		**1189**
AREA B													
Mauka Mixed-Use (Commercial below Residential)	14	150,000	-	12 VA/SF	1.80	1800	10 - 12[2]		18,000 - 21,600		6.57-7.88	1 PR/500 SF	30
Mauka Mixed-Use (Residential Apartment on top of Commercial)	-	-	150 - 200	10,000 VA/Unit	2.00	2000	4 - 6[1]	10 - 12	8,000 - 12,000	20,000 - 24,000	4.16 - 5.62	3 PR/Unit	600
Mauka Mixed-Use (Live-Work Units)	4	-	50 - 70	10,000 VA/Unit	0.70	700	4 - 6[1]	10 - 12	2,800 - 4,200	7,000 - 8,400	1.46 - 1.96	3 PR/Unit	210
Multi-Family & Mixed-Use Common Landscaping	(9)	-	-	-	-	-	-	-	-	-	-	-	-
Grocery Store	1	15,000	-	12 VA/SF	0.18	180	10 - 12[2]		1,800 - 2,160		.657 - .788	1 PR/500 SF	30
Multi-Family Residential	19	-	195 - 250	10,000 VA/Unit	2.50	2500	4 - 6[1]	10 - 12	10,000 - 15,000	25,000 - 30,000	5.20 - 7.02	3 PR/Unit	750
Charter School	3	-	-	12 VA/SF	1.57	1568	8 -10[5]	-	12,544 - 15,680	-	3.26 - 4.08	1 PR/500 SF	261
Road & Parking	10	-	-	-	-	-	-	-	-	-	-	-	-
Parks	3	-	-	-	-	-	-	-	-	-	-	-	-
Mamalahoa Highway Buffer	9	-	-	-	-	-	-	-	-	-	-	-	-
Street Lighting and Incidentals (5%)					0.44	437	11 - 13[4]		8,030 - 9,490		2.93 - 3.46		
Subtotal :	**63**	**165,000**	**395 – 520**		**9.19**	**9,186**					**24.2 - 30.8**		**1881**
AREA C													
Single Family Lot (5,000 - 6,000 sf)	35	-	260 - 300	10,000 VA/Unit	3.00	3000	4 - 6[1]	10 - 12	12,000 - 18,000	30,000 - 36,000	6.24 - 8.42	3 PR/Unit	900
Multi-Family Residential	6	-	55 - 75	10,000 VA/Unit	0.75	750	4 - 6[1]	10 - 12	3,000 - 4,500	7,500 - 9,000	1.56 - 2.11	3 PR/Unit	225
Multi-Family Common Landscaping	(2)	-	-	-	-	-	-	-	-	-	-	-	-
Community Park	7	-	-	-	-	-	-	-	-	-	-	-	-
Parks & Trails	7	-	-	-	-	-	-	-	-	-	-	-	-
Road & Parking	16	-	-	-	-	-	-	-	-	-	-	-	-
Mamalahoa Trail Undisturbed Zone / Setback Buffer	11	-	-	-	-	-	-	-	-	-	-	-	-
Street Lighting and Incidentals (5%)					0.19	188	11 - 13[4]		2,068 - 2,444		.755 - .892		
Subtotal :	**82**	**0**	**315 – 375**		**3.94**	**3,938**					**8.56 - 11.4**		**1125**
OTHERS													
Costal Preserved / Open Space	57	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline Park (Excluding the Public Canoe Club)	17	-	-	-	-	-	-	-	-	-	-	-	-
Subtotal :	**74**	**0**	**0**										
TOTAL :	**303**	**215,000**	**950 - 1,200**		**18.60**	**18,602**					**52.6 - 70.7**		**4,196**

[1]Residential: Typical power useage between 4pm - 10pm on weekdays and 9am - 9pm on weekends

[2]Commercial: Typical power useage between 6am - 6pm on both weekdays and weekends

[3]Canoe Club/Community Pavilion: Typical power usage between 5pm -10pm on both weekdays and weekends, for lighting during non-daylight hours

[4]Street Lighting: Typical power useage between 6pm -7am everyday, various with season

[5]School: Typical power usage between 6am-4pm on weekdays only, when school is in session

74-5605 Luhia Street, Suite B-1
Kailua-Kona, Hawaii 96740
Tel 808-329-2418
Fax 808-329-9459

OCEANIC TIME WARNER CABLE

M&E Pacific, Inc.
Davies Pacific Center
841 Bishop Street, Suite 1900
Honolulu, HI 96813
Attn: Jamie Hikiji

RECEIVED
SEP - 5 2006
M & E PACIFIC, INC.

August 30, 2006

R.E: **Ooma II Development**

Dear Mr. Hikiji,

Thank your request for information in planning of the Ooma Properties II near Natural Energy Laboratory. Our Fiber Trunk runs on the HELCO's transmission pole line along the east side of Queen Kaahumanu Highway.

1.) The development would have to be served from the Queen Kaahumanu pole line where our Fiber Trunk passes the project. Due to recent changes to our Engineering Specifications we may need to do additional offsite work such as adding additional Fiber Optic Trunking. I am unsure it we would charge for this work at this time.

2.) We have an existing node directly across the NEL that serves the Agriculture lots on the east (mauka) side of the road. A coaxial trunk could be extended from that point approximately 10,000 feet. If the distance is further we will have to add additional nods by extending a fiber tails into the project area. The capacity of each node is approximately 250 service accounts. If the hotel site were using all our services it would require a separate fiber extension.

3.) The cost per mile for CATV construction is approximately $20K per mile. We will normally build the CATV system where there are 25 homes per mile of cable. If there are only lots we would request sharing construction costs with the developer.

4.) There are no existing ducts crossing Queen Kaahumanu at the project road frontage. There is a substandard 2" duct crossing QK at the NEL entry that was installed at the initial construction years ago. It is not in use and too small for more than one small cable.

5.) We request a 4" duct for main roadways and 2" for side roads and cul-de-sacs. We use 2'x 4', 2'x 6', and 3'x 5' pull boxes at various locations. We also need ground rods in most pull boxes. The CATV system will also require Power Supply pads and easements in certain locations.

I can be reached at 331-4925 if you have more questions.

Aloha,

Robert W. Moeller

Robert W. Moeller
Construction Manager

Hawaii Electric Light Company, Inc. 74-5519 Kaiwi Street Kailua-Kona, HI 96740-1604
Phone: (808)327-0504 Fax: (808)327-0505

MEMO

Hawaii Electric Light Co., Inc.

September 12, 2006

To: Jamie Hikiji
Jamie.Hikiji@m-e.aecom.com
Company: M&E Pacific, Inc.
City & State: Honolulu, HI
Phone: (808) 521-3051
FAX: (808) 524-0246

From: Shelley Tomita
shelley.tomita@helcohi.com

Subject: Response to your fax dated 8/23/06
Ooma Development (Project No. 60012984.00300)

No. Of Pages Including Cover: 1

This memo is in response to your fax dated August 23, 2006.

Based on the updated load estimates received, HELCO has the following comments:

1. Original Conceptual Plan = 10 MVA
   Estimated cost = $1.7 million

2. Alternate Conceptual Plan = 29 MVA
   Estimated cost = $3.3 million

We will require a 150' x 150' minimum sized substation lot for the substation, this lot must be fairly flat with a maximum of 2% slope and preferably located near the existing overhead transmission lines on the mauka side of the existing highway. If the substation is to be located on the makai side of Queen Kaahumanu Highway, please add $400,000 to the totals above for the 69kV underground.

Please note the cost estimates represent the off-site requirements only.

cc: H. Kamigaki – HELCO WX

fooma091206.doc

Consulting
Electrical
Engineers

ECS, Inc.

October 18, 2002

Mr. Gordon Yadao
Verizon Hawaii, Inc.
161 Kinoole Street
Hilo, Hawaii 96720-2821

Project: Ooma Development (ECS No. 126-005)

Subject: Request for Information — sent to Mike Chang in Kona 10/23/02

Dear Gordon:

We are starting research for the due diligence phase of a new proposed residential/commercial development just South of the Natural Energy Laboratory along Queen Kaahumanu Highway in Keahole. See attached drawings. The estimated demand for the initial phase is 2500 pairs. Please provide us with answers to the following questions.

1. Where is your preferred service point? – existing fiber on 69KV pole line
2. Is a mini-hut or pair gain required for the project? yes Are there any existing mini-huts or pair gains nearby? Spare capacity? Mauka ag subdivision has a small one.
3. Please provide a ballpark cost of any mini-hut or pair gain addition or upgrades. We can estimate on-site distribution costs. Cost unknown
4. Do you know of any existing ducts crossing Queen Kaahumanu Highway we may be able to use? If so, please indicate on one of the drawings.
None existing

We need to turn in a pre-final report by early November. A quick response will be greatly appreciated. I will call to discuss in a few days.

Sincerely,

Glenn Karamatsu

Glenn T. Karamatsu, P. E.
Principal

GTK:am

Attachments

Appendix K

Market Assessment

MIKIKO
CORPORATION

MARKET ASSESSMENT FOR `O`OMA BEACHSIDE VILLAGE

North Kona, Island of Hawai`i

Prepared for:
`O`oma Beachside Village, LLC

FINAL REPORT
December 2007

Market Assessment for `O`oma Beachside Village

Table of Contents

Market Assessment for `O`oma Beachside Village

Acronyms and Other Terms Used in this Report

Ac	acres
ACS	American Community Survey, prepared by the U.S. Census Bureau
Airport	Kona International Airport at Keāhole
CDPs	Census Designated Places, as defined by the U.S. Census Bureau
Claritas	Claritas, Inc.
County	County of Hawai`i
CRMA	Competitive Residential Market Area, as defined for purposes of this study
CT	census tract, as defined by the U.S. Census Bureau
DBEDT	State of Hawai`i, Department of Business, Economic Development and Tourism
DEIS	Draft Environmental Impact Statement
DHHL	State of Hawai`i, Department of Hawaiian Home Lands
DLIR	State of Hawai`i, Department of Labor and Industrial Relations
EIS	Environmental Impact Statement
GLA	gross leasable area, in square feet
HHFDC	State of Hawai`i, Hawai`i Housing Finance & Development Corporation
HOST	Hawai`i Ocean Science & Technology Park
INA	information not available
Island	island of Hawai`i
LUC	State of Hawai`i, Land Use Commission

Makai Area (Petition Area)	the approximately 181.169 acre portion of the \`O\`oma property within TMK Nos. (3) 7-3-009: 004 and 7-3-009 (portion of State Right of Way) for which reclassification from the State Land Use Conservation District to the State Land Use Urban District is being sought
Mauka Area (Current LUC Urban District)	the approximately 83 acres of the \`O\`oma property within TMK No. (3) 7-3-009: 022 and currently within the State Land Use Urban District
Makai Village	a residential and retail mixed-use area proposed within the *Makai Area.*
Mauka Village	a residential and retail mixed-use area proposed within the Mauka Area.
MC	Mikiko Corporation
MFY	median family income
MU	mixed-use, including residential and retail
NELHA	Natural Energy Laboratory of Hawai\`i Authority
North-Kona North	the northwestern portion of the North Kona District, Census Tract 215.01
\`O\`oma	\`O\`oma Beachside Village, the subject property and/or development proposal
\`O\`oma Beachside Village, LLC	the entity that owns and proposes to develop \`O\`oma; also the entity that is petitioning the State Land Use Commission to reclassify the Petition Area into the LUC Urban District
PBR HAWAII	PBR HAWAII & Associates, Inc.
PTA	Primary Trade Area, retail trade area as defined for purposes of this study
QLT	Queen Lili\`uokalani Trust Estate
RBA	rentable building area, in square feet
Residential Village	a residential area within the Makai Area
RHU	primary residential housing unit
ROR	residential over retail
SC	shopping center
SCD	Stanford Carr Development, LLC

SFD	single-family residential development
SMA	Special Management Area Permit
SMS	SMS, Inc.
South Kohala-Waikoloa	the southwestern portion of the South Kohala District, Census Tract 217.01
sq. ft.	square feet
State ROW	the approximately 1.814 acre portion of the State Right-of-Way located within TMK No. (3) 7-3-009: that separates the Mauka and Makai Areas
TH	townhouse residential unit
U.S.	United States of America
U/A	units per gross acre
U/C	under construction
UHCWH	University of Hawai`i Center for West Hawai`i
UHERO	University of Hawai`i Economic Research Organization
YTD	year to date

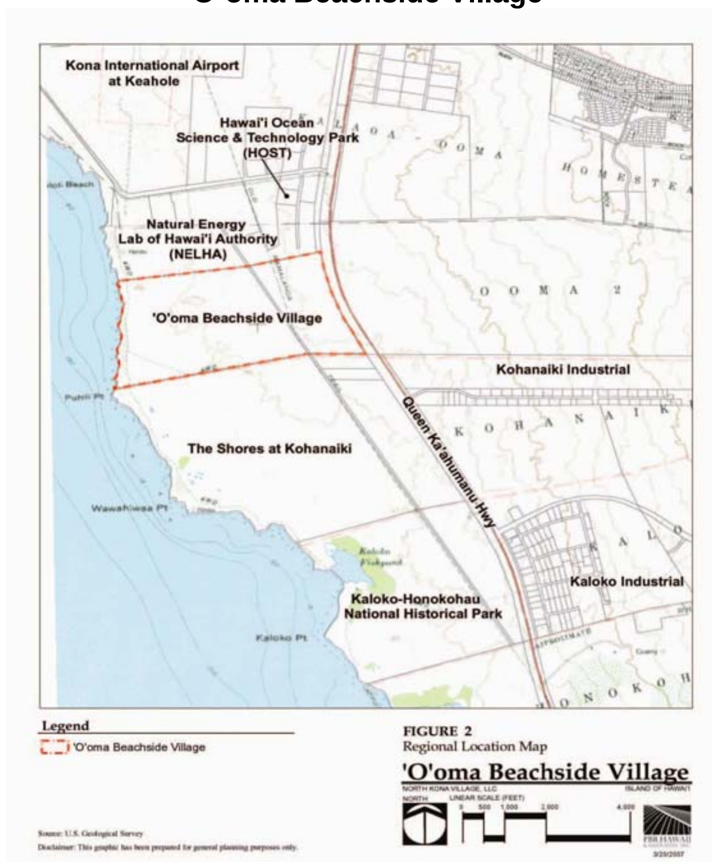
1 – Introduction and Executive Summary

Project Background

Location (Exhibits 1-1 and 1-2)

`O`oma Beachside Village, LLC owns some 303 acres in the North Kona District of the Island of Hawaii (Island). Some 83 acres are currently in the State Land Use Commission (LUC) Urban District, while the balance is designated in the LUC Conservation District. `O`oma Beachside Village, LLC proposes to develop these lands as a master-planned community called `O`oma Beachside Village (`O`oma). PBR HAWAII & Associates, Inc. (PBR HAWAII) is assisting `O`oma Beachside Village, LLC in developing land use plans and other assessments related to the entitlement process for these lands.

Location and Vicinity of `O`oma Beachside Village



Source: PBR HAWAII, 2007. See Exhibit 1-1 for copy at a larger scale

`O`oma is in a logical area for infill development, being located alongside Queen Ka`ahumanu Highway between the Kona International Airport at Keāhole (Airport) and the town of Kailua-Kona. Immediately north of `O`oma is the State's Natural Energy Laboratory of Hawai`i Authority (NELHA) and the Hawai`i Ocean Science & Technology Park (HOST). NELHA and HOST house commercial and light industrial production as well as research and educational endeavors. Immediately south of `O`oma is The Shores at Kohanaiki, which is planned to offer 500 luxury resort residential units upon completion. Also within a four-mile radius of `O`oma are:

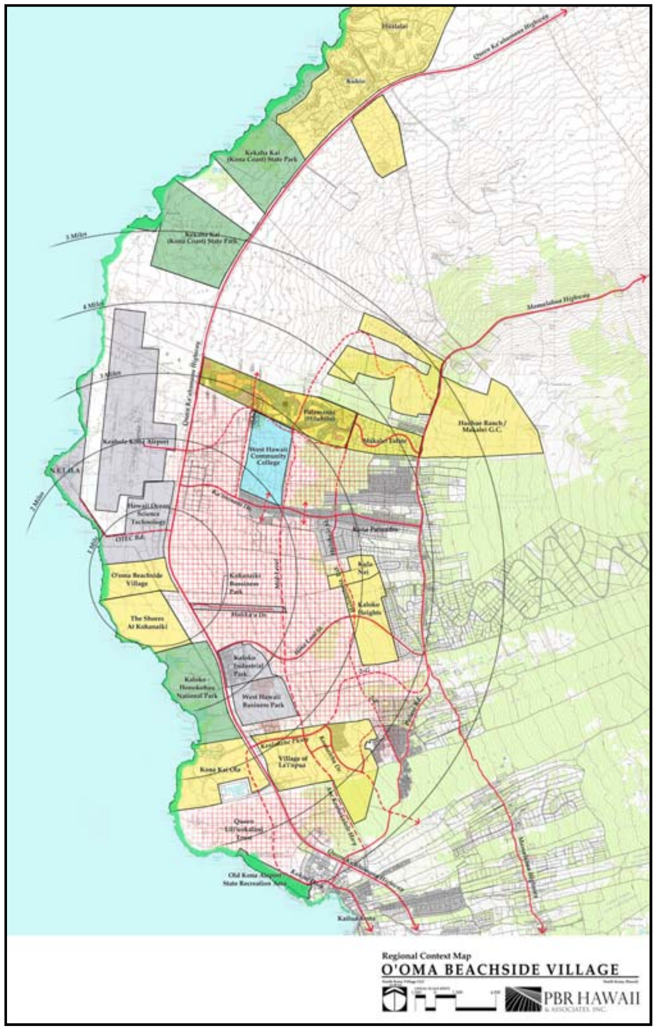
- **To the north** – the Airport.

- **Mauka**, across Queen Ka`ahumanu Highway – Kohanaiki Industrial Park, Kaloko Industrial Park and the West Hawaii Business Park; the proposed new University of Hawai`i Center for West Hawai`i (UHCWH) campus and the related, proposed community of Palamanui; the existing residential communities of Makalei Estates, Kona Palisades and the Department of Hawaiian Home Lands' (DHHL) Villages of La`i`ōpua; proposed residential, commercial and other urban developments.

- **To the south** – Kaloko-Honokōhau National Park; the proposed Kona Kai Ola commercial and visitor-related community to be centered around the Honokōhau Small Boat Harbor; various existing and proposed commercial uses on Queen Lili`uokalani Trust (QLT) properties.

- **Makai** - `O`oma fronts the ocean just north of Pūhili Point.

Regional Context



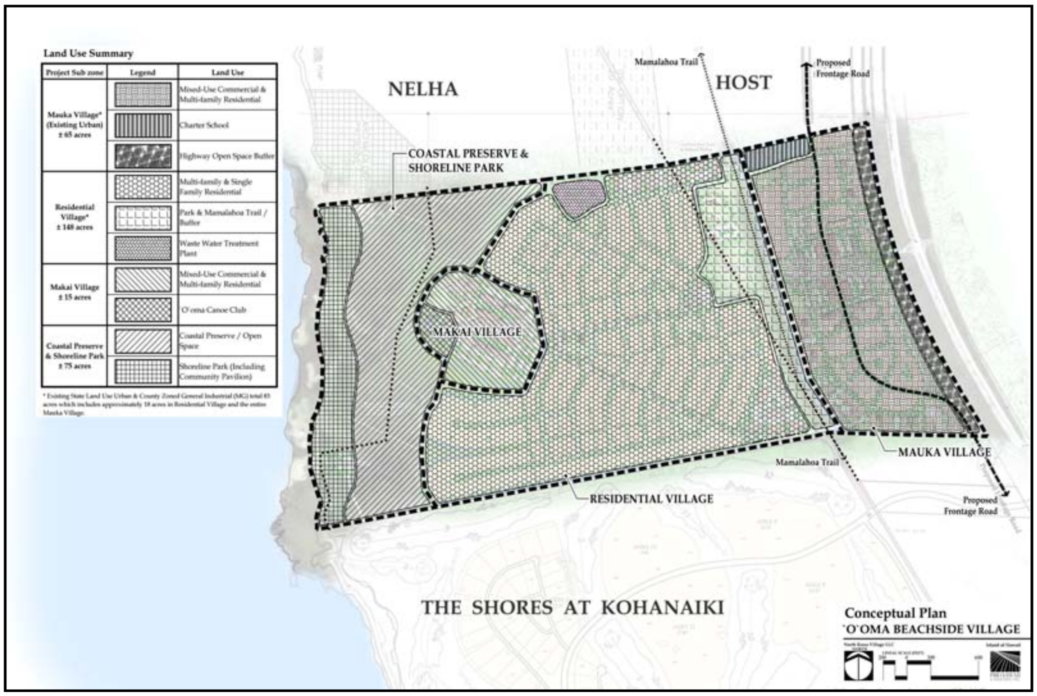
Source: PBR Hawaii, April 2007. See Exhibit 1-2 for copy at larger scale.

Conceptual Master Plan (Exhibit 1-3)

The Mauka and Makai Areas are separated by the State Right-of-Way (State ROW) and are distinguished by their respective LUC Urban and Conservation District designations.

- **Mauka Area (Current LUC Urban District)** - The 83-acre Mauka Area (TMK (3) 7-3-009:022) is within the LUC Urban District. These lands are proposed for development as a medium-density mixed-use village (the Mauka Village) with residential uses, including traditional apartments, "live-work" units, and residential/commercial mixed uses. The Mauka Area will also include park space, the Māmalahoa Trail and buffers and a charter school A connector road that is proposed to take traffic from south of `O`oma to the Airport would traverse the Mauka Area.

`O`oma Conceptual Master Plan



Source: PBR HAWAII, 2008. See Exhibit 1-3 for copy at larger scale.

- **Makai Area (Petition Area)** - The Makai, or Petition, Area consists of a portion of the approximately 217-acre parcel of land designated as TMK (3) 7-3-009:004 and TMK (3) 7-3-009: (State Right-of-Way, portion). This area is located within the LUC Conservation District. `O`oma Beachside Village, LLC is seeking LUC Urban District reclassification for only 179 acres of parcel 004, and will leave the remaining 38 acres in the LUC Conservation District.

The Makai Area is generally proposed for more traditional primary resident-oriented community developments in the Residential Village, as well as mixed uses within the smaller Makai Village. The Makai Area will be enhanced by extensive parks and trails, and a large area of open space leading to a shoreline park and the ocean.

In addition to frontage on the shoreline park, the Makai Area fronts the proposed luxury resort project, The Shores at Kohanaiki.

The Makai Village will be on a promontory set back about 1,100 feet from the shoreline. This area would include housing at lower densities than offered in the Mauka Village, as well as commercial areas likely to include ocean-facing restaurants, other services, or retail. The Makai Village is also proposed to include a private canoe club.

The Residential Village will include multi-family residential areas as well as single-family residential lots. All homes in the Residential Village will have direct or easy access to pedestrian/bike community trail systems that will connect to the shoreline, the various parks and the Mauka and Makai Villages.

Proposed Developments to be Marketed

Within the master plan, some 191 to 199 acres are proposed for residential or commercial uses. `O`oma Beachside Village, LLC estimates that the first real estate products at `O`oma could be sold as early as 2012. At buildout, `O`oma is proposed as shown on the following page:

Summary of Proposed Residential and Commercial Land Uses at `O`oma

	Estimated gross acres*	**Range of residential units**	**Estimated commercial development** (square feet)
Makai Area (Petition Area): Multifamily Units at Makai Village*	**+/- 11**	**35 to 60**	**Up to 30,000**
Restaurant & Canoe Club	**+/- 4**	**0**	**Up to 20,000**
Multifamily Units at Residential Village* (portion)	**+/- 9**	**75 to 105**	**0**
Single-Family Homes at Residential Village	**+/- 84**	**350 to 400**	**0**
Single-Family Lots at Residential Village	**+/- 32**	**70 to 85**	**0**
Subtotal	**+/- 140**	**530 to 650**	**Up to 50,000**
Mauka Area (Current LUC Urban District): Multifamily Units at Mauka Village*	+/- 49 to 57	395 to 520	Up to 150,000
Multifamily Units at Residential Village* (portion)	+/- 2	25 to 30	0
Subtotal	+/- 51 to 59	420 to 550	Up to 150,000
Total `O`oma	**+/- 191 to 199**	**950 to 1,200**	**Up to 200,000**

* Based on current County guidelines, 20% or some 190 to 240 of the residential units may be developed as affordable housing. These units might be developed within the areas noted.

Source: PBR HAWAII, July 2007.

Study Background

`O`oma Beachside Village, LLC has initiated a planning and entitlement process for `O`oma, including an Environmental Impact Statement (EIS) that will be used in the LUC and County zoning processes. PBR HAWAII is assisting `O`oma Beachside Village, LLC in this process and asked Mikiko Corporation (MC) to prepare market, economic, and fiscal impact assessments for `O`oma, addressing the residential and commercial retail/office land uses noted above.

This report covers the market assessment. Economic and fiscal impacts are described in a separate report.

Mikiko Corporation Study Objective

MC's objective in this study was to describe the market support for the residential and commercial uses proposed at `O`oma, in terms of:

a) Evidence of the demand and competitive supply for the residential and commercial retail/office development elements, and

b) Assessment of supportable market shares and market absorption at `O`oma; also, for residential units, assessment of supportable pricing.

These evaluations are based in part on information and planning parameters provided by PBR HAWAII and/or `O`oma Beachside Village, LLC.

The remaining sections of this chapter summarize the market conclusions. The rationale behind these conclusions, as well as documentation of the study methodology and supportive data, may be found in the subsequent chapters and appendices.

At the end of this report, Appendix 5 presents a statement of its report conditions.

Summary of Conclusions

Area Character

The North Kona area is appropriately seeing urban infill development and proposals, consistent with the Hawai`i County General Plan (2005) for this region. This urban infill development is especially along the major regional traffic corridor Queen Ka`ahumanu Highway, between the town of Kailua-Kona and the Airport. This area comprises the northwestern portion of the North Kona District, and is contained within Census Tract 215.01 (also referred to herein as "North Kona-North").[1] It already is the commercial and industrial heart of West Hawai`i, serving the Airport and the needs of the visitor, agriculture, ranching, technology, and other industries of the western half of the Island. The area also has a long-standing and growing residential population. This area will

[1] See Appendix 1 for a map of this census tract.

continue to be the focus of such development as the Island's population grows, given its proximity to the Airport and other existing infrastructure.

Need for Area Development

Together with the coastal portion of the adjacent South Kohala District (CT 217.01, also referred to herein as "South Kohala-Waikoloa")[2], North Kona-North is estimated to provide 21% of the Island's employment in 2006.[3] However, this center of employment supported residences for only 12% of the Island's population, leading to crowding among area households, and a tremendous amount of commuting into the region by persons who live in distant areas.

A relative lack of resident-oriented shopping, entertainment, and other services in the South Kohala-Waikoloa area also adds to traffic headed into the Kailua-Kona area from the north.

\`O\`oma is among a relatively small group of area properties that could offer a substantial solution for this imbalance of primary resident-oriented housing and services, relative to the area's existing and anticipated jobs base.

Residential Markets and Development Character

\`O\`oma is proposed to be developed as a master planned residential community with a variety of housing opportunities and mixed-uses, as well as abundant recreational resources. As part of the overall master planned community, the Mauka and Makai Areas each will have their own character and feel, thereby being able to appeal to a broad range of population:

- **Mauka Area (Current LUC Urban District) –** This area is seen as a mixed-use village community planned and developed along the lines of Traditional Neighborhood Design principles.[4] All residential uses would be multifamily, at densities of 7.5 to 12 units per acre, including homes that will address the County's affordable housing guidelines. Some homes would be located above or within the same structures as commercial retail or office uses. This area could also include "live-work" units that are designed to accommodate a home and commercial enterprise within a single unit. These commercial components and other commercial spaces developed in the Mauka Village are intended to provide attractive locations for sole proprietorships and other small businesses.

  This area is anticipated to appeal mostly to primary residents such as younger households who are attracted to an urban setting, higher activity levels, and relative

[2] See Appendix 2 for a map of this census tract.

[3] The 1,435 establishments of CTs 215.01 and 217.01 are estimated to support 19,100 of the Island's 92,900 employees in 2006, according to Claritas, Inc. Note that "employees" on the Island exceed the "civilian labor force," since labor force members may hold more than one job.

[4] See Chapter 4 for a discussion of Traditional Neighborhood Design.

affordability. It may also appeal to retirees, empty nesters or off-island business enterprises that regularly do business in the County and are attracted by its convenience to the Airport and area business services, and their mix of business and housing functions.

- **Makai Area (Petition Area) –** This area is proposed with more primary resident-oriented single- and multifamily homes, developed at gross densities ranging from 2.5 to 12 units per acre. This area may also offer some of `O`oma's affordable housing.

As in the Mauka Area, the majority of homes in the Makai Area are expected to serve a local resident base, including young families, empty nesters and move-up households. Homes along the ocean-facing edges of the community and bordering along The Shores at Kohanaiki would be developed at the lowest density range, from 2.5 to 3 units per acre. These estate lots could attract some part-time or former Island residents who customarily reside off-Island.

Considering residential developments in both the Mauka and Makai areas, some 84% of `O`oma homes are anticipated to be used as primary residences by established Island households, while the remaining 16% might be expected to attract second home or vacation property buyers.[5]

The residential developments could also include homes built in accordance with County affordable housing requirements.

Commercial Markets and Enterprise Types

Commercial uses at `O`oma would address needs of the community's own residents as well as those of the surrounding areas. The Primary Trade Area for `O`oma is expected to encompass the full North Kona and South Kohala Districts.

A variety of potential enterprise types are suggested in Chapter 6. They are envisioned to serve markets such as:

- `O`oma residents;
- Area shoreline park users;
- Daytime populations of North Kona and South Kohala;
- Airport users, especially if the NELHA/Airport connector road is developed;
- Businesses that support the part-time resident community of the broader region; and
- Off-island enterprises that frequently do business in West Hawai`i.

[5] This split is based on 20% of the market units being sold to second or vacation home buyers (20% x 80% = 16%).

Supportable Absorption

The projected absorption of residential and commercial uses at `O`oma is summarized as follows:

Supportable Market Absorption at `O`oma
(At maximum development)

	Makai (Petition Area)	Mauka (Current LUC Urban District)	Total Project
Residential units:			
Maximum inventory	**650**	550	1,200
Average annual sales	**46**	34	67
Years on market	**14**	16	18
Start date	**2012**	2014	2012
End date	**By 2025**	By 2029	By 2029
Commercial gross leasable area:			
Maximum square feet	**50,000**	150,000	200,000
Absorption date	**By 2020**	By 2029	By 2029

Source: Mikiko Corporation, 2007.

The overall residential absorption represents an average of about 67 per year. Year to year sales would be expected to vary around this average depending on the amount and types of product on the market at any time as well as business cycle conditions. `O`oma's projected average absorption could represent about 9% of the projected annual requirement for new primary resident housing in a market area consisting of census tracts 215.01 and 217.01[6], and about 5% of the North Kona District non owner-occupant, off-Island sales. The maximum commercial build-out could represent only about 3% of the North Kona and South Kohala commercial retail and office markets in 2030.

[6] See Chapter 2 for further explanation of this market reference area.

Residential Pricing – Market Units

Supportable unit pricing for the "market priced" finished homes is estimated at an average of $550,000, in 2007 dollars. By product type, this represents:

- **Multifamily Units at Mauka Village** (7.5 to 10 units per acre) - $425,000;
- **Multifamily Units at Makai Village** (3 to 4.5 units per acre) - $525,000;
- **Multifamily Units at Residential Village** (9 to 12 units per acre) - $425,000; and
- **Single-Family Homes at Residential Village** (finished homes, 5,000 to 6,000 square foot lots) - $650,000.

Additionally, \`O\`oma would offer 70 to 85 estate lots for custom home development, in a premium location. Pricing for these lots is estimated at:

- **Estate Lots at Residential Village** (with ocean views and alongside shoreline park or bordering Kohanaiki, 9,000 to 15,000+ square feet) - $650,000.

These estimated supportable prices were developed after review of developer products marketing or soon to be marketed within the Competitive Residential Market Area (CRMA) as of the study date, as discussed in Chapter 4.

With product averages ranging from $425,000 to $525,000, market priced multifamily homes at \`O\`oma would be affordable to households earning approximately 150% to 180% of the 2007 County median income of $58,200[7], assuming interest rates of 6.0% to 7.0% and a 20% down payment. At an average $650,000, the single-family homes, the highest priced finished product proposed, could be expected to be affordable to households earning between 210% and 220% of the 2007 County median income. A "move-up" or other household with more than 20% of purchase price funds available to apply as a down payment for a new purchase would be able to purchase any of these homes at lower income ranges.

The projected supportable prices may also be compared to recent resales of existing homes in the area. Average single family sales prices in the Kona Palisades and Kealakehe areas ranged from $662,000 in 2006 and $590,000 from January 1, 2007 to September 7, 2007, respectively. For multifamily homes they were $579,000 and $327,000, respectively. In Waikoloa Village, resales of existing single-family homes tended to be higher priced, at an average of $717,000 in 2006 and $748,000 as of September 7, 2007. On the other hand, multifamily homes in Waikoloa Village resold at slightly lower average prices than in the North Kona-North comparison areas, at an average of $435,000 in 2006 and $302,000 YTD September 7, 2007.[8]

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[7] This figure, as used by the County, differs slightly from the $58,528 estimated by Claritas, Inc. and reported in Exhibit 2-7.

[8] Data downloaded in September 2007, from Hawaii Information Service for tax map keys 3-7-3, 3-7-4 and 3-6-8.

Residential Pricing – "Affordable" Units

Pricing of the homes to be designated affordable will be established in future agreements with the County. For illustrative purposes, as of May 1, 2007, County guidelines would require that for-sale units marketed to families of four earning between 110% and 130% of the median income would range from $248,800 to $294,000. Some of the affordable housing could alternatively be developed as rental housing. Example monthly rents also based on the County's 2007 guidelines would range from $935 to $1,309 for one- to two-bedroom units rented to households earning between 80% and 100% of median income.

Style of Development

Considering the magnitude of demand for new housing and commercial facilities, yet with respect for Hawaii's finite island land, it is fortunate that Hawaii residents, like other people worldwide, are showing interest in "urban village" living styles. Given the environmental burdens of population growth, this Traditional Neighborhood Design sensibility not only reflects taste changes but a more sound approach to the use of natural resources. Chapter 4 offers an expanded discussion of these trends.

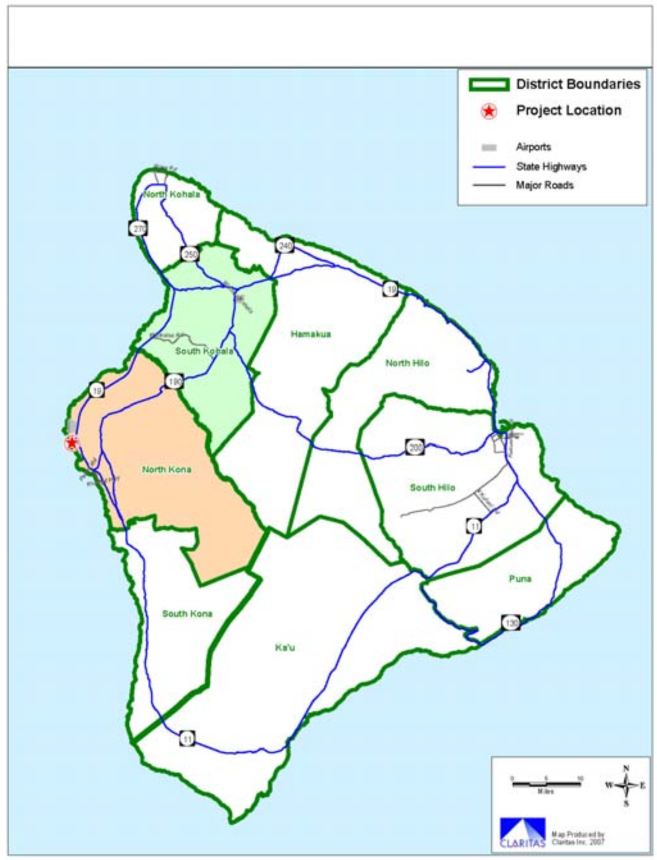
Most of \`O\`oma is within the Hawai\`i General Plan's (2005) designated Urban Expansion Area, near to existing and growing centers of employment, such as the several commercial and industrial complexes proposed in the area, and the proposed UHCWH campus. These characteristics enhance Traditional Neighborhood Design planning, and support the mixed-use, primary resident-oriented medium-density developments proposed at \`O\`oma.

2. Economic and Demographic Trends

Geographic Areas of Analysis

Judicial Districts

Island of Hawai`i Districts



Source: Claritas, Inc., 2007. See Exhibit 2-1 for copy at a larger scale.

The island of Hawai`i (Island) is divided into nine judicial districts. `O`oma is in the North Kona District, which extends from Kealakekua in the south, past Kīholo Bay in the north. It includes the Airport as well as the resort communities of Keauhou, Kailua-Kona, Kona Village, Hualālai and Kūki`o.

Adjacent to and north of this district is the South Kohala District, which includes the majority of the balance of the Island's visitor and second home infrastructure in the resort areas of Waikoloa Beach, Mauna Lani, and Mauna Kea. The other major communities in South Kohala are Waikoloa Village and Waimea Town, which offer both primary and second homes.

West Hawai`i

The island of Hawai`i is often considered in two major divisions, East Hawai`i and West Hawai`i. Although there is a great deal of commuting from East to West Hawai`i, this is in large part a reflection of the lack of appropriate housing opportunities for local families in West Hawai`i, rather than an integration of the two divisions' economies.

West Hawai`i is commonly defined as the districts of North Kohala, South Kohala, North Kona and South Kona. Within West Hawai`i, the North Kona and South Kohala Districts contain the primary drivers of the region's economy, which is anchored in the visitor, construction, and related service industries.

Areas of Market Evaluation

- **For purposes of commercial market assessment,** \`O\`oma's Primary Trade Area (PTA) is considered to encompass all of North Kona and South Kohala, the shaded areas of the map on the prior page. While this broad area may be considered to generate the majority of demand for commercial development at \`O\`oma, most of the supply that serves this demand is concentrated in the northern parts of the North Kona District.

- **For purposes of residential market assessment,** a tighter area is evaluated, reflecting the need for additional residential supply in the midst of the North Kona and South Kohala Districts, where the majority of West Hawai\`i's jobs are located. This smaller Competitive Residential Market Area (CRMA) for residential uses is defined herein to consist of:

North Kona-North: Census Tract 215.01, within the North Kona District

Source: Claritas, Inc., 2007. See Appendix 1 for copy at a larger scale.

South Kohala-Waikoloa: Census Tract 217.01, within the South Kohala District

Source: Claritas, Inc., 2007. See Appendix 2 for copy at a larger scale.

- “North Kona-North,” or Census Tract (CT) 215.01. This area extends from approximately Henry Street in the south to the northern border of the North Kona District. In includes the `O`oma site but excludes Kailua-Kona Town and Keauhou Resort.

- “South Kohala-Waikoloa,” or CT 217.01. This area extends from the southern border of the South Kohala District up past Kawaihae in the north. Its major residential community is Waikoloa Village; it excludes Waimea Town.

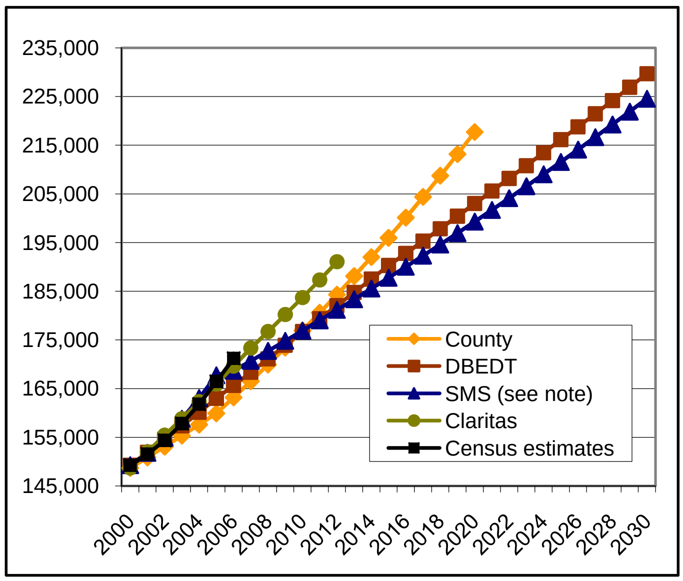
Many of the demographic trends reported in the section below refer to the Island as a whole and the CRMA as defined for residential purposes. Demographic data for the larger PTA for commercial uses are presented in Chapter 4, alongside the commercial market assessment.

Overview of Demographic Trends

Projected Island of Hawaii Population (Exhibit 2-2)

Hawai`i Island had approximately 149,000 residents at the time of the U.S. Census in 2000. Five sources are considered in estimating how population has grown since then, and how it is likely to grow over the next two decades.

Projected Resident Population – Island of Hawai`i



See Exhibit 2-2 for sources and further information.

- The U.S. Census provides annual population estimates for counties as of July of each year. The Census estimates the Island’s 2006 resident population at 171,191 persons, representing an annual average rate of increase of 2.4% since 2000.

- Claritas[7] provided MC’s study with 2007 population estimates and a 5-year projection to 191,052 by 2012. Claritas’ figures were prepared on the basis of the Census’ 2006 estimate and represent a 2.2% rate of growth since 2000, and 1.6% from 2007 to 2012.

- In its 2005 General Plan (amended December 2006), the County presented three scenarios of population growth. Series “B,” the mid-range projection, showed up to 217,718 persons by 2020. The County’s series represents 2.1% per annum growth from

[7] Claritas derives its information from the U.S. Bureau of the Census, State and local governmental planning and forecasting entities, its proprietary Business-Facts ® database and other sources.

2005 to 2020. Based on subsequent estimates, this series appears to have been low to date. However, it is the highest of the projections after 2011.

- The State of Hawai`i, Department of Business, Economic Development and Tourism (DBEDT) also offers a long-term projection; the latest was prepared in 2004. This series is relatively low in the long-term, and anticipates 229,700 residents on island of Hawai`i by 2030, a 1.4% average annual rate of growth after 2005.

- In 2007, SMS[8] completed a housing study that also offers a long-term population outlook, under various scenarios. Using the Hawai`i County "official parameter" growth rate of 1.2%, as cited in the SMS model, this data set yields a projected 224,573 Island residents by 2030. The SMS-derived projections are the lowest of the three long-term projections after approximately 2010.

MC has selected the 1.2% growth projection presented in the SMS housing study because this 1.2% growth rate is conservative and based upon recent estimates. SMS' relatively conservative series is considered appropriate for this study so as not to overstate the assessments for residential and commercial uses. Following this outlook, the Island could see about 225,000 residents in 2030, meaning it would need to accommodate some 54,000 more persons over the next 24 years. [9]

Aging of the Population (Exhibit 2-3)

The changing age-composition of the population will have an enormous impact on home-buying and other consumer spending patterns in Hawai`i as elsewhere in the nation. While long-term projected age-cohort data is not available by county or sub-areas, the U.S. Census does prepare decennial projections by state.

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[8] SMS, Inc., "Housing Policy Study, 2006: Hawaii Housing Model 2006," February 2007. The study was prepared for a consortium including the Housing Officers and other Administrators of the four Hawai`i counties, the State of Hawai`i, Hawai`i Housing Finance and Development Corporation, the Office of Hawaiian Affairs, and the Department of Hawaiian Home Lands.

[9] Note that on February 22, 2007 County Planning Director Chris Yuen testified to the State Legislature that the Island was on-track to add 60,000 people within 10 years. Honolulu Advertiser, "Big Island mayor grapples with rapid population growth," February 23, 2007.

Age Pyramids – State of Hawai`i: 2000 and 2010

Note: Each unit on horizontal axis represents 100,000 persons.
See Exhibit 2-3 for sources and further information.

Viewed in an age pyramid, a most notable feature is the aging of the Baby Boomers, whose members were between the ages of 41 and 60 in 2006, will range from about 45 to 64 years old by 2010, 55 to 74 by 2020, and 65 to 84 by 2030.

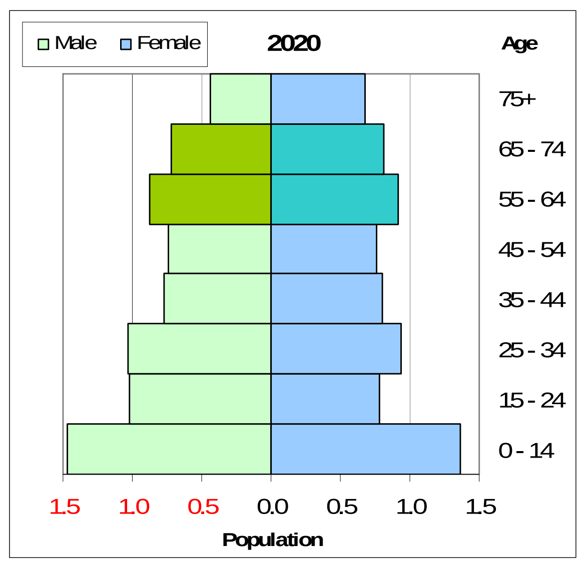
2000 to 2010 - As the dominant consumers in the overall marketplace today and for years to come, Baby Boomers are fueling a move-up home-buying market consistent with their middle-aged, peak earnings-power status.

Age groups showing the most population gains in the 2000 to 2010 period in Hawai`i are all over 45:

- 45 to 54: +14,000 persons
- 55 to 64: +64,000 persons
- 65 to 74: +16,000 persons
- 75+: +15,000 persons

2010 to 2020 – In the subsequent decade, Baby Boomers will continue to exert strong influence in the housing market. This will be reflected in rapidly growing demand for downsized, retirement and/or other specialized housing types reflecting their empty nester and retiree stages of life. Also notable in this decade will be strong growth in the entry and early-housing market, represented by persons aged 25 to 34.

Age Pyramid – State of Hawaii: 2020

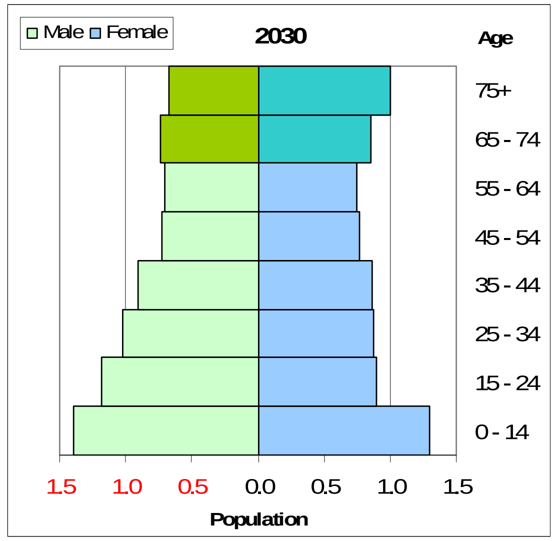


Note: Each unit on horizontal axis represents 100,000 persons.
See Exhibit 2-3 for sources and further information.

Thus, age groups projected to show the most gains in this later period include both early and older homebuyers:

- 25 to 34: +22,000 persons
- 55 to 64: +8,000 persons
- 65 to 74: +52,000 persons
- 75+: +21,000 persons

Age Pyramid – State of Hawaii: 2030



Note: Each unit on horizontal axis represents 100,000 persons.
See Exhibit 2-3 for sources and further information.

- **2020 to 2030** – The last decade evaluated will be characterized by rapid growth of the elderly population, necessitating specialized and age-catering housing solutions.

The second most rapidly growing potential housing market during this period will consist of those aged 15 to 24, an age that usually encompasses household formation, often in rental housing.

The third rapidly growing group would be those aged 35 to 44, typically a home-buying or early trade-up housing market.

Cohorts expected to gain population statewide in this decade include:

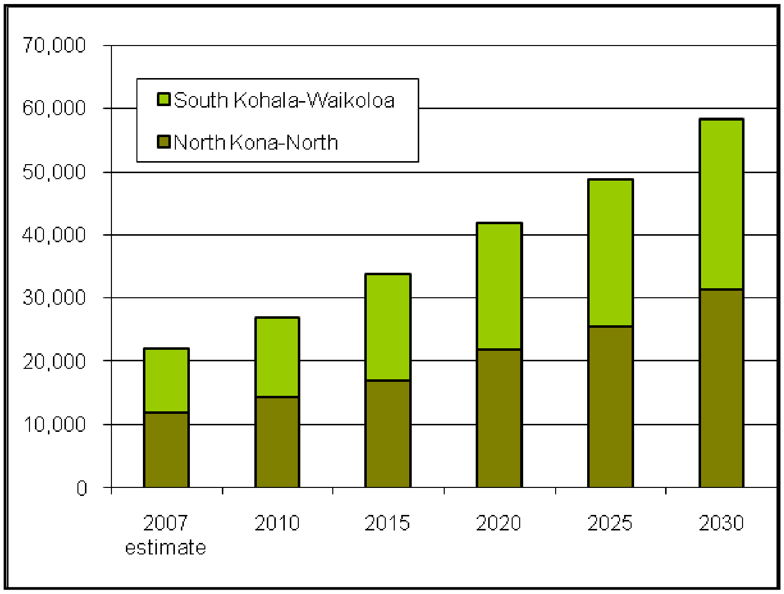
- 15 to 24: + 27,000 persons
- 35 to 44: + 19,000 persons
- 65 to 74: + 6,000 persons
- 75+: +56,000 persons

Projected Growth in the Competitive Market Area

Resident Population
(Exhibit 2-4)

Considering the SMS projection for population Island-wide, MC prepared 2030 projections for residents of the CRMA in North Kona-North and South Kohala-Waikoloa. MC's projections assume it is possible and desirable from a policy standpoint that residential opportunity in the CRMA approach the level of employment opportunity in the CRMA.

Resident Population –
Competitive Residential Market Area



See Exhibit 2-4 for sources and further information.

As of 2006, the CRMA was estimated to offer 21% of employment positions on the Island, while it housed only 12% of the Island population.[10] The area includes six of the seven largest employers on the Island, including the Hilton Waikoloa Village, the Fairmont Orchid, the Four Seasons Resort Hualālai, The Mauna Lani Bay Hotel & Bungalows, the Hāpuna Beach Prince Hotel and the Mauna Kea Beach Hotel[11] (the latter closed for renovations and is projected to reopen in late Fall, 2008). Additionally, large clusters of new development are planned within the CRMA at:

- UHCWH and its associated community, Palamanui;
- NELHA;
- Already zoned commercial areas in Keahuolū and elsewhere;
- Kona Kai Ola; and
- \`O\`oma.

MC assumed that the CRMA population matches its 2006 share of Island jobs within 14 years (achieving just over 20% of Island population in 2020), and that it continues to increase as a center of employment and population thereafter, achieving 26% of the Island population by 2030. This would result in a 2020 population of some 41,800

[10] The 1,435 establishments of CTs 215.01 and 217.01 are estimated to provide jobs for 19,100 of the Island's 92,900 employees, according to Claritas, Inc., April 2007. Note that "employees" exceed the "civilian labor force" discussed in a later section, since labor force members may hold more than one job.

[11] Pacific Business News, "2007 Book of Lists," December 22, 2006.

persons in CTs 215.01 and 217.01, and a 2030 population of about 58,300. These would represent a near doubling of the CRMA's population by about 2020 and a 4.3% per annum rate of increase for the 2007 to 2030 period as a whole.

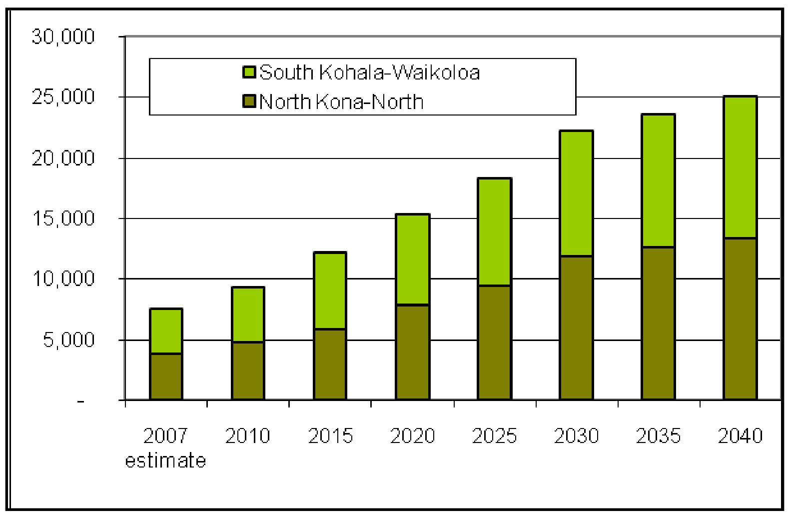
Population by Age Group (Exhibit 2-5)

The largest age groups in the CRMA, as for the Island as a whole, were those under age 25, followed by the 25 to 44 and 45 to 59 age groups. The CRMA as a whole includes almost 40% of the Island's population of persons under 59, but only 10% of those aged 60 to 74 and 7% of those aged 75 and over. This reflects the relatively young, working population of the CRMA, where the median age of residents in 2007 was estimated at 34 and 36 for North Kona-North and South Kohala-Waikoloa, respectively, compared to 37 for the Island as a whole.

Number of Households (Exhibit 2-6)

More housing opportunities in the CRMA would enable the uncoupling of some currently doubled up households. Together with age profile changes over time, this will lead to declining household sizes in the CRMA as well as the Island as a whole. MC employed Claritas' 2007 estimated household numbers for the three regions of interest, and then extrapolated future households in the CRMA by approximating the rate of decline projected by SMS for average household size in the County as a whole.

Projected Households – Competitive Residential Market Area



See Exhibit 2-6 for sources and further information.

For 2007, SMS estimated that the island of Hawai`i had about 62,000 households, at an average size of 2.75 persons. Within this, some 12% or about 7,400 households were located in the CRMA, at an average size of 3.08 persons in North Kona-North and 2.77 persons in South Kohala-Waikoloa, according to Claritas. Based on an average decline in household size of 0.3% to 0.7% per annum the CRMA, the area could expect to house some 22,200 households by 2030, assuming its future housing opportunities are allowed to approach its future employment opportunities.

Households by Income
(Exhibit 2-7)

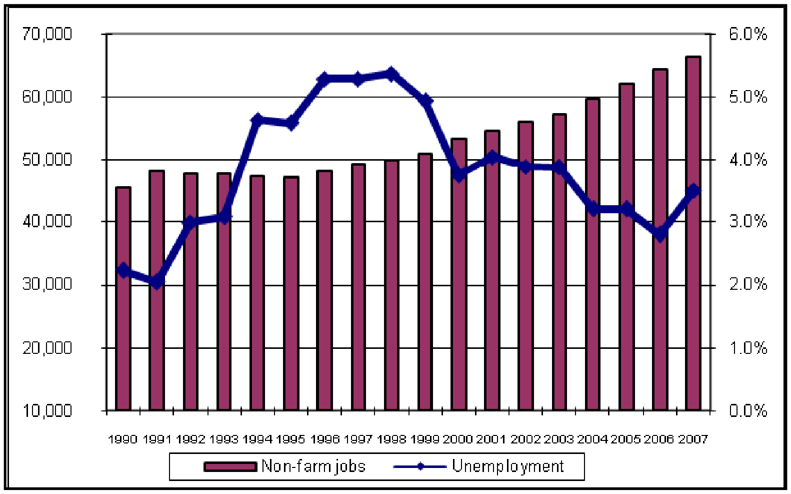
North Kona-North and South Kohala-Waikoloa show a higher household income profile than the Island as a whole, with relatively more households earning $50,000 or more in 2007, and relatively fewer earning less. Claritas estimates the median 2007 household income is approximately $61,800 in North Kona-North, $60,200 in South Kohala-South, and $58,528 for the Island of Hawai`i.[12]

Per capita income is also notably higher in the CRMA CTs than for the Island as a whole.

Employment Trends
(Exhibit 2-8)

The State of Hawai`i, Department of Labor and Industrial Relations (DLIR) reports island of Hawai`i unemployment averaging 3.5% as of September 2007, up from 3.0% in September 2006.[13] Hawai`i's unemployment rates have been among the lowest in the nation in recent years.

Island of Hawai`i Labor Force Trends



See Exhibit 2-8 for sources and further information.

[12] These do not reflect the substantially higher incomes of the region's part-time residents.

[13] Not seasonally adjusted, for civilian labor force.

The island of Hawai`i has supported annual increases in the number of employed persons and in non-farm and salaried jobs since 1995. In September 2007, there were an estimated 82,400 employed persons in the County, holding some 66,500 non-farm jobs. However, increases in the civilian labor force seem to be cooling since last year, according to the DLIR.

3. Residential Market Environment

Historical Supply Conditions

2005/2006 Inventories

- **Hawai`i County** had some 75,185 housing units in 2006, of which 63,178, or 84% were occupied, according to the American Community Survey (ACS).[14] Among occupied units, 65% were owner-occupied and 35% renter-occupied, a higher owner ratio than Honolulu County, according to the ACS. In the 2005 ACS survey, among those units estimated to be vacant, the majority was classified for seasonal, recreational or occasional use. An additional share of occupied units, estimated at a minimum of 5%, was also considered occupied by persons whose usual place of residence was outside of the County. [15]

  Subtracting the non-primary housing units from the inventory of occupied units yields an estimated 60,000 resident housing units (RHU) in the County in 2006, or 87% of the total stock.

- **North Kona-North and South Kohala-Waikoloa** - While the ACS does not break out housing supply by area, according to data obtained from Claritas, about 9,474 or 13% of the Island's 2007 housing units was located in the CRMA.[16] With its many resort second home communities such as Mauna Kea, Mauna Lani, Waikoloa, Hualālai, Kūki`o and others, the CRMA has a far greater share of units held for seasonal, recreational or occasional use than the County as a whole. Also, among homes that are occupied, a greater than average share is occupied by persons who customarily live off-Island.

  Considering these factors together, there were an estimated 6,900 RHUs in the CRMA in 2006, representing 73% of the area's total estimated housing stock. Based on surveys of new housing currently marketed in the CRMA, the RHU inventory in the CRMA in 2007 is estimated to have increased by about 200 units to some 7,100 homes.[17]

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[14] U.S. Census, "2006 American Community Survey," released September 12, 2007 and as reported in Hawai`i State Department of Business, Economic Development & Tourism, Research & Economic Analysis Division. This survey marked the first time that the ACS survey included group quarter populations, rather than household populations only.

[15] DBEDT does not report these variables for the 2006 ACS survey.

[16] Competitive Residential Market Area, as defined for the housing market analysis of this study, and explained in Chapter 2. The CRMA is defined to consist of Census Tracts 215.01, the northern part of the North Kona Judicial District (including `O`oma and excluding Kailua-Kona Town) plus 217.01, the Waikoloa area of the South Kohala Judicial District (excluding Waimea Town). These two Census Tracts may also be referred to in this report as North Kona-North and South Kohala-Waikoloa, respectively.

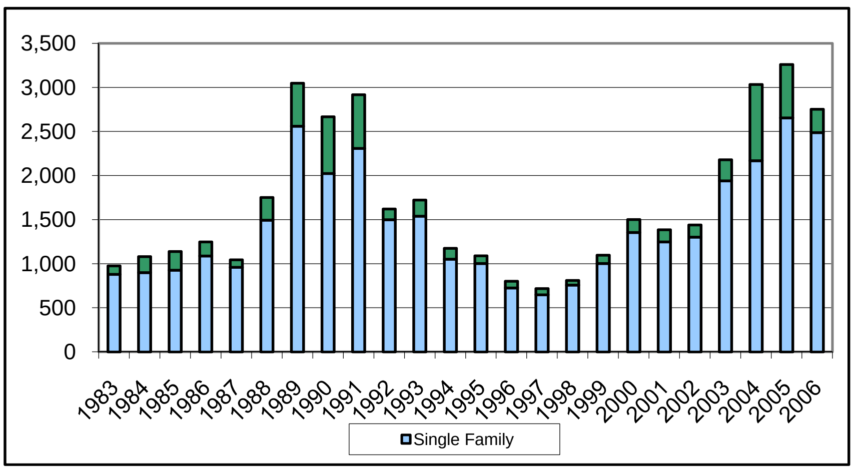
[17] The survey excluded new product being marketed in the beach resorts, and all properties makai of Queen Ka`ahumanu Highway.

North Kona-North's homeownership rate is equivalent to the County's as a whole, at 64%, while South Kohala-Waikoloa's is lower, at an estimated 53%, according to Claritas in 2007.

Residential Building Permits
(Exhibit 3- 1)

Hawaii County residential permitting is dramatically cyclical and evidenced a trough from 1996 to 1998. After 2001, permitting activity increased rapidly, culminating in a record 3,262 permits obtained in 2005. Activity has cooled since then, and 2006 showed 2,754 residential permits, of which 10% were multifamily and 90% single-family. As of September 2007, 1,070 single family and 349 multi-family permits had been obtained.

Building Permits – Hawai`i County



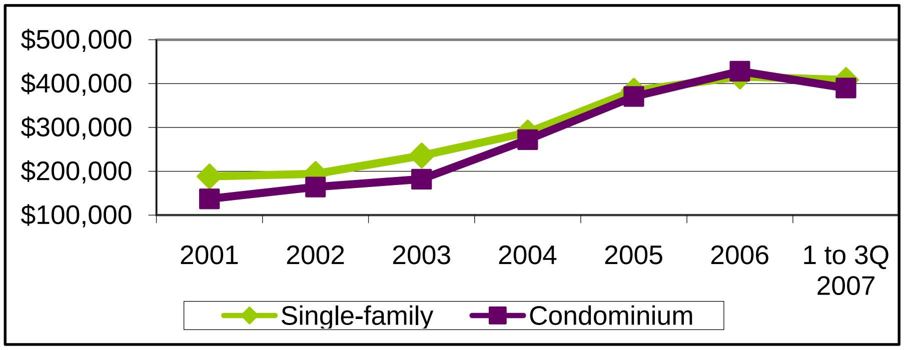
See Exhibit 3-1 for sources and further information.

Market Trends

Islandwide Sales (Exhibit 3-2)

Rapidly rising home prices in recent years reflect the relatively limited production of new housing, combined with strong labor market conditions and favorable financing conditions in recent years.

Hawaii Island Sales – Median Prices



See Exhibit 3-2 for sources and further information.

Sale recordations during the first three quarters of 2007 showed a median single-family price of $408,500 and a median condominium price of $390,000, according to UHERO.[18] These represent 5% and 13% declines from the corresponding periods in 2006, respectively.

The near parity in prices between condominiums and single-family homes reflects the relatively large share of resort and second home product on the Island. These units are generally higher priced than RHUs and much of the Island's existing condominium stock is in such use.

Residential sales velocity has slowed since a peak in 2005, and the first three quarters of data in 2007 reflect 16% and 35% fewer closings than in the corresponding period in 2006, for single-family and condominium units respectively.

In October 2007, the median priced single-family unit closed at $386,000, while the median price of a condominium unit was $420,000. These prices are -6% and +9% compared to October 2006 sales, according to Hawai`i Information Service.

The short-term outlook is for continued slowing sales and stabilized or somewhat declining prices as the market makes adjustments to reflect the overly rapid rises of past years. However, longer-term, ongoing population growth, household formation and pent-up demand will continue to fuel demand for new housing.

[18] University of Hawai'i Economic Research Organization, Economic Information Service, as accessed November 2007.

Single-Family Sales in North Kona and South Kohala (Exhibit 3-2)

Like the island as a whole, North Kona and South Kohala are recording fewer sales, while prices continued to appreciate through 2006.

- In 2006, single-family sales in the North Kona District numbered 456 at a median price of $645,000, but prices appear to have come down in 2007.
- South Kohala showed a 2006 median price of $550,000 with 287 closings.

Prices in these districts tend to be significantly higher than typical for the Island, and can be compared to the median single-family sale of $416,100 for the Island as a whole. These area premiums reflect both (1) the strong demand to live in the CRMA compared to a limited supply of area housing, as well as (2) the relatively high mix of resort residential product in the region.

Sales in Selected Areas, North Kona-North (Exhibit 3-3)

An analysis of residential sales in the Kona Palisades and Kealakehe communities of North Kona-North, both very close to `O`oma, was conducted. These are well-established primary residential communities with a predominance of single-family product. As for their surrounding districts and the Island as a whole, 2007 prices are generally lower than 2006. The median prices of single-family sales during the first eight months of 2007 were $540,000 in Kona Palisades, and $500,000 in Kealakehe.

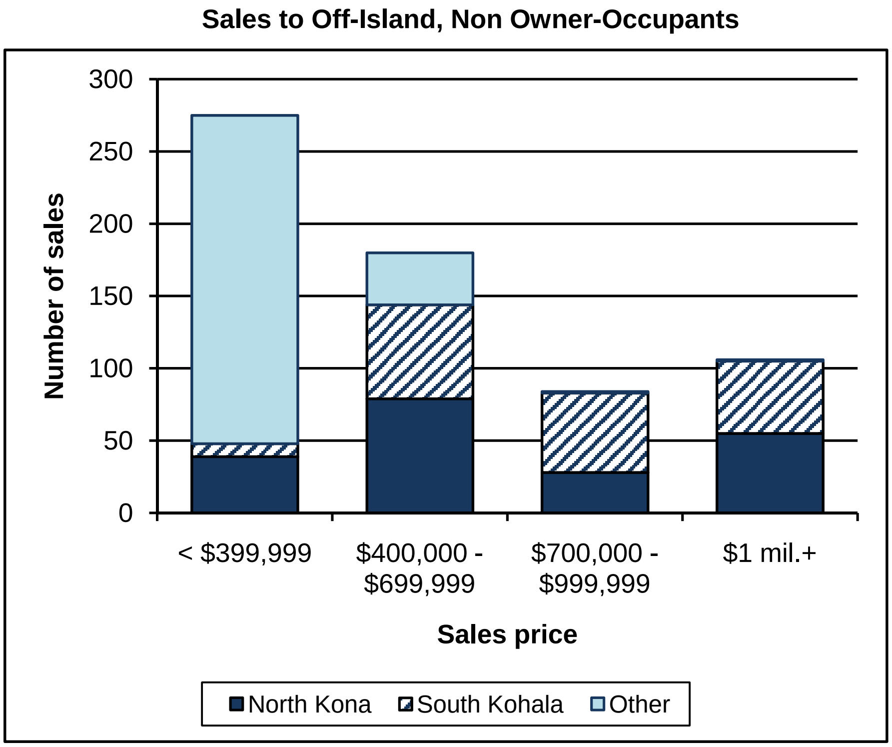
Off-Island Markets (Exhibit 3-4)

Portions of `O`oma, particularly those areas facing the ocean and shoreline park, as well as those along the southern border fronting Kohanaiki's golf fairways, are expected to appeal to off-Island buyers seeking part-time or vacation homes. To evaluate the potential market support from this segment, data was collected on sales transactions where the buyer did not claim an owner-occupant exemption and where the tax bill address is not on the Island. In 2007, there were 645 such transactions Island-wide, of which 31% were North Kona properties, 28% South Kohala properties, and 41% located elsewhere on the Island.[19] The total sample is down from about 800 such sales recorded in 2006. These findings are similar to those of another survey of vacation home sales.[20]

[19] The sample excludes vacant land sales and partial or multiple deed transactions. It includes 120 non owner-occupant sales transactions for which no tax bill address information was available. Data obtained from Hawai`i Information Service.

[20] Ricky Cassiday, in Honolulu Advertiser, "Fewer, pricier sales at resorts," August 21, 2007.

By sales price, 28% of 2007 off-Island, non owner-occupant sales were priced from $400,000 to $699,000, which as demonstrated elsewhere in this report, is a range encompassing the anticipated prices of all the market-priced, for-sale residential properties at `O`oma. North Kona is also shown to be the dominant location for property within this range, with 79 of the 180 transactions, or 44%.



See Exhibit 3-4 for sources and further information.

The less than $400,000 and $700,000+ ranges also demonstrate strong activity, although beyond $700,000, such transactions were largely confined to North Kona and South Kohala. This reflects a number of factors including:

- The desirability of proximity to the Airport and Kona area commercial offerings;
- Location on the Island's leeward side, which tends to offer beaches, drier weather, and sunset orientations;
- Development activity, which is centered in the Island's master-planned resort areas; and
- The off-Island market's familiarity with West Hawai`i locations, after years of successful marketing and operations.

Housing Supply Outlook

Potential New RHUs in the CRMA (Exhibit 3-5)

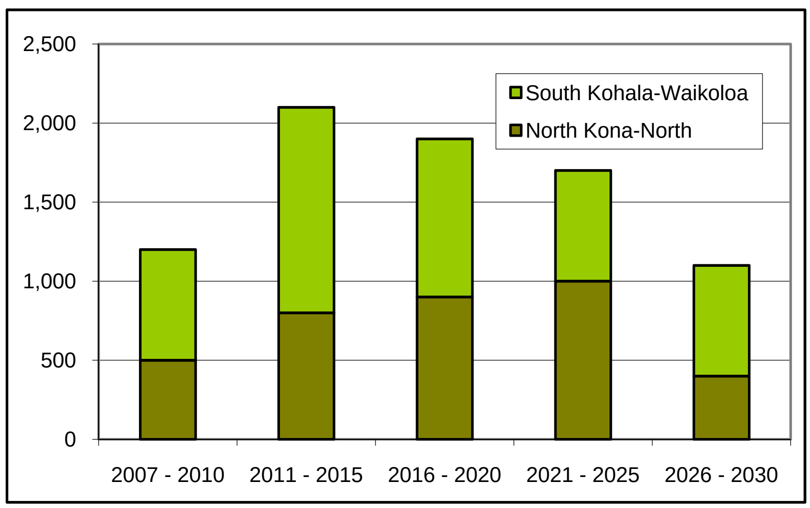
MC conducted a survey of planned residential projects within the CRMA, or CTs 215.01 and 217.01. This survey targeted projects of 100 units or more for which the LUC Urban District designation was in place as of October 1, 2007, and/or for which the landowner may be exempt from LUC governance.[21] The planned units reported are the maximum allowed by existing entitlements, and/or the maximum currently planned for development according to project representatives, whichever is lower. As such, these counts are likely to overstate future production, since most projects are not built to their ultimate entitled or planned capacity. Planned totals were also adjusted according to the share of development anticipated to be built for the primary residential market, as opposed to a second home or investor/other non-resident market.

The survey does not consider emergency shelters, dormitory beds, or other group living quarters.

- **North Kona-North** - Some 3,700 future units were identified at five projects in CT 215.01, of which 3,600 units are considered deliverable by 2030. The largest planned neighborhoods are Kaloko Heights by Stanford Carr Development (SCD) (estimated up to 1,160 RHUs) and the Villages of La`i`ōpua by the State of Hawai`i, DHHL (another 1,130 RHUs). With respect to La`i`ōpua, in 2012, DHHL faces an end to the significant State funding the department has been receiving, and this could disrupt its future production.

  These figures do not include `O`oma.

Potential New Resident Housing Units – Competitive Residential Market Area



See Exhibit 3-5 for sources and further information.

- **South Kohala-Waikoloa** shows about 4,800 future units entitled and planned, at seven projects. Among these projects, 4,400 units are considered deliverable by 2030. The largest in terms of potential future RHUs are Keolalani at Waikoloa by Keolalani Investment Partners (estimated 1,950 RHUs) and the County's Kamakoa Vistas, or Waikoloa Workforce Housing development (estimated at 1,140 RHUs). The development team for Kamakoa Vistas is still seeking to secure financing and funding for its project.

[21] The inventory excludes proposed residential developments on QLT lands in Keahuolū, where LUC-Urban District designation is already in place, but the lands are zoned for commercial use. QLT is considering petitioning the LUC for review of the use of these Urban lands within the next year. Likewise, the projected future inventory does not count plans on lands designated within the LUC Agricultural or Conservation districts as of October 1, 2007, because these plans require discretionary approvals at both the State and County levels and thus are currently considered too speculative to assume production. Such projects include `O`oma itself, as well as other announced proposals such as Kula Nei, Kaloko Makai and Waikoloa Highlands.

As noted, these potential inventories are generous since they consider current zoning or plan maximums and projected development schedules. Often projects get developed at less than their permitted or planned densities, and/or experience delays that push inventory further into the future.

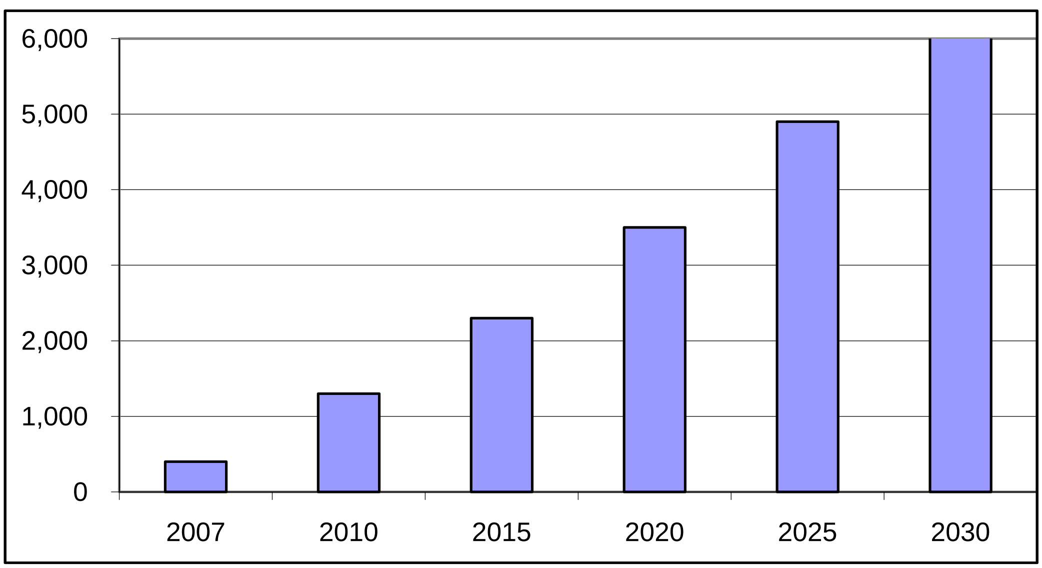
Summary of Island Demand and Supply Factors (Exhibit 3-6)

- **Current and Future Demand –** As presented previously in Exhibit 2-6, households in the CRMA would have to increase from about 7,481 in 2007, to 22,200 in 2030 in order to begin to address the area's imbalance of jobs and primary resident housing. This suggests a need to provide housing for some 15,000 new households by 2030. In addition, existing pent-up demand for RHUs in the CRMA as of the end of 2007 is estimated at 400 units.

- **Current Supply –** The 2007 supply of RHUs in the CRMA is estimated at 7,100 units, as presented at the beginning of this chapter.

- **Future Supply –** Future supply estimates are based on the schedule of LUC-entitled maximum potential future developments in the CRMA[22]. The identified projects could produce up to 8,000 new units by 2030, as discussed above. From this figure a 5% vacancy allowance is deducted, resulting in some 7,600 new units available for resident housing use. Note that these estimates are considered generous, as explained previously.

Resident Housing Unit Deficit in the CRMA
After Development of Currently LUC-Urban Lands



Source: Mikiko Corporation, 2007; see Exhibit 3-6 for further information.

[22] See previous footnote regarding sample selection based on land entitlement.

Taken together, the demand and entitled supply projections indicate a growing shortfall in currently permitted housing opportunities. In addition to the desire to house up to 15,000 new households in the CRMA by 2030, there is an estimated pre-existing pent-up demand for about 400 housing units, and only 7,600 net units LUC-enabled.[23] Thus, even with aggressive housing production efforts, without further LUC entitlement to allow for additional housing developments in the CRMA, the unmet demand for housing in the CRMA is estimated to be approximately 7,900 homes by the year 2030.

[23] Based on 8,000 LUC-entitled units delivered by 2030, less a 5% vacancy allowance among those units.

4 – `O`oma Residential Market Assessment

Future Housing Market Setting

Demand Generators (reference Exhibit 3-4)

`O`oma Beachside Village, LLC anticipates `O`oma's first housing units could be available for occupancy in 2012, with the first units produced within the Makai Area. At that time, there could be more pent-up demand for primary resident housing in the CRMA than there is today. The RHU supply in the area is projected to be more than 1,300 units short of what is anticipated to be desired by Island residents, even assuming aggressive and sustained development in the interim.

Additionally, demand generated during `O`oma's marketing will originate from new household formation as well as from existing households wishing to move into the area. This new demand can be characterized as:

- **Downsizers –** This is the Baby Boom generation between 2010 and 2020, and a larger share will be entering their mid-60s than their mid-50s by 2020. Many members of this generation can be expected to seek to live closer to community amenities as their children move out from home, they enter retirement and/or as they no longer care to maintain a large home.

  After 2020, the 55 to 64 age cohort could decline as Baby Boomers move into their 70s (see "senior markets," below.)

- **Entry level markets –** Hawai`i's next most rapidly growing cohort between 2010 and 2020 is likely to be persons aged 25 to 34, the "Echo Boom" generation. This life phase often includes household formation, and one's first rental or home purchase. Since affordability is key to this market and many do not yet have spouses or children, this market also tends to accept smaller units.

- **First move-ups –** A strong move-up market could emerge after 2020, as the Echo Boom cohort ages into its mid 30s and early 40s.

- **Retirement/senior markets –** The retiree/senior market will also show significant gains between 2010 and 2030. Typically one or two persons per household, this market is also amenable to smaller units.

As noted, many of these household types are expected to be willing to accept smaller living units and to value accessibility to community amenities. Within the Island, the CRMA (and `O`oma's site in particular) is considered a good location for attracting these growing market segments because of its proximity to existing and future anticipated Island jobs, the shoreline and regional parks, shopping and entertainment, the Airport and the many ongoing regional investments in public and private infrastructure throughout the region.

Housing Demand and Supply (reference Exhibit 3-6)

Currently entitled projects are estimated to yield up to 7,600 of the potentially demanded 15,000 housing units in the CRMA by 2030, if they are developed within the time frame and at the maximum levels of current plans and entitlements[24]

Despite these substantial developments and a strong and sustained rate of new home production forecast throughout the period, the CRMA could still anticipate a 7,800 to 7,900 unit shortage by 2030, the end of the projection period:

Supply and Demand for New Resident Housing Units - Competitive Regional Market Area, 2006 to 2030

Future Demand	Pent-up demand, 2006	400
	Future need, 2007-2030	15,000
	Total need	15,400
Future Supply	Planned and entitled (8,000 less 5% vacancy)	7,600
Shortage	**As of 2030**	**7,800***

* Exhibit 3-6 shows a 2030 shortage of 7,900 units; the difference is due to rounding of subtotals.

Source: Mikiko Corporation, 2007. See Exhibit 3-6 for further information.

The shortage appears to be particularly acute after about 2015, when many of today's projects could have already delivered substantial portions of their entitled and planned inventory.

[24] The projected future supply does not count plans on lands designated LUC Agricultural or Conservation District as of October 1, 2007, because these plans would require discretionary approvals at both the State and County levels and thus are currently considered too speculative to assume production. Such projects include `O`oma itself, as well as other announced proposals such as Kula Lei, Kaloko Makai and Waikoloa Highlands.

Development Style - Traditional Neighborhood Design

The mixed-use village development concept for portions of `O`oma is one that has been widely tested and refined as the principles of "Traditional Neighborhood Design," "New Urbanism," or "Smart Growth" are adopted in communities worldwide.[25] In contrast to the former suburban/commuter model of development, typical guidelines for Traditional Neighborhood Design include:

- Mixed land uses (residential, commercial, community);
- Walkable neighborhoods;
- A range of transportation opportunities;
- Housing opportunities and choices for a range of household types and incomes; and
- A greater balance of jobs and housing within each community.

According to The Congress for New Urbanism, even if overall demand for new housing were to slow, cultural changes are resulting in a preference for living in walkable neighborhoods, and thus the demand for homes in New Urbanism communities is expected to increase rapidly. This is being driven by several trends:

- Demand stemming from rapid increases in the number of households that are headed by persons who are middle-aged or older, even though these same persons likely grew up in and raised their children in suburban, car-centered communities;

- Receptivity of the young adult "Echo Boomers" to urban lifestyles and Traditional Neighborhood Design values, as well as a typical inability to afford living in the suburbs;

- Deteriorating driving experience on most US highways and roadways and ever-increasing transportation costs; and

- Workforce changes related to technology and outsourcing that encourage and enable more people to work from home.

`O`oma's Proposal

Development Concept

Consistent with the land use pattern envisioned for this region by The Hawai`i County General Plan (2005) and the Kona Community Development Plan concepts (in process), `O`oma is planned to respond to the trends and community needs discussed above. It will serve a County population that is evolving in terms of age profile and lifestyle, and it will

[25] The term "Traditional Neighborhood Design," as used herein, connotes similar design concepts as those that may be referred to elsewhere as "New Urbanism" or "Smart Growth." Although often dated to the late 1990s, all of these movements are rooted in the ideas of Jane Jacobs, who's The Death and Life of Great American Cities was published in 1961.

make available opportunities for primary resident living at more modest cost than now available almost anywhere else makai of Queen Ka`ahumanu Highway.

- It offers significant primary resident housing in a region that tends to be dominated by luxury resort second home developments.
- It offers a wide variety of housing types, including “live-work” units where a resident can combine a home and a small business.
- It offers an accessible lifestyle that is not car-driven, due to its medium-densities, mixed-uses, trails and “walkable” streets. These non-car options further enhance the affordability of the community, as studies have shown that automobile costs represent up to 15% or more of the typical U.S. household budget (and much more for lower income households.)
- It offers housing in an area with significant existing and anticipated jobs as well as schools, parks and other community amenities.

Product Mix

About 60% of `O`oma’s residential units could be for-sale multifamily units, and 40% for-sale single-family units, including some estate lots for custom home development. A share of `O`oma’s units is expected to be developed as affordable housing, in accordance with the County’s affordable housing requirements. A portion of these “affordable” homes could alternatively be developed as multifamily rental units.

The exact mix of units by type will be determined upon finalizing agreements with the County and during the years of build-out, as market conditions and preferences materialize.

A conceptual development scenario for \`O\`oma includes three distinct areas and types of multifamily development, and two main single-family product types:

Conceptual Mix of Residential Units at \`O\`oma

Unit type	**Development density** (units per gross acre)	**Total planned units**	**Multifamily homes**	**Single-family homes**	**Single-family lots**
Multifamily Units at Mauka Village	7.5 to 10	395 to 520	395 to 520	0	0
Multifamily Units at Makai Village	3 to 4.5	35 to 60	35 to 60	0	0
Multifamily Units at Residential Village	9 to 12	100 to 135	100 to 135	0	0
Single-Family Lots at Residential Village (ocean-facing properties)	2.5 to 3	70 to 85	0	0	70 to 85
Single-Family Homes at Residential Village	4 to 5	350 to 400	0	350 to 400	0
Total		**950 to 1,200**	**530 to 715**	**350 to 400**	**70 to 85**

Sources: PBR HAWAII, July 2007; prior studies.

Comparison Project Characteristics (Exhibit 4-1)

To develop market conclusions regarding the above product types, several North Kona and South Kohala projects were identified and evaluated in terms of their development densities, pricing, absorption and other characteristics. The survey results are summarized in Exhibit 4-1; highlights include:

- **Mixed-use villages (Mauka and Makai) –** The Big Island does not yet have any Traditional Neighborhood Design developments. However, a portion of Palamanui, a planned development north and mauka of the \`O\`oma site, is proposed for this style. Palamanui projects multifamily units in this area are proposed to be priced from about $400,000 to $500,000.

- **Other multifamily –** Makana Kai at Wehilani and Stanford Carr's developing Kaloko Heights project both offer townhomes, at 10 to 12 units per acre, comparable to what is proposed at \`O\`oma. As of this study's field work, these were priced from

$337,000 to $400,000+ at Makana Kai and are proposed to average about $400,000 at Kaloko Heights. Most buyers to date at Makana Kai were long-time Island residents.

- **Other single-family, finished homes –** Four mid-density comparison projects from North and South Kohala were identified as comparisons for single-family home development at `O`oma. These include Malulani Gardens (smaller lot homes only) and Pualani Estates in the southern part of North Kona (mauka of Kailua-Kona), Sunset Ridge in Waikoloa Village, and the planned mid-density single-family products at Kaloko Heights. Development densities at these projects range from 4.2 to about 5 units per acre, while achieved or planned sales prices clustered in the $500,000 to $600,000 range, but ranged up to $746,000.

- **Single-family estate lots –** There has been little vacant lot development catering to the primary residential market in the 2.5 to 3 units per acre range in West Hawai`i. Lot developments at these densities have generally been in resort settings and/or at very high-end oceanfront or golf-front locations. The most similar product identified was Bayview Estates, which is in an off-ocean but excellent view location in Keauhou Resort. Bayview resales between November 1, 2006 and October 31, 2007 ranged from $469,000 to $997,000 for still vacant lots with 71% of the buyers appearing to be established Island residents.

Residential Market Evaluation and Conclusions for `O`oma

Anticipated Buyer Markets (Exhibit 4-2)

The proposed products respond to the market opportunities identified previously as follows:

- **Entry-level markets –** Those units designated as affordable units, as well as many of the multifamily units in the Mauka Area are conceived to appeal to entry-level markets, typified by the rapidly increasing 25- to 34-year-old Echo Boom cohort in the 2010 to 2020 period.

- **Move-up markets –** `O`oma's Makai Village, which will be developed at lower densities than the Mauka Area, as well as its single-family housing, is expected to appeal to move-up markets and growing families. The first level move-up market, typified by persons aged 35 to 44, is projected to grow particularly rapidly in the 2020 to 2030 period as the Echo Boomers mature. A second-tier move-up market could be attracted to the custom home development opportunities at the estate lots.

- **Downsizers –** `O`oma's single-family units and all of its mixed-use multifamily units are seen to appeal to the Baby Boomer cohort that is looking to simplify its lifestyle, lessen homeowner commitments and enhance access to urban amenities. This market may overlap with the retiree segment described below.

- **Retirement/senior markets** – All of the multifamily units and some of the built single-family product could appeal to retiree markets. The age 70+ population will be a rapidly increasing age classification especially towards the latter years of `O`oma's marketing.

The great majority of `O`oma homebuyers (estimated at 84%) are anticipated to be long-term Island residents. However, some product types, notably a few of the Mauka Village live-work" units and the estate lots, could also appeal to second home buyers, relocating retirees, or others that may come from off-Island. Such non-primary resident buyers are projected to account for about 16% of all homes at build-out.[26]

Projected Sales Prices (Exhibit 4-2)

Evaluation of supportable residential prices at `O`oma takes into account its unique community characteristics:

- It is in North Kona, on the ocean side of Queen Ka`ahumanu Highway, an area that has been dominated by luxury second home developments with little to no housing opportunities for full-time Island residents.
- `O`oma includes more than a half-mile of shoreline planned for public use, including a beach and shoreline park. It will also connect to an extensive public waterfront park and other open spaces that will extend beyond `O`oma to the Kaloko-Honokōhau National Park, the Honokōhau Harbor, and possibly further south.
- It is planned to include a private canoe club as well as a public community pavilion.
- It is planned as a mixed-use community that is walkable and bikeable through a network of paths offering easy access to the beach, the shoreline park and retail, dining and entertainment options.
- It will offer considerable employment within the community itself, as well as "live-work" units that allow residents to combine their business and residential investments.
- The mixed-use villages would provide community retail and support services to minimize the need to travel outside the community for everyday needs.
- It is within a rapidly developing area of North Kona, where new developments include:
  - The proposed UHCWH, which would support new professional, technical, and research careers;

[26] This split is based on 20% of the market units being sold to second or vacation home buyers (20% x 80% = 16%).

- ❑ Additional tenants and expansions at NELHA and HOST, which are likewise expected to generate new positions in research, education and manufacturing;

- ❑ West Hawai`i's first regional mall and "lifestyle center" at Kona Commons; and

- ❑ Some of the Island's most unique commercial establishments.

- `O`oma's proximity to the Airport is both a positive and negative factor. On the one hand, it offers great convenience for those who travel frequently or whose business involves use of the Airport facilities. On the other hand, the Airport generates noise levels that are addressed through project design.

On balance, where density and other product characteristics are equivalent, `O`oma's site and location characteristics are considered to convey a premium over prices for comparable product at the selected comparison properties that were surveyed. It is also noted that elsewhere in the U.S., Traditional Neighborhood Design communities tend to enjoy a price premium over equivalent other residential products not developed in a mixed-use village setting with support community services.

The pricing conclusions for `O`oma are presented in Exhibit 4-2 and summarized as follows:

Market Unit Price Conclusions for `O`oma
2007 dollars

	Average sales price	Average unit density or lot size
Finished homes:		
Multifamily Units at Mauka Village*	$425,000	7.5 to 10 units/acre
Multifamily Units at Makai Village*	$525,000	3 to 4.5 units/acre
Multifamily Units at Residential Village*	$425,000	9 to 12 units/acre
Single-Family Homes at Residential Village (finished units)	$650,000	5,000 to 6,000 square foot lots
Vacant lots:		
Single-Family Lots at Residential Village	$650,000	9,000 to 15,000+ square foot lots

* Prices are for market-priced units, not considering any affordable units that could be offered among these product types.

Source: Mikiko Corporation. See Exhibit 4-2 for further information.

The prices listed on the prior page do not consider the affordable units that would also be developed on-site. Their pricing would be set in accordance with County requirements. Likewise, rental rates, assuming some affordable housing units are developed as rentals, would also be based on County requirements.

For illustrative purposes, according to County guidelines in effect as of May 1, 2007, affordable housing prices would include:

- For-sale units priced from $248,800 to $294,000, for those offered to families of four earning 110% to 130% of the median income; and

- One- to two-bedroom rental units priced from $935 to $1,309 per month, including utilities, and offered to households earning 80% to 100% of the median income.

Projected Supportable Sales Absorption

It is concluded that `O`oma could support a long-term sales absorption averaging about 67 units per year. Within this absorption rate are the 16% or so of buyers anticipated to come from off-Island and to be purchasing for other than primary housing purposes. As discussed in Chapter 3, North Kona is a well- proven area for such market activity, and the $400,000 to $699,999 price range is a very strong segment. The single-family estate lots, with a projected average price of $650,000, can be expected to result in finished home values of $900,000 or more, and these price ranges are also well tested in the North Kona vacation and part-time resident market.

Assuming off-Island buyers account for 16% of `O`oma's residential sales, they would account for approximately 11 sales in an average year. This in turn would represent an Island market share of less than 2% of the non owner-occupant sales identified in 2006 and 2007, or about 5% of 2007 North Kona non owner-occupant purchases (reference Exhibit 3-4.)

The remaining 56 of the 67 total average annual sales projected at `O`oma are assumed to be to Island residents who are seeking a primary home. This would mean `O`oma could satisfy approximately 9% of the 650 new units projected to be required within the CRMA in an average year between 2007 and 2030 (reference page 25 and Exhibit 3-4).

The overall conclusion considers:

- The experience of single-product types at the selected price comparison projects;

- The variety of product types at varying prices (including affordable units) to be provided at `O`oma, enabling appeal to many market segments;

- The location, pricing and community characteristics represented for `O`oma;

- `O`oma's extensive shoreline park and ocean access; and

- The strong future demand for new housing in the CRMA, which is projected at an average of about 650 units per year until 2030.

The 67 unit average might support the various product types approximately as follows:

Projected Supportable Residential Unit Sales Rate at `O`oma by Product Type, 2012 - 2029

	Maximum units	Average annual absorption*	Potential marketing period (years)*	Comments
Makai Area (Petition Area) (start 2012)**:**				
Multifamily Units at Makai Village	**60**	**10**	**6**	Some mixed-use units
Multifamily Units at Residential Village (portion)	**105**	**15**	**7**	No mixed-use; site spans Urban and Petition Areas
Single-Family Lots at Residential Village	**85**	**10**	**9**	No mixed-use
Single-Family Homes at Residential Village	**400**	**30**	**13**	No mixed-use
Subtotal	**650**	**46**	**14**	
Mauka Area (Current LUC Urban District) (start 2014)**:**				
Multifamily Units at Mauka Village	520	33	16	Some “live-work” units
Multifamily Units at Residential Village (portion)	30	15	2	No mixed-use; site spans Urban and Petition Areas
Subtotal	**550**	**34**	**16**	
Total `O`oma	**1,200**	**67**	**18**	

Note: Total and subtotals assume several but not all products are marketed simultaneously in any given year.

* Based on maximum number of units of each type, assuming all marketed for-sale (rather than some also as rentals), thus possibly high estimates. However, sales periods for products may also be extended due to phasing.

Absorption rates assume affordable for-sale housing. Actual inventory and unit tenure to be determined in future agreements with relevant government agencies.

Sources: PBR HAWAII, October 2007; Mikiko Corporation, 2007. See Exhibits 4-2 and 4-3 for further information.

Actual sales from year to year would vary depending on market cycles and the types of units available for sale at any given time. An illustrative mix of absorption periods for residential products within the Mauka and Makai areas of `O`oma are provided below:

Illustrative Summary of Maximum Potential Residential Sales Absorption at `O`oma

	Makai Area (Petition Area)	**Mauka Area (Current LUC Urban District)**	**Total for-sale housing** (maximum)*
Potential total inventory	**650**	550	1,200
Average annual sales	**46**	34	67
Years on market	**14**	16	18
Start date	**2012**	2014	2012
End date	**By 2025**	By 2029	By 2029

*Assumes several but not all products are marketed simultaneously in any given year, thus total project years on market could exceed that for the Makai or Mauka Areas individually; also, total average annual sales is less than the sum of those for the two areas individually.

Source: Mikiko Corporation, 2007.

As shown, developments within the Makai Area could be expected to be absorbed within about 14 years, or by 2025. Marketing of the Mauka Area could be expected to overlap with the Makai Area, but could extend somewhat longer, to about 2029.

Alternatively, if the community is developed at less than its planned maximum capacity, or if some of the units were developed as rental products, the residences could be absorbed more rapidly.

5 - Commercial Market Environment

Background

Various commercial areas offering retail and office facilities are planned at `O`oma. This chapter presents a review of area retail and office market conditions. Although many retail shopping centers include substantial office space, and office buildings often include retail, comparison properties are classified as one or the other based on the predominant use or representation of type by property managers.

Analytical Approaches

- **Retail** - The market assessment for retail space compares retail supply to area daytime populations. Daytime population consists of residents of an area, less those who may be away during the daytime for work or other purposes, plus those who may live elsewhere but are in the area during the daytime, such as workers employed in the area. The U.S. Census estimates daytime population for primary residents of the area; to this MC adds average daily visitors. Daytime population is a better indicator of commercial demand in West Hawai`i than resident population because of the strong influence of visitor spending on area commercial markets.[26]

- **Office –** Demand for office space is related to civilian employment at jobs located within the region, regardless of where the employees live. Government office buildings are not considered, since their development and placement is more often a matter of policy and budget processes than market trends.

Primary Trade Area

The Primary Trade Area (PTA) for commercial uses at `O`oma is considered to be the entire North Kona and South Kohala districts of the Island. This is a larger reference area than considered in the residential market review, where it was referred to as the Competitive Residential Market Area. This larger area of interest for commercial purposes is appropriate because:

- Commercial establishments in North Kona, and particularly its northern half, defined by CT 215.01, serve broad regional markets on the Island that extend far beyond CT 215.01. Obvious examples of this are Costco and The Pottery Terrace, the latter being the largest office building on the Island.

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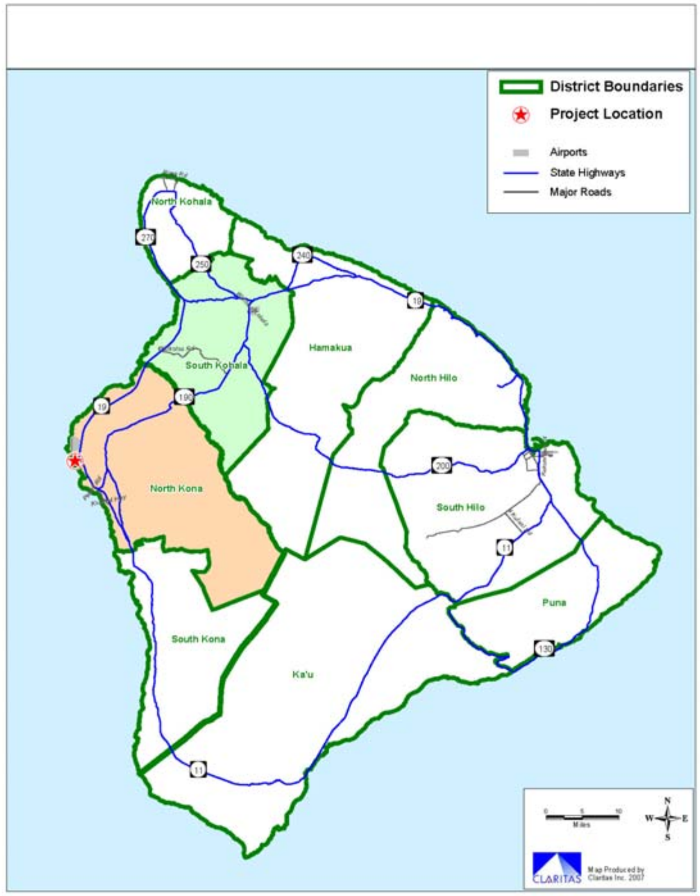
[26] Part-time residents of the region are another potentially very significant market segment, but this source is not evaluated quantitatively here.

Primary Trade Area



See Exhibit 2-1 for sources and further information.

- There appears to be significant commuting within North Kona and South Kohala, meaning that residents travel within the area for work, their children's schooling or for other activities. Hence, they may shop or patronize businesses within a broad area.

- There is a large daily visitor population in the PTA, mostly accommodated along the coastline. A significant share of this population is likewise considered quite mobile within the region, since they are vacationing.

North Kona and South Kohala also serve commercial markets that originate outside their borders. These sources of market demand are not addressed quantitatively in this analysis, and hence the conclusions expressed could be somewhat conservative.

Commercial Supply

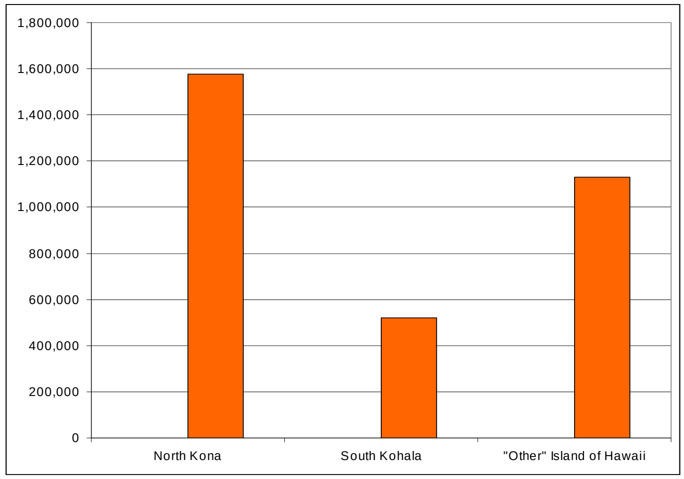
Existing Retail Supply in the PTA (Exhibit 5-1)

The PTA had some 2.1 million square feet of retail space in place as of the first quarter of 2007. About 75% or 1.6 million square feet of this was located in the North Kona District. The PTA accounts for about 65% of Island's retail-based commercial gross leasable area (GLA).

On the other hand, Hilo is home to the Island's largest existing centers, the Prince Kuhio Plaza with over 500,000 square feet, and Waiakea Center with about 230,000 square feet.

Overall, Hawai`i Island's retail market appears undersupplied, with an August 2007 composite vacancy rate of about 3%. The West Hawai`i area appears to be near balance with an average vacancy of about 5%.

Existing Retail GLA – Island of Hawai`i
(square feet)



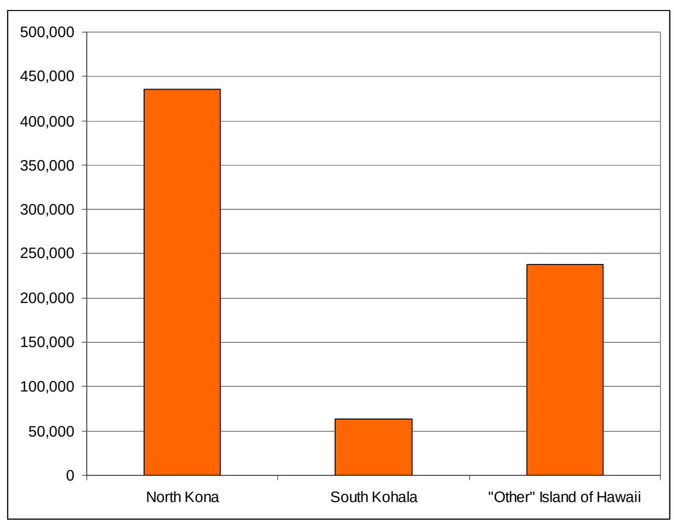
See Exhibit 5-1 for sources and further information.

Retail Benchmark Areas
(Exhibit 5-1)

Hawai`i Island as a whole has a different economic profile than does West Hawai`i, with significantly less visitor influence, and without the benefit of the major international port of the Island. Thus, while market data is provided and considered for the Island, it is not viewed as an ideal benchmark for the PTA, and a comparison locale was sought on Oahu.

As a planned community nearing buildout, with retail centers operating at or near capacity and a growing jobs base, Hawai`i Kai is a better indicator for the relationship of balanced retail supply to population levels in a suburban community.[27] Hawai`i Kai has about 857,000 square feet of GLA, of which 247,000 are in the regional Hawai`i Kai Towne Center, about 322,000 in Koko Marina Shopping Center, and 133,600 in Hawai`i Kai Shopping Center.

Existing Office RBA – Island of Hawai`i
(square feet)



See Exhibit 5-2 for sources and further information.

Existing Office Supply in the PTA
(Exhibit 5-2)

Office supply and demand is evaluated in terms of rentable building area (RBA), also expressed in square feet. Like retail, North Kona also dominates the office-based supply in the PTA, with an estimated 435,000 RBA, compared to only 63,000 in South Kohala and 238,000 elsewhere on the Island.

[27] Because Hawai`i Kai is a suburban community, whereas the PTA is emerging as an urban infill development, Hawai`i Kai's ratios are possibly low indicators for the PTA.

The PTA as a whole houses about 66% of the County's office-based RBA.

Office vacancies were about 7% in North Kona, 0% in South Kohala, and 10% for the Island as whole, as of November 2006.

Office Benchmark Areas (Exhibit 5-2)

As in the retail market, office market characteristics for Hawai`i Island as a whole are considered low indicators for office demand in the PTA. Thus, the study also looks to O`ahu as an example of more mature office markets and a labor force that includes a greater share of non-service-based employment, as may West Hawai`i in the future. While O`ahu includes some highly urbanized areas, taken as a whole it is a composite of urban, rural and suburban areas.

The island of O`ahu had a total of 15.7 million RBA, of which 11.4 million or 73% was in urban Honolulu. O`ahu's average vacancy rate was about 7% as of the third quarter of 2007.

Planned and Future Space in the PTA (Exhibit 5-3)

A total of 2.6 million square feet of planned and entitled commercial inventory was identified in North Kona and South Kohala.[28]

Within the PTA, North Kona is the focus of current commercial development interest. There is an estimated 1.9 million square feet of potential retail- and/or office-based commercial spaces proposed or already underway on lands that are entitled and planned for commercial development, as of October 2007.

- The largest will be the Kona Commons, an approximately 70,000 square foot "lifestyle" center planned on lands leased from QLT in the Keahuolū area. The first phase of about 132,000 square feet of this center is anticipated in October 2008.

- Second largest is the up to 500,000 square feet proposed at Kona Kai Ola, which would also include a marina and hotel, and timeshare units on lands extending from Honokōhau Harbor to Queen Ka`ahumanu Highway. Although most of these lands are now designated LUC-Urban, developer Jacoby and the State landowners Department of Land & Natural Resources (DLNR) and DHHL are initiating an EIS process because of agreements between DLNR and Jacoby. The property will also require a Special Management Area Permit (SMA) to proceed.

[28] As for residential developments, this analysis considers only those proposals on lands designated Urban by the LUC as of October 1, 2007. Additionally, commercial developments within projects designated for industrial use are not considered. These would include the West Hawaii Business Park and Kaloko Industrial Park. In addition, the Department of Transportation-Airports division is currently working a revised Master Plan for KOA, which may result in additional commercial uses at KOA. These potential uses have not been considered here because the DOT-A master planning process is still underway and specific uses have not been determined, therefore such development is too speculative for analysis at this time. "

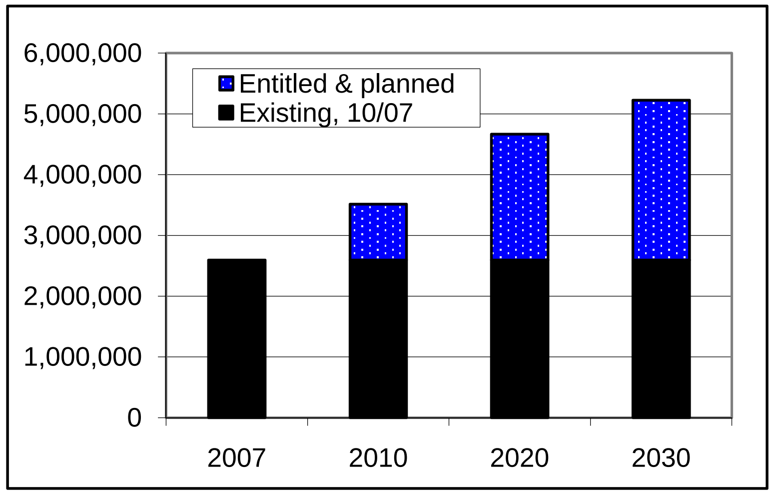
South Kohala has some 740,000 square feet of commercial area proposed over the next 20 years, at four locations: Queen's Marketplace in Waikoloa Beach Resort (under construction), the proposed Aina Le`a development across from Mauna Lani Resort, Waikoloa Village and in Waimea Town.

Specific projects and land areas from which these estimates were derived are presented in Appendix 4.

Future Trade Area Inventory (Exhibit 5-3)

If all of the planned and entitled projects identified were developed to their full capacity, and no existing retail- or office-based centers were demolished, the PTA's commercial inventory could approximately double by 2030, to some 5.2 million square feet.

Potential Future Commercial Space - PTA (square feet)



See Exhibit 5-3 for sources and further information.

Retail Supply and Demand Relationships

Area Resident Profiles (Exhibit 5-4)

The PTA was home to some 50,917 persons, representing an estimated 30% of the Island's population in 2006. Claritas estimates the PTA population grew 3.4% per year after 2000, much more rapidly than the Island as a whole. The benchmark market Hawai`i Kai housed about 28,000 persons in 2000 and is estimated to have grown just 0.8% per annum to about 29,000 in 2006.

North Kona's median age in 2006 was about 39, somewhat older than in South Kohala or the Island as a whole, whose medians were estimated at 36 and 37, respectively. North Kona's median age is closer to that of Hawai`i Kai, where it was estimated at 44 in 2005.

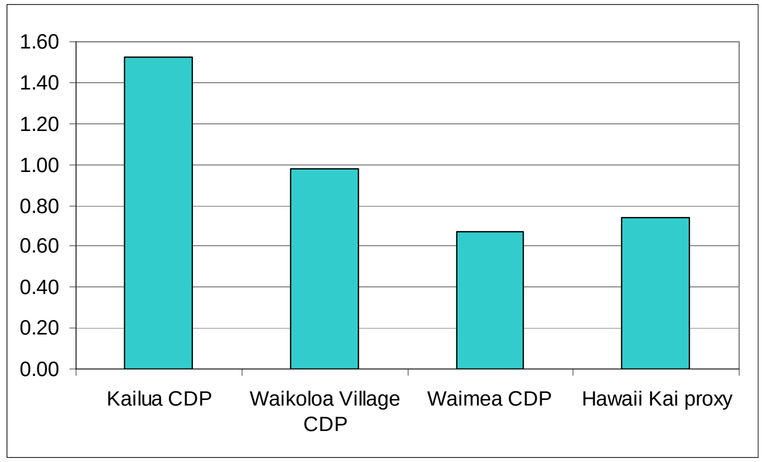
Daytime Population Ratios (Exhibit 5-5)

Daytime populations within the Trade Area and benchmark market are estimated based on 2000 ratios prepared by the U.S. Census within Census Designated Places (CDPs).[29] The PTA is evaluated by means of three CDPs: Kailua (Kailua-Kona area), Waikoloa Village and Waimea. The ratios derived from this source are considered baseline figures for the current analysis, as explained below.

[29] US Census Bureau, Census 2000, PHC-T-40, "Estimated Daytime Population and Employment-Residence Ratios: 2000" Journey to Work and Migration Statistics Branch, 2005.

Hawai`i Kai is not a "Place" designated by the Census. Therefore, Kailua on O`ahu is used as a proxy for Hawai`i Kai, since both are long-established bedroom communities to Honolulu, located about 30 minutes away, and both have shown recent increases in retail- and service-related employment.

Ratio of Daytime Population to Residents



See Exhibit 5-5 for sources and further information.

On average, the PTA CDPs showed a daytime to resident ratio of 1.13 persons in 2000, suggesting significant in-commuting during the day, especially to the Kailua-Kona area. These figures do not consider the impact of non-Island residents such as visitors staying at area resorts.

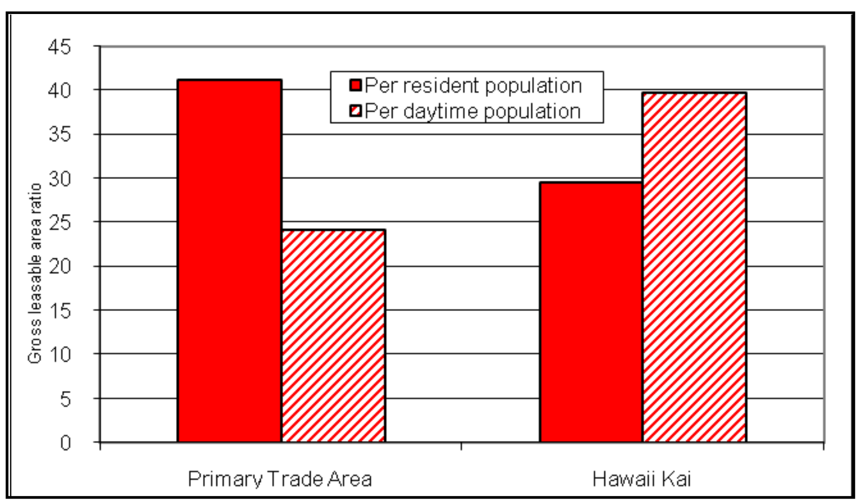
In-commuting to the PTA as a whole could be even greater than these figures reflect, because there are persons who live and work in different CDPs but still within the Trade Area.

As a proxy for Hawai`i Kai, Kailua CDP showed a 0.74 daytime to resident population ratio.

Retail Supply in Relation to Population
(Exhibit 5-6)

Comparing retail GLA to resident population, the PTA suggests high supply when one considers resident population, but upon evaluation of the more relevant daytime population, it is well below the Hawai`i Kai benchmark. The PTA supply represents 24 square feet per daytime resident, while Hawai`i Kai is considered a relatively balanced suburban market, at 40 square feet per daytime resident.

Retail GLA Per Person
(square feet)



See Exhibit 5-6 for sources and further information.

Hawai`i Kai was able to support this significantly higher space ratio despite virtually no vacancies.

Office Supply and Demand Characteristics

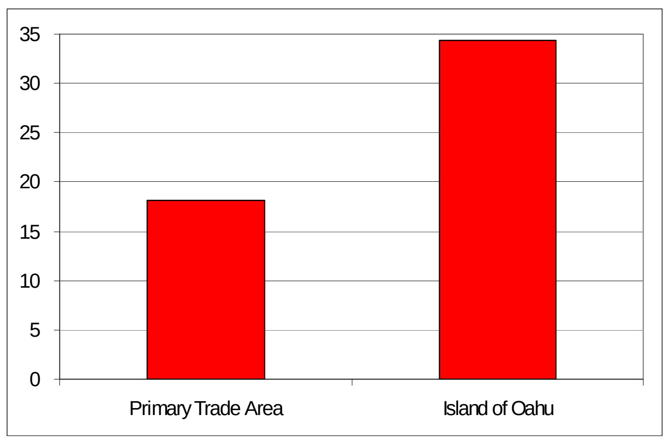
Employment Ratios (Exhibit 5-7)

The PTA's civilian labor force accounted for about 54% of its resident population in 2006, with insignificant variation between North Kona and South Kohala. For the island of Oahu as a whole, the ratio was 49%. The PTA's higher ratio reflects its relatively young and workforce-dominated population. With the job and career opportunities of the PTA, it is likely to continue to attract a substantial workforce population, but its age profile will also "gray" as will the rest of the State's.

RBA Ratios
(Exhibit 5-7)

Comparing existing office RBA to the number of civilian employed persons, the PTA offered significantly less office space than O`ahu as a whole. In 2006, the PTA's private office inventory was estimated at 18 square feet per person in the civilian labor force, compared to 34 for O`ahu.

RBA Per Civilian Employee
(square feet)



See Exhibit 5-7 for sources and further information.

6 – `O`oma Commercial Market Assessment

This chapter presents the estimated market support for additional commercial space in the PTA and at `O`oma, as derived from retail- and office-based market indicators.

Supportable Commercial Area in the Primary Trade Area

Methodology (Exhibit 6-1)

Additional future retail-and office-based market needs will be related to growth in the daytime populations of the PTA for retail space, and in the labor force for office space. The potentially rapidly increasing resident population of the PTA itself would anchor demand in the area. Additionally, the populations of rest of West Hawai`i could also contribute significant retail expenditures to the PTA, as the PTA becomes further established as the regional hub for jobs, services, entertainment and shopping. This analysis of supportable commercial area considers only demand that originates within the PTA, and thus may be considered conservative.

Retail-Based Demand (Exhibit 6-1)

- Retail-based demand is evaluated as a function of daytime population. This assessment assumes daytime to resident population ratio in the PTA rises from the 1.28 level that was derived from year 2000 working patterns, to 1.40 by 2020 and beyond. This is considered possibly conservative due to:
    - The PTA ratio is likely already higher than the 1.28, since that figure reflects 2000 working patterns and only those persons remaining within small CDP areas within the Trade Area.
    - The many proposed commercial developments in North Kona reinforce its position as a jobs and commercial hub of West Hawai`i, and reflect its status as an urban infill area.
- Added to this "resident daytime population" is an estimate of the average daily visitor population in the area, which is assumed to grow at about 2% in the future, according to projections prepared by UHERO.[30,31]

[30] UHERO, "Tourism Pause Means Further Slowing Ahead," March 2, 2007.

[31] This methodology may also be considered conservative in that the sizeable and growing area population of second home residents is not quantified as a part of daytime population.

These components identify a future PTA retail consumer population of about 179,000 persons by 2030, reflecting a 3.1% per annum rate of increase from 2010. Employing a ratio of 40 GLA square feet per person, equivalent to that realized in Hawai`i Kai in 2006, the PTA could be expected to support some 3.0 million square feet of retail-based GLA by 2010, or up to 5.9 million by 2030.

Office-Based Demand (Exhibit 6-1)

North Kona already dominates the Island's office market with the majority of the Island's supply at better than average occupancy.

Future office-based demand is considered a function of growth in the civilian labor force in the PTA. This can be expected to follow from the relocation and expansion of UHCWH, additional job creation at NELHA and HOST, and from plans for commercial, second home, timeshare and hotel developments within the area. Some of these developments represent expansion of non-service industries in the PTA and can be expected to support more professional and technical opportunities than are available today. These sectors tend to generate more office-based employment than others. Accordingly, supportable RBA in the PTA is projected to increase to up to 25 square feet per civilian employed resident by 2020. This would be a significant change from the 2006 profile of the area, but is still well within the 34-square foot average evidenced on Oahu.

Using these assumptions and considering just the PTA as a demand generator, by 2030, the PTA could require up to 1.4 million square feet of office RBA.

Total Commercial Demand (Exhibit 6-1)

In total, the retail- and office-market derived demand indicator suggest support for up to 3.6 million square feet of commercial area by 2010, or 7.3 million throughout the PTA, by 2030:

Projected Supportable Commercial Areas in the PTA (square feet)

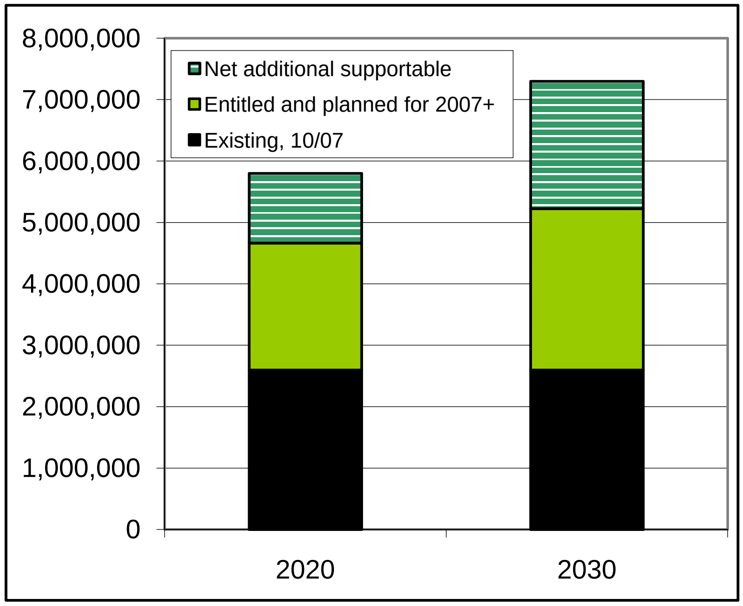
	2010	2020	2030
Retail-based demand	3,000,000	4,700,000	5,900,000
Office-based demand	600,000	1,100,000	1,400,000
Total	**3,600,000**	**5,800,000**	**7,300,000**

Note: Represents total projected supportable areas, including existing and entitled/planned developments. See Exhibit 6-1 for further information.

Supportable Additional Areas

Considering the already existing State entitled and planned areas,[32] the PTA could be expected to support an additional 1.13 million square feet of commercial space by 2020. By 2030, the cumulative total of new supportable areas could amount to about 2.07 million square feet over and above those areas already existing or proposed and entitled for development.

Projected Supportable Commercial Areas in the PTA
(square feet)



Source: Mikiko Corporation. See Exhibit 6-2 for further information.

Assessment for `O`oma
(Exhibit 6-2)

`O`oma Proposal

`O`oma Beachside Village, LLC proposes to offer approximately 200,000 square feet of commercial areas at `O`oma. The majority, up to about 150,000 square feet, would be located in the Mauka Village, which may be traversed by a proposed NELHA/Airport connector road. This would create highly desirable commercial sites at the Mauka Village.

The balance of up to about 50,000 square feet would be located in the ocean-facing, Makai Village, at the edge of the shoreline park. This Village could include a private canoe club, restaurants and other retail or entertainment-oriented establishments that would benefit from the ocean and shoreline views.

As with the residential development, the first finished commercial building products are assumed to be available for use in about 2012.

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[32] See Appendix 4 for listing and explanation of areas considered "entitled and planned" future inventory.

Commercial Markets and Enterprise Types

`O`oma's commercial development will address `O`oma residents' retail and office needs as well as those of the PTA and in some cases, the broader West Hawai`i community. Facilities could include neighborhood or community shopping centers, office buildings, "live-work" or "flex units" that could accommodate a proprietor's office as well as home, and retail spaces mixed into residential and/or office structures.

The location suggests a variety of enterprise types of interest, such as:

- **Neighborhood retail and services** directed at `O`oma and Kohanaiki primary residents and the `O`oma and NELHA workforce. This demand could support establishments such as eating and drinking places, convenience grocery, sundries, laundry services and banking;

- **Community retail and businesses** directed at `O`oma residents as well as the broader West Hawai`i community, but particularly the North Kona and South Kohala districts. These could include unique eating and drinking places, specialty foods or nursery/floral shops; postal or other civic services; and offices for professional services, real estate and rental agencies;

- **Airport convenience goods and services** such as gas stations, gifts and packaging/mailing, especially if the NELHA/Airport connector road is developed;

- **Service businesses that support area part-time resident communities** such as at Hualālai, Kūki`o and Kohanaiki, with services such as home maintenance and repair, housekeeping, pool maintenance, landscaping, and auto storage and maintenance;

- **Branch offices** of professional or construction-related enterprises that frequently do business in West Hawai`i.

It is estimated that a majority of the commercial space planned throughout `O`oma could be supported by resident and daytime populations that originate within a three- to four-mile radius of `O`oma. In addition to offering convenience to these area residents, workers and visitors, the planned commercial areas could also benefit the broader region:

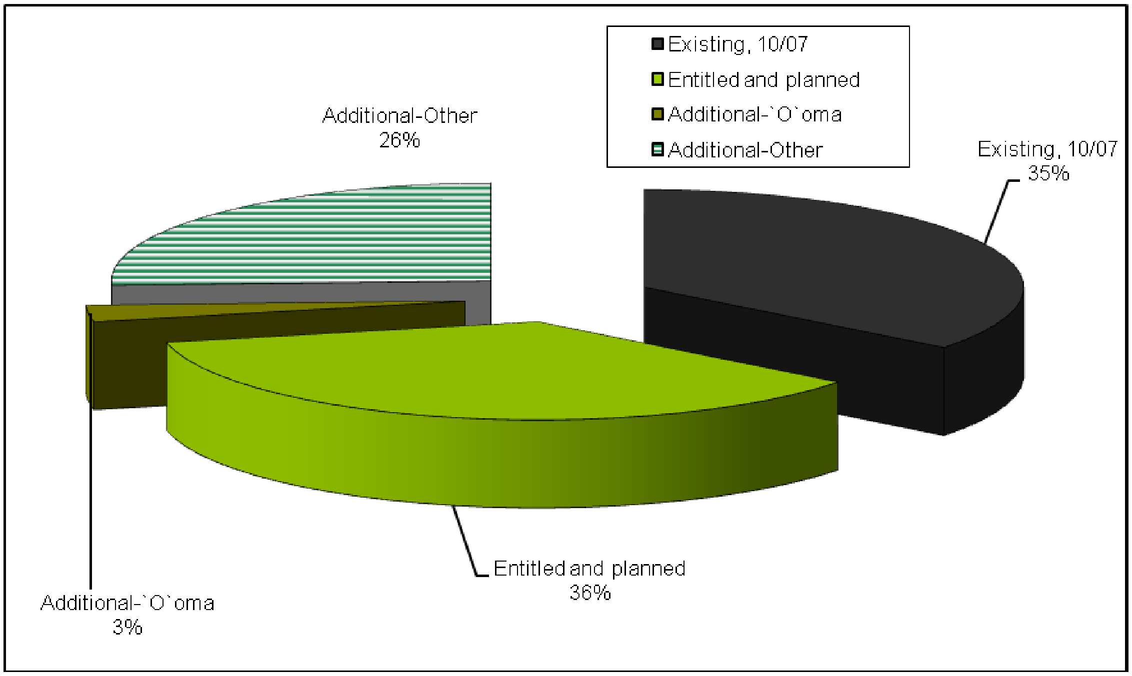
- **Traffic alleviation –** With its prime location near to the Airport, between Kailua-Kona and the resorts of North Kona, and with frontage along Queen Ka`ahumanu Highway and a potential NELHA/Airport connector road, commercial development at `O`oma could alleviate unnecessary traffic into congested Kailua-Kona for residents, employees and visitors to the region.

- **Ocean access –** The proposed Makai Village will greatly enhance public access to the shoreline. This would be a great departure from existing commercial developments near to the shoreline in North Kona, which have tended to be entirely private or very exclusive.

Projected Supportable Commercial Areas (Exhibit 6-2)

If developed to the full-proposed approximate capacity of 200,000 square feet, `O`oma's commercial spaces could represent some 3% of the PTA's total 2030 inventory. It could also represent a venue for about 10% of the currently unplanned but future supportable commercial space in the PTA.

Distribution of Projected Supportable Commercial Space in the PTA: 2030



See Exhibit 6-2 for sources and further information.

`O`oma is projected to support about 100,000 square feet within nine years (by 2020). This could include all of the 50,000 square feet proposed within the Makai Area, and about one-third of areas proposed within the Mauka Area. The balance of commercial development could be expected to be completed coincident with the buildout of the residential community.

A potential development scenario consistent with the market findings is outlined on the following page. The assessment addresses commercial spaces that may be developed within "live-work" units, as well as those that may be built in dedicated commercial or mixed-use centers.

Summary of Projected Commercial Absorption at `O`oma
2012 - 2029

	2012 - 2020	2021 - 2029	Total
Number of years	9	9	18
Makai Area (Petition Area) (start 2012):			
Mixed-use	30,000	0	30,000
Restaurant/canoe club	20,000	0	20,000
Subtotal	**50,000**	**0**	**50,000**
Mauka Area (Current LUC Urban District) (start 2014):*			
Mixed-use*	50,000	100,000	150,000
Total	**100,000**	**100,000**	**200,000**

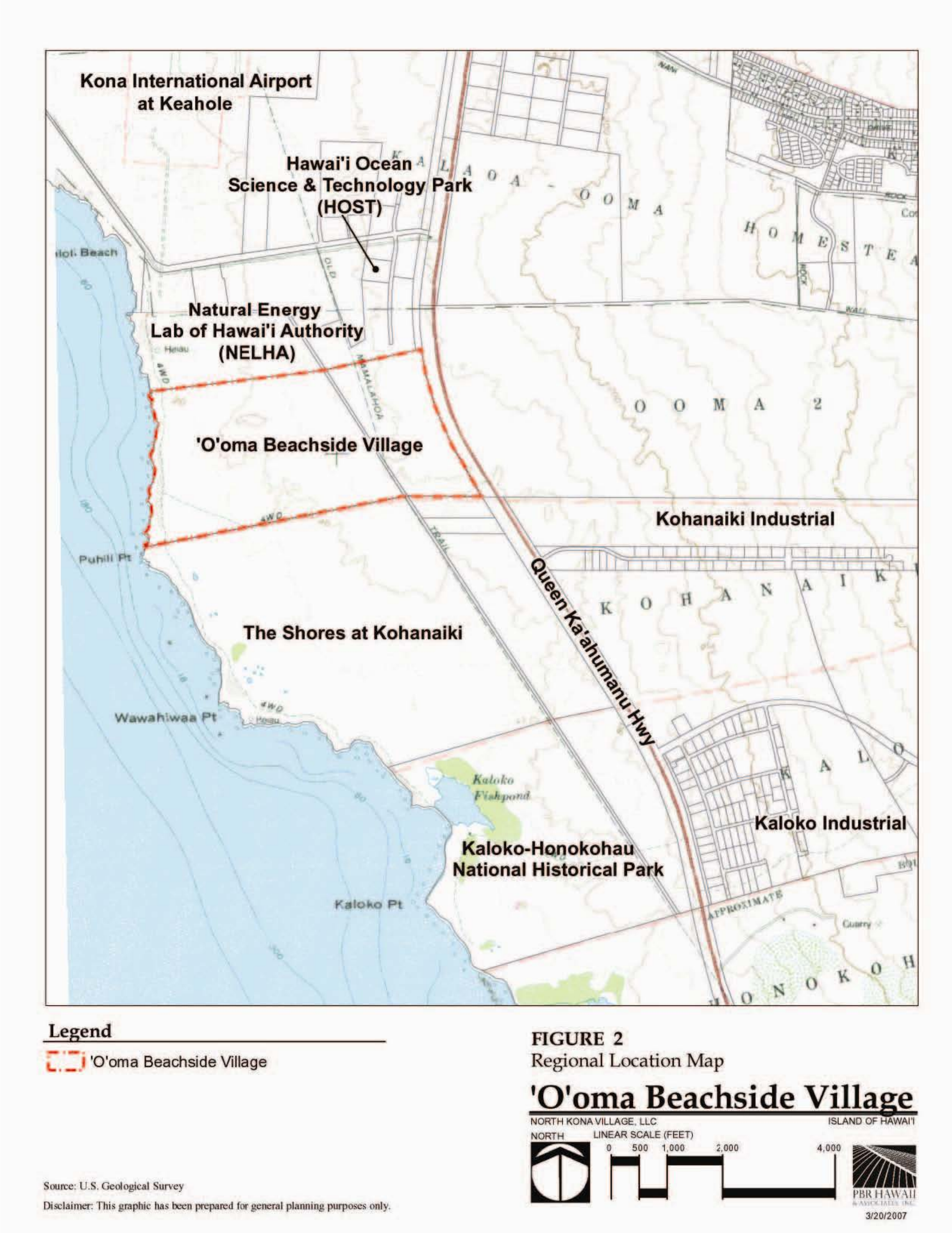
* Start date refers to all developments within the Current LUC Urban District, including residential uses. Commercial uses likely to be initiated a year or more after residential uses within this area.

Source: Mikiko Corporation, 2007.

Market Assessment for `O`oma Beachside Village

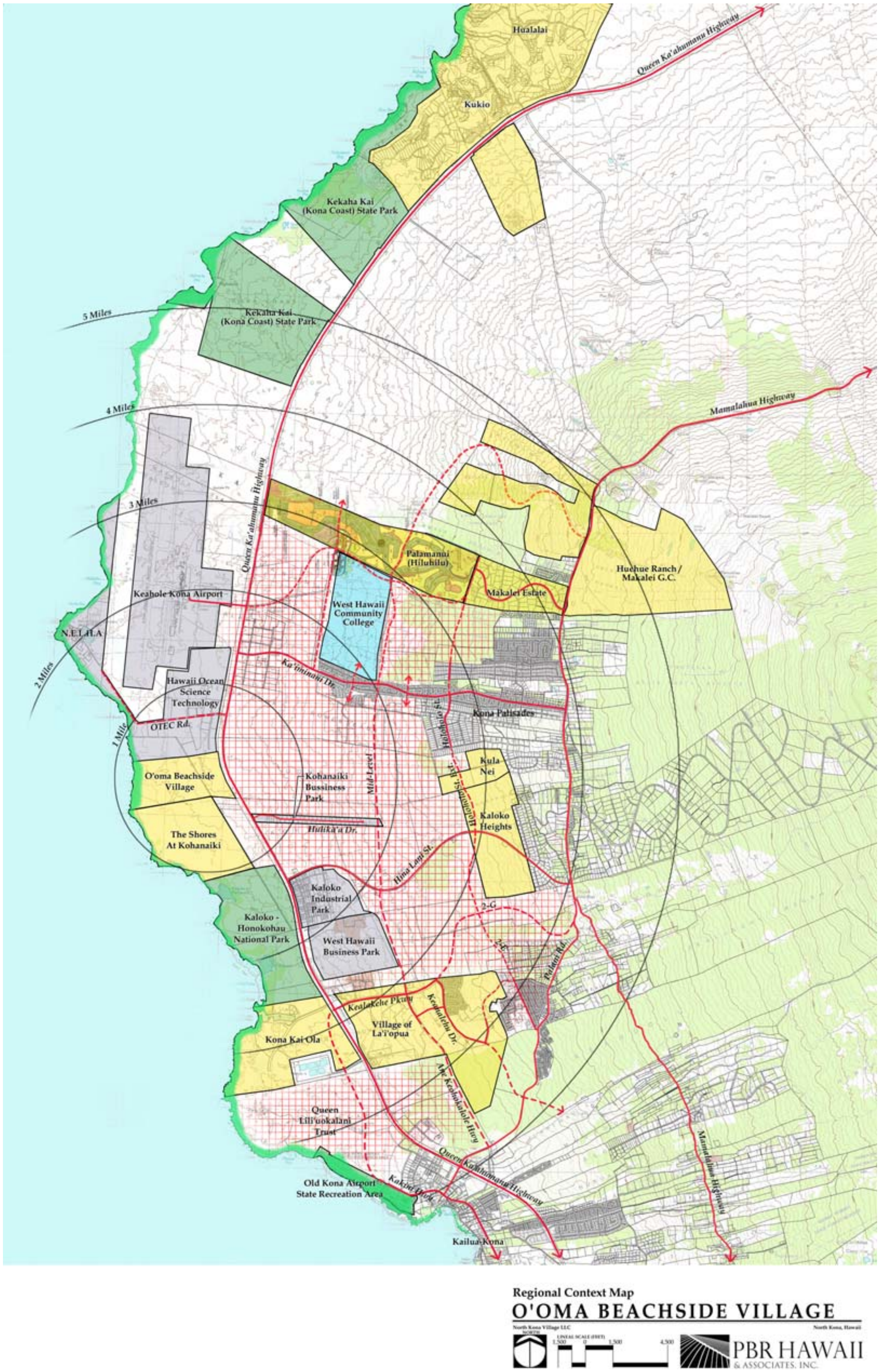
Exhibits

Exhibit 1-1
`O`oma Beachside Village – Site Location



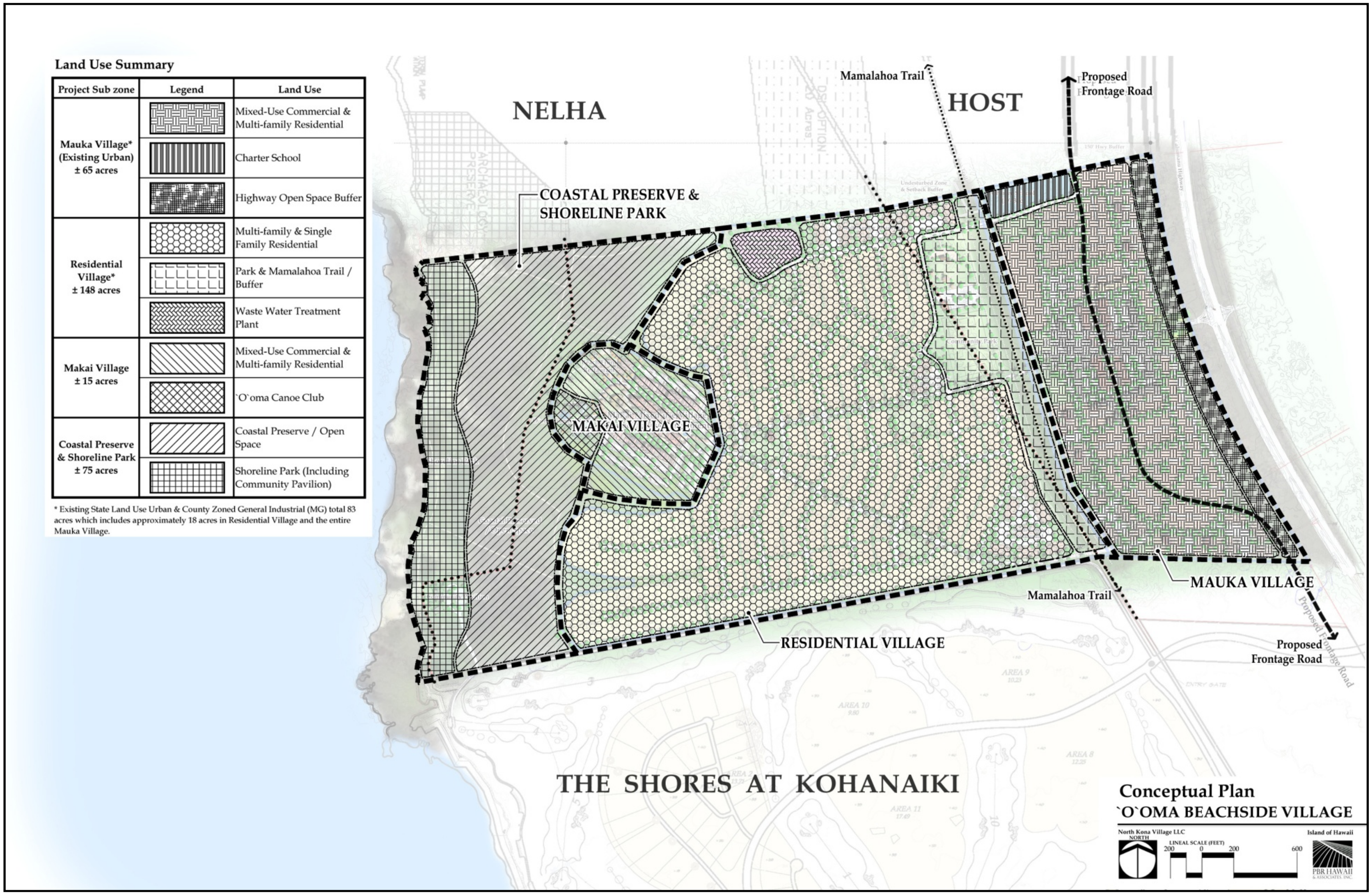
Source: PBR Hawaii, 2006.

Exhibit 1-2
`O`oma Beachside Village – Regional Context



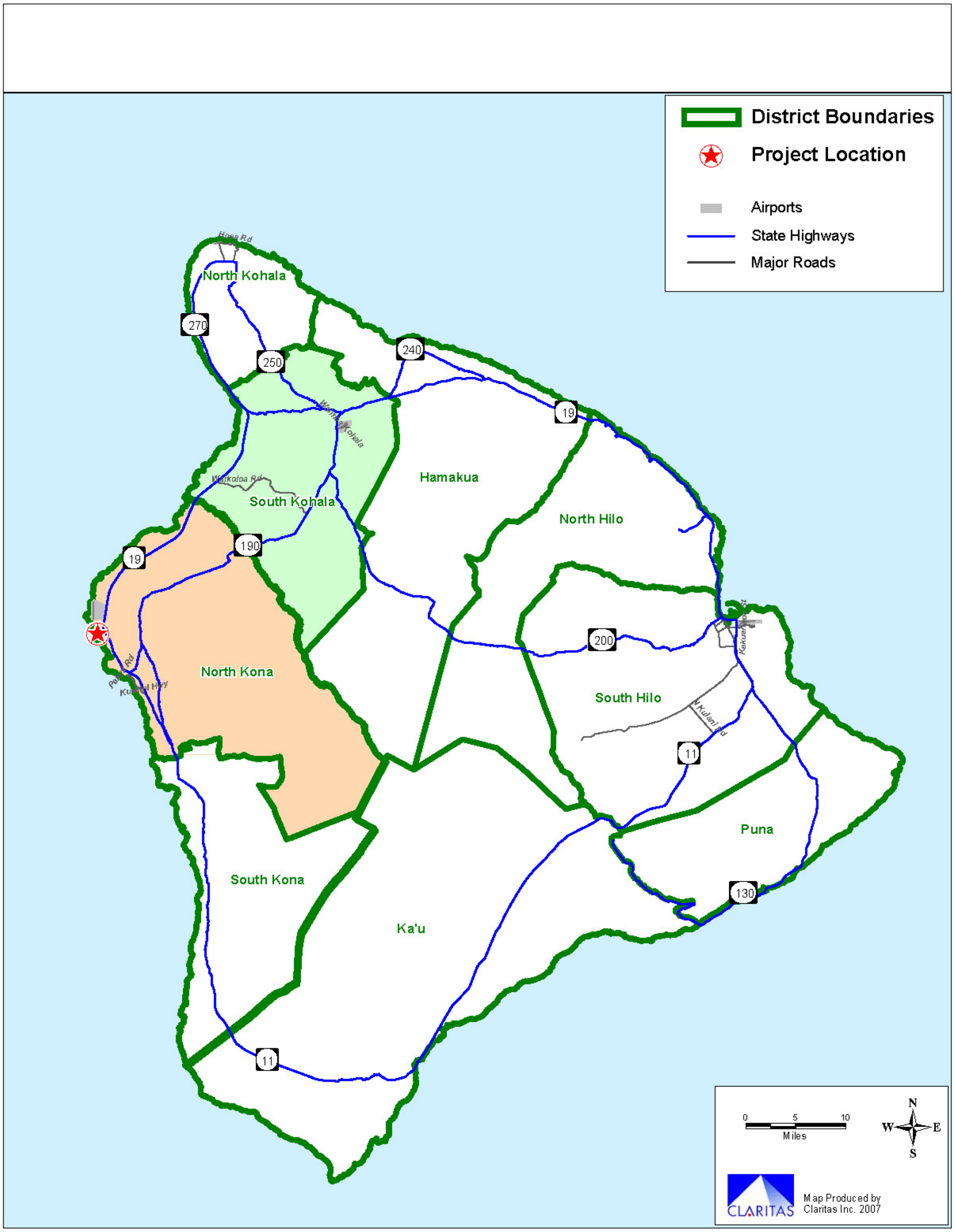
Source: PBR Hawaii, April 2007.

Exhibit 1-3
`O`oma Beachside Village – Proposed Land Uses



Source: PBR Hawaii, 2008.

Exhibit 2-1
`O`oma Location and Hawaii Island Districts

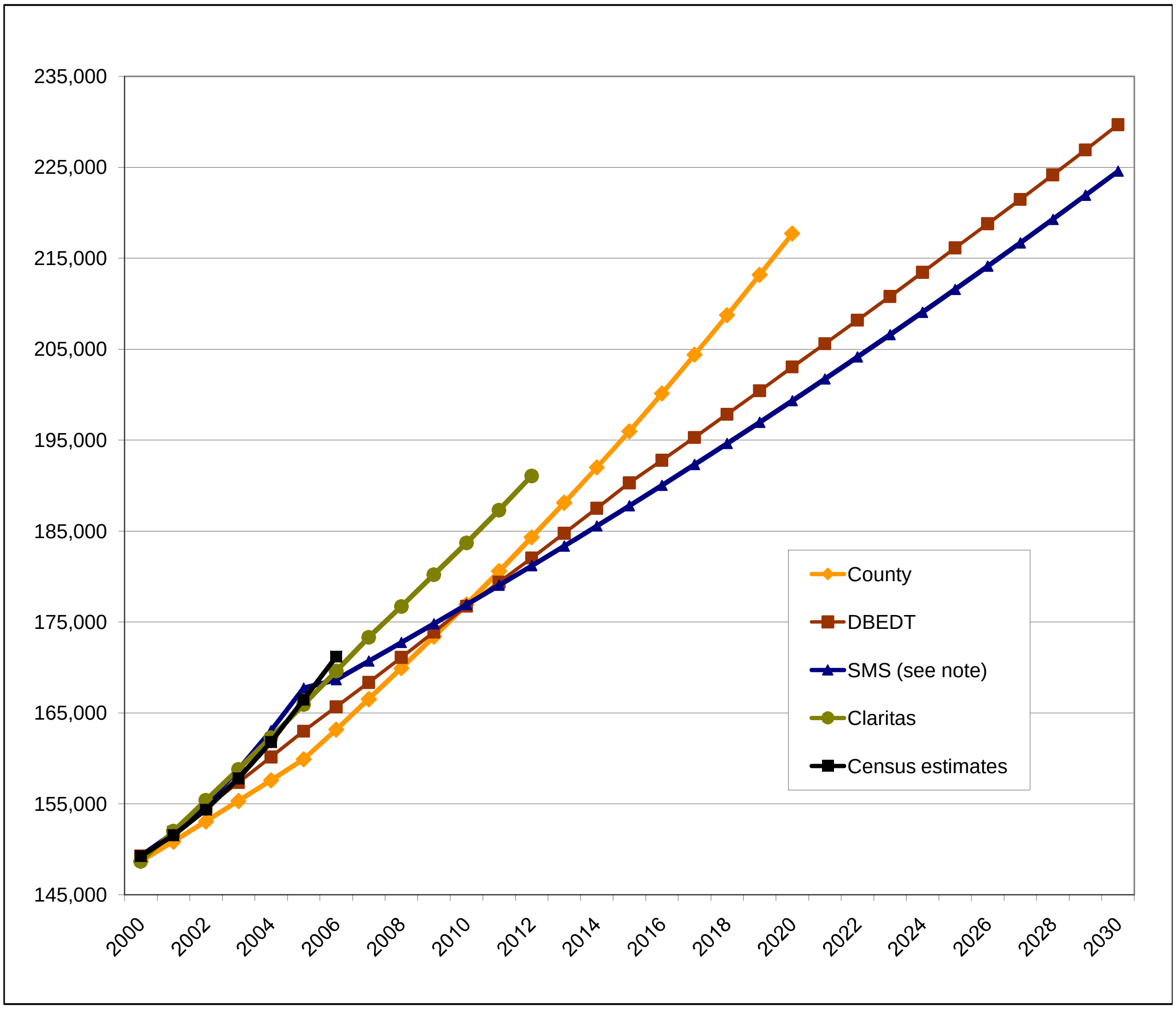


Source: Claritas, Inc., March 12, 2007.

Exhibit 2-2
Resident Population - Island of Hawaii
Comparison of Estimates and Projections

2000 to 2030

	Date of study	2000	2005	2007	2012	2020	2030	Average annual growth 2000-2005	2005-2020	2020-2030
County[1]	*2001*	148,677	159,907	166,513	184,316	217,718		1.5%	2.1%	NA
DBEDT[2]	*2004*	149,261	163,000	168,367	182,050	203,050	229,700	1.8%	1.5%	1.2%
SMS[3]	*2007*	149,261	167,729	170,689	181,179	199,321	224,573	2.4%	1.2%	1.2%
Claritas[4]	*2007*	148,677	165,900	173,314	191,052			2.2%	NA	NA
U.S. Census[5]	*2007*	149,243	166,461					2.2%	NA	NA



NA - Not applicable.

1 County of Hawaii, Hawaii County General Plan, 2001; ("Series "B," mid-range projections).

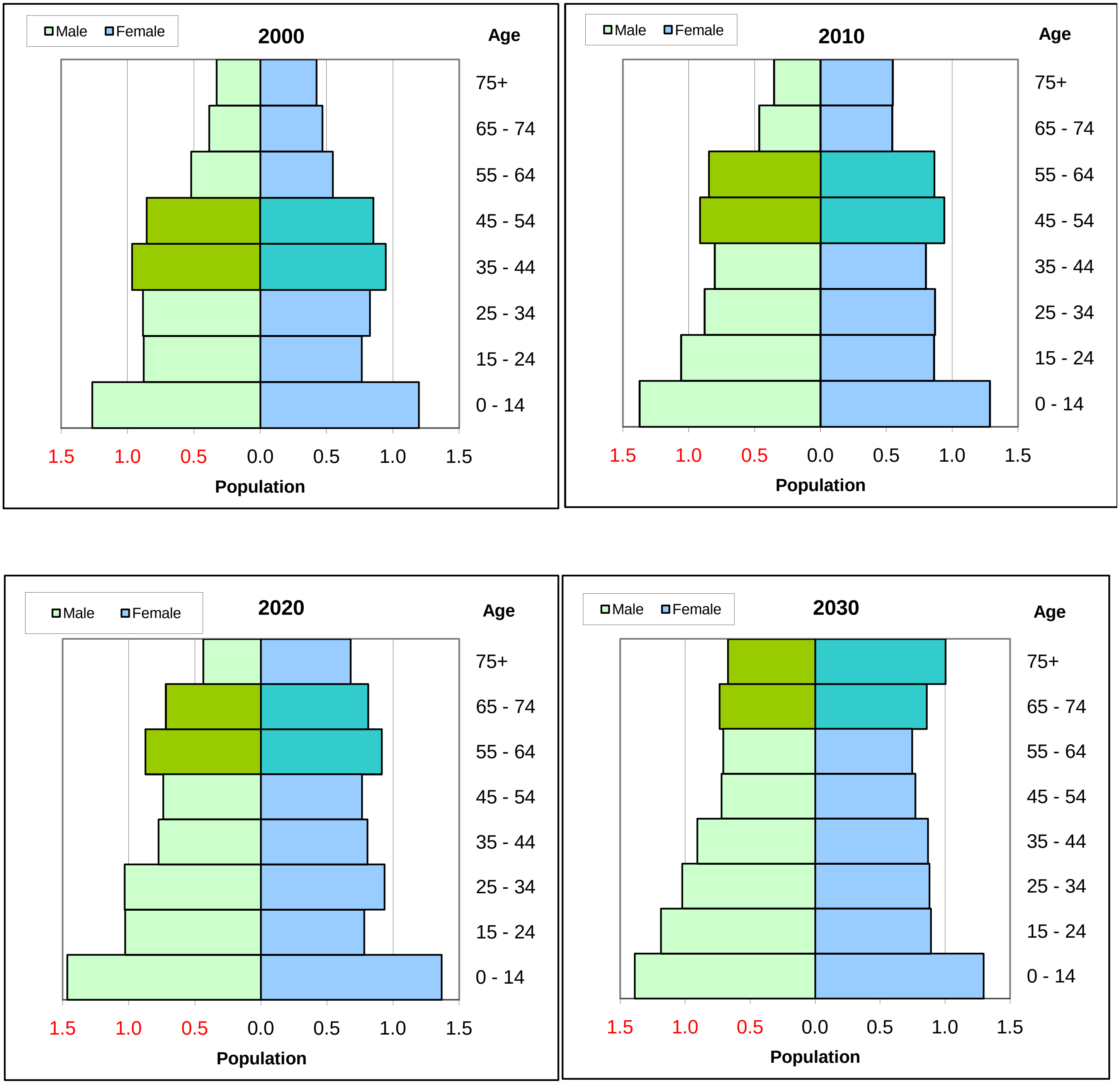
2 State of Hawaii, Research and Economic Analysis Division, Department of Business, Economic Development and Tourism, "Population and Economic Projections for the State of Hawaii to 2030," August 2004.

3 SMS, Inc. "Hawaii Housing Policy Study, 2006: Hawaii Housing Model 2006," February 2007, prepared for the State of Hawaii, Hawaii Housing Finance and Development Corporation and the housing officers/administrators for Honolulu, Maui, Hawaii and Kauai Counties. The population projections shown above are obtained from the excel model SMS prepared for HHFDC in association with this study, with Hawaii County population growth set to the "official parameter" of 1.2% to 2030.

4 Claritas, Inc., November 6, 2007. Estimate for 2007; projection for 2012; figures interpolated in-between.

5 U.S. Census Bureau, Population Division, Table 1: Annual Estimates of the Population for Counties of Hawaii: April 1, 2000 to July 1, 2006 (COEST2006-01-15), March 20, 2007 (as of July 1 each year).

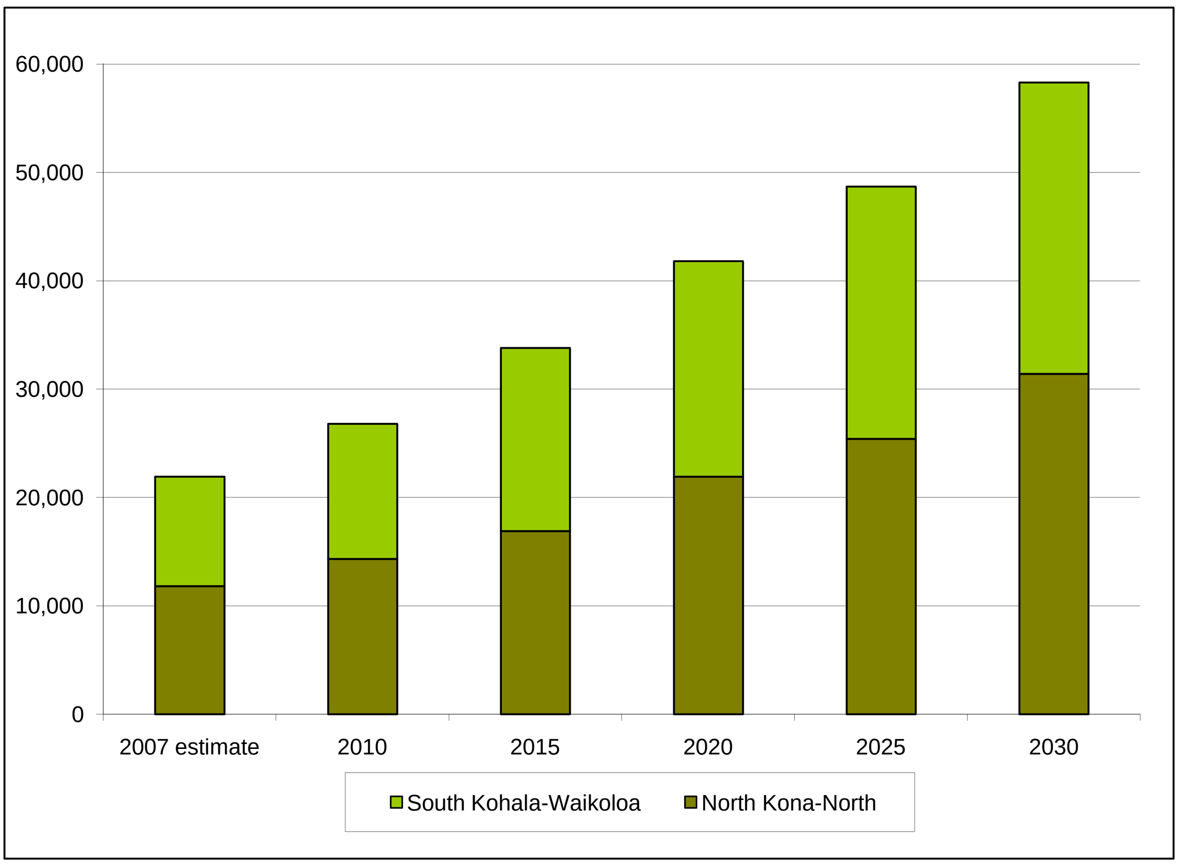
Exhibit 2-3
Projected Population by Age Group - State of Hawaii
2000 to 2030



Notes: Each unit on X axis represents 100,000 persons. Highlighted bars include Baby Boom cohort.
Source: U.S. Census Bureau, Population Division, Interim State Population Projections (released 4/21/05), http://www.census.gov/population/www/projections/statepyramid.html.

Exhibit 2-4
Resident Population -
Competitive Residential Market Area and Island of Hawaii
2007 to 2030

	2007 Estimate	2010	2015	2020	2025	2030	Average annual % increase, 2007-30
Competitive Residential Market Area[1]:							
North Kona-North[2]	11,804	14,300	16,900	21,900	25,400	31,400	4.3%
South Kohala-Waikoloa[3]	10,114	12,500	16,900	19,900	23,300	26,900	4.3%
Total	**21,918**	**26,800**	**33,800**	**41,800**	**48,700**	**58,300**	**4.3%**
Island of Hawaii[4]	168,665	179,031	187,780	199,321	211,570	224,573	1.3%
As a percentage of Island:							
North Kona-North[2]	7.0%	8.0%	9.0%	11.0%	12.0%	14.0%	--
South Kohala-Waikoloa[3]	6.0%	7.0%	9.0%	10.0%	11.0%	12.0%	--
Total Trade Area	13.0%	15.0%	18.0%	21.0%	23.0%	26.0%	--



[1] As provided by Claritas for 2007. Thereafter, population projected by Mikiko Corporation assuming the area's Island share should approach alignment with its jobs base.

[2] Census Tract 215.01, the northern part of the North Kona District, generally to Henry Road. Excludes Kailua-Kona and areas southward. See Appendix 1 for map.

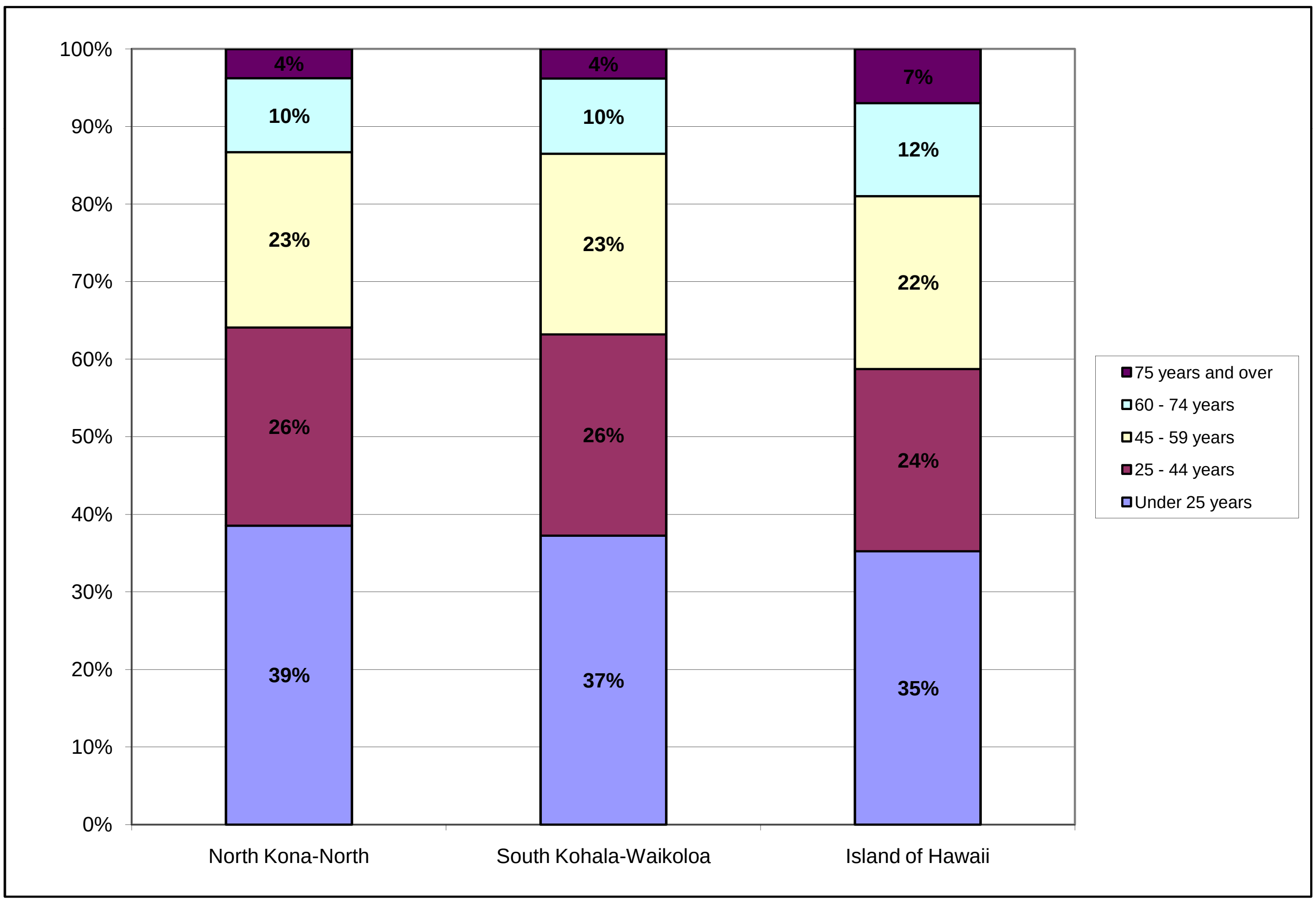
[3] Census Tract 217.01, the southern part of the South Kohala District, generally from Waikoloa Beach Resort to Mauna Kea Resort, and mauka to Waikoloa Village. Excludes Waimea Town. See Appendix 2 for map.

[4] SMS/Mikiko series, as shown in Exhibit 2-2.

Exhibit 2-5
Population by Age Group -
Competitive Residential Market Area and Island of Hawaii

2007 Estimate

	North Kona-North[1]	South Kohala-Waikoloa[2]	Island of Hawaii	As a percentage of Island of Hawaii: North Kona-North[1]	As a percentage of Island of Hawaii: South Kohala-Waikoloa[2]
Under 25 years	4,553	3,769	61,088	7%	6%
25 - 44 years	3,016	2,626	40,737	7%	6%
45 - 59 years	2,667	2,355	38,670	7%	6%
60 - 74 years	1,129	982	20,782	5%	5%
75 years and over	439	382	12,037	4%	3%
Total	11,804	10,114	173,314	7%	6%
Median age	**34**	**36**	**37**		



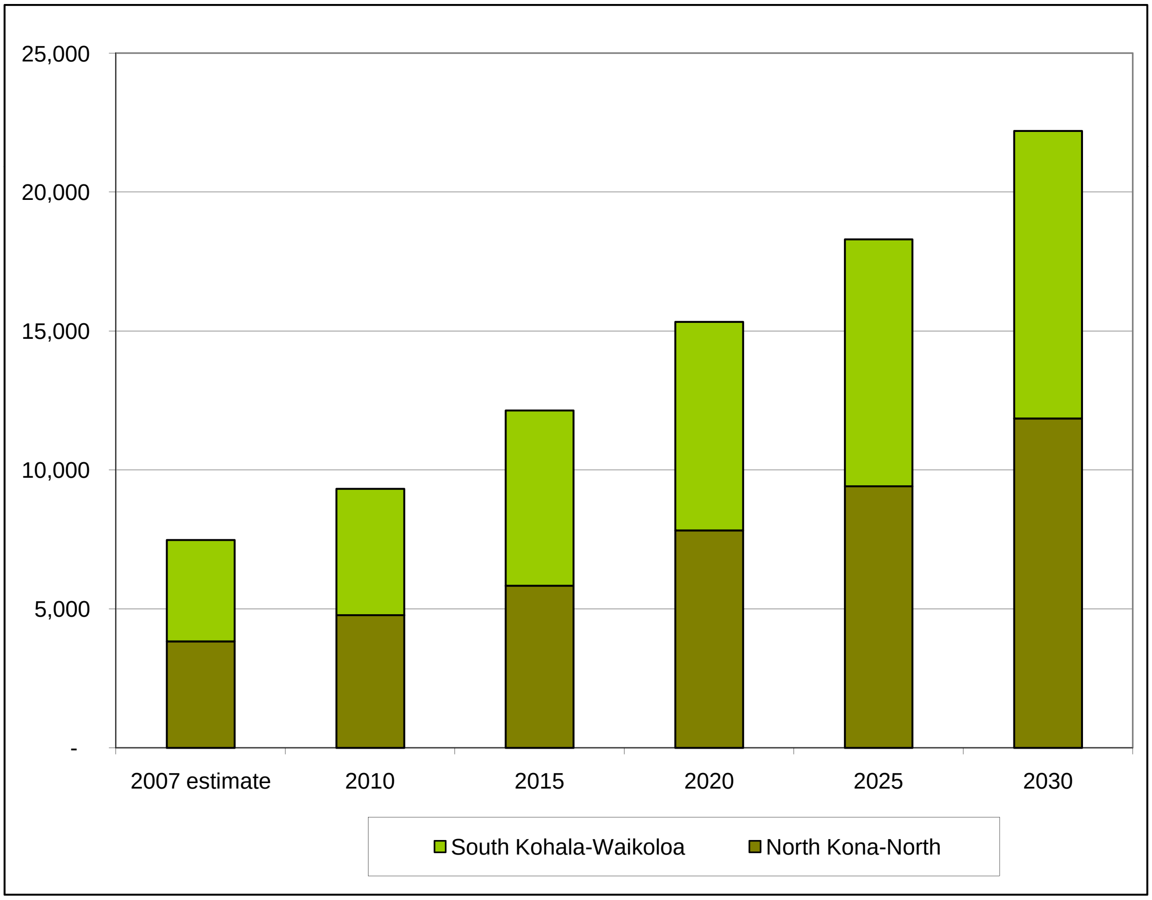
[1] Census Tract 215.01, the northern part of the North Kona District, generally to Henry Road. Excludes Kailua-Kona and areas southward. See Appendix 1 for map.

[3] Census Tract 217.01, the southern part of the South Kohala District, generally from Waikoloa Beach Resort to Mauna Kea Resort, and mauka to Waikoloa Village. Excludes Waimea Town. See Appendix 2 for map.

Source: Claritas, Inc., November 6, 2007.

Exhibit 2-6
Households - Competitive Residential Market Area and Island of Hawaii
2007 to 2030

	2007 Estimate	2010	2015	2020	2025	2030	Average annual % increase, 2007-30
Number of households:							
Competitive Residential Market Area[1] -							
North Kona-North[2]	3,831	4,770	5,830	7,820	9,410	11,850	5.0%
South Kohala-Waikoloa[3]	3,650	4,550	6,310	7,510	8,890	10,350	4.6%
Total	**7,481**	**9,320**	**12,140**	**15,330**	**18,300**	**22,200**	4.8%
Island of Hawaii[4]	62,021	64,510	68,881	73,549	78,533	83,855	1.3%
Average household size:							
North Kona-North[2]	3.08	3.00	2.90	2.80	2.70	2.65	-0.7%
South Kohala-Waikoloa[3]	2.77	2.75	2.68	2.65	2.62	2.60	-0.3%
Island of Hawaii[4]	2.75	2.74	2.73	2.71	2.69	2.68	-0.1%



[1] As provided by Claritas for 2007. Thereafter, based on projected population as shown in Exhibit 2-4 and household sizes as shown.

[2] Census Tract 215.01, the northern part of the North Kona District, generally to Henry Road. Excludes Kailua-Kona and areas southward. See Appendix 1 for map.

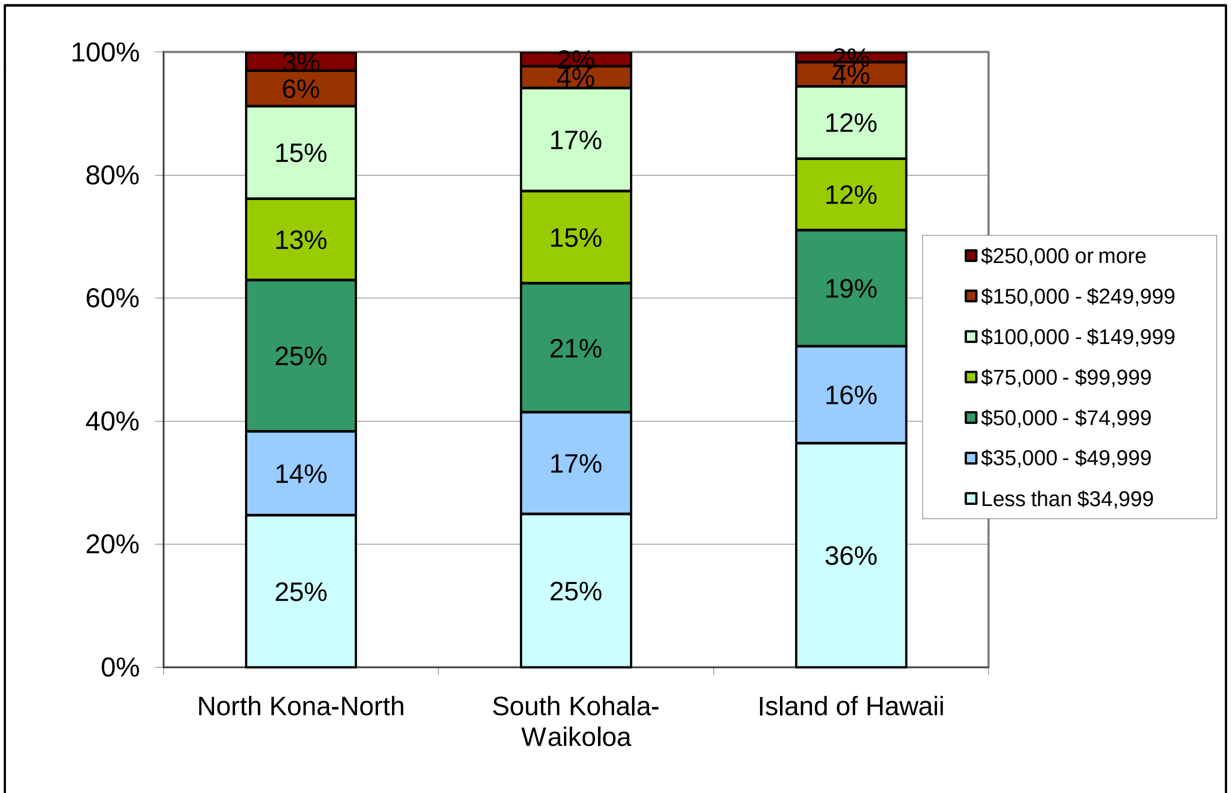
[3] Census Tract 217.01, the southern part of the South Kohala District, generally from Waikoloa Beach Resort to Mauna Kea Resort, and mauka to Waikoloa Village. Excludes Waimea Town. See Appendix 2 for map.

[4] SMS, Inc., excel model accompanying "Hawaii Housing Policy Study, 2006: Hawaii Housing Model 2006," February 2007. Population growth set to 1.2%, the "official parameter" for the County.

Exhibit 2-7
Households by Household Income -
Competitive Residential Market Area and Island of Hawaii

2007 Estimate

	North Kona-North[1]	South Kohala-Waikoloa[2]	Island of Hawaii
Median household income	**$61,825**	**$60,166**	**$58,528**
Per capita income	**$26,042**	**$27,092**	**$22,973**
Number of households, by income -			
Less than $34,999	947	911	22,569
$35,000 - $49,999	522	603	9,740
$50,000 - $74,999	944	765	11,699
$75,000 - $99,999	506	547	7,180
$100,000 - $149,999	576	612	7,277
$150,000 - $249,999	220	129	2,439
$250,000 or more	116	83	993
Total	**3,831**	**3,650**	**61,897**



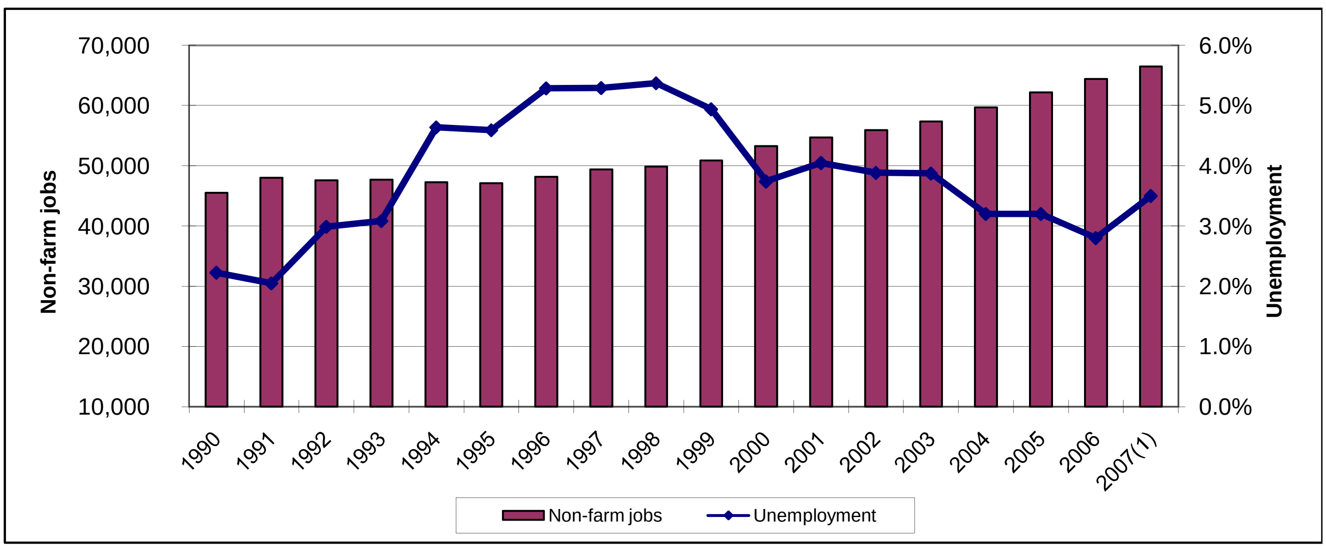
[1] Census Tract 215.01, the northern part of the North Kona District, generally to Henry Road. Excludes Kailua-Kona and areas southward. See Appendix 1 for map.

[2] Census Tract 217.01, the southern part of the South Kohala District, generally from Waikoloa Beach Resort to Mauna Kea Resort, and mauka to Waikoloa Village. Excludes Waimea Town. See Appendix 2 for map.

Source: Claritas, Inc., November 6, 2007.

Exhibit 2-8
Labor Force Trends - Hawaii County
1990 to 2007

	Civilian labor force	Employed persons	Non-farm wage & salary jobs	Percent unemployment
1990	58,350	56,300	45,500	3.5%
1991	62,600	59,750	48,000	4.5%
1992	64,250	59,450	47,600	7.5%
1993	64,850	59,900	47,700	7.6%
1994	65,500	59,400	47,300	9.2%
1995	65,400	59,100	47,100	9.6%
1996	67,400	61,200	48,200	9.2%
1997	69,300	62,900	49,400	9.3%
1998	69,500	63,400	49,900	8.7%
1999	70,750	65,250	50,900	7.8%
2000	74,200	70,750	53,300	4.7%
2001	76,300	72,500	54,700	5.0%
2002	76,450	72,950	55,950	4.6%
2003	77,900	74,300	57,350	4.6%
2004	79,100	76,050	59,700	3.8%
2005	81,300	78,650	62,200	3.2%
2006	83,650	81,300	64,400	2.8%
2007[1]	85,400	82,400	66,500	3.5%

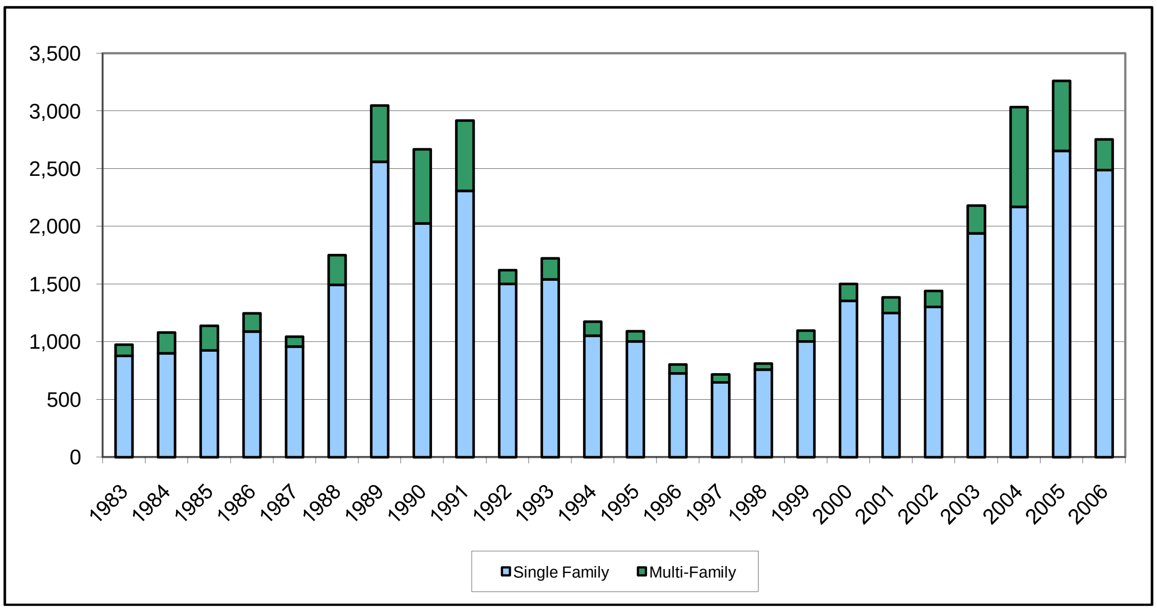


[1] Data are for September 2007; year to date data are not available.

Source: "Hawaii State Department of Labor & Industrial Relations, 2007. Labor force estimates revised by DLIR with new methodology employed by U.S. Bureau of Labor Statistics, as of 2007. As referenced in: www.hiwi.org/admin/uploadedPublications/469_LFHC.PDF. Non-farm wage and salary job estimates provided by DLIR as referenced in:
http://www.hiwi.org/admin/uploadedPublications/778_CESHC90S.PDF;
http://www.hiwi.org/admin/uploadedPublications/700_CESHC00S.PDF; and
http://www.hiwi.org/admin/uploadedPublications/1687_CHC2007.pdf

Exhibit 3-1
Residential Building Permits - County of Hawaii
1990 - 2007[1]

	Single Family	Multi-Family	Total
Average	**1,513**	**263**	**1,776**
1990	2,025	644	2,669
1991	2,309	609	2,918
1992	1,501	121	1,622
1993	1,540	184	1,724
1994	1,052	123	1,175
1995	1,003	88	1,091
1996	726	77	803
1997	649	69	718
1998	759	53	812
1999	1,004	94	1,098
2000	1,356	147	1,503
2001	1,249	138	1,387
2002	1,303	138	1,441
2003	1,941	239	2,180
2004	2,169	866	3,035
2005	2,655	607	3,262
2006	2,488	266	2,754
2007[1]	1,070	349	1,419

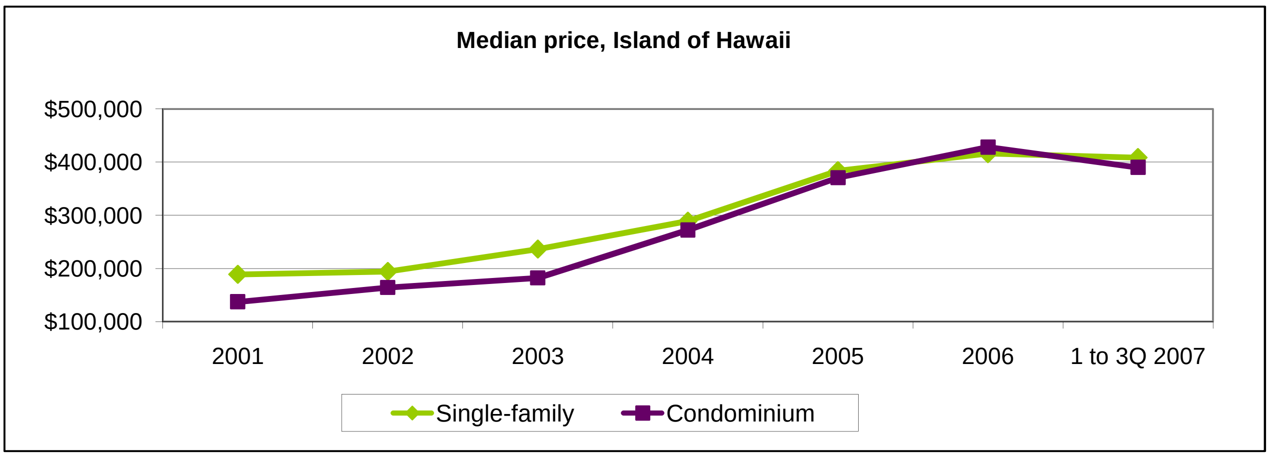


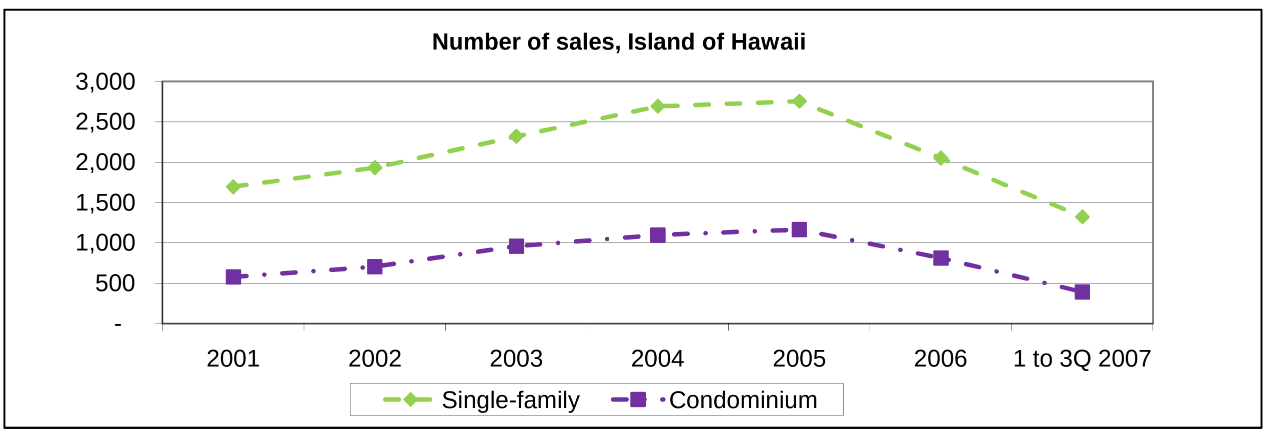
[1] Through September 2007.

Source: County of Hawaii, Department of Public Works.

Exhibit 3-2
Hawaii County Residential Sales Trends
2001 to 3rd Quarter 2007

	2001	2002	2003	2004	2005	2006	2007, 1st-3rd Q	2007-Oct
Island of Hawaii:								
Median price -								
Single-family	$188,400	$194,100	$236,000	$288,800	$383,800	$416,100	$408,500	$386,000
Condominium	$137,100	$164,000	$182,000	$272,200	$370,600	$428,200	$390,000	$420,000
Number of sales -								
Single-family	1,696	1,933	2,322	2,694	2,757	2,052	1,324	118
Condominium	580	707	959	1,097	1,166	814	392	39
North Kona District - single-family:								
Median price	INA	INA	INA	INA	$620,000	$645,000	INA	(down)
Number of sales	INA	INA	INA	INA	651	456	INA	INA
South Kohala District - single-family:								
Median price	INA	INA	INA	INA	$530,000	$550,000	INA	(up 3%)
Number of sales	INA	INA	INA	INA	313	287	INA	INA



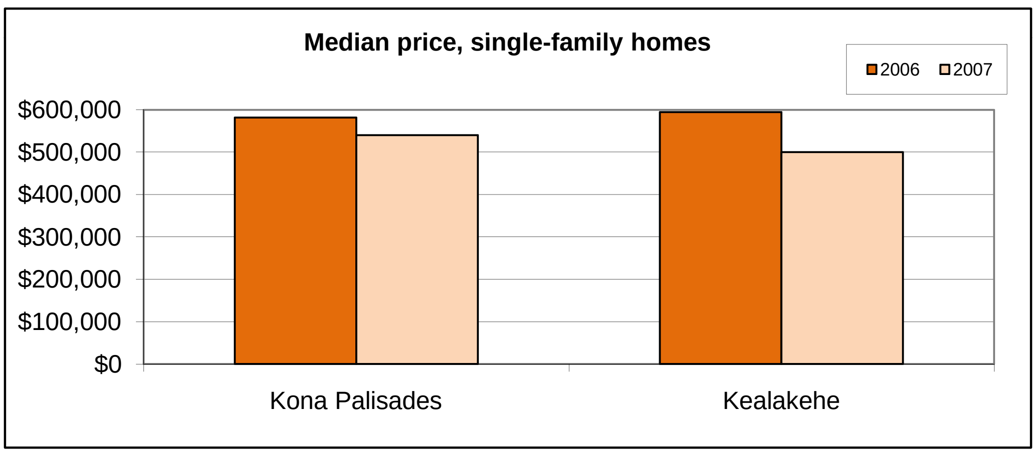


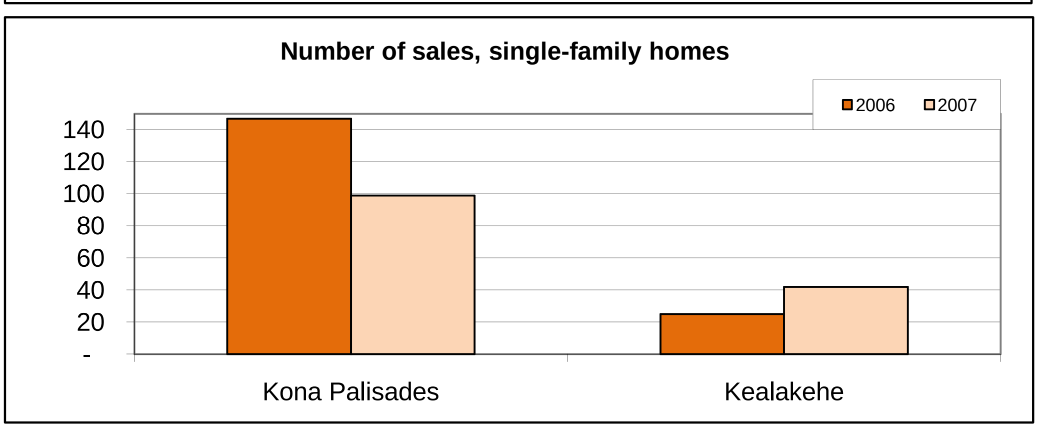
INA = Information not available.

Sources: Annual county data from University of Hawai'i Economic Research Organization, Economic Information Service, as accessed November 4, 2007; 2007 updates and district data from (1) Hawaii Information Service, in Honolulu Advertiser, November 6, 2007 (Andrew Gomes), Pacific Business News, October 5, 2007 (Leroy Laney) and West Hawaii Today, January 7, 2007; and (2) Star Bulletin, October 6, 2007.

Exhibit 3-3
Residential Sales in Kona Palisades and Kealakehe
TMKs 3-7-3 & 4, North Kona-North
2006 and 2007[1]

	2006	2007	Percent change
Kona Palisades:			
Median price -			
Single-family	$581,900	$540,000	-7%
Condominium	$585,000	$293,400	-50%
Number of sales[1] -			
Single-family	147	99	-33%
Condominium	13	20	50%
Kealakehe:			
Median price -			
Single-family	$595,000	$500,000	-16%
Condominium	$489,000	$510,000	4%
Number of sales[1] -			
Single-family	25	42	68%
Condominium	3	2	-50%



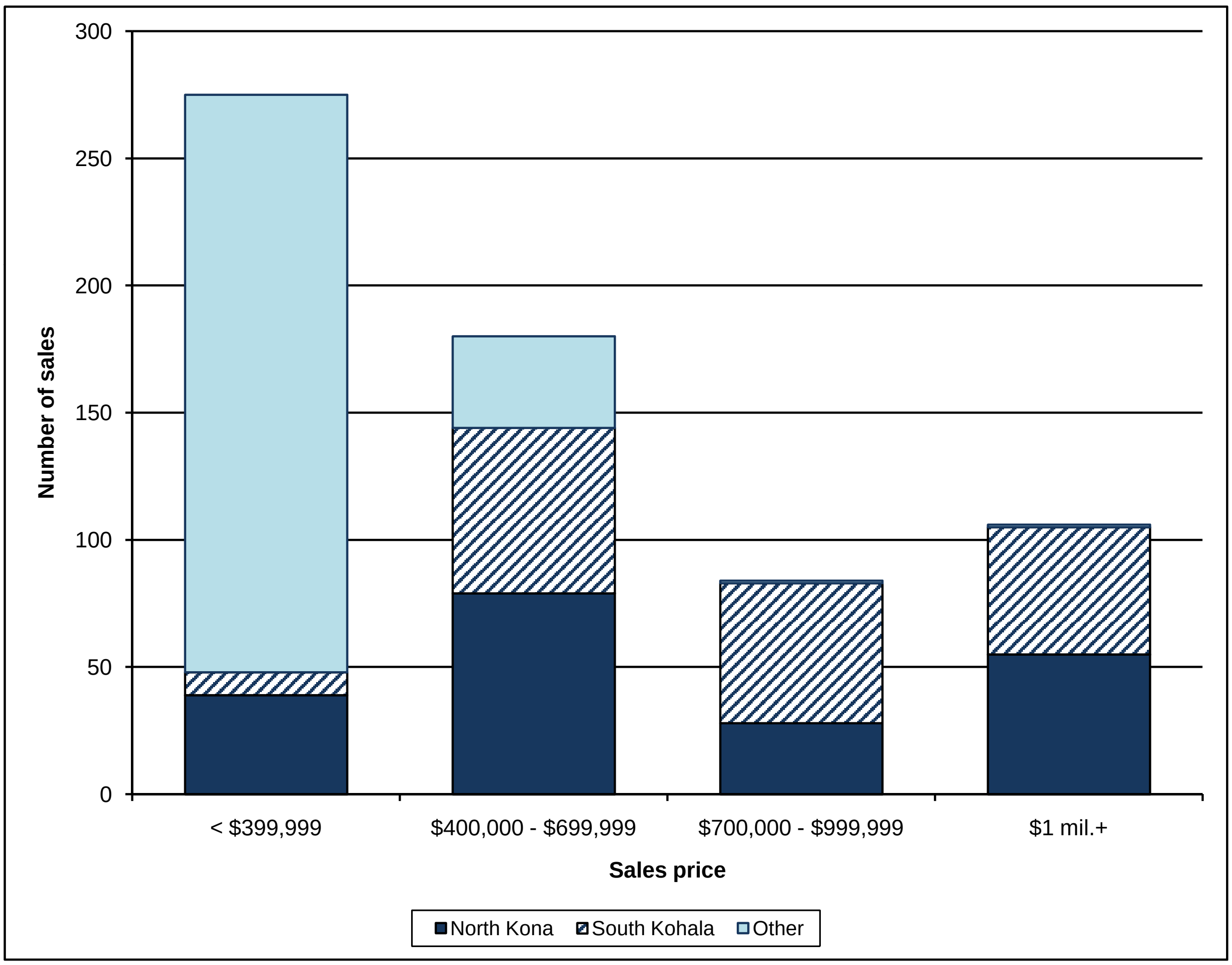


[1] Annualized based on 8 months data.

Source: Hawaii Information Service, data as of September 7, 2007.

Exhibit 3-4
Sales to Off-Island, Non Owner-Occupants
Island of Hawaii, 2007

	< $399,999	$400,000 - $699,999	$700,000 - $999,999	$1 mil.+	Total	Distribution
North Kona	39	79	28	55	201	31%
South Kohala	9	65	55	50	179	28%
Other	227	36	1	1	265	41%
Total	275	180	84	106	645	100%
Distributon	43%	28%	13%	16%	100%	

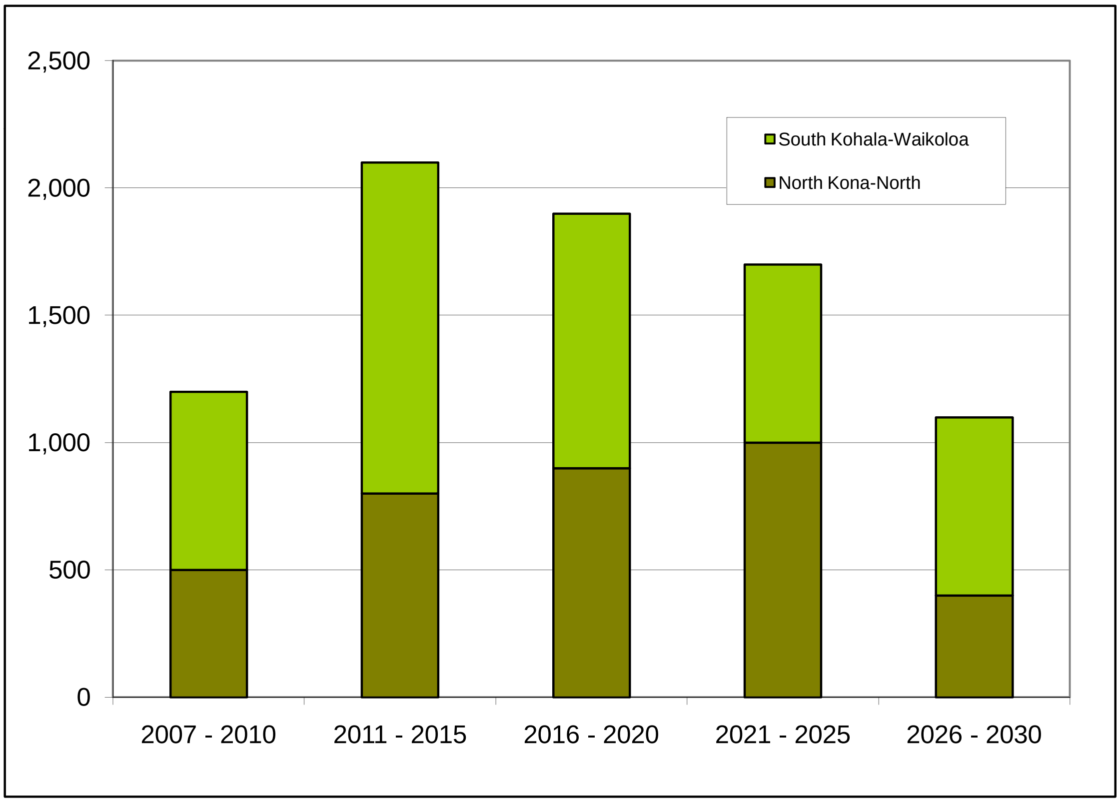


Source: Based on data obtained from Hawaii Information Service, March 13, 2008. Represents closed deed sales that do not show an owner-occupant exemption and where the tax bill address is other than Hawaii Island. Excludes vacant land sales, and partial or multiple deed transactions.

Exhibit 3-5
Potential New Resident Housing Units -
Competitive Residential Market Area

Based on Planned Developments with State Entitlement or Exemption as of October 2007

	2007 - 2010	2011 - 2015	2016 - 2020	2021 - 2025	2026 - 2030	Total, 2007-2030
North Kona-North[1]	500	800	900	1,000	400	3,600
South Kohala-Waikoloa[2]	700	1,300	1,000	700	700	4,400
Total (rounded)	**1,200**	**2,100**	**1,900**	**1,700**	**1,100**	**8,000**
% of projection period	**15%**	**26%**	**24%**	**21%**	**14%**	**100%**



[1] Census Tract 215.01, the northern part of the North Kona District, generally to Henry Road. Excludes Kailua-Kona and areas southward. See Appendix 1 for map.

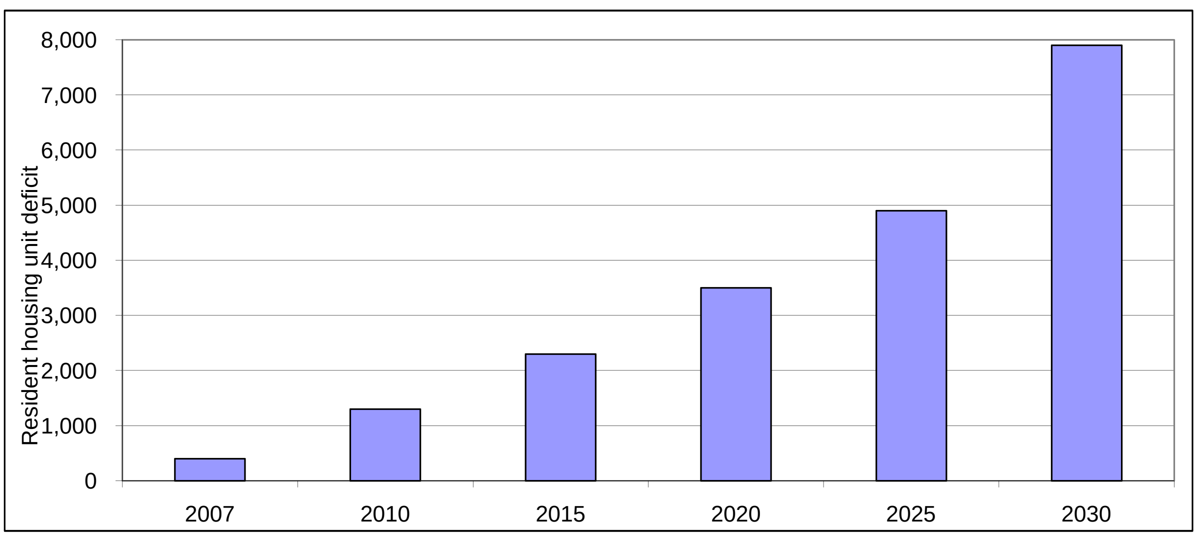
[2] Census Tract 217.01, the southern part of the South Kohala District, generally from Waikoloa Beach Resort to Mauna Kea Resort, and mauka to Waikoloa Village. Excludes Waimea Town. See Appendix 2 for map.

Note: Targeting projects of 100 units or more. Excludes emergency shelters, dormitory beds and other group living quarters.

Sources: Interviews with developers, landowners and project principals as shown in Appendix 3. Component numbers may vary slightly from those in Appendix 3, due to rounding.

Exhibit 3-6
Projected Supply and Demand for Housing - Competitive Residential Market Area
2007 to 2030

	Basis/ reference	2007	2010	2015	2020	2025	2030	Total/ average, 2007-2030
Demand (households):								
Number	Exhibit 2-6	7,481	9,320	12,140	15,330	18,300	22,200	
Change since prior date -								
Total (rounded)		--	2,000	3,000	3,000	3,000	4,000	15,000
Average annual		--	670	600	600	600	800	650
Supply (resident housing units):								
Estimated occupied RHUs in 2006[1]	ACS/ Claritas	6,900						
Developer RHUs delivered 2007[2]		200						
Entitled new developments -								
Development since prior date	Exhibit 3-4	--	1,200	2,100	1,900	1,700	1,100	8,000
Less vacancy allowance (applied to new units)	5%	--	-60	-105	-95	-85	-55	-400
Net available RHUs (rounded)		7,100	8,240	10,240	12,050	13,670	14,720	7,600
Change since prior date -								
Total		--	1,140	2,000	1,810	1,620	1,050	7,600
Average annual		--	380	400	360	320	210	330
Resident housing unit surplus/(deficit):								
At prior date shown		INA	(400)	(1,300)	(2,300)	(3,500)	(4,900)	
Net surplus (deficit) in RHU production since prior date		INA	(860)	(1,000)	(1,190)	(1,380)	(2,950)	
By end of column date (rounded)		(400)	(1,300)	(2,300)	(3,500)	(4,900)	(7,900)	



INA = Information not available.

[1] RHU = resident housing unit. 2006 estimate based on data provided by the U.S. Census Bureau, 2005 American Community Survey, as accessed April 2007; Ricky Cassiday, April 2007; Claritas, Inc., 2007. See beginning of Chapter 3 text for discussion.

[2] Estimated 2007 developer closings in CMRA as of October 2007.

Exhibit 4-1
Market Performance of Selected Comparison Residential Projects

`O`oma product type (density in U/A)	Comparison projects: Name, location (developer)	Density (U/A)	Typical current pricing[1]	Recent developer sales rate	% Island buyers[2]	Comment
Mixed-use villages (3 to 10)	**Palamanui**, North Kona-North (Hiluhilu Development LLC)	7 to 14	$400,0000-$500,000 (proposed)	INA-not yet marketed	INA	Reported preliminary pricing for market units in mixed-use setting.
Other multifamily, at residential village (7.5 to 12)	**Makana Kai,** Wehilani, Waikoloa Village (Castle & Cooke)	10.3	$337,000-$400,000+	51	85%	TH 4- and 6-plexes. 4 units bought as housing for off-island construction workers.
	Kaloko Heights, North Kona-North (Stanford Carr Development)	11.8	$400,000 (average, proposed)	INA-not yet marketed	INA	THs on RM-3 zoning.
Single-family lot, rim (2.5 to 3.0)	**Bayview Estates at Keauhou** (Kamehameha Investment Corporation)	2.2	$469,000 to $997,000; $525,000 (median)	INA - resales only	71%	Vacant lots, 15,000 to 22,650 sq. ft.; all have ocean view.
Other single-family, finished home (4 to 5)	**Malulani Gardens**, North Kona-South (Brian Cook)	5	$485,000 - $645,000 $609,500 (median)	INA - resales only	25%	Only considers those homes on lots of 6,000 s.f. or less.
	Pualani Estates, North Kona-South (DR Horton)	4.2	Up to $706,750; $555,000 (median)	65	36%	Average 6,000 sq. ft. lots, range 5,000 to 8,000
	Kaloko Heights, North Kona-North (Stanford Carr Development)	4.2 and 4.7	$550,000 and $520,000 (proposed)	INA-not yet marketed	INA	SFD starter homes on RS-7.5 and SFD condos.
	Sunset Ridge, Waikoloa Village (Towne Development)	4+	Up to $746,000; $500,700 median	70 (2006)	67%	SFD, two product types

[1] Current asking prices for projects in marketing; recorded sales prices since 11/1/06 - 10/31/07 for projects in resales; projected sales prices for planned developments. Excludes pricing of affordable units within projects, where applicable.

[2] Based on tax bill address of sampled buyers or interviews.

INA - Information not available; SFD - single-family detached home; U/A - units per acre.

Sources: Interviews with developers and other project representatives, project websites, Hawaii Information Service.

Exhibit 4-2
Residential Market Assessment for `O`oma
2007 Dollars

Unit type/area	Number of units: Low	Number of units: High	Average density (U/A)	Lot size (sq. ft.)	Average annual absorption rate[1]	Average unit sales price, market units[2]	Potential marketing period (years)[3]	Comments
Finished homes								
Multifamily Units at Mauka Village[4]	395	520	7.5 to 10	n/a	33	$400,000	16	Young families, singles, retirees, corporate investors; ROR or TH.
Multifamily Units at Makai Village	35	60	3 to 4.5	n/a	10	$500,000	6	Move-up families, singles, empty nesters, corporate investors; ROR or TH.
Multifamily Units at Residential Village[4]	100	135	9 to 12	n/a	15	$425,000	9	Young and move-up families, singles, corporate investors; TH or flats.
Single-Family Homes at Residential Village	350	400	4 to 5	5,000 - 6,000	30	$650,000	13	Move-up families, local and off-Island buyers.
Subotal/average, finished homes	880	1,115	6.8			$500,000	16	**Average price excludes affordable units**
Vacant lots								
Single-Family Lots at Residential Village	70	85	2.5 to 3	9,000 - 15,000+	10	$650,000	9	Price for lot only, expected to appeal to local and off-Island buyers.
Total/average, all products	**950**	**1,200**	**6.2**		**46 to 80 (av. 67)**	**$510,000**	**16**	**Average price excludes affordable units**

U/A - units per gross residential acre; ROR - residential over retail; TH - townhouse; n/a - not applicable.

1 Total assumes several but not all products are marketing simultaneously; therefore it is less than sum of average absorption of individual product types. Absorption rates within Mauka Village and Residential Village assume for-sale affordable housing is also marketed within those two areas.

2 For market-priced units only. See footnote 4 for price indicators on affordable unit pricing.

3 Based on high scenario for unit counts and assuming all units are marketed for-sale (rather than some also as rentals), which could make the numbers shown high. On the other hand, anticipated phasing of development could extend sales periods. See text for further information.

4 Area expected to include for-sale affordable housing, assumed to represent 20% of total units being developed, based on current County guidelines. Actual affordable home inventory and tenure to be determined based on future agreements with government agencies and then-prevailing market conditions.

For illustrative purposes, Hawaii County guidelines in effect as of May 1, 2007 would specify for-sale affordable housing offered to families of four earning 100% to 140% of median income be priced from $226,200 to $316,600; and one- to two-bedroom rental units offered to households earning 80% to 100% of median income be priced from $935 to $1,309 per month, including utilities.

Exhibit 4-3
`O`oma - Potential Residential Sales Absorption By Area
Based on maximum development scenario and no rentals

Unit type/area	Maximum units	Average annual absorption rate[1]	2012 - 2020	2021 - 2025	2026 - 2030
Number of years in period			**9**	**5**	**5**
Current Urban District (start 2014):					
Multifamily Units at Mauka Village[2]	520	33	230	170	120
Multifamily Units at Residential Village (portion)[2]	30	15	0	30	0
Subtotal, Urban Area	**550**	**34**	**230**	**200**	**120**
Petition Area (start 2012):					
Multifamily Units at Makai Village	**60**	**10**	**60**	**0**	**0**
Multifamily Units at Residential Village (portion)[2]	**105**	**15**	**105**	**0**	**0**
Single-Family Lots at Residential Village	**85**	**10**	**85**	**0**	**0**
Single-Family Homes at Residential Village	**400**	**30**	**270**	**130**	**0**
Subtotal, Petition Area	**650**	**46**	**520**	**130**	**0**
Total `O`oma	**1,200**	**46 to 80 (av. 67)**	**750**	**330**	**120**

[1] Total and subtotals consider that not all products would be marketed simultaneously; therefore they are less than the sums of individual product types or areas.

[2] Based on 20% of total units being developed as affordable for-sale housing, with some in indicated locations. Actual inventory and unit tenure to be determined in future agreements with government agencies.

Exhibit 5-1
Existing Retail Space - Primary Trade Area and Benchmarks
In square feet, 2007

	Island of Hawaii					
	Primary Trade Area					
	North Kona	South Kohala	Total PTA	Other	Total	Benchmark - Hawaii Kai
Gross leasable area	1,576,000	522,000	2,098,000	1,130,000	3,228,000	857,000
Vacancy indicators[1]	"West Hawaii" - 5%			INA	3%	1%
Largest properties	Makalapua Shopping Center (170,000)	Parker Ranch Center (146,800)	Makalapua Shopping Center (170,000)	Prince Kuhio Plaza (505,600)	Prince Kuhio Plaza (505,600)	Koko Marina Shopping Center (322,300)
	Keauhou Shopping Center (169,700)	Waikoloa Village Center (78,000)	Keauhou Shopping Center (169,700)	Waiakea Center (229,300)	Waiakea Center (229,300)	Hawaii Kai Towne Center (247,000)

INA - Information not available.

Note: Includes retail in shopping centers and free-standing "big box" stores. Excludes other single-tenant or owner-occupied buildings as well as retail uses in light industrial or business centers. Includes some office/service tenants within shopping centers or other primarily retail complexes.

[1] Based on shopping center-based retail only, as surveyed by Colliers Hawaii Consulting in August 2007; for centers representing approximately 70% of the Island's GLA.

Sources: PM Realty, 2007; Metric Holdings, Inc.; Colliers Hawaii Consulting, A Division of Colliers Monroe Friedlander, Inc., private communication, 11/19/2007; Ibid, "Big Island Retail Guide," in Hawaii Business, November 2006; Pacific Business News, "The List: Shopping Centers - Neighbor Islands," November 3, 2006; Pacific Business News, 2007, "Book of Lists: 2007;" listing agents for respective centers.

Exhibit 5-2
Existing Office Space - Primary Trade Area and Benchmarks

Rentable building area, 2007

	Island of Hawaii					
	Primary Trade Area					Benchmark - Island of Oahu
	North Kona	South Kohala	Total PTA	Other	Total	
Rentable building area (rounded)	435,000	63,000	498,000	238,000	736,000	15,702,000
Vacancy indicators[2]	7%	0%	6%	11%	10%	7%
Largest properties/areas (Rentable building area)	The Pottery Terrace (47,500)	Waikoloa Highlands Center (19,900)	The Pottery Terrace (47,500)	Bank of Hawaii Building - Hilo (31,600)	The Pottery Terrace (47,500)	Central Business District (8,057,000)
	Kaiwi Square (37,600)[3]	Kamuela Business Center (18,400)	Kaiwi Square (37,600)[3]	Kealakekua Business Center (27,000)	Kaiwi Square (37,600)[3]	Kaka`ako/ Kapiolani/ King (3,370,000)

Notes: Excludes government-owned buildings and exclusively owner-occupied buildings. Properties may include some retail spaces. INA - information not available.

[1] Includes the Central Business District, Kapiolani and King Streets and Kaka'ako District, as defined by CMF. Excludes Waikiki.

[2] Hawaii Island data is as of November 2006 and based properties for which vacancy and total RBA figures are available (36 of 47 properties, or 83% of total RBA reported), as provided by Colliers Monroe Friedlander. Oahu data is as of 3rd quarter 2007.

[3] May include ground floor retail.

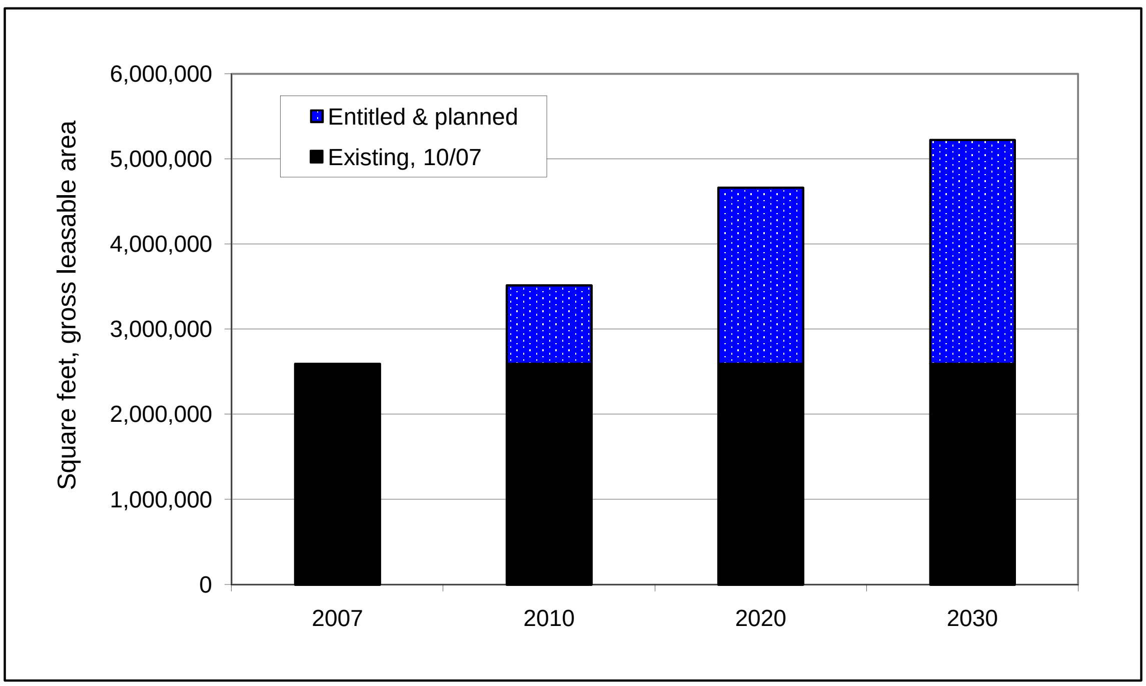
Sources: PM Realty Group; interviews with property managers and agents; Loopnet, April 2007; Colliers Hawaii Consulting, A Division of Colliers Monroe Friedlander, Inc., "Big Island Office Guide," in Hawaii Business, November 2006; ibid, "Office Market Briefing: Honolulu 3Q2007."

Exhibit 5-3
Potential Future Commercial Space - Primary Trade Area

Existing and Planned/Entitled Developments as of October 2007

Square feet of gross leasable area

	Reference	Existing, October 2007	Potential future, by period end: 2007 - 2010	2011 - 2020	2021 - 2030	Total
Existing inventory:						
Retail	*Exhibit 5-1*	2,098,000				2,098,000
Office	*Exhibit 5-2*	498,000				498,000
Entitled & planned space (in period)	*Appendix 4, distributed*					
North Kona			640,000	900,000	350,000	1,890,000
South Kohala			280,000	250,000	210,000	740,000
Total			920,000	1,150,000	560,000	**2,630,000**
Potential future inventory (cumulative)		**2,596,000**	**3,516,000**	**4,666,000**	**5,226,000**	



Note: Includes proposed retail and office uses, but excludes industrial lands that could potentially accommodate similar uses.

Exhibit 5-4
Resident Profiles - Primary Trade Area
2000 Census and 2006 estimates

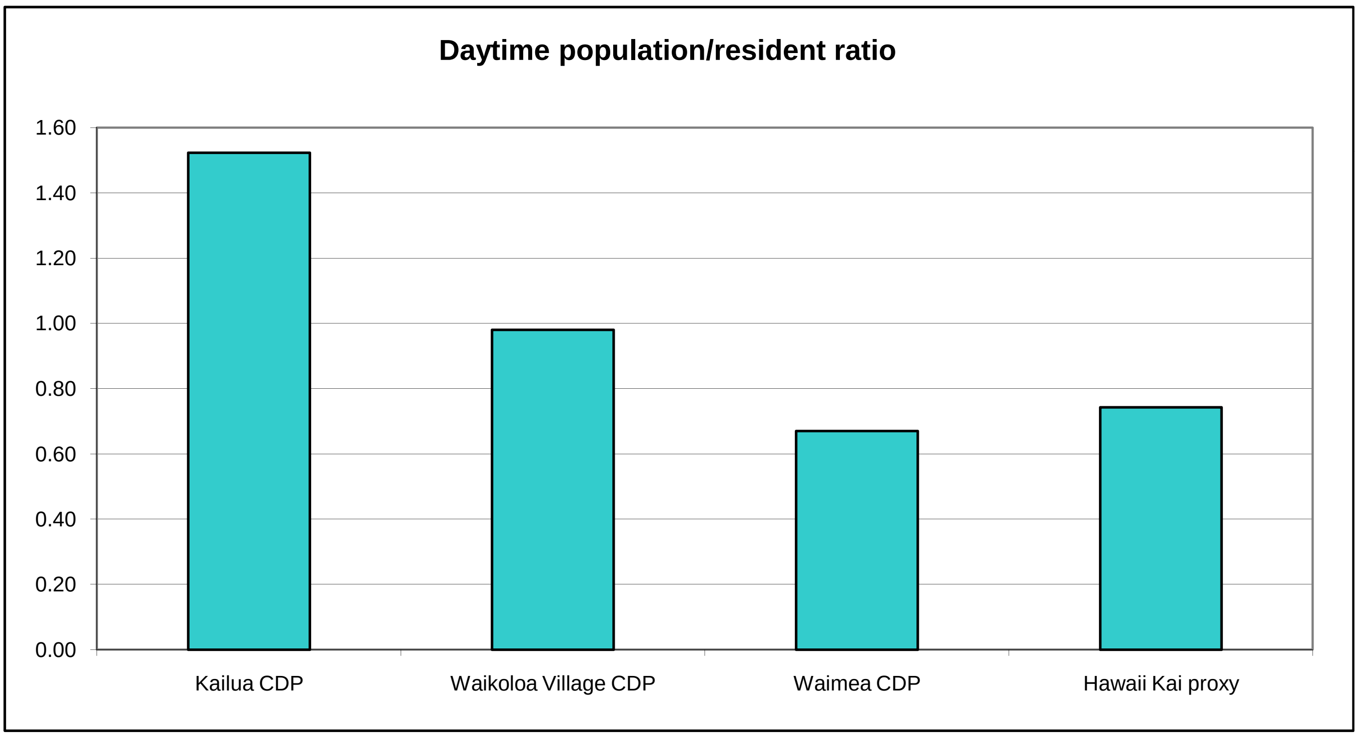
	Primary Trade Area			Benchmark markets	
	North Kona	**South Kohala**	**Total PTA**	**Island of Hawaii**	**Hawaii Kai**
Resident population:					
2000 U.S. Census	28,543	13,131	41,674	148,677	27,657
2006 estimated	33,634	17,283	50,917	168,612	29,023
Compound annual % increase, 2000-2006	2.8%	4.7%	3.4%	2.1%	0.8%
Median age (2006, except Hawaii Kai)	39	36	INA	37	44 (2005)
Civilian labor force (2006):					
Number	18,225	9,203	27,428	83,850	16,500
Percent of population	54%	53%	54%	50%	57%

Note: INA = Information not available.

Sources: Claritas Inc., 2005, 2006 and 2007. Hawaii Kai income data supplied by ESRI; Hawaii Kai 2006 population and labor force estimates based on growth rates projected by Claritas in 2005.

Exhibit 5-5
Daytime Resident Population and Employment Residence Ratios by Census Designated Places
2000

	Residents, 2000	Employment residence ratio[1]	Daytime population[2]	Daytime pop/ residents
Primary Trade Area CDPs:				
Kailua CDP	9,870	2.07	15,036	1.52
Waikoloa Village CDP	4,806	0.96	4,713	0.98
Waimea CDP	7,028	0.53	4,713	0.67
Total Trade Area	21,704	1.33	24,462	1.13
Benchmark markets:				
Hawaii County	148,677	1.00	148,509	1.00
Hawaii Kai proxy[3]	INA	0.49	INA	0.74



INA = Information not available.

Note: All ratios shown are within the respective CDP. Ratios would be higher if reported on a regional basis.

[1] Workers working in the CDP divided by workers living the CDP.

[2] Residents of area plus workers working in area less workers living in area.

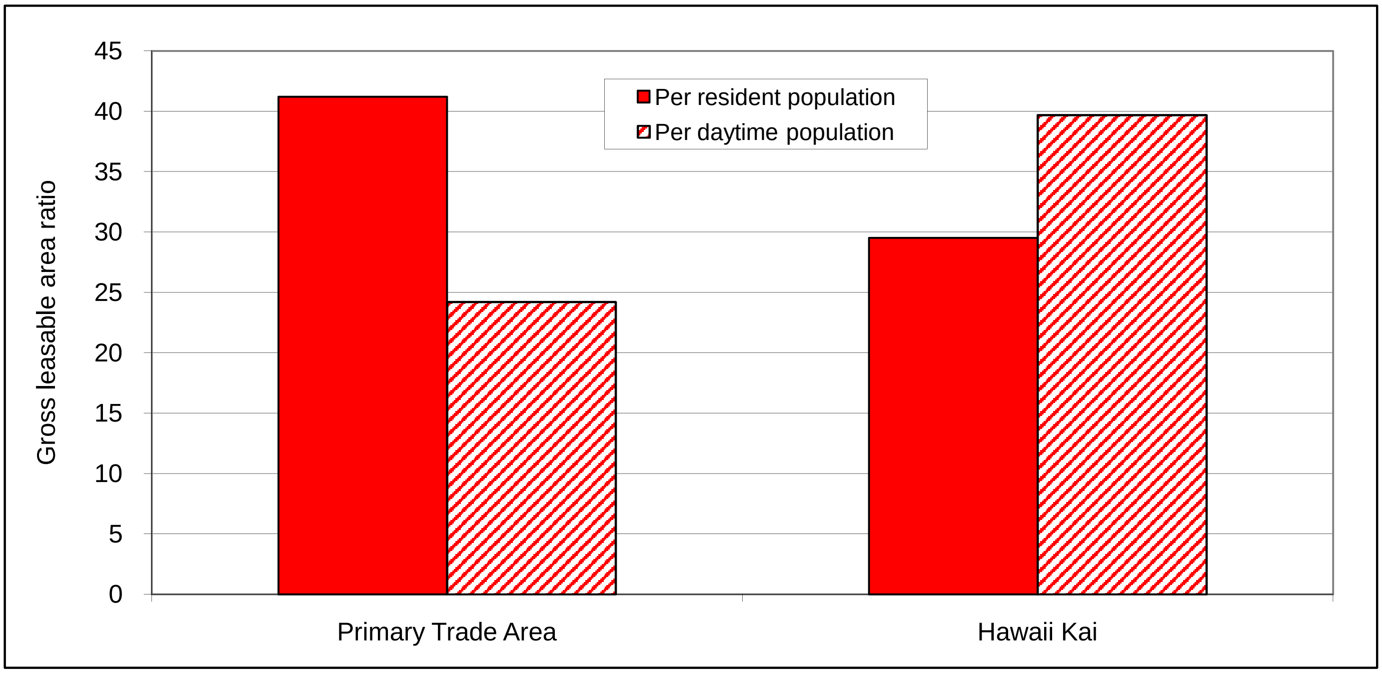
[3] The 2000 Census included Hawaii Kai within the Honolulu CDP, so Kailua CDP used as a proxy for Hawaii Kai ratios; actual population figures not relevant.

Source: US Census Bureau, Census 2000, PHC-T-40, "Estimated Daytime Population and Employment-Residence Ratios: 2000" Journey to Work and Migration Statistics Branch, 2005.

Exhibit 5-6
Existing Retail Areas in Relation to Consumer Population

As of 2006, except where noted

	Primary Trade Area				
	North Kona	South Kohala	Total PTA	Island of Hawaii	Benchmark - Hawaii Kai
Estimated consumers:					
Resident population[1]	33,634	17,283	50,917	168,612	29,023
Daytime population -					
Daytime resident ratio[2]	*1.52*	*0.80*	*1.28*	*1.00*	*0.74*
Daytime resident pop.	51,200	13,800	65,000	168,400	21,600
Average daily visitors[3]	11,200	10,500	21,700	27,600	0
Total daytime pop.	62,400	24,300	86,700	196,000	21,600
Existing retail GLA[4]	1,576,000	522,000	2,098,000	3,228,000	857,000
Existing GLA ratios:					
Per resident population	47	30	41	19	30
Per daytime population	25	21	24	16	40



Note: DPAs (Development Plan Areas) are those defined by the City and County of Honolulu, but approximated for data generation purposes by zip code area. See Chapter 2 for further information.

INA - Information not available.

[1] Primary Trade Area populations as shown in Exhibit 5-4.

[2] 2000 ratios, as shown in Exhibit 5-5. Total PTA ratio shown here varies from that shown for the three CDPs within the PTA in Exhibit 5-5, since the former reflects a weighted average for the total PTA, while the latter is a weighted average for the CDPs only.

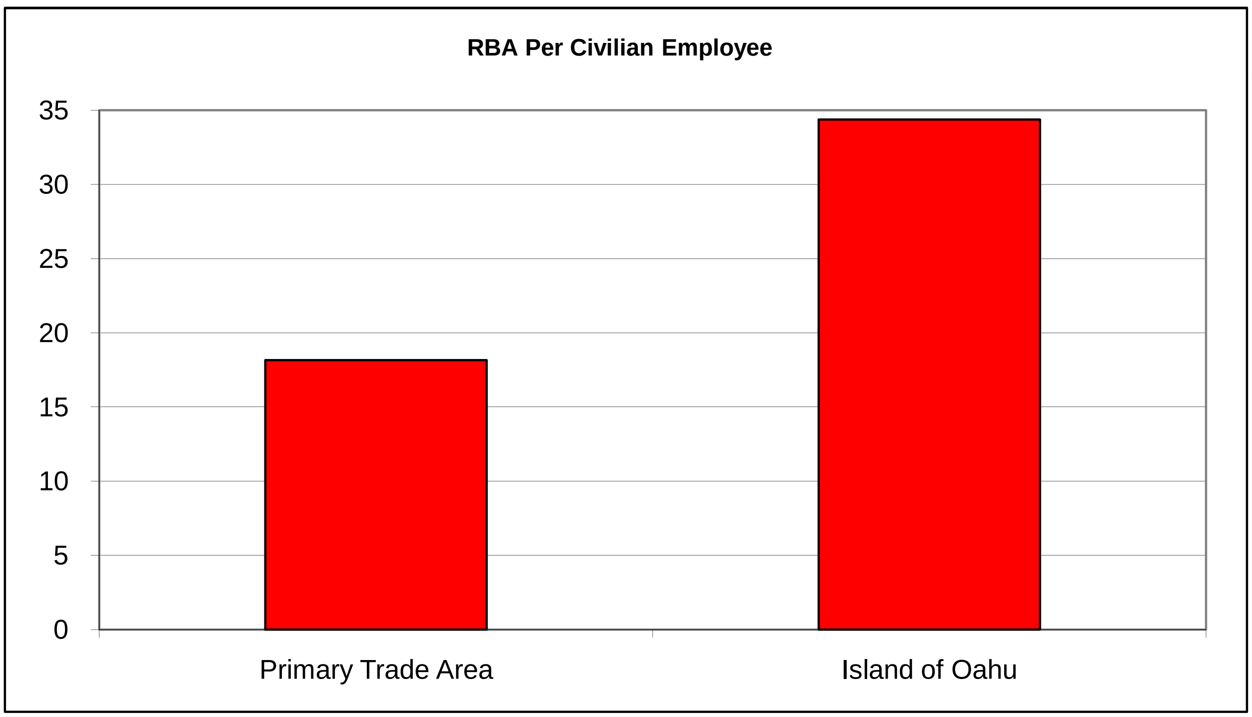
[3] Hawaii island data based on average daily visitor census for Kona, 2005.

[4] As shown in Exhibit 5-1.

Sources: Claritas Inc., 2006 & 2007; State of Hawaii, Department of Business Economic Development and Tourism, "Annual Research Report," 20065.

Exhibit 5-7
Existing Office RBA in Relation to Employment
As of 2006

	Primary Trade Area			
	North Kona	South Kohala	Total PTA	Benchmark - Island of Oahu
Estimated consumers:				
Resident population	33,634	17,283	50,917	909,408
Civilian labor force[1]	18,225	9,203	27,428	446,200
% in civilian LF	54%	53%	54%	49%
Existing office RBA[2]	435,000	63,000	498,000	15,337,000
Existing RBA ratio				
Per civilian employee	24	7	18	34



Notes: INA - Information not available; RBA - Rentable building area, in square feet.

[1] Trade Area estimates provided by Claritas, Inc., 2007; Island figures derived from DLIR data on civilian labor force; Hawaii island figure, as shown in Exhibit 2-8.

[2] As shown in Exhibit 5-2.

Sources: Claritas Inc., 2007; American Factfinder, 2007; Colliers Monroe Friedlander, 2007; prior exhibits as cited.

Exhibit 6-1
Projected Supportable Commercial Areas - Primary Trade Area
In square feet, 2010 to 2030

	Basis/reference		2010	2020	2030	Ave. annual change, 2010-2030
Resident population in Primary Trade Area:						
Population in North Kona-North & South Kohala-Waikoloa[1]	Exhibit 2-4		26,800	41,800	58,300	4.0%
Relation to Trade Area	2.7 2.4	in 2000 in 2006	2.1	2.0	1.8	-0.8%
Population in Trade Area			56,000	84,000	105,000	3.2%
Retail-based demand assessment:						
Trade Area daytime resident population -	*Estimated at*					
Ratio to resident pop	*1.28*	*in 2006*[2]	*1.35*	*1.40*	*1.40*	0.2%
Daytime residents			75,600	117,600	147,000	3.4%
Visitor population[3]	*2006:*	*21,700*	23,500	26,500	32,300	1.6%
Retail consumer population in Trade Area			97,300	144,100	179,300	3.1%
Supportable GLA in Primary Trade Area	40	sf/person	3,000,000	4,700,000	5,900,000	3.4%
Office-based demand assessment:						
Civilian labor force	54%	of resident population	30,200	45,200	56,600	3.2%
Supportable RBA in Primary Trade Area	18	sf/person in 2006[4]	20	25	25	1.1%
			600,000	1,100,000	1,400,000	4.3%
Total supportable commercial areas			**3,600,000**	**5,800,000**	**7,300,000**	**3.6%**

Note: Demand projections could be conservative in that market support from area second home is residents not explicitly considered.

[1] Census Tracts 215.01 and 217.01, respectively.

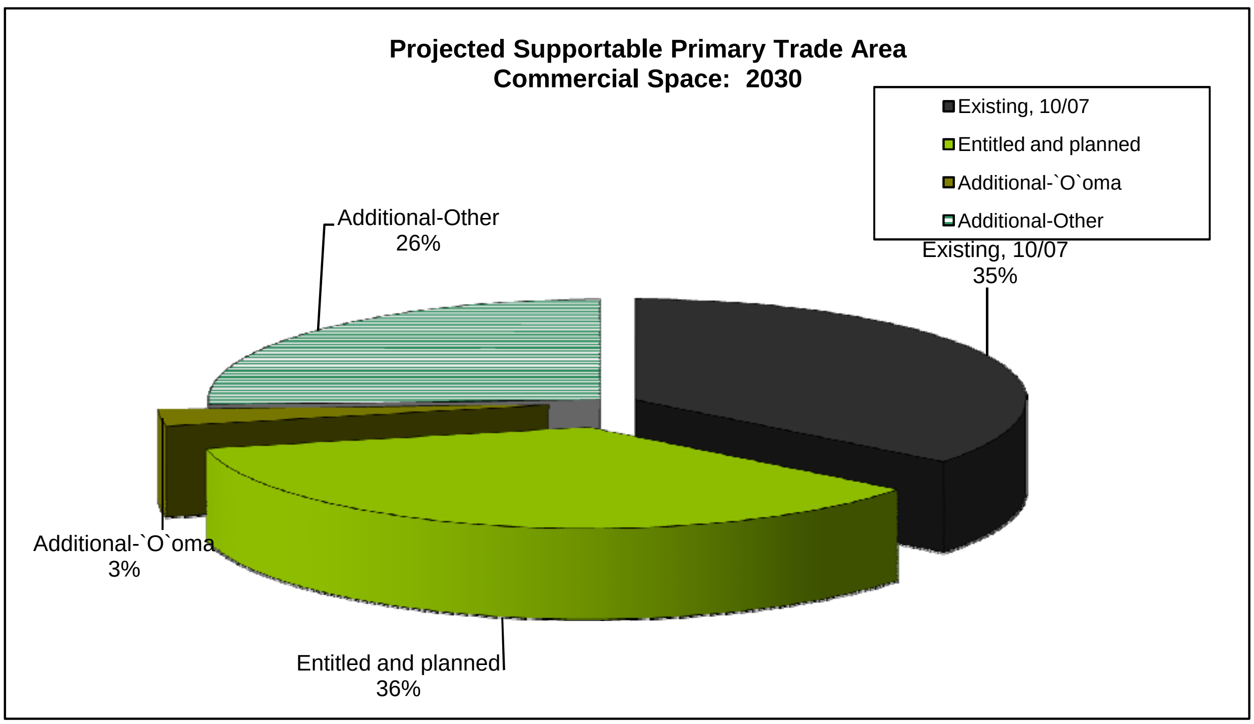
[2] Based on 2000 ratios and weighted average for PTA, as shown in Exhibit 5-6. This indicator could be low compared to the daytime ratios that would be effective for the larger regions considered here, since it is derived from the relatively small CDP places.

[3] Assumes annually compounded 2% average growth in visitor population, most originating in planned interval ownership developments. 2006 figure as shown in Exhibit 5-6. Growth rate based on projections set forth by University of Hawaii Economic Research Organization in "Tourism Pause Means Further Slowing Ahead," March 2, 2007; visitor populations projected do not consider the growing resort second home resident population of the region.

[4] As shown in Exhibit 5-7. Future ratio assumed to approach Oahu's 2006 average.

Exhibit 6-2
Commercial Market Assessment for `O`oma
Cumulative square feet, 2020 and 2030

	Basis/reference		2020	2030
`O`oma commercial market:				
Potential development phasing	***200,000***	*maximum*	**100,000**	**200,000**
Mauka (Current Urban District)	*150,000*	*maximum*	50,000	150,000
Makai (Petition Area)	*50,000*	*maximum*	50,000	50,000
Share of total future PTA			2%	3%
Share of net unplanned PTA market support			9%	10%
Projected supportable space in Primary Trade Area:	***Cumulative figures***			
Existing, 10/07	*Exhibit 5-3*		2,596,000	2,596,000
Entitled and planned for 2007+	*Exhibit 5-3*		2,070,000	2,630,000
Net additional supportable			1,134,000	2,074,000
Total	*Exhibit 6-1*		**5,800,000**	**7,300,000**



Note: Demand projections could be conservative in that market support from area second home residents is not explicitly considered.

Source: Mikiko Corporation, 2007

Market Assessment for O`oma Beachside Village

Appendices

Appendix 1: Census Tract 215.01 – Portion of North Kona District Considered Within the Competitive Residential Market Area

Source: Claritas, Inc., March 8, 2007.

Appendix 2: Census Tract 217.01 – Portion of South Kohala District Considered Within the Competitive Residential Market Area

iXPRESS Page 1

Project 2833751 - Prepared for Mikiko Corporation
Census Tract 217.01
Hawaii County, HI

Source: Claritas, Inc., March 8, 2007.

Appendix 3: Planned Primary Residential Development Projects in Census Tracts 215.01 and 217.01, Island of Hawaii

Subject and Primary Residential Projects with State Entitlement or Exemption, as of October 2007

Project identification	Landowner or developer	Number of units: Total	Number of units: Built as of 10/07	Number of units: Potential future	*Est % primary resident & buildout* [1]	Projected additional RHU at buildout	Comment
North Kona-North (CT 215.01):							
Subject: `O`oma Beachside Village	***`O`oma Beachside Village, LLC***	***1,200***	***0***	***1,200***	***84%***	***1,010***	***Subject. Planned for 1,000 to 1,200 units, including affordable housing.***
Palamanui (previously Hilu Hilu)	Hunt Development Group/Charles Schwab/Guy Lam	1,100	0	1,100	*85%*	940	Within 725-acre site tied to proposed UH West Hawaii campus; first homes 2009+. Excludes dormitories.
Keauhuolu Lands (RCX-2)	Queen Lili`uokalani Trust	234	0	234	*95%*	220	Mauka of Henry St. & South of Palani Rd. Plans in flux as of September 2007.
Kaloko Heights	Stanford Carr Development/Kaloko Heights Associates LLC	1,362	0	1,362	*85%*	1,160	Adjacent to Subject, on Hina Lani Drive. Market homes on 7,500 to 15,000 sq. ft.; also MF. First product +/- 2013.
Villages of La'iopua (Kealakehe ahupua'a)	State-DHHL	1,364	0	1,364	*95%*	1,300	Residential lots at Villages 1,2,4,5,6,7,11. Village 3 (Kaniohale) completed 2001. Villages 8, 9, 10 taken by HHFDC and are subject to EIS for Urbanization.
Seascape	Westpro Holdings	108	0	108	*90%*	100	Affordable condos with buy-back provision. Building permits issued 2007.
Wainani Estates	INA; marketed by Clark Realty Corporation	49	30	19	*85%*	20	Vacant lots, Increment One (30 lots) now on the market, 15,000 to 25,000 sq. ft. Ko'i Ko'i Street near Kaiminani Street.
South Kohala-Waikoloa (CT 217.01):							
Aina Le`a	Bridge Aina Le`a (Banter, Inc.); seeking developer	1,924	0	1,924	*20%*	380	Across from Mauna Lani Resort; plans include 2 golf courses & 25-acre shopping center.
Wehilani (formerly "Na Puu Nani")	Castle & Cooke Waikoloa LLC (C&C Homes Hawaii, Inc. subsidiary)	883	65	818	*90%*	740	Makana Kai (MF) and Kikaha (SF) now marketing. West & south of Waikoloa Village entrance.
Kilohana Kai at Waikoloa Phase II	Clearly Waikoloa; marketed by Hawaiian Island Homes, Peter Savio	230	115	115	*70%*	80	80 homes/150 vacant lots. Ph I (51 units) sold out 2005; Phase II now being marketed. Completion of Ph III projected 2008.
Kamakoa Vistas (Waikoloa Workforce Housing)	UniDev LLC/Hawai`i Island Housing Trust (land owner)	1,200	0	1,200	*95%*	1,140	1,000 to 1,200, of which 400 rentals. County deeded land to HIHT & has committed $40 million for infrastructure. Community Facilities District financing.

Appendix 3: Planned Primary Residential Development Projects in Census Tracts 215.01 and 217.01, Island of Hawaii

Subject and Primary Residential Projects with
State Entitlement or Exemption, as of October 2007

Project identification	Landowner or developer	Number of units: Total	Number of units: Built as of 10/07	Number of units: Potential future	*Est % primary resident & buildout* [1]	Projected additional RHU at buildout	Comment
Sunset Ridge	Towne Development	197	100	97	*95%*	90	High $400,000s to low $700,000s in 2007; 65 acres, north of Wehilani.
Keolalani at Waikoloa (formerly "Waikoloa Heights")	Keolalani Investment Partners (purchased from Lynch; entity known as Waikoloa Ma La'i)	3,000	0	3,000	*65%*	1,950	Land zoned RS-10; assumed RHU productivity estimated based on slope and a share of development being purchased by off-island investors. No affordable condition; required sewer, water line and bridge improvements will add to project infrastructure costs.
Waikoloa Village	Metric Holdings, Inc.	476	0	476	*90%*	430	45 acres total; also planned for lifestyle retail. Across Waikoloa Road from Village Golf Course.

	Total	Built as of 10/07	Potential future	Projected additional RHU at buildout
Totals, rounded (excludes Subject):				
North Kona-North	4,200	0	4,200	3,700
South Kohala-Waikoloa	7,900	300	7,600	4,800
	12,100	**300**	**11,800**	**8,500**

Note - Based on survey of projects planned on lands with State Land Use "Urban" designation as of October 1, 2007, or with landowner that may be exempt from LUC governance. Survey targeted projects of 100 or more planned units. Excludes projects developed in conjunction with beachfront resorts offering golf and/or hotel amenities; also excludes QLT Urban lands for which LUC petitions to be filed to redesignate uses from commercial to residential. Figures shown based on stated owner or developer plans where available, else maximum entitled units.

INA - Information not available; sq. ft. - square feet; u - residential unit; RHU - primary resident housing unit; MU - Mixed use development including residential and retail uses; SF - Single-family detached home; MF - Multifamily; TH - Townhouse (multifamily); LUC - State Land Use Commission; HHFDC - Hawaii Housing Finance & Development Corporation; DHHL - Department of Hawaiian Home Lands; DLNR - Department of Land & Natural Resources; MFY - median family income; DEIS - Draft Environmental Impact Statement; QLT - Queen Lili`uokalani Trust.

1 Reflects estimated percent of project anticipated to sell to primary residents already established on-Island and the likelihood of project building to maximum entitled capacity.

Sources: Interviews with project principals, developers, planners and brokers, and County and State officials; Honolulu Advertiser; Honolulu Star Bulletin; Pacific Business News; West Hawaii Today; State of Hawaii, Office of Environmental Quality Control; project websites and internet searches.

Appendix 4: Entitled and Planned Commercial Developments in the North Kona and South Kohala Districts

Subject and Projects with State LUC Entitlement and Plans, as of October 2007

Project identification	Landowner or developer	Site area (Ac)	Estimated GLA (Sq. ft.)	Comments
North Kona:				
`O`oma Beachside Village	***North Kona Village, LLC***	***INA***	***200,000***	***6 acres in Makai Area, of which 3 to be canoe club; balance on Mauka Area.***
Kaloko Heights	Stanford Carr Development/Kaloko Heights Associates LLC	5	50,000	Neighborhood commercial; zoned CN-20.
Palamanui (previously Hilu Hilu)	Hunt Development Group/Charles Schwab/Guy Lam	INA	70,000	Village and Community Commercial areas designated within 725-acre site. Excludes 70-acre potential business park.
Kona Kai Ola	Jacoby Development, Inc. (Atlanta)/State DLNR and DHHL	51	500,000	50-acres along Queen Kaahumanu, rest around harbor. Project also includes 800-slips, 700 hotel rooms, 1,800 timeshare units.
Kona Commons	MacNaughton, Kobayashi, Queen Lili`uokalani Trust	65	700,000	"Village style Main Street". Phase I - 132,400 sq. ft. by 10/08. On QLT leased lands makai of Queen Kaahumanu Hwy.
CG10 site	Queen Lili`uokalani Trust Estate	12	200,000	Office and retail potential development; no residential planned at this time.
Lots 14 & 15	Queen Lili`uokalani Trust Estate	9	60,000	Plans under review.
Makalapua Shopping Center Phase 2	Queen Lili`uokalani Trust Estate	20	116,000	Up to 20-acre expansion permitted by water agreements within current Urban Phase 1. Development likely pending petition to LUC for residential uses in this area.
Lanihau Shopping Center Phase 2	Westwood Development Group	22.4	220,000	Fronts Henry Street. Westwood also involved in Aina Le`a.
INA	Pua`a Development, LLC	14.97	20,000	SLU-04-009, Neighborhood commercial. Across Pualani Estates, makai of Hwy 11.
South Kohala:				
Queen's Marketplace	INA	INA	135,000	Anchor Island Gourmet Markets (ABC Stores/KTA).
Aina Le`a	Bridge Aina Le`a	25	200,000	Estimate based on land area; project in need of financing and development partner.
Waikoloa Village	Metric Holdings, Inc.	12.92	200,000	Zoned CV-10; project also includes residential rentals, senior housing, hotel.
Waimea Town Center	Parker Ranch	20	200,000	Town Center Plan under review; represents maximum development expected.
Potential development but no plans specified:				
NELHA	State of Hawaii	400	0	Plans unspecified but some 400 acres of Commercial/Industrial land are potentially available.

Totals of available information, rounded (excludes Subject):	
North Kona	1,890,000
South Kohala	740,000
Total, Primary Trade Area	**2,630,000**

Note: Survey covers projects with LUC "Urban" designation as of April 1, 2007, and targeted community and regional retail/office facilities, generally those of 20,000 square feet or more. Excludes industrial-designated commercial projects such as West Hawaii Business Park and Kaloko Industrial Park.

INA - Information not available; Ac - Acres; LUC - Land Use Commission; U/C - Under construction; MU - mixed-use development, including residential and retail; SC - Shopping center

Sources: Interviews with project developers, landowners, planners and brokers; area site visits; PM Realty Group, 2007; Pacific Business News, 2006, "Book of Lists: 2007"; Pacific Business News (weekly); developer websites; Honolulu Advertiser; West Hawaii Today; internet searches.

Appendix 5: Report Conditions

This assessment is based on information provided by government agencies, developers, brokers, landowners, and other third party sources. While every attempt has been made to verify information via multiple sources, it is not always possible to do so. MC cannot guarantee the accuracy of all information upon which its assessments may be based.

MC has no responsibility to update this report or any of the underlying data for events and circumstances occurring after October 1, 2007, the date of substantial completion of primary data collection.

This report is for the planning purposes of NKV, PBR and their consultants, as well as for public disclosure of the nature of `O`oma pursuant to seeking State and County land entitlements. It is not to be used for solicitation of investment or other third party purposes without prior written consent of the author.

This report does not offer an appraisal of `O`oma, nor should it be construed as any opinion of value for `O`oma.

Economic & Fiscal Impact Assessment

MIKIKO
CORPORATION

ECONOMIC AND FISCAL IMPACT ASSESSMENT FOR `O`OMA BEACHSIDE VILLAGE

North Kona, Island of Hawai`i

Prepared for:
`O`oma Beachside Village, LLC

FINAL REPORT
April 2008

Economic and Fiscal Impact Assessment for `O`oma Beachside Village

Table of Contents

Report Text

Exhibits

Market Assessment for `O`oma Beachside Village

Acronyms and Other Terms Used in this Report

AGI	Adjusted Gross Income, for tax purposes
av.	Average
County	County of Hawai`i
CPI-U	Consumer Price Index - Urban
CT	Census tract, as defined by the U.S. Census Bureau
DBEDT	State of Hawai`i, Department of Business, Economic Development and Tourism
est.	Estimated
FY	Fiscal Year
FF&E	Furniture, fixtures & equipment
FTE	Full-time equivalent
GET	General Excise Tax
GLA	Gross leasable area, in square feet
Island	Island of Hawai`i
LUC	State of Hawai`i, Land Use Commission
MF	Multi-family
MC	Mikiko Corporation
mils.	Millions
`O`oma	`O`oma Beachside Village, the subject property and/or development proposal
`O`oma Beachside Village, LLC	The entity that owns and proposes to develop `O`oma; also the entity that is petitioning the State Land Use Commission to reclassify the Petition Area into the LUC Urban District
PBR HAWAII	PBR HAWAII & Associates, Inc.
psf	Per square foot
SF	Single-family home
sq. ft.	Square feet

State.......................................State of Hawai`i

TI...Commercial tenant improvements

wtd...Weighted, as in a weighted average

Economic and Fiscal Impact Assessment for `O`oma Beachside Village

Report Text

1 – Introduction and Executive Summary

This chapter relates the study background, objectives, approach and principal conclusions of an economic and fiscal impact assessment prepared for the proposed `O`oma Beachside Village (`O`oma) on the island of Hawai`i (Island) The following chapters offer a more detailed explanation of the findings and analyses on which these conclusions are based.

`O`oma Beachside Village and Study Background

`O`oma Beachside Village, LLC has initiated a planning and entitlement process for its proposed `O`oma development. The mixed-use, master-planned community is planned for some 303 acres in the North Kona District of the Island. The site fronts on Queen Ka`ahumanu Highway as well as the ocean, and is south of the State of Hawai`i's Natural Energy Laboratory of Hawai`i and north of The Shores at Kohanaiki, a resort development. Some 83 acres of the site are currently in the State Land Use Commission (LUC) Urban District, while the balance is designated in the LUC Conservation District.

The planning firm PBR HAWAII & Associates, Inc. (PBR HAWAII) is preparing materials to support these entitlement efforts.

Mikiko Corporation Study Objectives

Mikiko Corporation (MC) was engaged to prepare two reports for `O`oma:

1) **Market assessment –** An assessment of the anticipated future market support for the residential and commercial uses proposed.

2) **Economic and fiscal impact assessment –** An assessment of the anticipated future economic and fiscal impacts of `O`oma.

The market report is contained in a separate document. The economic and fiscal impact assessment reported in this document uses the findings of the market report as input assumptions.

Study Approach

This economic and fiscal impact assessment is intended to assess `O`oma's effects within the State of Hawai`i (State) and Hawai`i County (County). Impacts that were evaluated include:

- Economic impacts:
  - Expenditures by persons who move to the County because of `O`oma;
  - Development-related employment;
  - Operations-related employment; and
  - Personal income deriving from development and operations.
- Population impacts:
  - Residential utilization patterns; and
  - In-migrants to the State and Island.
- Fiscal impacts:
  - Property tax and other County government revenues;
  - General excise tax, income and other State government revenues;
  - County and State government expenditures; and
  - County and State net fiscal operating impacts.

State and County revenues and expenses projected herein are generally based on the structure of tax collections and services reported as of the fiscal year ending June 30, 2006 for the State[1], and June 30, 2007 for the County. The projected impacts would differ if governmental taxing and spending policies were to be materially altered in the future.

All dollar amounts in this report are stated in 2007 dollars, and year references are to calendar years, unless otherwise stated.

[1] While the County's Comprehensive Annual Financial Report for the fiscal year ended June 30, 2007 was available for use in this study, the State's analogous report is not due to be released until late May, 2008. Thus, the study utilizes the State's Comprehensive Annual Financial Report for the fiscal year ended June 30, 2006, with adjustment for inflation.

Executive Summary

Development Proposal

`O`oma Beachside Village, LLC is the fee owner of an approximately 303-acre site in North Kona, island of Hawai`i. It proposes to develop a mixed-use community to be known as `O`oma Beachside Village on this property. `O`oma would include up to 1,200 homes and 200,000 square feet of commercial retail and office spaces, including ocean-facing restaurants and a canoe club. The community would also include a 3-acre charter school site, an 18-acre public shoreline park, and 85 acres of other trails, preserve areas, and open space.

Based on the entitlements required to commence development and other factors, the first properties at `O`oma could be expected to be available for sale or lease in 2012. `O`oma is projected be completely built out, and all homes sold by the developer, by 2029.

The development plan is as summarized below.

Overview of Proposed Developments at `O`oma Beachside Village
2007 dollars

	Comment	2010 to 2020	2021 to 2030	Total
Homes:	***Average sales price:***			
Finished homes (single & multifamily), market	$540,000	553	322	875
Estate lots, market	$650,000	85	0	85
Affordable homes (multifamily)*	$271,000	112	128	240
Total/wtd. average	**$494,000**	**750**	**450**	**1,200**
Other:				
Commercial centers	*GLA sq. ft.*	100,000	100,000	200,000
School site	*Acres*	3	0	3
Parks, trails, open space/buffers	*Acres*	103	0	103
Canoe club	*Acres*	2	0	2
Total development costs	Hard and soft costs (mils.)	**$312.5**	**$228.1**	**$540.6**

* Assumes 20% of total units and a 1:1 credit per County guidelines currently in effect. Actual credits could vary depending on affordable housing market segments and other factors to be agreed upon with the County, and such variation could change the affordable unit count.

Estimated average price considers County's 2007 guidelines for pricing of for-sale units for a family of four earning 110% to 130% of the County median family income. Target markets and specific pricing to be determined in agreements to be established with the County

Based on current guidelines, about 20% of `O`oma's homes are expected to be provided in accordance with County standards for affordable housing (see note to box above.) This analysis assumes that this housing is developed for sale. Alternatively, `O`oma Beachside Village, LLC may develop some of its affordable housing as rental housing.

As noted above, `O`oma development costs are estimated to total some $540.6 million, including on- and off-site infrastructure, vertical construction, and commercial tenant improvements, as well as "soft costs" such as professional services, administration of operating subsidiaries, marketing and the like.

`O`oma Beachside Village Impacts[2]

`O`oma would generate significant, on-going economic and fiscal benefits for residents of Hawaii, as well as for the County and State governments. Development of `O`oma would generate employment and consequent income and taxes. In addition, by attracting new residents to the Island and generating additional real estate sales activity, `O`oma is expected to support long-term impacts, including additional consumer expenditures, employment opportunities, personal income and government revenue enhancement.

Highlights of the projected impacts are summarized in the table on the next page.

Economic Impacts

- **Development employment –** During the approximately first half of its development, `O`oma could generate employment for some 380 full-time equivalent (FTE) persons per year through its direct, indirect and induced impacts. During the subsequent years of the community's buildout, this might subside to some 290 FTE development-related jobs per year, considering direct, indirect and induced impacts. These jobs are expected to be associated with average annual personal earnings[3] of some $21.4 million (2010 to 2020) or $17.1 million (2021 to 2030), at about $57,000 to $59,000 per FTE job.

- **Operational employment** - By 2030, when all developer products at `O`oma are projected to have been sold out and/or to be in stabilized operations, `O`oma is expected to have generated about 480 permanent, ongoing new FTE jobs on-site and in real estate sales and marketing. These 480 FTE jobs are in addition to the development-related employment described above.

  Among the 480 new FTE jobs, about 200 could be net additional to the County and State[4]. They could include professional, technical and managerial positions at

[2] See following chapter for study methodology and definitions of key terminology, such as "direct," "indirect" and "induced" impacts.

[3] Earnings are defined as wage, salary and proprietary income, plus director's fees and employer contributions to health insurance, less employee contributions to social insurance. "Earnings" are typically less than salaries.

[4] See Chapter 2 for explanation of new vs. net additional jobs, under bullet header "Commercial facilities."

the office areas, sales and marketing positions supported by sales and leasing of property, and myriad other positions generated throughout the economy, as supported by the activity generated by such new expenditures. Altogether, these net additional operations-related positions could be expected to generate personal earnings for Hawai`i residents of about $10.8 million per year, or an average of about $54,000 per FTE job.

Summary of Projected Economic and Fiscal Impacts
2007 dollars, in millions except where noted

	Comment	By 2020	By 2030	Average/ At completion*
FTE employment[**]:				
Development-related	*Average annual in preceding period (direct, indirect & induced)*	380	290	340
Operations-related				
Total generated by project	*On-site and directly supported*	250	480	480
Net additional jobs	*Additional to County or State*	90	200	200
Total personal earnings[***]:	***Annual, on-going***			
Development-related	*Average annual in preceding period (direct jobs only)*	$21.4	$17.1	$19.3
Operations-related	*On net additional jobs only (direct, indirect & induced)*	$6.1	$10.8	$10.8
Average earnings per FTE job[***]:	***Direct, indirect and induced (not in millions)***			
Development-related	*Average annual in preceding period*	$57,000	$59,000	$56,000
Operations-related	*On net additional jobs only*	$67,000	$54,000	$54,000
On-site resident population	***Average daily residents, including FTE visitors/second home owners***	1,670	2,850	2,850
In-migrant resident population:	***Average daily employees, dependents, and part-time residents***			
To the County	*Total in-migrants*	160	430	430
To the State	*Subset of County in-migrants*	110	320	320
Net additional government operating revenues[****]:	***Operating revenues less operating expenditures***			
For the County		$2.3	$3.2	$3.2
For the State		$2.1	$1.4	$1.4
Revenue/expenditure ratio[****]:	***For government operations***			
For the County		10.6	6.0	6.0
For the State		5.2	1.9	1.9

* Figures represent average annual estimates for development-related impacts, considering the 2010-2030 period as a whole (these impacts would not exist after 2030) and 2030 estimates ("at completion") for operations-related, population and fiscal impacts. The latter figures are considered to stabilize in 2030 and to persist thereafter.

** FTE = Full-time equivalent, defined as 40 hours per week or 2,080 hours per year.

*** Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance.

**** Does not consider impact and permit fees that may be paid to County or State governments.

Sources: `O`oma Beachside Village, LLC, 2007; Mikiko Corporation, 2008.

Population Impacts

- **In-migrants to the County and State** - It can be assumed that the jobs created by `O`oma, particularly its professional, technical and managerial career opportunities, as well as the homes to be developed, will create incentives for some neighbor islanders or former Island residents to move to Hawai`i Island. `O`oma's housing opportunities are also expected to attract some second home owners or other investors who normally live off-Island.

  These and other indirect factors can be expected to result by 2030 in perhaps 430 FTE persons living on the Island, but not necessarily at `O`oma, who otherwise might not have moved to the Island. Of these 430, approximately 110 are anticipated to come from elsewhere in the State, and 320 might be persons who moved to the Island from out-of-State.

- **On-site population at `O`oma** - At `O`oma itself, resident population on an average day is projected at some 2,850 persons at buildout. Of this total, some 2,580 or about 90% could be expected to be primary residents.

Fiscal Impacts

- **Net County fiscal impacts** - Net additional County revenue resulting from the completed development of `O`oma is expected to exceed the concomitant County government expenditures by a factor of 6.0, or some $3.2 million per year in net additional County revenues, at project completion.

- **Net State fiscal impacts** - For the State, net additional operating revenues generated by `O`oma are estimated at $1.4 million per year by 2030 and beyond. This represents a revenue/expenditure ratio of about 1.9.

These public sector contributions do not consider the value of the school site, public parks or various off-site infrastructural improvements to be contributed by `O`oma Beachside Village, LLC. Neither do they consider the various impacts and permit fees that may be paid to the County and State governments during development. Such additional contributions would increase the public and fiscal benefits of `O`oma.

Report Organization

The rest of the report is organized in three parts, as follows:

1) **Remainder of Text** - Explanation of the study analyses and conclusions, including:

   - Study Approach
   - Economic Impacts
   - In-Migrant Population
   - Fiscal Impacts

2) **Exhibits**- Detailed bases and findings on which the conclusions are based.

3) **Appendices –** Report conditions and further documentation of input assumptions.

2. Study Approach

Special Considerations

Special considerations for some of `O`oma's facilities guide the analyses presented herein. These and other aspects of this study's analytical framework are set forth below.

- **Time frame –** This analysis extends from 2010 to 2030, a 21-year period that would span from preconstruction planning through `O`oma's buildout. The first homes at `O`oma are estimated to be available for purchase in 2012, and the first commercial developments to be available for occupancy the same year. All residential units, as well as commercial and industrial spaces, are projected to be sold and/or occupied by 2029. Thus, in contrast to its buildout period, `O`oma's sell-out period is estimated to be 18 years (2012 to 2029).

- **Use and classification of residential units –** As explained further in MC's market study, some 16% of the homes sold at `O`oma are anticipated to be used for purposes other than as primary residences.[5] These could include second or vacation home buyers, as well as investor-buyers who do not plan to rent the units as primary residences. For purposes of this analysis, such buyers are assumed to customarily live off-Island. This group is distinguished from the primary resident buyers in terms of their economic and fiscal impacts.

  - Non primary residents staying at `O`oma (estimated to be approximately 270 persons at completion) would bring new investments, earnings and expenditures to the State and County. Conversely, such buyers also require some additional government resources and services. In short, they generate new economic and fiscal impacts within the County and State.

  - Primary residents living at `O`oma (estimated to be approximately 2,580 persons at completion) are assumed to have lived elsewhere on the Island even if `O`oma were not developed. Thus, while they may increase population at the `O`oma site itself, from the County or State's standpoint, their presence is not an impact.

- **Commercial facilities -** The proposed commercial facilities are expected to attract spending from `O`oma residents and employees, Island residents not living at `O`oma, and Island visitors. However, it is likely that Island residents and visitors would have spent an equivalent amount on dining out and/or personal services whether or not `O`oma's commercial facilities were developed. Thus, given a competitive retail market on the Island, the planned commercial facilities could lead

[5] This is based on 20% of the 80% of units estimated to be sold as market units (20% x 80% = 16%).

to a geographic reallocation of spending within the region, but would not in themselves be expected to increase expenditures made in the County or State.

On the other hand, commercial facilities would contribute to `O`oma's ability to attract residential buyers to `O`oma.

In other words, `O`oma's on-site commercial facilities will employ workers, pay taxes and generate other economic and fiscal benefits. These are considered directly generated impacts and most of the new jobs would be located on-site. However, the net benefits of `O`oma's commercial facilities are measured in terms of the new Island residents and visitors that `O`oma attracts, and the spending, taxes and other benefits these non primary resident persons will generate throughout the County and State. Many of these impacts are likely to be felt off-site.

This report distinguishes the "new" vs. the "net additional" jobs attributable to `O`oma. The net additional jobs would be those supported by the additional spending generated on-Island by those who attracted to live on the Island because of `O`oma's development.

Only the net additional jobs (as opposed to the new jobs) and spending are considered as input to the estimation of fiscal impacts, such as income taxes, GET, and the like. This methodology is considered a conservative approach to estimating `O`oma's fiscal impacts. For instance:

- ❑ While the opening of a new store may not in itself increase aggregate spending on the Island, it is likely to lead to some net additional job creation, since each store needs a manager and some operating staff, regardless of its level of sales.

- ❑ Existing Island residents who move out of another household because of the living opportunities in `O`oma are likely to spend more, at least initially, on various household items, since there are many costs typically associated with setting up a new household. In the methodology described above, such additional spending is ignored, while only that spent by additional Island residents is modeled.

Other uses/considerations not modeled – This assessment does not consider the economic and fiscal impacts of development that would be of a public or civic nature. Thus, the costs and employment generated by buildings or other facilities at the proposed charter school, the parks, or any other public facilities, are not modeled. Neither are the values of the lands underlying such uses considered in estimating real property taxes.

Additionally, impact and permit fees that may be paid to the State and County governments are not modeled.

- **Entitlement spending not considered –** `O`oma Beachside Village, LLC's currently on-going entitlement process for `O`oma is already generating economic and fiscal benefits by employing professionals and supporting various vendors around the State. However, since such benefits are not dependent on the outcome of the entitlement process, they are not enumerated in this analysis.

- **Other –**This study does not compare the proposed developments to prior master plan(s) for the property nor to other developments that could be hypothesized given the lands' existing entitlements.

Definition of Terminology

Within this report, the following definitions apply:

- **Direct impacts -** Those economic, population or other impacts attributable to persons or activities that are a direct result of the proposed development. For instance, direct employment impacts might include those involved in building the proposed facilities, such as construction workers, and those who would later work at them in their operations.

  Many, but not all of direct impacts can be expected to occur on-site. For instance, a portion of the construction budget is for architects and engineers. While such persons' employment might be temporarily dependent on the contracts generated by `O`oma, they may do the majority of their work from offices in Kona, Honolulu or elsewhere. Likewise, administrative and managerial staff located off-site would support construction professionals working on-site.

- **Indirect impacts –** Indirect impacts occur when the businesses or persons who are directly affected make expenditures for additional supplies or services. For instance, some of the additional retail spending by those newly attracted to Hawai`i by `O`oma could be spent on eating out. These elevated dining out expenditures could indirectly increase demand for produce, seafood and meats from Hawai`i farms, fishermen and/or ranching enterprises. `O`oma would thus have indirectly supported new business opportunities for area providers of such goods and services.

- **Induced impacts –** Induced impacts occur throughout the community when those persons or companies that have benefited from the direct or indirect impacts of `O`oma spend their associated earnings on consumer goods and services. For instance, a construction worker may spend her earned wages to buy a new pair of shoes, or to pay for her child's day care. The farmer who sells produce to a restaurant at `O`oma may use some of his profit to take his family out to the movies. The businesses and individuals impacted by such re-spending are said to enjoy induced economic impacts from `O`oma.

- **Total impacts –** Total impacts are defined as the sum of direct, indirect and induced impacts for any given variable.

- **Resident population –** Resident population refers to all those persons who habitually reside in a given area, whether or not they may have temporarily traveled away.

- **De facto population –** De facto population refers to all those persons who could be expected to be present in a place at any given time. Thus it would exclude residents who are temporarily away on a trip, but would include visitors who are temporarily present.

- **Full-time equivalent –** This study measures employment opportunities in full-time equivalent (FTE) units. For purposes of this study, one full-time equivalent position is defined as 2,080 hours of employment (including paid vacation and sick leave) per year. This is equivalent to 40 hours per week, and may also be referred to as a "person-year" of employment. Two half-time jobs would be considered together represent one FTE job.

`O`oma Beachside Village Parameters

Assumptions regarding the scale, nature and timing of `O`oma are made in order to assess its impacts. This assessment is based on findings of the market study, and on timelines and development programs provided by `O`oma Beachside Village, LLC, PBR HAWAII and others as noted.

Development Program (Exhibit 2-1)

`O`oma is proposed to be developed with up to 1,200 residential units, and up to 200,000 square feet of commercial retail and office space.

Among the residential units, about 20% or some 240 could be developed as affordable housing, in accordance with County guidelines. If these units were developed for sale (as opposed to rentals), they could expect to be sold for about $271,000 on average, based on County guidelines in effect as of May 2007 for a family of four earning 110% to 130% of the County median family income.

Market-priced residential properties offered for sale would include finished multi- and single-family homes as well as estate lots on which buyers might construct their own custom homes. Finished homes are projected to be sold at an average price of $540,000, while the estate lots could be priced at about $650,000. Considering both finished homes and estate lots, average market home production and sales could occur at about 54 units per year.

Assuming entitlements are obtained on a timely basis, infrastructure development could begin in 2010, and the first residential homes could be available for occupancy in 2012. All developer products at `O`oma are anticipated to be sold out and/or leased by 2029.

This analysis extends to 2030, in order to capture the impacts of stabilized operations a year or so after sell-out.

Residential Buyer and Utilization Patterns (Exhibit 2-2)

Based on buyer origin patterns at representative other developments on the Island, as explained in MC's market study, 80% of market units and all of the affordable units are assumed to be purchased (or in the case of affordable units, possibly rented) by primary residents who are already established on the Island. The remaining 20% of market units could be purchased by non primary resident household, who are assumed to come from off-Island, as explained above.

As a percent of total units (not just of market units), at completion, `O`oma's units are assumed to be used as follows (numbers rounded):

- **Primary residences**, including market and affordable units – 1,010 units, or 84%;
- **Non primary residences**, all market units – 190 units, or 16%.

The primary residences at `O`oma are assumed to be occupied 95% of the time, at 2.7 persons per household for both market units and affordable units. Projected household size is based on the projected average Island household size for 2030, as also presented in MC's market study. The number of primary residents expected to be on-site on an average day is 2,580.

Non primary residents are assumed to reside at their `O`oma property an average of 20% of the year by 2020, and up to 50% by 2030. This increase is attributable to the gradual buildout of homes on the estate lots, a share of which could be expected to be purchased for second or vacation home use.

Non primary resident homes are estimated to house an average of 2.8 persons when they are in use, based on interviews with brokers, developers and others familiar with the Kona second and vacation home marketplace. Thus, the number of non primary residents expected to be on site on an average day is about 270.

These assumptions support an average daily `O`oma population of some 2,850 persons by 2030, of which 2,580 or about 90% could be primary residents and 270 or about 10% could be second home owners or vacationers.

3. Economic Impacts

`O`oma may be expected to impact the State and County economies by (a) generating development activity, which supports expenditures for goods and services, (b) creating and supporting jobs and business enterprises in its ongoing operations, and (c) attracting new Island residents who would make new expenditures. The new jobs would in turn generate additional personal earnings in the County and throughout the State.

Non Primary Resident Expenditures (Exhibit 3-1)

Expenditures by part-time or vacation home owners attracted to the County by `O`oma will contribute economic benefits. Direct expenditures made in Hawai`i by the non primary residents themselves are projected to amount to about $1.6 million in 2020, increasing to some $6.0 million per year by 2030 and thereafter. Including the indirect and induced impacts of these direct expenditures, the total contribution to the State economy by `O`oma's non primary residents is expected to amount to about $10.3 million per year by 2030 and thereafter.

`O`oma Beachside Village Costs

Coefficients and Multipliers (Exhibit 3-2)

The State of Hawai`i, Department of Business, Economic Development and Tourism (DBEDT) periodically evaluates the economic interdependencies of the various industries within the State, and their rates of job and personal earnings creation. The latest such study is dated June 2006 and entitled, "The 2002 State Input-Output Study for Hawai`i." Appendix 2 shows the information extracted from this report for use in the analysis of `O`oma's development activity.

- **Final demand industry coefficients** show the relationship between input, or spending within any given industry category, and its resulting creation of jobs and earnings in other sectors of the State economy[6]. Such coefficients are used to estimate the direct effects of the construction and development activities planned for `O`oma.

- **Industry multipliers** show the relationship between direct jobs or earnings and the indirect and induced jobs or earnings that they can be expected to subsequently support.

[6] Personal earnings are defined in the DBEDT study as wage and salary income plus proprietors' income, director's fees, and employer contributions to health insurance, less personal contributions to social insurance (i.e., social security taxes).

Development Costs (Exhibits 3-3 and 3-4)

Based on estimates provided by `O`oma Beachside Village, LLC, their planners, engineers and other sources as cited in the exhibits, `O`oma's development is expected to lead to some $540.6 million in development-related expenditures over the 21 years between 2010 and 2030. This budget is in 2007 dollars and includes:

- **Professional services –** planning, architectural, engineering, landscape design, development management, and similar services. Note that this excludes those services related to the effort to entitle `O`oma's lands, as expenditures for such services are not contingent upon obtaining the entitlements

- **Construction –** on- and off-site infrastructure, land subdivision and site preparation, commercial and residential facility development, and retail and office tenant improvements.

- **Other –** administrative overhead, subsidiary operations, marketing, public relations, off-site community contributions, legal services and other "soft" costs incurred during `O`oma's development and developer sales, post-entitlement.

Because the latest DBEDT coefficients are calibrated to 2002 dollars, the development budgets are also re-estimated in 2002 dollars, as shown in the middle rows of Exhibit 3-3.

Exhibit 3-4 restates the 2007 figures on an average annual basis within each period, rather than as a total. Over the projection period, `O`oma could be expected to average $25.7 million per year in development expenditures in the State. The rate of expenditures would be higher than this average between 2010 and 2020, when large shares of the planning, infrastructure development and vertical construction are expected to take place.

Employment and Earnings

Development Employment (Exhibit 3-5)

During its buildout, `O`oma could directly generate some 3,000 person-years of development-related work. The majority of this work would occur on-site. However, some, such as the professional services and administrative positions, are likely to be located off-site. A great deal of the off-site employment may be expected to be located elsewhere on the Island or in Honolulu. This estimate includes wage, salaried and proprietary employment opportunities supported by `O`oma's development.

Considering also the indirect and induced employment opportunities that these direct impacts are likely to support, the total impacts of `O`oma's development could be expected to have represented 7,200 total FTE jobs by 2030, or 3,000 direct jobs plus 4,200 indirect and induced jobs[7].

[7] See Chapter 2 for discussion and examples of direct as compared to indirect and induced impacts.

The impacts are also considered on an average annual basis, in order to suggest the numbers of persons that could be employed in `O`oma's development in an average year. Over the entire development period from 2010 to 2030, `O`oma is anticipated to support an average of 140 direct FTE development-related jobs within the State each year. Total employment impacts, including direct, indirect and induced FTE jobs, could represent about 340 FTE positions each year.

Personal Earnings from Development (Exhibits 3-6 and 3-7)

Direct personal earnings associated with the above positions could amount to some $208.0 million over `O`oma's development. Considering the indirect and induced earnings, the State's workers could expect to enjoy some $406.0 million in additional earnings over `O`oma's development.

On an annual basis, these total earnings represent an average of $19.3 million from 2010 to 2030. The indirect and induced benefits could be expected to be supported throughout the State, with concentration on Hawai`i Island.

Comparing projected earnings to the employment figures shown previously, the FTE-wages, salaries, proprietary income and other earnings generated by `O`oma's overall development are estimated to average about $69,000 per direct FTE position, or $56,000 considering its total, more dispersed impacts.

Since many households include more than one jobholder, and many employees themselves hold more than one job, these position-specific earnings can be expected to be associated with higher average household incomes.[8] On average, those employed in positions directly supported by `O`oma's development could be expected to have household incomes averaging $90,000, while those associated with all jobs created through `O`oma's direct, indirect or induced effects could be expected to have household incomes averaging $73,000. These would represent 155% and 125% of the median household income for the County, which was estimated at $58,200.[9]

Operational Employment (Exhibits 3-8 and 3-9)

In addition to its development-related positions, `O`oma would create numerous long-term permanent jobs in its operations. Operational employment may be considered in two ways:

[8] Ratio derived from 2006 average Hawai`i County earnings for full-time, year-round workers with earnings ($45,284) and 2006 average Hawai`i County household income ($60,912). Earnings as provided by U.S. Census Bureau, 2006 American Community Survey; household income estimated by Claritas, Inc., February 2007. See Exhibit 3-7 for further information.

[9] Median based on 2006 figures from the U.S. Department of Housing & Urban Development, for a family of four, as provided by the County of Hawai`i; this income level used in County affordable housing guidelines in effect as of May 2007.

- **Employment generated by facilities ("new" jobs)** (Exhibit 3-8) – The development and operations of `O`oma's facilities are expected to be directly associated with about 480 permanent new FTE positions in its operations. Most of these jobs would be on-site, such as employees of `O`oma's retail and office facilities. These estimates do not include employees of public or community facilities and amenities that may be developed on-site, such as at the proposed charter school or parks.

- **Net additional employment** (Exhibit 3-9) - As explained in Chapter 2, it is conservatively assumed that existing Island residents would spend an equivalent amount on consumer goods and services whether or not `O`oma's commercial facilities were developed. One impact of `O`oma's development may be a geographic reallocation of spending and hence jobs within the region. Thus, while representing new jobs, many of the jobs located at `O`oma would not necessarily be net additional jobs for the State or County.

  On the other hand, to the extent that `O`oma attracts new residents to the Island, those persons' spending can be considered new monies in the State's and the County's economies. Such new spending will generate new employment opportunities that may be dispersed Statewide.

  In conclusion, `O`oma's impacts on employment opportunities Statewide are estimated:

  - Via employment multipliers applied to estimated spending by non primary residents attracted by `O`oma, and

  - Via employment multipliers applied to the projected volume of sales and leasing costs and commissions.

  Altogether, some 40 direct FTE operational jobs to be generated Statewide by `O`oma are considered likely to be net additional jobs in 2020, and some 90 by 2030. Indirect and induced effects would add more permanent positions, for a total of some 200 net additional permanent FTE positions by the time of `O`oma's stabilization in 2030.

Personal Earnings from Net Additional Operational Activity (Exhibits 3-10 and 3-11)

Personal earnings are estimated for the net additional operational jobs supported by `O`oma. Direct wages and salaries paid to those employed in `O`oma's operations, plus proprietary earnings, director's fees and the like earned as a direct result of `O`oma's resident spending are expected to reach $4.6 million per year by `O`oma's stabilization in 2030. Including personal earnings associated with the indirect and induced positions, `O`oma could be expected to generate some $10.8 million per year in ongoing payroll within the State.

These figures do not include gratuities, bonuses or some of the employee benefits that would also be realized by many of the employees and proprietors benefiting from this economic growth.

Based on the multipliers derived from DBEDT's Input-Output Study, the direct employment and proprietary opportunities generated by `O`oma could be expected to support average FTE earnings of about $51,000 at stabilization. Indirect and induced operational positions could be expected to support FTE earnings of about $56,000.

As for development employment, these earnings per job may be expected to be associated with higher average household incomes. Using the same methodology explained previously, the households that include a person employed through direct, indirect or induced employment impacts of `O`oma is expected to have average incomes of about $70,000. This would mean these `O`oma-associated households would be earning about 120% of the County's median income as defined for a family of four, as defined in the County's 2007 affordable housing guidelines.

4. In-Migrant Population

The development of `O`oma is expected to result in some in-migration to the State and from within the State to the County.

`O`oma Beachside Village Residents (Exhibit 4-1)

The majority (perhaps 90%) of non primary resident homebuyers at `O`oma are anticipated to come from out-of State, while 10% or so could be from neighbor islands.

By 2020, non primary residents living at `O`oma are estimated at about 70 persons on any given day. By 2030, the in-migrant population residing at `O`oma is estimated at 270 FTE persons, or about 10% of the total resident population at `O`oma on any given day.[10] Some 240 of these persons are estimated to come from out-of-State.

Employees and Dependents (Exhibit 4-1)

Some of those employed by activity generated by `O`oma may come from off-Island, attracted to Hawai`i County because of a job opportunity, or because `O`oma's development provided an entrée to the Island. These might include young householders who grew up in Hawai`i but had been working on the U.S. mainland due to the lack of attractive career and living environments in Hawai`i, or neighbor islanders who seek employment and lifestyle opportunities such as envisioned at `O`oma. Other household members might also accompany such in-migrating workers.

- **Development employees** - Hawai`i's labor market is considered to have sufficient supply and the required skills to satisfy most of `O`oma's development labor needs. A nominal 5% of FTE specialty staffing needs are assumed to come from outside the State. Such persons may temporarily reside on the Island during periods of `O`oma's development, and could represent some 6 to 8 persons at any given time.

  The construction labor pool on Hawai`i Island is more limited than found Statewide. Therefore, approximately 5% of `O`oma's development employees are expected to come from elsewhere within the State. The combined total of development related employees expected to come from off-Island (either from out of State, or from neighbor islands) would thus be 10% of the FTE employees needed for development of `O`oma. This would still be a relatively nominal number, such as 12 to 16 FTE positions in any given year.

[10] Based on the estimated total of 2,850 average daily persons in residence as of 2030, as shown in Exhibit 2-2.

- **Operational employees –** Some 95% of \`O\`oma's operational employee needs are anticipated to be satisfied from within the State's and 85% from within the County's labor pool. Conversely, this could mean that at stabilization in 2030, perhaps 70 persons would have been attracted to the County because of \`O\`oma's operational employment needs, while the other 410 new operational employees would be expected to have been previously established Island residents[11].

- **Dependents -** In-migrant dependents are estimated at an average of 0.2 per FTE in-migrant construction worker, since the position on which the "move" is based would be temporary, and 1.0 per FTE in-migrant operational employee.

Total In-Migrant Impacts (Exhibit 4-1)

In total, by 2030, \`O\`oma is projected to have been associated with about 430 in-migrants to the County, of whom perhaps 320 could also have been new to the State. This would include those in-migrating as vacation or second home owners, those moving because of employment opportunities, and the dependents of both these populations.

[11] Based on the total of 480 new FTE operational jobs shown in Exhibit 3-8.

5. Fiscal Impacts

`O`oma's fiscal impacts are estimated by comparing its anticipated impacts on government revenues to the government service costs associated with the additional population `O`oma could attract to the State and County.

Operating Revenues

Real Property Taxes (Exhibit 5-1)

`O`oma's most significant fiscal impact would be the higher real property taxes it would generate compared to those currently paid on the site. Net new real property taxes are based on the County's Fiscal Year 2007-2008 (FY08) rates for land and building uses of the relevant land use classifications.

Future assessed values will be based on the County assessors' estimates at a future time, and County standards of practice for establishing such values. For projection purposes, the following proxies are used:

- **Assessed values of the residential areas as improved** are based on an estimated average primary home sales price of $495,000, which is slightly higher than the overall figure shown previously in Exhibit 2-1. This is due to the exclusion of vacation or second homes from this mix, and the inclusion of custom improvements on a few of the estate lots.

  Vacation or second homes (those owned by non primary residents) are anticipated to have an average tax assessed value of $933,000, based on an assumed mix of units by type (multifamily, single-family and estate lots) and the addition of custom homes expected to be built on a share of the estate lots.

- **Assessed values of the unimproved residential areas** are based on comparison to FY08 tax assessed values per acre at Kaloko Heights, which is near to `O`oma in North Kona, and LUC Urban-designated with residential zoning. `O`oma's unimproved areas' assessed values are also based on a pro-rata share of `O`oma's residential lands assumed to remain undeveloped at any given time. This figure goes to $0 by 2030, since all homes are anticipated to be built by that date.

- **Assessed values of the commercial improvements** are estimated based on the estimated "hard" construction costs for the buildings, plus their tenant improvement costs, as presented previously in Exhibit 3-3.

- **Assessed values of the commercial lands** are based on comparison to currently assessed values for LUC Urban-designated, unimproved, zoned commercial sites at Kaloko Heights and in Keahuolū, both in North Kona.

Based on these inputs, `O`oma is estimated to have a tax assessed value of about $504.2 million in 2020, and $744.1 million by 2030, when it is assumed to be fully built-out.

County Real Property Tax Revenues (Exhibit 5-1)

Considering the estimated assessments and the current County real property taxation structure, `O`oma could support potential new real property taxes of up to $3.0 million by 2020 or $4.5 million per year by 2030 and thereafter.

Deductions from these figures include real property taxes currently paid for the subject lands, and an allowance for homeowner's exemptions.

On balance, `O`oma is projected to supply the County with about $2.5 million in net additional real property tax revenues in 2020, and $3.7 million on an on-going annual basis after its completion in 2030.

Total County Government Operating Revenues (Exhibit 5-2)

In addition to real property taxes, the County obtains liquid fuel taxes, license and permit fees and various other charges from residents and businesses. Based on the revenues reported by Hawai`i County for FY07, these minor County taxes and fees amount to about $277 per resident, in 2007 dollars. Applying this revenue rate to the number of persons expected to move to the County because of `O`oma yields a nominal amount of other new County revenues.[12]

Added to the real property taxes discussed above, net new taxes earned by the County as a result of `O`oma's development and operations are estimated at a total of $2.5 million in 2020 or $3.8 million per year by 2030 and thereafter.

These figures do not include impact and permit fees anticipated to be paid to the County during the development of `O`oma, nor the value of lands or improvements that may be dedicated to County agencies such as for parks and roads.

State Government Operating Revenues (Exhibits 5-3 and 5-4)

Additional operating revenues accruing to the State government are expected to derive principally from:

[12] The estimate excludes public service company taxes, public utility franchises taxes, investment earnings and other revenues noted as "miscellaneous." It includes charges for services; business and other permits, licenses and fees; and the fuel tax. County of Hawai`i, "Comprehensive Annual Financial Report: Fiscal Year Ended June 30, 2007," January 2008.

- GET applied to `O`oma's development expenditures, brokers' commissions, the in-State spending by its non primary residents and those employees who came from out of State.

- Individual income taxes paid by `O`oma's employees, including both its development- and operations-related employees.

- Other sources evaluated include income taxes on new personal earnings generated by `O`oma, and specific excise, licenses, fees, fines and other payments to the State made by those who move to Hawai`i because of `O`oma.

Assumptions on which the above sources are estimated are shown in Exhibit 5-3.

Exhibit 5-4 applies these assumptions and shows net new operating revenues for the State at some $2.6 million in 2020, or $2.8 million per year by 2030 and thereafter.

These projected State tax revenues are conservative in that they do not include:

- Potential income taxes from certain business operating incomes, including those that may be paid by the operating entity for `O`oma,

- Personal income tax on gratuities, bonuses or other earnings by `O`oma employees not accounted for herein,

- GET and income taxes that may be incurred on rental income earned by owners at `O`oma,

- Conveyance taxes on commercial space leasing,

- Conveyance taxes on the ongoing resales of residential and commercial properties within `O`oma, and

- State surcharges on motor and tour vehicles that could be rented by `O`oma's residents.

The figures cited also exclude fees and permits that may be paid to the State on behalf of `O`oma over the years of its development. Neither do they include the value of lands or improvements that may be dedicated to the State.

Operating Expenses

Per Capita Government Operating Expenditures (Exhibits 5-5 and 5-6)

Both State and County governments can be expected to incur additional operating expenses in supporting the in-migrants that are attracted by `O`oma. An analysis of the County's FY07 operating expenditures, net of Federal and State grants, suggests that the County spends some $1,490 per FTE resident per year, in 2007 dollars. These expenditures support functions ranging from public safety and highways to recreation, as well as County debt service and benefits for its employees.

A similar analysis of State government operating expenditures, based on data available for FY06, suggests that the State spends about $4,600 per year to support government operations on behalf of each FTE resident.

Additional County Government Operating Expenditures (Exhibit 5-7)

The per capita budgets derived above are applied to the counts of those anticipated to in-migrate to the County because of employment or housing opportunities at `O`oma. This results in an estimated $0.6 million in additional County government operating expenditures in 2030 and thereafter.

Additional State Government Operating Expenditures (Exhibit 5-8)

Employing an analogous methodology, the State could be expected to require up to $1.5 million more per year to support the net additional residents `O`oma could eventually attract, by 2030.

Net Fiscal Benefits (Exhibit 5-9)

Comparing the net new government operating revenues and expenditures discussed above yields projected net fiscal benefits for the County and State governments.

- **County government** operating revenues attributable to `O`oma are anticipated to exceed the additional operating expenses in both of the benchmark years evaluated. By `O`oma's stabilization in 2030, net additional operating revenues could represent some $3.2 million per year, for a revenue/expenditure ratio of about 6.0.

- **The State government's** operating revenues are also anticipated to exceed the additional operating expenses throughout `O`oma's development and operating periods. The State's net additional revenues are projected to amount to $1.4 million per year by project stabilization in 2030. New revenues to the State government could then represent about 1.9 times new State government operating expenditures.

Economic and Fiscal Impact Assessment for `O`oma Beachside Village

Exhibits

Exhibit 2-1
`O`oma Concept and Potential Development Timing
2010 to 2030

	Unit	Notes		2010-20	2021-30	Total
Highlights of period:				■ 2010-2012: infra-structure planning and development ■ 2012: first home sales ■ 2012: first commercial development	■`O`oma buildout by 2029 ■ 2029: final home sale	
Development in period:						
Residential unit completions/sales -		*Av. price:*	*Av. sales/year* [1]			
Finished homes (single & multifamily), market	*Sold homes*	*$540,000*	*49*	553	322	875
Estate lots, market	*Sold lots*	*$650,000*	*5*	85	0	85
Affordable homes (multifamily)[2]	*Sold homes*	*$271,000*	*13*	112	128	240
Subtotal, residential units/weighted average price		*$494,000*	*67*	750	450	1,200
Custom home development on estate lots (by lot buyers)	*50%* *90%*	*by end of first period* *by end of second period*		*43*	*34*	*77*
Commercial centers	*Gross leasable square feet*			100,000	100,000	200,000
Cumulative development by end of period:						
Residential unit completions/sales -						
Finished homes (single & multifamily), market	*Sold homes*			553	875	
Estate lots, market				85	85	
Affordable homes (multifamily)[2]	*Sold homes*			112	240	
Subtotal				750	1,200	
Custom home development on estate lots (by lot buyers)				*43*	77	
Commercial centers	*Gross leasable square feet*			100,000	200,000	

1 Average over entire project selling period; not necessarily the pace each product class is projected to sell at during its own marketing period.

2 Assumes 20% of total units and a 1:1 credit per County guidelines currently in effect. Actual credits could vary depending on affordable housing market segments and other factors to be agreed upon with the County, and such variation could change the affordable unit count. Estimated average price considers County's guidelines in effect as of May 1, 2007, as applicable to for-sale units for a family of four earning 110% to 130% of the County median family income; figure shown is that specified for the 120% of median family income family of four. Target markets and specific pricing to be determined in agreements to be established with the County.

Sources: `O`oma Beachside Village, LLC, 2007; Mikiko Corporation.

Exhibit 2-2
Buyer Origins and Residential Utilization Patterns
2020 and 2030

	Basis/reference	2020	2030
Usage assumptions:			
Market units-primary residences	*80% of sold market units*	510	768
Market units-non primary residences	*20% of sold market units*	128	192
Affordable units [1]	*100% of sold affordable units*	112	240
Total		750	1,200
Unit occupancy assumptions:			
Market units-primary residences	*Allowance for vacancy/transitions*	*95%*	*95%*
Market units-non primary residences	*Share of year spent on-island (increases as homes are built on estate lots)*	*20%*	*50%*
Affordable units	*Allowance for vacancy/transitions*	*95%*	*95%*
Utilization pattern:			
Average daily occupied units -	*Usage and occupancy assumptions*		
Market units-primary residences		485	730
Market units-non primary residences		26	96
Affordable units (all primary homes)		106	228
Total, rounded		**620**	**1,050**
Average daily persons in residence[2] -			
Market units-primary residences	*2.7 persons per occupied unit*	1,309	1,970
Market units-non primary residences	*2.8 persons per occupied unit*	71	269
Affordable units	*2.7 persons per occupied unit*	287	615
Total, rounded		**1,670**	**2,850**

1 Assumes 20% of total units and a 1:1 credit per County guidelines currently in effect. Actual credits could vary depending on affordable housing market segments and other factors to be agreed upon with the County, and such variation could change the affordable unit count.

2 Average household sizes for primary residents based on 2020 Island of Hawai`i figure as shown in Mikiko Corporation, "Market Assessment for `O`oma Beachside Village," December 2007, Exhibit 2-6. That for non primary residents based on interviews with selected comparison property brokers and developers.

Exhibit 3-1
Non Primary Resident Expenditures in Hawai`i: Average Annual
2020 and 2030 (2007 dollars, in millions, except as noted)

	Basis/reference (not in millions)		2020	2030
Bases for direct expenditures:				
Average household income	*Second & vacation home owners*	*$250,000*		
Percent of income spent on island[1]	*(See Exhibit 2-2):*	*25%*		
Persons per household	*(See Exhibit 2-2):*	*2.8*		
Projections:				
Direct expenditures	*Expenditure per FTE person:*	*$22,300*	$1.6	$6.0
Indirect & induced	*0.71 multiplier*[2]		$1.1	$4.3
Total			**$2.7**	**$10.3**

1 Based on estimated average spending on local consumption items of 53% of pre-tax income, weighted according to average occupancy of unit, as shown on prior exhibit. Spending allocation derived from figures shown in Department of Business, Economic Development and Tourism, State of Hawaii Data Book 2006, "Table 13.25, Average Annual Expenditures and Other Characteristics of Consumer Units, for Honolulu: 2000-2001 to 2004-2005," 2004-2005 figures, excluding shelter and personal insurance and pensions expenditures. DBEDT source references U.S. Bureau of Labor Statistics, Selected Western Metropolitan Statistical Areas: Average annual Expenditures and Characteristics, Consumer Expenditure Survey (annual.)

2 Based on estimates by Dr. Xijun Tian, DBEDT (personal communication, 4/18/1999). Considers weighted average visitors to Hawai`i and their expenditures as allocated to 118 industry categories as available in 1992 State Input-Output model by DBEDT.

Exhibit 3-2
Industry Coefficients and Multipliers for Development Activities

FINAL DEMAND INDUSTRY COEFFICIENTS[1]		Final demand coefficient per $1 million (2002$) project cost		
	DBEDT industrial categories applied	Jobs[2]	FTE factor[3]	$ Earnings[4]
Professional services	*#45-Architectural and engineering services*	10.31	0.80	0.63
Construction:				
Residential units	*#13-SF housing construction, and #14-Construction of other buildings*	7.99	0.87	0.40
Commercial facilities	*#14-Construction of other buildings*	8.41	0.87	0.44
Tenant improvements	*#14-Construction of other buildings*	8.41	0.87	0.44
Infrastructure	*#15-Heavy & civil engineering construction*	11.61	0.87	0.86
Other costs	*#42-Real estate, #44-Legal services, #40-Other finance and insurance*	8.55	0.80	0.52

DIRECT-EFFECT INDUSTRY MULTIPLIERS[5]		Indirect & induced multiplier per direct:	
	DBEDT industrial categories applied	FTE job	$ Earnings[4]
Professional services	*Same as above*	1.03	0.63
Construction:			
Residential units	*Same as above*	1.46	1.12
Commercial facilities	*Same as above*	1.42	1.05
Tenant improvements	*Same as above*	1.42	1.05
Infrastructure	*Same as above*	1.40	0.67
Other	*Same as above*	0.97	1.17

1 For direct impacts of development expenditures. Type I total jobs and earnings direct impact coefficients, from Hawai`i State Department of Business, Economic Development & Tourism, "The 2002 State Input-Output Study for Hawai`i," June 2006 (revised from May 2006), Detailed Tables. Jobs coefficients are for 2012; earnings coefficients not provided for future years.

2 **B**ased on final demand, total jobs multipliers from the Input-Output Study. Study estimates total wage, salaried and proprietary jobs, both full- and part-time (not full-time equivalent).

3 Adjustment factor applied in addition to the jobs coefficient to estimate full-time equivalent jobs at 40 hours per week. Factor derived from the 34.9 average weekly hours reported worked in the natural resources, mining and construction industries and 32.0 in professional & business services industries for the State of Hawai`i for 2007, as reported by Hawai`i Department of Labor and Industrial Relations, "Experimental All Employee Hours & Earnings," 3/28/2008, at www.hiwi.org, as accessed 4/1/2008.

4 Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance.

5 For indirect and induced impacts of respective direct impacts. Indirect and induced factors derived from Type II Direct-Effect total job/total job and earnings/earnings multipliers as shown in DBEDT, Ibid, "Job multipliers for 2012-2012" and "2002 Detailed Output, Earnings and Tax Multipliers for Hawaii."

Exhibit 3-3
Estimated Current Development Costs: Total for Each Period
2010 to 2030 (2007 and 2002 dollars, in millions unless stated)

	Basis/reference (not in mils unless stated)	**2010 2020**	**2021 2030**	**Total**
In 2007 dollars:				
Professional services[1]	*3% of construction excl. infrastructure, with 60% assumed expended by 2020*	$6.9	$4.6	$11.5
Construction -	*"Hard" costs, net of contingencies:*			
Production homes (affordable & market, SF and MF)	*1,110 sq. ft. at psf cost: $210*	$155.0	$104.9	$259.9
Custom homes (built by lot buyers)	*2,500 sq. ft. at psf cost: $400*	$42.5	$34.0	$76.5
Commercial facilities	*$160 per sq. ft. developed in period*	$16.0	$16.0	$32.0
Tenant improvements[2]	*$70 per sq. ft. developed in period*	$7.0	$7.0	$14.0
Infrastructure[3]	*$108.4 mil. total, of which 60% assumed expended by 2010*	$65.1	$43.4	$108.4
Subtotal		$285.6	$205.3	$490.8
Other	*10% of construction excl. infrastructure, distributed pro rata by number of years in period*	$20.0	$18.2	$38.2
Total, rounded		**$312.5**	**$228.1**	**$540.6**
In 2002 dollars:[4]	*72% of 2007 costs*			
Professional services		$5.0	$3.3	$8.3
Construction -				
Residential units		$142.2	$100.0	$242.2
Commercial facilities		$11.5	$11.5	$23.0
Tenant improvements		$5.0	$5.0	$10.1
Infrastructure		$46.8	$31.2	$78.1
Other		$14.4	$13.1	$27.5
Total, rounded		**$255.6**	**$188.7**	**$444.3**

Sources: \`O\`oma Beachside Village, LLC; brokers and developers of selected comparison projects; other sources as noted.

1 Planning, engineering and related for infrastructure and commercial and residential pad development; architectural, engineering and related for vertical developments.

2 Includes developer- and tenant-provided construction budgets.

3 M&E Pacific, Inc., estimated $100,500,000 in 2006 dollars (est. May 2007). Inflated based on DBEDT estimate for 2006-2007 construction cost change of 7.9% based on the Honolulu Construction Cost Index: Single Family Residence (Quarterly Statistical and Economic Report, 1Q 2008, published February 26, 2008; Table E-6.) Cost estimate includes site preparation, roadways, drainage, sewer and water systems, and utilities stubbed to development pads on-site, plus frontage road/highway connection and water and utilities off-site. Excludes landscaping, parks and related equipment, beachfront improvements, community pavilion and contingencies.

4 Construction cost deflator from DBEDT, single-family residence construction cost indices from First Hawaiian Bank and DBEDT, see citation above.

Exhibit 3-4
Estimated Current Development Costs: Average Annual
2010 to 2030 (2007 dollars, in millions)

	Basis/reference	2010 2020	2021 2030	Overall average
Costs by type:	*Exhibit 3-3, annualized*			
Professional services		$0.6	$0.5	$0.5
Construction -				
Residential units		$14.1	$10.5	$12.4
Commercial facilities		$1.5	$1.6	$1.5
FF&E/Tenant improvements[1]		$0.6	$0.7	$0.7
Infrastructure[2]		$5.9	$4.3	$5.2
Other		$1.8	$1.8	$1.8
Total, rounded		**$28.4**	**$22.8**	**$25.7**

1 Includes developer- and tenant-provided construction budgets.

2 Excludes landscaping, parks and related equipment, beachfront improvements, community pavilion and contingencies.

Exhibit 3-5
Development Employment: FTE Jobs[1]
2010 to 2030 (Total in each period)

	Basis/reference	2010 2020	2021 2030	Total/ average
Total:				
Direct jobs -	*Exhibits 3-2 and 3-3*			
Professional services		41	27	68
Construction -				
Residential units		988	695	1,684
Commercial facilities		84	84	169
FF&E/Tenant improvements[2]		37	37	74
Infrastructure[3]		473	315	789
Other		99	90	188
Subtotal direct jobs (rounded)		1,700	1,200	3,000
Indirect and induced jobs[4]	*Exhibit 3-2*	2,416	1,744	4,160
Total jobs (rounded)		**4,100**	**2,900**	**7,200**
Average annual:				
Direct jobs -				
Professional services		4	3	3
Construction[2,3]		144	113	129
Other		9	9	9
Subtotal direct jobs (rounded)		**160**	**120**	**140**
Indirect and induced jobs[4]		220	174	198
Total jobs (rounded)		**380**	**290**	**340**

1 FTE = Full time equivalent, defined as 40 hours per week or 2,080 hours per year.

2 Includes employees supported by developer- and tenant-provided construction activities.

3 Excludes landscaping, parks and related equipment, beachfront improvements, community pavilion and contingencies.

4 Based on weighted average of Direct-Effect jobs multipliers for each job category, as shown on Exhibit 3-2.

Exhibit 3-6
Personal Earnings from Development: Total in Period
2010 to 2030 (2007 dollars, in millions)

	Basis/reference	2010 2020	2021 2030	Total
Direct earnings[1]:	*Exhibits 3-2 & 3-3*			
Professional services		$3.0	$2.0	$5.1
Construction -				
Residential units		$60.2	$42.3	$102.5
Commercial facilities		$5.4	$5.4	$10.7
FF&E/Tenant improvements[2]		$2.3	$2.3	$4.7
Infrastructure[3]		$42.7	$28.4	$71.1
Other		$7.3	$6.6	$13.9
Subtotal, direct		**$120.9**	**$87.1**	**$208.0**
Indirect and induced earnings[4]		$114.5	$83.6	$198.0
Total earnings		**$235.3**	**$170.7**	**$406.0**

Note: Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance.

1 Based on industry coefficients and FTE factors as shown in Exhibit 3-2 and estimated construction costs in 2002 dollars, as shown in Exhibit 3-3. Figures inflated to estimated 2007 dollars based on change in Honolulu CPI-U from 2002 to 2007, at: 21.7% as obtained from U.S. Department of Labor, Bureau of Labor Statistics, http://data.bls.gov/PDQ, as accessed April 3, 2008.

2 Includes earnings supported by developer- and tenant-provided construction activities.

3 Excludes landscaping, parks and related equipment, beachfront improvements, community recreation facilities.

4 Weighted average of estimated direct earnings by industry as shown above, and Direct-Effect industry multipliers shown in Exhibit 3-2.

Exhibit 3-7
Personal Earnings from Development: Average Annual
2010 to 2030 (2007 dollars, in millions except average earnings)

	Basis/reference		2010 2020	2021 2030	Average
Average annual in period:	*Exhibit 3-6, refers to all jobs*				
Direct earnings			$11.0	$8.7	$9.9
Indirect & induced earnings			$10.4	$8.4	$9.4
Total earnings			**$21.4**	**$17.1**	**$19.3**
Average per new FTE job:	*Exhibits 3-5 and 3-6, rounded*				
Direct jobs			$71,000	$73,000	$69,000
Indirect and induced jobs			$47,000	$48,000	$48,000
Average per job			**$57,000**	**$59,000**	**$56,000**
Estimated household income[1]:	*1.3*	*times average wage*			
For direct job-holders			$92,000	$95,000	$90,000
For indirect and induced job-holders			$61,000	$62,000	$62,000
All `O`oma-related job-holders			**$74,000**	**$77,000**	**$73,000**
Percent of County median income[2]:	*$58,200*	*for a family of four, as applicable to affordable housing guidelines*			
For direct job-holders			158%	163%	155%
For indirect and induced job-holders			105%	107%	107%
All `O`oma-related job-holders			**127%**	**132%**	**125%**

Note: Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance.

1 Ratio estimated from 2006 average Hawai`i County earnings for full-time, year-round workers with earnings ($45,284) and 2006 average Hawai`i County household income ($60,912). Earnings as provided by U.S. Census Bureau, 2006 American Community Survey, "S2001: Earnings in the Past 12 Months;" household income estimated by Claritas, Inc., February, 2007. Multiplier reflects multiple job-holders within each family as well as multiple job-holding by individuals.

2 Median income based on 2006 figures from U.S. Department of Housing & Urban Development, for a family of four, as provided by the County of Hawai`i. This income level used in County affordable housing guidelines effective May 1, 2007.

Exhibit 3-8
Direct Operational Employment Generated by Facilities at `O`oma: New FTE Jobs
2020 and 2030

	Basis/reference		2020	2030
On-site:				
Commercial retail/office	*425*	*square feet GLA per FTE job*	235	471
Other associated jobs:				
Residential and commercial leasing and sales	See Exhibit 3-9		14	10
Total direct jobs associated with `O`oma, rounded			**250**	**480**

Note: Excludes employees at public or community facilities on-site, such as at the school and parks; also excludes service providers to private homes.

Exhibit 3-9
Net Additional Operational Employment:
Net Additional FTE Jobs[1]

2020 and 2030 (2007 dollars, in millions)

	Basis/reference		2020	2030
Bases for projection:				
Av. annual spending by non primary residents		*Direct, indirect & induced, in state: Exhibit 3-1*	*$2.7*	*$10.3*
Av. annual residential selling costs		*See Exhibit 3-1*		
Sell-out of developer inventory	*2.0%*	*of gross sales, preceding years*[2]	*$0.8*	*$0.5*
Resales after 2020	*3.5%* *6.0%*	*Turnover per year*[3] *of gross sales, same av. price*	*$0.0*	*$0.1*
Av. annual commercial leasing expenses -		*Listor & outside brokers' commissions plus sales & marketing expenses*		
Initial lease-up	*$1.4*	*mil total, listing & outside agents*	*$0.2*	*$0.1*
Releasing after 2020	*5.0%*	*Turnover per year*	*$0.0*	*$0.0*
Projected net additional jobs:				
Direct -				
Attributable to non primary residents[4]	*23.0*	*/$mil, net margin: 35%*	22	82
Real estate leasing & sales	*14.0*	*/$mil selling costs, new and resales*	14	10
Subtotal, direct jobs, rounded			**40**	**90**
Indirect and induced -		*Multiplier and industry category applied*[5]*:*		
Attributable to non primary residents	*1.07*	*Average of select industries*	23	88
Real estate leasing & sales	*1.91*	*Real estate & rentals industries*	26	19
Subtotal, indirect & induced jobs, rounded			50	110
Total net additional jobs			**90**	**200**

1 FTE = Full time equivalent, defined as 40 hours per week or 2,080 hours per year.

2 Assumes 2% inside commissions; no outside commissions.

3 From 2020 on, resales activity assumed at 3.5% of completed and sold residential inventory shown in Exhibit 2-1. Resales factor based on 2006 Hawai`i Island activity of 2,833 units vs. estimated 75,185 total housing units (3.8%): University of Hawai`i Economic Research Organization, April 3, 2008 and American Community Survey, September 12, 2007; also considers 2002 sales of 2,640 homes vs. housing inventory of 65,703 (4.0%). Housing inventories for both sampled years as reported by DBEDT. Commissions and other selling costs estimated at rate shown and average prices shown in Exhibit 2-1.

4 Category includes shopping center and office operational employment, since net additional employment is largely considered a function of induced new spending on-island, not leasable area to be developed at `O`oma. Also spending by existing island residents, such as at the commercial centers to be developed, is assumed to have occurred elsewhere on-island even if `O`oma were not developed.
Retail spending subject to reduction by 35% assumed retail trade margin prior to application of weighted average Type II jobs multiplier shown in Appendix 2.
This results in conservative estimates since DBEDT multipliers for many applicable industry categories such as services, agriculture, food processing & etc. are calculated assuming they will be applied to total expenditures rather than trade margin expenditures.

5 Based on Type II Direct-Effect Multipliers (less 1.0 each) as shown by industry groups in Appendix 2. Non primary residents based on all industries shown.

Exhibit 3-10
Personal Earnings from Net Additional Operational Activity: Total Annual

2020 and 2030 (2007 dollars, in millions except where noted)

	Basis/reference (not in millions)	2020	2030
Direct earnings -	*Estimated average FTE salary or other basis:*		
Attributable to non primary residents	*$47,400 Average Hawai`i Island earnings* [1]	$1.0	$3.9
Av. annual commercial leasing -	Residential & commercial properties, Ex. 3-9		
Initial lease-up		$0.2	$0.1
Releasing after 2020		$0.0	$0.0
Real estate sales & marketing -	Residential & commercial properties, Ex. 3-9		
Sell out of developed inventory		$0.8	$0.5
On-going resales after 2020		$0.0	$0.1
Subtotal, direct earnings		**$2.0**	**$4.6**
Indirect and induced earnings -	*Multiplier and industry category* [2]*:*		
Attributable to non primary residents	*1.01 Average of select industries*	$1.0	$3.9
Real estate leasing and sales	*3.07 Real estate & rentals industries*	$3.0	$2.2
Subtotal, indirect & induced		$4.1	$6.1
Total earnings		**$6.1**	**$10.8**

Note: Exhibit portrays on those earnings on positions that would be new to the Island; not on all employment associated with `O`oma.

1 Exclusive of tips, bonuses, etc. Mean earnings for full-time, year-round workers with earnings of $45,284 in 2006, as reported by U.S. Census Bureau, 2006 American Community Survey, with inflation to 2007 dollars based on 4.75% change in Honolulu CPI-U from 2006 to 2007, as reported by U.S. Department of Labor, Bureau of Labor Statistics, http://data.bls.gov/PDQ, as accessed April 3, 2008.

2 Based on Type II Direct-Effect Multipliers (less 1.0 each) as shown by industry groups in Appendix 2. Non primary residents based on all industries shown.

Exhibit 3-11
Personal Earnings from Net Additional Operational Activity: Average Per Job and Household
2020 and 2030 (2007 dollars)

		Basis/reference	2020	2030
Average earnings per net additional FTE job:		*Not in millions*		
Direct jobs			$50,000	$51,000
Indirect and induced jobs			$81,000	$56,000
Average per job			**$67,000**	**$54,000**
Estimated household income[1]:	*1.3*	*times average wage*		
For direct job-holders			$65,000	$66,000
For indirect and induced job-holders			$105,000	$73,000
All `O`oma-related job-holders			**$87,000**	**$70,000**
Percent of County median income[2]:	*$58,200*	*for a family of four, as applicable to affordable housing guidelines*		
For direct job-holders			112%	113%
For indirect and induced job-holders			180%	125%
All `O`oma-related job-holders			**149%**	**120%**

Note: Exhibit portrays earnings on positions that would be new to the Island; not on all employment associated with `O`oma.

Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance.

1 Ratio estimated from 2006 average Hawai`i County earnings for full-time, year-round workers with earnings ($45,284) and 2006 average Hawai`i County household income ($60,912). Earnings as provided by U.S. Census Bureau, 2006 American Community Survey, "S2001: Earnings in the Past 12 Months;" household income estimated by Claritas, Inc., February, 2007. Multiplier reflects multiple job-holders within each family as well as multiple job-holding by individuals.

2 Median income based on 2006 figures from U.S. Department of Housing & Urban Development, for a family of four, as provided by the County of Hawai`i. This income level used in County affordable housing guidelines effective May 1, 2007.

Exhibit 4-1
Average Daily In-Migrant Population
2020 and 2030

	Basis/reference	2020	2030
`O`oma non primary residents:			
Average FTE persons in residence	*At non primary resident units: Exhibit 2-2*	71	269
In-migrants to State (rounded)	*90% of FTE persons in residence*	60	240
In-migrants to Co. (rounded)[1]	*100% of FTE persons in residence*	70	270
Employees:			
In-migrants to the State[1] -	*(Subset of in-migrants to County)*		
Development employees	*5% of direct av. annual jobs (Ex. 3-5)*	8	6
Direct operational employees	*8% of jobs generated (Exhibit 3-8)*	20	38
Dependents[2]	*Ratio of in-migrant employees*	22	40
In-migrants to State (rounded)[3]		50	80
In-migrants to County[3] -	*(Includes in-migrants to State)*		
Development employees	*10% of direct av. annual jobs (Ex. 3-5)*	16	12
Operational employees	*15% of jobs generated (Exhibit 3-8)*	38	72
Dependents[2]	*Ratio of in-migrant employees*	41	74
In-migrants to County (rounded)[3]		90	160
Total population impact (average daily):	*Non primary residents (FTE), employees and their dependents*		
To State		**110**	**320**
To County		**160**	**430**

1 Subset of County in-migrants. See footnote 3, below.

2 In-migrant dependents estimated to average 0.2 per in-migrant development employee, and 1.0 per in-migrant operational employee.

3 In-migrants to the County include all those moving to the State plus any that may move between islands due to job opportunities at `O`oma.

Exhibit 5-1
Real Property Taxes Generated by Development
2020 and 2030 (2007 dollars, in millions except as noted)

	Basis/reference (not in millions)			2020	2030
Total assessed values:					
Improved primary residences[1]	*1,008*	*units @ av. value:*	*$495,000*	$308.1	$499.0
Improved second/vacation homes[1]	*192*	*units @ av. value:*	*$933,000*	$119.1	$179.1
Unimproved residential[2]		*Estimated assessed value per acre:*	*$40,000*	$2.6	$0.0
Commercial - land[2]	*20*	*acres, @ per acre:*	*$450,000*	$9.0	$9.0
Commercial - improvements		*Vert. cost (Ex. 3-3) + share of TI @*	*100%*	$23.0	$23.0
Parks, recreation center & other[3]		*Not estimated*		$0.0	$0.0
Total assessed values				**$504.2**	**$744.1**
Real property tax revenues:					
Potential new revenues -		*FY08 rates per $1,000 net taxable value*			
Improved primary residences	*$5.55*	*Homeowner*		$1.7	$2.8
Improved second/vacation homes	*$8.10*	*Improved Residential; Apartment*		$1.0	$1.5
Unimproved residential	*$8.10*	*Unimproved Residential*		$0.0	$0.0
Commercial - land	*$9.00*	*Commercial*		$0.1	$0.1
Commercial - improvements	*$9.00*	*Commercial*		$0.2	$0.2
Subtotal, potential tax revenues				$3.0	$4.5
Less deductions -					
RPT payments prior to \`O\`oma	*$45,000*	*FY08, per \`O\`oma Beachside Village, LLC*		$0.0	$0.0
Homeowner's exemption[4]	*$132,000*	*average/unit, primary residences*		$0.5	$0.7
Subtotal deductions				$0.5	$0.8
Estimated net additional RPT				**$2.5**	**$3.7**

Note: Figures exclude real property tax impacts of public facility lands such as schools, parks and roads presumed to be dedicated but not taxed.

1 Average values differ from those shown in Exhibit 2-1 because they include owner-built improvements on the estate lots and because they combine the three product types in different mixes, in order to represent primary vs. second/vacation home owner properties.

2 Tax assessed values for unimproved lands based on other lands of similar classification in North Kona. Undeveloped residential areas estimated pro rata based on the number of units sold and a total of 173 acres in residential use, for a total value of: $6,920,000 Includes 127 acres planned exclusively for residential uses plus share o 66 acres proposed for mixed uses within the Villages; the latter area allocated for tax estimation purposes as follows: 20 acres for commercial and 46 acres for residential uses.

3 Taxes on parks, roads, trails, recreation center, school and open spaces not estimated as they are assumed to be exempt (if publicly owned) and/or taxed at a negligible rate.

4 Assumes 75% of primary resident household heads are less than 60, qualifying for a $120,000 exemption, 15% are aged 60 to 69, qualifying for a $160,000 exemption, and 10% are aged 70 or more, for a $180,000 homeowner's exemption. Exemptions likely overstated and thus tax collections understated because affordable housing units would not be able to achieve the full "additional exemption" of $80,000 that is based on 20% of assessed value. Exemption levels based on rules stated in County of Hawai\`i, Real Property Tax Division, "Explanation of the Real Property Tax Homeowner Exemption," revised January 2006, at www.hawaiipropertytax.com, as accessed April 3, 2008. Age distribution based on 2007 estimates for population aged 25 and older, for CTs 215.01, 217.01 and the County of Hawai\`i, base data provided by Claritas, Inc., November 2007.

Exhibit 5-2
Total Annual Revenues to County Government
Attributable to Development & In-Migrant Population
2020 and 2030 (2007 dollars, in millions, except as noted)

	Basis/reference (not in millions)	2020	2030
Bases for projection:			
FTE in-migrants to County -	*Exhibit 4-1*		
`O`oma non primary residents		*70*	*270*
Employees and their dependents		*90*	*160*
Estimated tax and other revenues:			
Net new property tax revenues	*Exhibit 5-1*	$2.5	$3.7
Taxes and other revenue sources from in-migrant residents[1]	*Other than real property taxes* *$277 per resident*	$0.0	$0.1
Total new County revenues		**$2.5**	**$3.8**

Note: Does not consider impact and permit fees that may be paid to the County.

1 Includes fuel tax, licenses and permits and charges for services. Excludes public service company tax, public utility franchise tax, investment earnings and miscellaneous. As stated in County of Hawai`i, "Comprehensive Annual Financial Report: Fiscal Year Ended June 30, 2007," January 2008.

Exhibit 5-3
Bases for Projecting State Government Revenues
2020 and 2030 (2007 dollars, in millions, except as noted)

	Basis/reference		2020	2030
For GET calculations:				
\`O\`oma development costs -	*Exhibit 3-4, average annual for preceding period*			
Professional services			$0.6	$0.5
Construction and other			$27.8	$22.3
Subtotal development cost			$28.4	$22.8
Real estate sales & marketing costs -	*Based on average activity in prior 5 years*			
Residential	*New and resold units, Exhibit 3-9*		$0.8	$0.6
Commercial	*Leasing revenue, Exhibit 3-9*		$0.2	$0.1
Subtotal			$1.0	$0.7
Spending by non primary residents	*In-State spending: Exhibit 3-9*		$2.7	$10.3
In-migrant employees & dependents to State -				
Number persons	*Exhibit 4-1*		50	80
Estimated number households	*2.5 persons per household*		20	32
In-State spending by hhds[1]	*58% of average of earnings per development and operational job (below)*		$0.7	$1.0
For individual income taxes:				
Net new personal income earned -	*Average annual in preceding period*			
Development employment	*Exhibit 3-7 (total personal earnings)*		$21.4	$17.1
Operational employment	*Exhibit 3-10 (total personal earnings)*		$6.1	$10.8
Av. personal earnings/FTE job -				
Development employment	*Exhibit 3-7 (total personal earnings)*	*Not in millions >>*	$57,000	$59,000
Operational employment	*Exhibit 3-10 (total personal earnings)*	*Not in millions >>*	$67,000	$54,000
For other State taxes:				
FTE in-migrants to State	*FTE non primary residents, employees and their dependents Exhibit 4-1*		110	320

Note: Does not consider impact and permit fees that may be paid to the State.

1 U.S. Department of Labor, Bureau of Labor Statistics, "Consumer Spending Patterns in Honolulu: 2001-02", released April 30, 2004 at www.bls.gov/ro9/cexhono.htm. Estimate uses study findings showing 77.6% of pre-tax income of household units was spent, of which 75.1% were on items likely subject to Hawai\`i Gross Excise Tax. Excludes spending on shelter (owned dwellings), cash contributions, personal insurance and pensions. Applied to estimated in-migrant households and average of personal earnings for 2020 and 2030 for operational employees, as shown. Excludes potential household income from other household members.

Exhibit 5-4
Projected State Government Revenues
2020 and 2030 (2007 dollars, in millions, except as noted)

	Basis/reference (not in millions)				2020	2030
General excise taxes, on:						
Development[1]					$0.7	$0.6
Real estate sales and marketing	*4.0%*	*of costs*			$0.0	$0.0
Spending by `O`oma's non primary residents	*4.0%*	*of spending*			$0.1	$0.4
Spending by in-migrants to State	*4.0%*	*of employee & dependent spending*			$0.0	$0.0
Individual income taxes[2]:						
Development employees	*6.1%*	*effective tax rate on av. family income*			$1.3	$1.0
	estimated at	*$62,000*	*as shown in Ex. 3-7*			
Operational employees	*6.1%*	*effective tax rate on av. family income*			$0.4	$0.7
	estimated at	*$60,000*	*as shown in Ex. 3-11*			
Other taxes and revenues from in-migrants[3]	*$222*	*per person*			$0.0	$0.1
Total, additional revenues					**$2.6**	**$2.8**

Note: Does not consider impact and permit fees that may be paid to the State.

1 Based on 4% on 100% of professional services and 60% of construction costs, plus a wholesale construction materials tax of 0.5% against 40% of construction costs.

2 Based on 2007 Tax Tables, for married taxpayers filing joint returns and range of average personal earnings per job shown in prior exhibits noted. Adjusted Gross Incomes (AGI) assumed to be 15% less than total average earnings shown. Estimated tax impact likely to be conservative due to frequency of dual incomes and multiple job-holding among Hawai`i households, which could push household incomes to higher tax brackets.

3 Based on total FY 2006 State tax revenue receipts as reported by State of Hawai`i, "Comprehensive Annual Financial Report for the Fiscal Year Ended June 30, 2006," statement of activities-general revenue taxes. Includes tobacco and liquor taxes, liquid fuel tax, and motor vehicle weight & registration tax. Excludes fines & forfeitures, licenses and other fees. Figures inflated to 2007 dollars.

Exhibit 5-5
Hawai`i County Governmental Expenditures
Net of Intergovernmental Revenues (State and Federal)
Per Capita in Fiscal Year July 1, 2006 to June 30, 2007

	Expenditures ($thousands)	Service population[1]	Expenditures (not in thousands) per: Resident	Visitor
Governmental funds:				
General Government	$37,651	193,500	$195	$195
Public Safety	$93,241	193,500	$482	$482
Highways and Streets	$14,033	193,500	$73	$73
Sanitation	$31,817	193,500	$164	$164
Health, Education & Welfare	$21,470	171,200	$125	$0
Culture and Recreation	$17,118	193,500	$88	$88
Pension and Retirement Contributions	$21,796	171,200	$127	$0
Employees' Health Insurance	$16,941	171,200	$99	$0
Miscellaneous	$5,108	193,500	$26	$26
Debt Service (principal & interest)	$25,970	193,500	$134	$134
Capital Outlays	$52,285	193,500	$270	$270
Less: Intergovernmental revenues (Federal and State)	($63,599)	193,500	($329)	($329)
Subtotal	$273,831		$1,456	$1,104
Proprietary funds:				
Kulaimano Elderly Housing Project	$277	171,200	$2	$0
`O`uli Ekahi Affordable Housing Project	$317	171,200	$2	$0
Less: Federal rental subsidy	($134)	171,200	($1)	$0
Subtotal	$460		$3	$0
Total, in 2006-2007 dollars	$274,291		$1,458	$1,104
Total, in 2007 dollars, rounded, based on increase of[2]	2.3%		**$1,490**	**$1,130**

Note: Line items may also have debt service and employee benefit expenses within each, but exclude depreciation.

1 Resident population as of January 1, 2007 estimated based on July 1 estimates from U.S. Census Bureau, Federal-State Cooperative Program for Population Estimates, as reported by State of Hawai`i, DBEDT, March 2008; de facto population estimated based on 2005 and 2006 ratios of de facto to resident population, as also reported by DBEDT.

2 Based on annual 2007 Honolulu CPI-U vs. average of 2nd half 2006 and 1st half 2007 CPI-U, as reported by U.S. Department of Labor, Bureau of Labor Statistics at http://data.bls.gov, accessed April 3, 2008.

Source: County of Hawai`i, "Comprehensive Annual Financial Report: Fiscal Year Ended June 30, 2007," January 2008.

Exhibit 5-6
State of Hawai`i Governmental Expenditures
Net of Intergovernmental Revenues (Federal)
Per Capita in Fiscal Year July 1, 2005 to June 30, 2006

	Operating expenditures ($thousands)	Service population[1]	Expenditures (not in thousands) per: Resident	Visitor
Governmental funds:				
General Government	$493,301	1,393,000	$354	$354
Public Safety	$322,578	1,393,000	$232	$232
Highways	$267,213	1,393,000	$192	$192
Conservation of Natural Resources	$86,628	1,393,000	$62	$62
Health	$685,679	1,393,000	$492	$492
Welfare	$1,709,810	1,273,100	$1,343	$0
Lower Education	$1,984,129	1,273,100	$1,559	$0
Higher Education	$678,338	1,273,100	$533	$0
Other Education	$19,183	1,273,100	$15	$0
Culture and Recreation	$87,478	1,393,000	$63	$63
Urban Redevelopment and Housing	$60,725	1,273,100	$48	$0
Economic Development and Assistance	$215,559	1,273,100	$169	$0
Other	$4,634	1,273,100	$4	$4
Debt service	$447,577	1,393,000	$321	$321
Less: Intergovernmental revenues	($1,601,005)	1,393,000	($1,149)	($1,149)
Subtotal	$5,461,827		$4,237	$570
Proprietary funds:				
Airports	$175,884	1,393,000	$126	$126
Harbors	$38,224	1,393,000	$27	$27
Unemployment compensation	$105,786	1,273,100	$83	$0
Nonmajor proprietary fund	$2,587	1,393,000	$2	$2
Less: Federal grants to Airports Division	($7,750)	1,393,000	($6)	($6)
Subtotal	$314,731		$233	$150
Total, in 2005-2006 dollars	**$5,776,558**		**$4,470**	**$720**
Total, in 2007 dollars, rounded, based on increase of[2]	3.0%		**$4,600**	**$740**

Note: Figures include legislative expenses; line items may also have debt service and employee benefit expenses within each. They exclude depreciation and expenses of "Component Units" including the University of Hawai`i, Housing and Community Development Corporation of Hawai`i, Hawai`i Health Systems Corporation and Hawai`i Hurricane Relief Fund. The first three charge for services, and receive capital and operating grants and contributions.

1 Resident and de facto populations as of January 1, 2006 estimated based on July 1 estimates from U.S. Census Bureau, Federal-State Cooperative Program for Population Estimates, as reported by State of Hawai`i, DBEDT, March 2008.

2 Based on annual 2007 Honolulu CPI-U vs. average of 2nd half 2005 and 1st half 2006 CPI-U, as reported by U.S. Department of Labor, Bureau of Labor Statistics at http://data.bls.gov, accessed April 3, 2008.

Source: State of Hawai`i, Department of Accounting and General Services, "State of Hawai`i: Comprehensive Annual Financial Report For the Fiscal Year Ended June 30, 2006," 2007.

Exhibit 5-7
Annual County Government Expenditures
Attributable to Population In-Migrating
2020 and 2030 (2007 dollars, in millions, except where noted)

	Basis/reference (not in millions)			2020	2030
Bases for County projection -					
FTE in-migrants to County	*Non primary residents, employees and dependents (Ex. 4-1)*			*160*	*430*
Annual expenditures -					
FTE in-migrants to County	*$1,490*	*per person, ref:*	*Exhibit 5-5*	$0.2	$0.6
Subtotal new County expenditures				**$0.2**	**$0.6**

Exhibit 5-8
Annual State Government Expenditures
Attributable to Population In-migrating
2020 and 2030 (2007 dollars, in millions, except where noted)

	Basis/reference (not in millions)	2020	2030
Bases for State projection -			
FTE in-migrants to State	*Non primary residents, employees and dependents (Ex. 4-1)*	*110*	*320*
Annual expenditures -			
FTE in-migrants to State	*$4,600 per FTE person, ref: Exhibit 5-6*	$0.5	$1.5
Subtotal new State expenditures		**$0.5**	**$1.5**

Exhibit 5-9
County & State Government Revenue and Expenditure Comparison
2020 and 2030 (2007 dollars, in millions)

	Basis/reference	2020	2030
County of Hawai`i:			
New revenues	*Exhibit 5-2*	$2.5	$3.8
New expenditures	*Exhibit 5-7*	$0.2	$0.6
Net additional revenues		$2.3	$3.2
Revenue ÷ expenditure ratio[1]		**10.6**	**6.0**
State of Hawai`i:			
New revenues[2]	*Exhibit 5-4*	$2.6	$2.8
New expenditures	*Exhibit 5-8*	$0.5	$1.5
Net additional revenues		$2.1	$1.4
Revenue ÷ expenditure ratio[1]		**5.2**	**1.9**

N/A - Not applicable.

Note: Other than school impact fees, does not consider applicable impact and permit fees to be paid to County and State governments. These could include sewer, water, transportation and other fees and permits.

1 New revenues divided by new expenditures. Calculated where denominator (additional expenses) exceeds zero.

2 Excludes potential income taxes from any operating entities, GET on ground lease rents and applicable government permit and impact fees that may be paid.

Economic and Fiscal Impact Assessment for `O`oma Beachside Village

Appendices

Appendix 1: Report Conditions

This assessment incorporates information provided by government agencies, developers, brokers, landowners, `O`oma Beachside Village, LLC, PBR HAWAII, and other sources as cited in the exhibits. While attempts have been made to verify information via multiple sources, it is not always possible to do so. MC cannot guarantee the accuracy of all information upon which its assessments may be based.

MC has no responsibility to update this report or any of the underlying data for events and circumstances occurring after April 4, 2008, the date of substantial completion of primary data collection.

This report is for the planning purposes of `O`oma Beachside Village, LLC, PBR HAWAII and their consultants, as well as for public disclosure of the nature of `O`oma pursuant to seeking State and County land entitlements. It is not intended to be used for solicitation of investment.

This report does not offer an appraisal of the Subject, nor should it be construed as an opinion of value for `O`oma.

Appendix 2: Derivation of Multipliers for Part-Time Resident Spending

	Type II final demand multipliers		Type II final demand effect multipliers (for indirect & induced impacts	
	Earnings	**Job**	**Earnings**	**Job**
Agriculture	0.66	36.6	1.77	1.44
Food processing	0.51	21.6	3.05	3.05
Other manufacturing	0.34	10.2	1.97	2.36
Transportation	0.57	17.7	2.26	2.55
Information	0.52	13.6	1.71	2.15
Utilities	0.33	8.2	2.38	4.17
Wholesale trade	0.55	17.1	1.76	1.96
Retail trade	0.57	24.4	1.69	1.51
Real estate & rentals	0.22	9.1	4.07	2.91
Professional services	0.81	23.3	1.69	1.97
Business services	0.83	30.9	1.69	1.62
Educational services	0.83	33.2	1.70	1.57
Health services	0.77	24.1	1.71	1.91
Arts & entertainment	0.77	37.4	1.59	1.38
Accommodations	0.63	20.0	1.90	2.06
Eating & drinking	0.60	30.5	1.99	1.54
Other services	0.69	30.7	1.80	1.54
Government	0.85	24.7	1.40	1.54
Average	**0.61**	**23.0**	**2.01**	**2.07**

Source: State of Hawai`i, Department of Business, Economic Development and Tourism, "The 2002 State Input-Output Study for Hawaii," June 2006 (as revised from May 2006), Table 2.4.