~~Draft~~ Final Supplemental Environmental Impact Statement for

TURTLE BAY RESORT EXPANSION

Portions of Ahupuaʻa O ʻŌpana-Kawela, Ahupuaʻa O Hanakaʻoe, and Ahupuaʻa O Kahuku, Koʻolau Loa District, Island of Oʻahu

Volume Four of Four

PREPARED FOR TURTLE BAY RESORT, LLC by LEE SICHTER LLC • ~~NOVEMBER 2012~~ JULY 2013

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F. Flora and Fauna Impact Assessment
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M. Trip Generation Survey Report

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APPENDIX F:

FLORA AND FAUNA IMPACT ASSESSMENT

F

Biological Surveys Conducted in Support of a Supplemental Environmental Impact Statement For the Turtle Bay Resort, Kahuku District, Island of O'ahu

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Introduction

Turtle Bay Resort, LLC (TBR) is preparing a Supplemental Environmental Impact Statement (SEIS) updating their original EIS, which was prepared in 1985. The SEIS will cover all of the lands included in the original EIS plus the following three additional areas:

• Approximately 11 acres immediately south of Turtle Bay Hotel and immediately east of Ocean Villas. These lands are owned by TBR but were excluded from the 1985 EIS,
• A former *kuleana* of approximately 4 acres on the eastern boundary of the Turtle Bay Lands classified as State Agricultural District (TMK 5-6-003:033). (This parcel, now owned by TBR, was excluded from the 1985 EIS),
• Approximately 11 acres east of the Turtle Bay Lands. These lands constitute the Marconi Road ROW Lands and are currently owned by Cottonwood Development LLC, Marconi Point LLC, and the Estate of James Campbell.

This report describes the methods used and the results of the botanical, avian and mammalian surveys conducted on the subject property as part of the environmental disclosure process associated with the proposed project.

The primary purpose of the surveys was to determine if there are any botanical, avian or mammalian species currently listed, or proposed for listing under either federal or State of Hawai'i endangered species statutes within or adjacent to the study area. The federal and State of Hawai'i listed species status follows species identified in the following referenced documents, (Department of Land and Natural Resources (DLNR) 1998; U. S. Fish & Wildlife Service (USFWS) 2005a, 2005b, 2011). Fieldwork was conducted on March 23 and 24, 2011 and then repeated on September 19 and 20, 2011. Turtle Bay Resort, LLC will use the information in this report to evaluate the extent to which its proposed resort expansion plans may impact any endangered species (either current or proposed for listing) identified on the SEIS lands.

Hawaiian and scientific names are italicized in the text. A glossary of technical terms and acronyms used in the document, which may be unfamiliar to the reader, are included at the end of the narrative text.

General Site Description

The approximately 842 acres of land included in the SEIS lands are owned by Turtle Bay Resort, LLC (with the exception of the Marconi Road ROW Lands discussed above), and located *makai* of Kamehameha Highway, extending from the highway to the ocean, and laterally between Marconi Road (formerly known as the Kahuku Airport Road) on the east and the mid-point of Kawela Bay on the west (Figure 1). We did not survey the existing Turtle Bay Hotel grounds for avian or mammalian resources, though the botanist did make a cursory walkthrough of the grounds. We also did not survey the adjacent Ocean Villas, or Kuilima Estates, essentially the areas demarcated on Figure 1 in white.

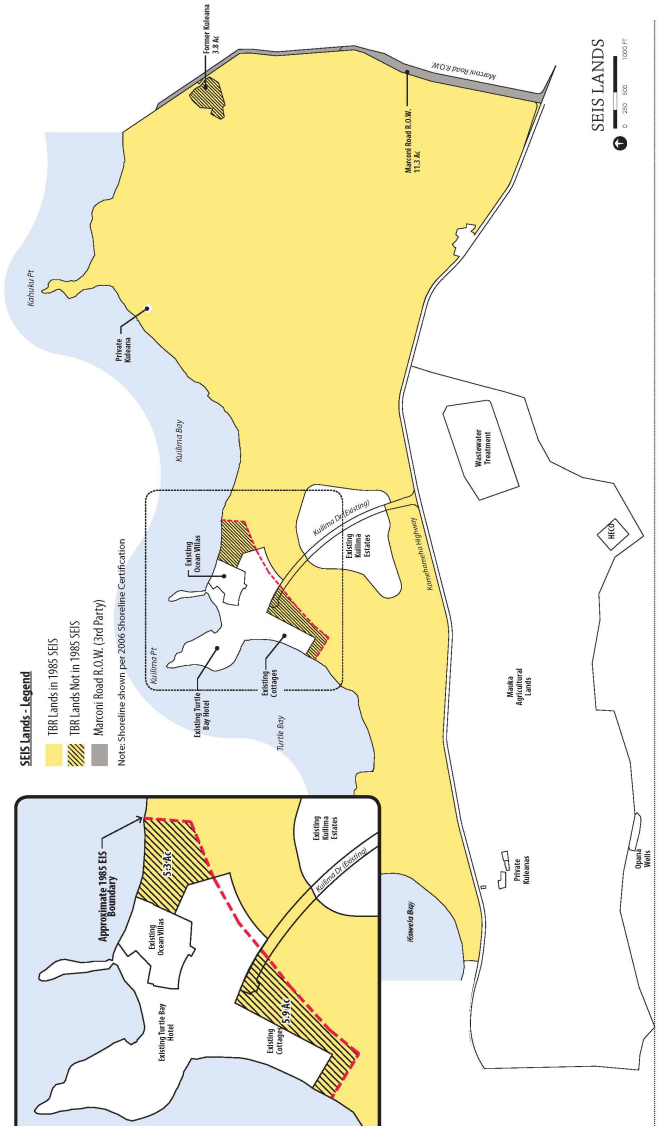

Figure 1- Turtle Bay SEIS Lands

The lands are located within three *ahpuaa'a*. From west to east these are *na ahupua'a O 'Ōpana Kawela, Hanaka'oe* and *Kahuku*. TBR lands extend inland from the shoreline between 150 meters at Kawela Bay and 2000 meters at the southern terminus along Marconi Road.

The SEIS Lands can be generally characterized as a disturbed area that has been subjected to development and redevelopment since the late 1700s. The first written descriptions of the area date back to 1779 when Captain Charles Clerke and Lieutenant James King of the HMS Resolution described the area of Kahuku Point as fine and fertile and occupied by a large village (Cook and King, 1784). Subsequent to the decline of the Hawaiian population in the area, the SEIS Lands were converted to a sheep and cattle ranch.

Records indicate that in 1873, Kahuku Ranch included all of the SEIS Lands; and scattered remains of the ranch have been found in the vicinity of Punaho`olapa Marsh. By the 1880s the land was transformed from cattle ranching to sugar cane cultivation (Figure 2). In 1889, construction of the O'ahu Railway and Land Company's railroad linking Kahuku to other parts of O`ahu began The rail line was officially opened in 1899 and its right-of-way crossed the SEIS Lands, passing through Punaho`olapa Marsh.

The coastal plains around Kahuku Point were again dramatically transformed during the course of World War II. Land modification activities included the construction of concrete bunkers, asphalt runways, and large soil/sand revetments along with barracks and numerous other buildings. After the war, beach cottages were constructed along the shoreline, especially in the area of Kawela Bay and Kawela Point. The portions of the SEIS lands cultivated in cane eventually turned fallow with the closure of the Oahu Sugar Company.

In the early 1970s, the Kuilima Resort opened and the SEIS Lands were transformed once again with the development of the original Kulima Resort Hotel, residential condominiums, an 18-hole golf course and a wastewater treatment plant (Figure 2).

In the late-1980s, the residential cottages along Kawela Point and the eastern half of Kawela Bay were demolished, structural fill was brought in, and construction of the foundations for a new multi-story hotel structure began. The structure was never completed, but underground utilities and concrete piles remain today. During this period the 18-hole Palmer Golf Course was built and the Fazio Golf Course was reduced to 9-holes. Punaho'olapa Marsh was enhanced by the construction of a moat around much of its perimeter. The original wastewater treatment plant was decommissioned after a more modern facility was constructed *mauka* of Kamehameha Highway. Around 2002 the Fazio Golf Course was expanded back to an 18-hole golf course.

The present-day vegetation of the site can be characterized as either developed landscape plantings (all hotel/resort grounds and appurtenances, and golf courses) or naturalized, non-native scrub and forest on previously disturbed lands. Areas of wetland vegetation are also extensive. Forming coastal strand and dune vegetation zones occur along most coastal

portions of the site. For the most part, the dune vegetation is also dominated by non-native, naturalized species and merges inland with either inland scrub/forest or landscaping. In contrast, the most seaward part of the coastal strand, and an area of active dunes at the east end of the SEIS lands, support a native strand vegetation.

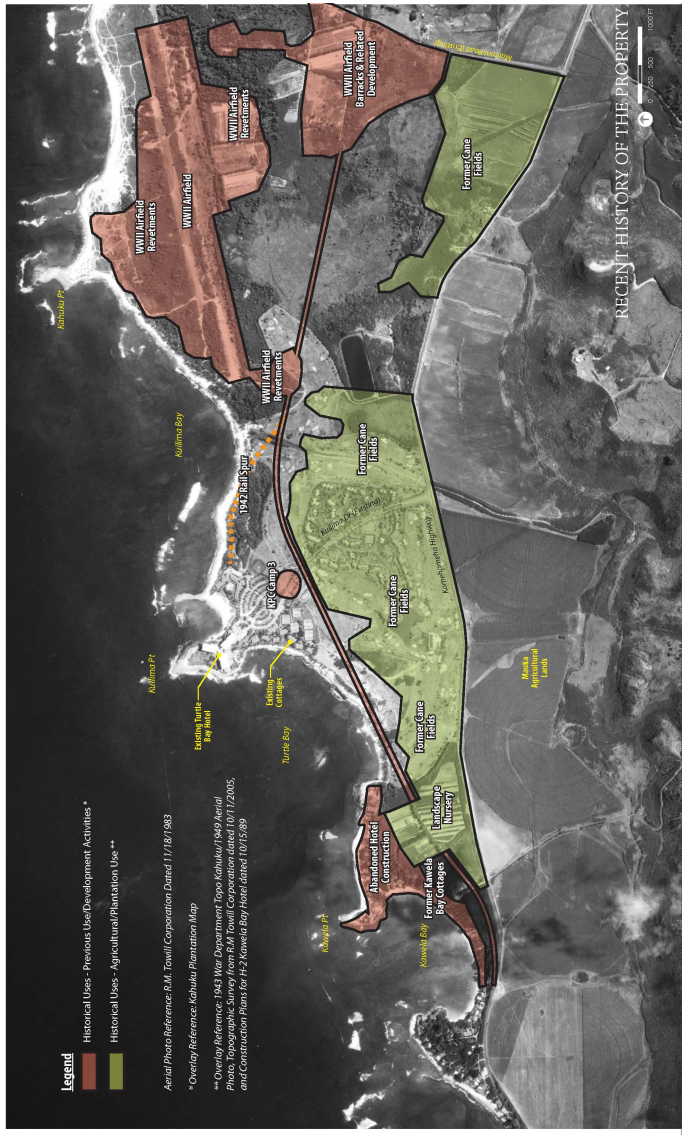

Figure 2- Turtle Bay Recent History of the Property

Methods

Plant names mostly follow *Manual of the Flowering Plants of Hawai'i* (Wagner *et al*., 1990, 1999) for native and naturalized flowering plants, Palmer (2003) for ferns, and *A Tropical Garden Flora* (Staples and Herbst, 2005) for crop and ornamental plants. Some plant species names have been updated following more recently published literature. The avian phylogenetic order and nomenclature used in this report follows the *AOU Check-List of North American Birds* (American Ornithologists' Union, 1998), and the 42nd through the 52nd supplements to the Check-List (American Ornithologists' Union, 2000; Banks et al., 2002, 2003, 2004, 2005, 2006, 2007, 2008; Chesser *et al*., 2009, 2010, 2011). Mammal scientific names follow (Tomich, 1986). Place names follow (Pukui *et al*., 1974).

Botanical Survey Methods

The botanical survey was undertaken twice: a wet season survey on March 23-24, 2011 and a dry season survey on September 19-20, 2011. The two surveys were conducted independent of each other, which is to say the second survey was conducted without reference to any notes (or species list) generated by the first survey. The surveys both utilized a pedestrian (walking) transect methodology to cover the project area. Guided by a real-time, GPS tracking record, the botanist attempted to cover all parts of the site and to visit all areas representing various vegetation types and environments supporting plants. As the walking survey progressed, a list of all higher plants (ferns, conifers, and flowering plants) encountered was recorded in field notes, along with a sense of the relative abundance of each species overall or within various vegetation types.

This approach is vastly superior to using more rigorous quantitative transects when the primary purpose is to characterize the flora and discover the presence of normally rare, listed species or native species having resource value. In essence, by recording all plants encountered, the resulting flora (plant species) listing provides information useful to characterize the nature of botanical resources present, including species that now or perhaps in the future may be of interest or concern from a variety of perspectives, such as native plant protection, listed species, occurrence of invasive species, etc. Completeness of the listing is partly dependent upon the actual proportion of the land covered. It is neither reasonable nor necessary to cover 100 percent of an area by traversing continuously until every possible location is viewed. Utilizing ever-changing view planes and the fact that species occur in populations of individuals that form a repeating mosaic within environment types enables the botanist to direct the survey track into all areas of the site that hold promise of yielding species not encountered earlier in a survey; and this process is repeated until no new species are being added to the field notes. Thus, very rare species represented by one or just a few individuals in area as large as the SEIS lands could be missed. But certainly the vast majority of species present will be "discovered."

One result of conducting two "independent" field visits is to provide a cross check on the completeness of the surveys, although in this case, conducting one survey (March 2011) near the end of the wet season and the other (September 2011) near the end of the dry

season was more for the purpose of demonstrating that seasonal factors were covered. Much of the site consists of vegetation that is highly tolerant of extended dry conditions, so plants not seen due to the season would be annual species surviving as seeds in the soil. Finding native shrubs or trees would not be dependent upon the season, as these species are persistent and recognizable in both the wet and dry periods.

Avian Survey Methods

Point Counts

Twenty avian count stations were sited within the project site. Stations were roughly equidistant from each other. A single eight-minute avian point count was made at each count station. The same methodology was repeated during the fall survey. Field observations were made with the aid of Leica 10 X 42 binoculars and by listening for vocalizations. The point counts were conducted between 6:30 am and 11:00 am. Time not spent counting the point count stations was used to search the rest of the SEIS lands for species and habitats not detected during the point counts.

Time Dependant Waterbird Counts

Fifteen minute, time dependant waterbird counts were made at all of the water features located within the golf courses, and a set of thirty minute time dependant waterbird counts were made around and within Punahoʻolapa Marsh.

Mammalian Survey Methods

With the exception of the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), or *ʻōpeʻapeʻa* as it is known locally, all terrestrial mammals currently found on the Island of Oʻahu are alien species, and most are ubiquitous. The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign. A running tally was kept of all terrestrial vertebrate mammalian species detected within the project area during the time spent on the site.

Results

Botanical Surveys, Flora

"Flora" is the diversity of plant species living in the survey area. A plant checklist (Table 1) was compiled from field observations, with entries arranged alphabetically under plant family names (standard practice). Included in the list are scientific name, common name, and status (whether native or non-native) for each species observed during the survey. Species status given in **bold** indicates a plant of particular interest to the Hawaiian Islands flora (indigenous, endemic, or Polynesian introduction). Qualitative estimates of plant abundance were recorded for each species on each survey date, and within the vegetation type indicated in the "notes" column. Abundance values are coded in the table as explained in the Legend to Table 1. For some species, a two-level system of abundance is used; with a letter-number code indicating a species having a somewhat clustered distribution. For example, a species infrequently encountered but numerous where found would have an abundance rating of "R" indicating a plant encountered only one to three times during the entire survey of the site, but an "R2" to indicate several to many individuals present where encountered. An "R3" would be a plant similarly seldom encountered (i.e., rare), but locally abundant in one or more of the locations where encountered. A species marked "O3" would be one seen with some regularity, usually occurring in patches of numerous individuals (as opposed to "C" for a species seen with regularity throughout the vegetation zone). As with any system attempting to ascribe abundance, the task becomes increasingly difficult where spread across a large area of constantly varying terrain.

A total of 226 species of vascular plants was identified from the survey area. This total number is certainly high, although the SEIS lands represent a large area with a variety of different environments. Forty-five or one-fifth (20 percent) of the tabulated species are ornamentals (**Orn**), meaning landscape plants that have not become naturalized in Hawaiʻi. A much higher percentage are actually serving landscape purposes at Turtle Bay Resort, since many naturalized species are also used for landscaping; once a plant introduced for landscaping escapes into the wild or naturalizes, it's status changes to naturalized (**Nat**). Eighty-two of the species (36 percent) in Table 1 were recorded in the "landscape" vegetation type (note <4>); that is, were observed either around the develop resort buildings and appurtenances or around the golf courses. Given the nature of this vegetation type, these species are either weeds or plants serving an ornamental function.

Twenty-six of the species (11.5 percent) are Hawaiian natives, indicated under the status column as either indigenous (**Ind**) or endemic (**End**). Another 8 species (3.5 percent) are early Polynesian introductions (**Pol**), technically not native, but so-called "canoe plants" that have been in the Islands for several thousand years. A majority (18 of 26 species or 8 percent of total species) of the indigenous and endemic species occur in the wetland and coastal strand vegetation, which is why these two environments are botanically the most sensitive in the SEIS lands. Only four native species were recorded within the developed lands or landscape vegetation areas. Another five Polynesian introductions—typically

thought of as Hawaiian native plants due to their association with native peoples and long presence in the Islands—are found in the landscaped areas surveyed.

Of course, percentages based upon total species recorded can be misleading without considering a sense of abundance. In this regard, plants such as *hala* (*Pananus tectorius*), *naupaka* (*Scaevola taccada*), and *niu* (coconut or *Cocos nucifera*) are prominent species in the landscaping, within the resort. The same is true for the wetland and the most seaward part of the strand vegetation, where natives tend to dominate (see below).

Comparison between wet and dry season surveys can be made, although interpreting these results is tricky. It is not entirely the case that the differences between the two species lists represents plants present in one season and not present in the other. A total of 45 species were recorded in March ("wet season") and not later observed in September ("dry season"). For the September listing, 33 species had not been previously observed on the SEIS lands in March. The higher number in March appears to be mostly ruderal species that might be expected to be more prominent under wetter conditions. All but seven of the 45 species were recorded either within the landscaped or disturbed areas (notes <3> and <4>) of the property. Two of the seven are forest vines seen only once each in the March survey; one an indigenous species: *kā'e'e* (*Mucuna gigantea*). Three other native, indigenous species were missed in September: *pā'ū-o-Hi'iaka* (*Jacquemontia ovalifolia*), recorded as rare in a disturbed area previously; *moa* (*Psilotum nudum*) recorded from a single plant seen in the landscaping in March; and *'uhaloa* (*Waltheria indica*), a ruderal species that should have been seen, was uncommon in March.

Only thirteen of the 33 species recorded in September but not in March were from environments other than landscaped areas or highly disturbed areas. These were mostly weedy or non-characteristic species in the strand or wetland environments (notes <1> and <2>). Two indigenous species recorded in September were missed (or not present) in the previous, March survey. One, *pōhinahina* (*Vitex rotundifolia*) was only seen as a landscape bedding plant in September. The other, the sedge *'ahu'awa* (*Mariscus javanicus*), is a wetland plant noted as rare in September; and *'uhaloa* (*Waltheria indica*) should have been seen, although was uncommon in March.

Because the Turtle Bay Hotel grounds were included in both surveys only in passing—species encountered were recorded, but no attempt was made to be thorough around the buildings—differences in the species list are to be expected from this area: 17 species of ornamentals were recorded in only one or the other survey, 22 percent of the recorded once species. Clearly, these are plants that are not present or absent due to the season, but missed as a result of the route taken by the botanist around the grounds.

With but a few exceptions, the plants missed in one survey or the other, were recorded as (mostly) rare or uncommon when seen. The exceptions include a couple of grasses and

weedy species associated with mowed lawns. Grasses can be missed if not in flower at the time of the survey. Nephthytis (*Syngonium* sp.), elephant grass (*Pennisetum purpureum*), pitted beardgrass (*Bothriochloa pertusa*), narrow-leaved carpetgrass (*Axonopus fisifolius*) and prostrate indigo (*Indigofera hendecaphyla*) were each recorded as present in numbers greater than rare or uncommon in one survey, but still missed in the other survey.

Table 1 - Checklist of Plants Found in SEIS Lands at the Turtle Bay Resort, O'ahu, Hawai'I

FAMILY		STATUS	ABUNDANCE		NOTES
Species	**Common name**		**Wet Season**	**Dry Season**	
PTERIDOPHYTES ~ FERNS & FERN ALLIES					
NEPHROLEPIDACEAE					
Nephrolepis multiflora (Roxb.) F.M. Jarrett ex C.V. Morton	sword fern	Nat	U	---	<4>
POLYPODIACEAE					
Phymatosorus grossus (Langsd. & Fisch.) Brownlie	*laua'e*	Nat	R, R3	U2, U2	<4, 5>
PSILOTACEAE					
Psilotum nudum (L.) P. Beauv.	*moa*	**Ind**	R	---	<4>
THELYPTERIDACEAE					
Cyclosorus interruptus (Wild.) H. Itō	*neke*	Nat	O3	O3	<2>
GYMNOSPERMS					
ARAUCARIACEAE					
Araucaria columnaris (G. Forster) J.D. Hoiok..	Cook Island pine	Nat	U3	U3	<1>
FLOWERING PLANTS					
DICOTYLEDONS					
ACANTHACEAE					
Aphilandra squarrosa C. Nees	zebra plant	Orn	R	R	<4>
Asystasia gangetica (L.) T. Anderson	Chinese violet	Nat	R, U, C	R,U,O	<1, 4, 5>
Barlaria repens C. Nees	pink –ruellia	Nat	R1	--	<3>
Pseuderanthemum carruthersii var. *carruthersii* (Seemann) Guill.	---	Orn	R	R	<4>
AIZOACEAE					
Sesuvium portulacastrum (L.) L.	*'akulikuli*	**Ind**	O2, U	O,	<1, 3>
Tetragonia tetragonioides (Pall.) Kuntze	New Zealand spinach	Nat	U, U	O3, R	<1, 5>
AMARANTHACEAE					
Alternanthera pungens Kunth	khaki weed	Nat	R	U	
Ameranthus spinosus L.	spiny amaranth	Nat	R	R	<1>
Amaranthus viridis L.	slender amaranth	Nat	U	U	<3>
ANACARDIACEAE					
Schinus terebinthifolius Raddi	Christmas berry	Nat	O	O	<5>

Table 1 (continued).

FAMILY		STATUS	ABUNDANCE		NOTES
Species	**Common name**		**Wet Season**	**Dry Season**	
APIACEAE					
Centella asiatica (L.) Urb.	Asiatic pennywort	Nat	--	R	<2>
Ciclospermum leptophyllum (Pers.) Sprague	fir-leaved celery	Nat	R	--	<3>
Hydrocotyle sibthorpioides Lam.	pennywort	Nat	R	--	<4>
APOCYNACEAE					
Nerium oleander L.	oleander	Orn	U	U	<4>
Plumeria obtusa L.	Singapore plumeria	Orn	R	R	<4>
Plumeria rubra L.	frangipani	Orn	U	O	<4>
Thevetia peruviana (Pers.) K. Schum.	be-still tree	Nat	R3	U	<4>
ARALIACEAE					
Schefflera actinophyla (Endl.) Harms	octopus tree	Nat	U	U	<4>
Polyscias guilfoylei (W. Bull.) L.H. Bailey	panax	Orn	U	U	<5>
ASTERACEAE (COMPOSITAE)					
Ageratina riparia (Regel) R. King & H. Robinson	*Hāmākua pāumakani*	Nat	R	--	<3>
Bidens alba (L.) DC	beggartick	Nat	C3, C, O2	C1, C, U	<1, 3, 4>
Calyptocarpus vialis Less.	---	Nat	U2, U2	O, O	<3, 4>
Conyza bonariensis (L.) Cronq.	hairy horseweed	Nat	R	C	<3>
Cyanthillium cinereum (L.) H. Rob.	little ironweed	Nat	--	R	<3>
Eclipta prostrata (L.) L.	false daisy	Nat	R, --	--, U3	<4, 5>
Emilia fosbergii Nicolson	Flora's paintbrush	Nat	U	R	<3>
Pluchea carolinensis (Jacq.) G. Don	sourbush	Nat	C	O	<5>
Pluchea indica (L.) Less.	Indian fleabane	Nat	O, O, C	U, C, U	<2, 3, 5>
Pluchea x fosbergii Cooperr. & Galang	pluchea hybrid	Nat	O	R	<2>
Sonchus oleraceus L.	sow thistle	Nat	O, O3	--, R	<1, 3>
Sphagneticola trilobata (L.) Pruski	wedelia	Nat	C1, U, U	--, --, O	<1, 2, 3>
Verbesina encelioides (Cav.) Benth. & Hook.	golden crown-beard	Nat	U3	C	<1>
Xanthium strumarium L.	kīkānia, cocklebur	Nat	--	R	<3>
Youngia japonica (L.) DC	Oriental hawksbeard	Nat	R	--	<4>
BALSAMINACEAE					
Impatiens walleriana J. D. Hook.	busy lizzy	Nat	--	R	<4>
BIGNONIACEAE					
Spathodea campanulata P. Beauv.	African tulip tree	Nat	R	--	<4>

Table 1 (continued).

FAMILY		STATUS	ABUNDANCE		NOTES
Species	**Common name**		**Wet Season**	**Dry Season**	
Tabebuia heterophylla (A.P. de Candolle) Britton	pink tecoma	Orn	R	R	<4>
BALSAMINACEAE					
Impatiens walleriana J. D. Hook.	busy lizzy	Nat	--	R	<4>
BIGNONIACEAE					
Spathodea campanulata P. Beauv.	African tulip tree	Nat	R	--	<4>
Tabebuia heterophylla (A.P. de Candolle) Britton	pink tecoma	Orn	R	R	<4>
BORAGINACEAE					
Cordia subcordata Lam.	*kou*	**Ind**	R	R	<4>
Heliotropium anomalum Hook. & Arnott	*hinahina*	**Ind**	O	O	<1>
Tournefortia argentea L. fil.	tree heliotrope	Nat	C	C	<1>
BRASSICACEAE					
Lepidium virginicum L.	common pepperwort	Nat	--	U	<1>
CACTACEAE					
Hylocereus undatus (Haw.) Britt. & Rose	night-blooming cereus	Nat	R	R2	<5>
CAPRIFOLIACEAE					
Lonicera japonica Thunb.	Japanese honeysuckle	Orn	R	---	<4>
CARICACEAE					
Carica papaya L.	papaya	Nat	R	R	<5>
CARYOPHYLLACEAE					
Spergularia marina (L.) Griseb.	saltmarsh sand spurry	Nat	R	--	<3>
CASUARINACEAE					
Casuarina equisetifolia L.	common ironwood	Nat	AA, U, A	AA, U, C	<1, 2, 5>
CHENOPODIACEAE					
Chenopodium murale L.	*'aheahea*	Nat	U2, R	U, --	<1, 3>
CLUSIACEAE					
Calophyllum inophyllum L.	*kamani*	**Pol**	R	R	<5>
Clusia rosea Jacq.	autograph tree	Nat	R	R	<4>
COMBRETACEAE					
Conocarpus erectus L.	button mangrove	Orn	R	R	<4>
Terminalia catappa L.	tropical almond; false *kamani*	Nat	U	O	<1>
CONVOLVULACEAE					
Ipomoea alba L.	moon flower, *koali pehu*	Nat	R	--	<5>
Ipomoea obscura	---	Nat	U	U	<3>

Table 1 (continued).

FAMILY		STATUS	ABUNDANCE		NOTES
Species	**Common name**		**Wet Season**	**Dry Season**	
CONVOLVULACEAE (continued)					
Ipomoea pes-caprae (L.) R. Br.	*pōhuehue*	Nat	U	O	<1>
Ipomoea triloba L.	little bell	Nat	R	U	<3>
Jacquemontia ovalifolia (Choisy) H. Hallier	*pā'ū-o-Hi'iaka*	**Ind**	R	---	<3>
CUCURBITACEAE					
Coccinia grandis (L.) Voigt	ivy or scarlet-fruited gourd	Nat	O, O	R, --	<1, 4>
Momordica charantia L.	wild bitter melon	Nat	--	R	<3>
EUPHORBIACEAE					
Acalypha hispida N.L. Burm.	chenille plant	Orn	--	R	<4>
Aleurites moluccana (L.) Wild.	*kukui*	**Pol**	R	R	<4>
Codiaeum variegatum (L.) Blume	croton	Orn	R	R	<4>
Euphorbia albomarginata Torr. & A. Grey	rattlesnake weed	Nat	R	U	<3>
Euphorbia degneri (Sherff) Croizat & Degener	*'akoko*	**End**	O2	O1	<1>
Euphorbia hirta L.	garden spurge	Nat	U	O	<1>
Euphorbia hypericifolia L.	graceful spurge	Nat	U	O	<3>
Macaranga tanarius (L.) Müll. Arg.	---	Nat	C	U	<5>
Manihot esculenta Crantz	cassava	Orn	R	---	<4>
Phyllanthus debilis Klein ex Willd.	niruri	Nat	U	O	<3>
Ricinus communis L.	castor bean	Nat	U	U	<3>
FABACEAE					
Albizia saman F. Muell.	monkeypod	Nat	R	R	<4>
Alysicarpus vaginalis (L.) DC	alyce clover	Nat	U	U1	<4>
Canavalia cathartica Thouars	*maunaloa*	Nat	R	U	<5>
Crotalaria incana L.	fuzzy rattlebod	Nat	--	U	<3>
Desmanthus pernambucanus (L.) Theilung	virgate mimosa	Nat	O3	U	<3>
Erythrina variegata L.	Indian coral tree	Nat	R	R	<4>
Indigofera hendecaphyla Jacq.	prostrate indigo	Nat	--	O	
Indigofera suffruticosa Mill.	indigo	Nat	R	R	<3>
Leucaena leucocephala (Lam.) deWit	koa haole	Nat	U, AA	O, AA	<1, 5>
Macroptilium atropurpureum (DC) Urb.	---	Nat	R	---	<3>
Macroptilium lathyroides (L.) Urb.	cow pea	Nat	R	U	<3>
Medicago polymorpha L.	bur clover	Nat	R	--	<1>
Melilotis indica (L.) All.	yellow sweet clover	Nat	R	R	<3>

Table 1 (continued).

FAMILY		STATUS	ABUNDANCE		NOTES
Species	**Common name**		**Wet Season**	**Dry Season**	
FABACEAE (Continued)					
Mimosa pudica L.	sensitive plant	Nat	U	U	<3>
Mucuna gigantea (Willd.) DC	sea bean, *kāʻeʻe*	**Ind**	R	---	<5>
Neonotonia wightii (Wight & Arnott) Lackey	glycine vine	Nat	U3, O	U2,	<3, 5>
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	*kiawe*	Nat	R	U	<4>
Senna surattensis (N.L. Burm.) H. Irwin & Barneby	scrambled egg plant, *kolomona*	Nat	R	---	<1>
Sesbania grandiflora (L.) Poir.	sesban; *ʻohai keʻokeʻo*	Orn	---	R	<4>
Vigna marina (J. Burm.) Merr.	beach pea	**Ind**	U	U1	<1>
GOODINACEAE					
Scaevola taccada (J. Gaertn.) Roxb.	*naupaka kahakai*	**Ind**	C	C	<1>
LAMIACEAE					
Leonotis nepetifolia (L.) R. Br.	lion's ear	Nat	U	O	<3>
LOGANIACEAE					
Fagraea berteroana Benth.	*pua kenikeni*	Orn	R	--	<4>
MALVACEAE					
Abutilon grandifolium (Willd.) Sweet	hairy abutilon	Nat	R	--	<5>
Hibiscus rosa-sinensis L.	Chinese hibiscus	Orn	U	U	<4>
Hibiscus tiliaceus L.	*hau*	**Ind**	U1	---	<5>
Hibiscus tiliaceus var. cf. *purpurascens*	*hau* cultivar	Orn	R	R	<4>
Malva parviflora L.	cheeseweed	Nat	R1	--	<3>
Malvastrum coromandelianum (L.) Garcke	false mallow	Nat	R, U	--, --	<1, 3>
Sida ciliaris L.	---	Nat	U	O	
Sida rhombifolia L.	Cuba jute	Nat	R	---	<3>
Sida spinosa L.	prickly sida	Nat	R	R	<3>
Thespesia populnea (L.) Sol. ex Corrêa	milo	Ind	U, O3	O, O	<1, 5>
MORACEAE					
Ficus elastica Horn.	India rubber tree	Orn	R	R	<5>
Ficus macrophylla Pers.	Moreton Bay fig	Orn	R	R	<4>
Ficus microcarpa L.	Chinese banyan	Nat	R	U	<4>
MORINGACEAE					
Moringa oleifera Lam.	horseradish tree	Orn	R	R	<4>

Table 1 (continued).

FAMILY		STATUS	ABUNDANCE		NOTES
Species	**Common name**		**Wet Season**	**Dry Season**	
MYRSINACEAE					
Ardisia elliptica Thunb.	shoe-button ardisia	Nat	R	R1	<5>
MYRTACEAE					
Psidium guajava L.	common guava	Nat	--	R	<5>
Syzigium cumini (L.) Skeels	Java plum	Nat	U	U	<5>
NYCTAGINACEAE					
Boerhavia coccinea Mill.	false *alena*	Nat	U	O	<3>
Boerhavia repens L.	*alena*	**Ind**	C	O	<1>
Bougainvillea spectabilis Wild.	bougainvillea	Orn	U	U	<4>
Mirabilis jalapa L.	marvel of Peru, four-o'clock	Nat	--	R	<5>
ONAGRACEAE					
Ludwigia octovalvus (Jacq.) Raven	primrose willowl	**Pol**	--	R	<2>
OXALIDACEAE					
Oxalis corniculata L.	yellow wood sorrel	**Ind**	O, U	U, --	<1, 5>
Oxalis debilis var. *corymbosa* (A.P. de Candolle) Lour.	pink wood sorrel	Orn	R	--	<4>
PASSIFLORACEAE					
Passiflora foetida L.	love-in-a-mist	Nat	--	U	<1>
Passiflora suberosa L.	wild passionfruit	Nat	O, R, U	U, --, U3	<1, 3, 5>
PHYTOLACCACEAE					
Rivina humilis L.	coral berry	Nat	O3	R	<5>
PITTOSPORACEAE					
Pittosporum sp.	---	Orn	R	--	<4>
PLANTAGINACEAE					
Plantago lanceolata L.	nrw-lvd plantain	Nat	U2	O	<1>
Plantago major L.	common plantain	Nat	O	O	<3>
POLYGONACEAE					
Antigonon leptopus Hook. & Arnott	Mexican creeper	Nat	R		<5>
Coccoloba uvifera (L.) L.	sea grape	Nat	U2, R	U, R	<1, 5>

Table 1 (continued).

FAMILY		STATUS	ABUNDANCE		NOTES
Species	**Common name**		**Wet Season**	**Dry Season**	
PORTULACACEAE					
Portulaca oleracea L.	pig weed	Nat	R	U	<1>
Portulaca pilosa L.	---	Nat	--	R	<3>
PRIMULACCACEAE					
Anagallis arvensis L.	scarlet pimpernel	Nat	R	---	<3>
RHIZOPHORACEAE					
Rhizophora mangle	American mangrove	Nat	--	R	<2>
ROSACEAE					
Rhaphiolepis umbellata (Thunb.) Makino	Yeddo hawthorn	Orn	R1	R1	<4>
RUBIACEAE					
Gardenia cf. *augusta* (L.) Merr.	gardenia	Orn	---	R	<4>
Gardenia taitensis A.P. de Candolle	tiare, Tahitian gardenia	Orn	R	---	<4>
Morinda citrifolia L.	*noni*	**Pol**	R, O	U, O	<4, 5>
Spermacoce assurgens Ruiz & Pav.	buttonweed	Nat	U	--	<3>
RUTACEAE					
Murraya paniculata (L.) W. Jack	mock orange	Orn	U	U	<4>
SCROPHULARIACEAE					
Bacopa monnieri (L.) Penell	*ʻaeʻae*	**Ind**	U	U	<2>
SOLANACEAE					
Lycium sandwicense A. Gray	*ʻōhelo kai*	**Ind**	R	R	<1>
Solanum americanum Mill.	*pōpolo*	**Ind**	U2	R	<3>
Solanum lycopersicum var. *cerasiforme* (Dunal) Spooner, G.J Anderson, & R.K. Jansen	cherry tomato	Nat	R	--	<3>
Solanum torvum Sw.	---	Nat	R	--	<3>
STERCULIACEAE					
Waltheria indica L.	*ʻuhaloa*	**Ind**	U	--	<3>
ULMACEAE					
Trema orientalis (L.) Blume	gunpowder tree	Nat	R	R	<5>

Table 1 (continued).

FAMILY		STATUS	ABUNDANCE		NOTES
Species	**Common name**		**Wet Season**	**Dry Season**	
VERBENACEAE					
Citharexylum spinosum L.	fiddlewood	Nat	--	R	<4>
Lantana camara L.	lantana	Nat	R	--	<1>
Stachytarpheta australis		Nat	--	U	<3>
Stachytarpheta jamaicense		Nat	R	R	<3>
Verbena litoralis Kunth	*ōwī*	Nat	--	R	<1>
Vitex rotundifolia L. fil.	*pōhinahina*	**Ind**	--	U	<4>
	MONOCOTYLEDONES				
AGAVACEAE					
Cordyline fruticosa (L.) A. Chev.	ti, *ki*	**Pol**	U	O	<4>
Furcraea foetida (L.) Haw.	Mauritius hemp	Nat	R?	R	<1>
Sansevieria trifasciata Prain	mother-in-law tongue	Orn	U2	U2	<5>
ARACEAE					
Epipremnum pinnatum ʻAureumʼ G.S. Bunting	pothos	Nat	R, R3	--, U	<1, 4>
Monstera delicosa Liebmann	monstera	Orn	R	R	<4>
Philodendron bipinnatifidum Endl.	selloum	Orn	R	R	<4>
Syngonium cf. *podophyllum* Schott	nephthytis	Nat	--	O	<5>
ARECACEAE					
Caryota cf. *mitis* Lour.	fishtail palm	Orn	R	R	<4>
Cocos nucifera L.	coconut, *niu*	**Pol**	R, C	R, C	<1, 4>
Dypsis lutescens (H. Wendl.) Beentje & Dransfield	golden-fruited palm	Orn	R	R	<4>
Phoenix dactylifera L	Phoenix palm	Nat	U, C	U, U	<2, 5>
Roystonia regia (Kunth) O. F. Cook	royal palm	Orn	--	U	<4>
Veitchia merrilli (Beccari) H.E. Moore	Manila palm	Orn	R	R	<4>
COMMELINACEAE					
Commelina diffusa N.L. Burm.	day flower	**Pol**	R	O	<2>
Tradescantia zebrina Bosse	*hohohonoʻula*	Orn	R	--	<4>
CYPERACEAE					
Bulboschoenus maritimus (L.) Palla	*kaluhā*	**Ind**	C	O	<2>
Cladium jamaicense Crantz	*ʻuki*, saw-grass	**Ind**	O3	O3	<2>
Cyperus halpan L.	---	Nat	R	--	<4>
Cyperus involucratus Rottb.	umbrella sedge	Nat	--	R	<2>

Table 1 (continued).

FAMILY		STATUS	ABUNDANCE		NOTES
Species	**Common name**		**Wet Season**	**Dry Season**	
CYPERACEAE (continued)					
Cyperus polystachyos Rottb.	---	**Ind**	O, U	U	<2, 3>
Cyperus rotundus L.	nut grass	Nat	O, O2	--, U2	<2, 4>
Eleocharis sp.	---	Nat	R, R	O, --	<2, 4>
Fimbristylis cymosa R. Br.	*mau'u*	**Ind**	R	U	<1>
Fimbristylis sp.	---	???	--	U	<2>
CYPERACEAE (continued)					
Kyllinga brevifolia Rottb.	*kili'o'opu*	Nat		U	<4>
Mariscus javanicus (Houtt.) Merr. & Metcalfe	*'ahu'awa*	**Ind**	--	R	<2>
Schoenoplectus lacustris (L.) Palla	*'aki'akai*, bulrush	**Ind**	O3	U	<2>
Schoenoplectus californicus (C.A. Mey.) Palla	great bulrush	Nat	A	A	<2>
IRIDACEAE					
Dietes bicolor (Steud.) Klatt	African iris	Orn	R	--	<4>
indet.	---	Orn	--	R	<4>
LEMNACEAE					
Lemna sp.	duckweed	Nat	--	R3	<2>
LILIACEAE					
Crinum asiaticum L.	giant lily	Nat	R	R	<1>
Crinum pedunculatum R. Brown	river lily	Orn	R	R	<4>
Hippeastrum striatum (Lam.) H.E. Moore	amaryllis; Barbados lily	Nat	R	--	<4>
Liriope sp	lilly turf	Orn	--	U	<4>
PANDANACEAE					
Pandanus tectorius Z	*hala*	**Ind**	R, U	U, U	<1, 4>
Pandanus tectorius cult. 'Veitchii'	*hala* cultivar	Orn	R	R	<4>
POACEAE (GRAMINEAE)					
Axonopus compressus (Swartz) P. Beau.	brd-lvd carpetgrass	Nat	O3	O3	<4>
Axonopus fisifolius	nrw-lvd carpetgrass	Nat	--	O	<4>
Bothriochloa pertusa (L.) Camus	pitted beardgrass	Nat	A	--	<4>
Cenchrus echinatus L.	common sandbur	Nat	U1	U	<5>
Chloris barbata (L.) Sw.	swollen fingergrass	Nat	U	O	<1, 3>
Chloris divaricata R. Br.	stargrass	Nat	R	--	<3>
Chloris virgata Sw.	feather fingergrass	Nat	U	U	<3>
Cynodon dactylon (L.) Pers.	Bermuda grass	Nat	O, AA	O, AA	<2, 4>
Cynodon x magennisii Hurcombe	Bermuda hybrid	Orn	R3	--	<4>

Table 1 (continued).

FAMILY		STATUS	ABUNDANCE		NOTES
Species	**Common name**		**Wet Season**	**Dry Season**	
POACEAE (GRAMINEAE) continued					
Dactyloctenium aegypticum (L.) Willd.	beach wiregrass	Nat	R	--	<1>
Digiteria ciliaris (Retz.) Koeler	Henry's crabgrass	Nat	O1	U	<3>
Digitaria insularis (L.) Mez ex Ekman	sourgrass	Nat	U, O	--, U	<1, 3>
Digitaria violascens Link	smooth crabgrass	Nat	U	--	<3>
Echinochloa crus-galli (L.) P. Beauv.	barnyard grass	Nat	O	O	<2>
Eleusine indica (L.) Gaertn.	wiregrass	Nat	O, C	,O	<1, 3>
Eragrostis brownie (Kunth) Nees ex Steud.	sheepgrass	Nat	R	R3	<3>
Eragrostis pectinacea (Michx.) Nees	Carolina lovegrass	Nat	A	U1	<3>
Eragrostis tenella (L.) P. Beauv. ex Roem. & Schult.	lovegrass	Nat	R1	R1	<3>
Eremochloa ophiuroides (Munro) Hackel	centipede grass	Orn	U	--	<3>
Panicum maximum Jacq.	Guinea grass	Nat	C3	A	<3>
Paspalum conjugatum Bergius	Hilo grass	Nat	C	O	<4>
Paspalum fimbriatum Kunth	Panama grass	Nat	U	--	<3>
Paspalum sp.		Nat	R	--	<3>
Pennisetum purpureum Schumach.	elephant grass	Nat	O	--	<2>
Paspalum vaginatum Sw.	seashore paspalum	Nat	O1	O1	<2>
Saccharum officinarum L.	sugar cane, *kō*	**Pol**	--	R	<4>
Setaria verticillata (L.) P. Beauv.	bristly foxtail	Nat	R	R	<3>
Sorghum bicolor (L.) Moench	---	Nat	R	R	<3>
Sporobolus cf. indicus (L.) R. Br.	dropseed	Nat	R	O2	<4>
Sporobolus virginicus (L.) Kunth	'aki'aki	Ind	AA	AA	<1>
Stenotaphrum secundatum (T. Walter) Kuntze	St. Augustine grass	Nat	U3	U	<1>
Urochloa mutica (Forssk.) Nguyen	California grass	Nat	A, R	C1,	<2, 3>
Zoysia matrella var. pacifica Gouds.	Mescarene grass	Orn	U, --	U, U	<1, 4>
STRELITZIACEAE					
Strelitzia reginae Dryander	bird-of-paradise	Orn	U	U	<4>
TYPHACEAE					
Typha latifolia L.	common cattail	Nat	R3	U2	<2>
ZINGERBERACEAE					
Alpinia purpurata (Viell.) K. Schum.	red ginger	Orn	R	--	<4>
Alpinia zerumbet (Pers.) B.L. Burtt & R.M. Smith	shell ginger	Orn	--	R	<4>
Etlingera elatior (Jack) R.M. Smith	torch ginger	Orn	--	U	<4>

Table 1 (continued).

Legend to Table 1

Status = distributional status

End = endemic; native to Hawaii and found naturally nowhere else.

Ind = indigenous; native to Hawaii, but not unique to the Hawaiian Islands.

Nat = naturalized, exotic, plant introduced to the Hawaiian Islands since the arrival of Cook Expedition in 1778, and well-established outside of cultivation.

Orn = exotic, ornamental or cultivated; plant not naturalized (not well-established outside of cultivation).

Pol = early Polynesian introduction (before 1778).

Abundance = occurrence ratings for plants in survey area.

R – Rare - only one, two, or three plants seen.

U - Uncommon - several to a dozen plants observed.

O - Occasional - found regularly around the site.

C - Common - considered an important part of the vegetation and observed numerous times.

A - Abundant - found in large numbers; may be locally dominant.

AA - Abundant - abundant and dominant in some areas surveyed, defining vegetation in those areas.

Numbers following a letter modify the letter to account for clustered distribution. Thus R3 would indicate a plant encountered rarely (one to three times), but numerous where encountered.

Notes:

<1> Associated with beach, dune, and limestone shelf (strand vegetation)
<2> Associated with wetlands and golf course water hazard (aquatic) sites.
<3> Associated with disturbed areas around structures and golf course.
<4> Associated with the extensive mowed (lawn) areas; grounds landscaping; golf course.
<5> Associated with forest vegetation type inland of dunes.
<6> A plant which was lacking flowers or fruit; identification uncertain.

Botanical Surveys, Vegetation

"Vegetation" refers to the type of plants that dominate an area. For the SEIS lands, we can describe the following basic vegetation types: Landscape, Forest (several types), Shrub-scrub, Wetland, and, along a narrow zone at the coast, Strand. Each of these vegetation types and the distribution (shown in Figure 3) are discussed here, in order from the largest to smallest based upon proportion of area within the SEIS lands.

The Landscape Vegetation type (**Lnd**) refers to all areas where the dominant plants are controlled and maintained by humans. Included are hotel grounds, golf course (Figure 4) and other high resort use areas, Kuilima Estates, and other landscaped areas (roads and parking lots). Of course, many of the ruderal weed species (plants adapted to conditions of regular disturbance, such as mowing, grading, etc.) that occur on the property will be found in landscaped areas, since levels of maintenance will vary greatly dependent upon land use. Not all of these areas were surveyed (for example most of the hotel grounds and Kuilima Estates were excluded) because they represent completely developed areas where all botanical resources are managed and for the reasons stated in the Introduction. A sizable fraction (36 percent) of the listed flora occurs in the landscaped areas because this category constitutes a high percentage of the SEIS lands and because of contributions from both diverse plantings and ruderal weeds. This vegetation type has low numbers of native species with the exception of plants used in landscaping as discussed under Flora above and a few ruderal natives such as *pōpolo* (*Solanum americanum*) and '*uhaloa* (*Waltheria indica*), which were not very abundant in the surveys.

Figure 4 - View of highly manicured vegetation of the golf course at Turtle Bay Resort. Note aquatic feature (water hazard). Forest in background is actually trees in and around Punaho'olapa Marsh.

Figure 3 - Vegetation and "wetlands" map of the SEIS lands. Landward boundary of survey area shown in red and yellow dotted line. Wetlands and other aquatic features shown in blue, modified from National Wetland Inventory maps. Vegetation zones outlined in yellow: FoC - Ironwood forest; FoM - mixed forest; Grl - grassland and open disturbed areas; Lnd - landscaped and developed areas (and some highly disturbed areas); ShO - coastal shrubland; ShS - *koa haole* shrubland; STr - coastal strand.

The Forest Vegetation type (**Fo**) is the most complex on the property, consisting of trees forming a closed or nearly closed canopy. This vegetation covers a considerable proportion of the SEIS lands, and varies in composition from place to place, merging into all of the other vegetation types along boundaries that are, in places, not well-defined. For example, either planted trees or trees naturalized along the forest border may, at the interface between the Landscape and Forest types be included in the mapping as in one or the other. A line between the Forest and Strand cannot be accurately drawn where the strand is dominated by trees, such as ironwood (*Casuarina equisetifolia*).

The ironwood forest (**FoC**) is the dominant Forest type on SEIS lands, found particularly close to the coast (Figure 5). Ironwood grows on dunes and immediately behind the beach (or rocky shore) in some places (see strand vegetation below). Ironwoods are very tolerant of the conditions that set the strand apart from inland plant communities, but are allelopathic (needle-like litter accumulated on the ground prevents most other species from germinating and forming an understory). Thus, an understory is either absent or sparse in dense ironwoods. In one area, the ground under the ironwoods is singularly covered by the vine, *Passiflora suberosa*, perhaps because scattered seedlings that do germinate can spread out over the surface unaffected by any allelopathic chemicals in the soil. Although obviously a useful species for the dry Kahuku Point area, and widely incorporated in the landscaping of the developed areas including the golf course, ironwoods should be considered invasive in two vegetation types: strand and wetland.

Figure 5 - Ironwood forest on dunes looking inland from the open part of the strand. Note the paucity of other vegetation under the dense canopy of the ironwoods.

Areas of forest not dominated by ironwood tend to comprise several common, mostly non-native tree species: Christmas berry (*Schinus terebinthefolius*), *Macaranga tanarius*, *milo* (*Thespesia populnea*), *koa haole* (*Leucaena leiucocephala*), Java plum (*Syzygium cumini*), and even hau (*Hibiscus tiliaceus*) as monotypic stands in a few low-lying areas. Ironwood is usually present, just not dominant. These forested areas are mapped as mixed forest (**FoM**). Many other species of trees, shrubs, and herbs occur in various parts of these forests, but tend not to be dominant. The understory typically includes Chinese violet (*Asystasia gangetica*), Guinea grass (*Panicum maximum*), and sourbush (*Pluchea indica* and *P. carolinenesis*), although many other shrubs and herbs are listed in Table 1 from this vegetation type. An area planted in Cook Island pines (**FoP**) occupies a part of the high dune just east of the Ocean Villas development.

Koa haole grows as a shrub or small tree, and can reach high densities. In areas where *koa haole* is the dominant species, the tall, woody plants approach a forest type, but here are labeled as scrub or shrub-scrub (**ShS**). Sometimes other trees occur scattered in this vegetation type or *koa haole* occurs as patches of scrub within the other forest types or diffused throughout the forest. The areas of purest shrub-scrub are areas of former sugar cane lands (see Figure 2) that have not been developed. Typical understory plants in the *koa haole* shrub-scrub are Guinea grass, Chinese violet, and gycine vine (*Neonotonia wightii*). Other scrublands occur (**ScO**) inland from the strand. These are dominated by *Pluchea* spp.

Wetlands on the SEIS lands are of two types: 1) former wetlands that were part of Punahoʻolapa Marsh and 2) wetlands and aquatic features associated with the golf course hazards. The latter were either constructed during grading for the courses (that is, are lined ponds), or incorporated (and perhaps dredged) from prior existing wetlands or stream courses. Aquatic features are mapped in Fig. 3 from the National Wetland Inventory (NWI) shape files provided by USFWS[1]. These shapefiles have been modified by removal of all features that are not ponds or wetlands (essentially NWI data base errors). Streams and marine habitats have also been removed, the former replaced by our stream designations. For "streams" and other water courses, and the boundary of Punahoʻolapa Marsh where not defined by a dredged moat, the map depicts results from a survey of these features undertaken by AECOS (2011).

Most of the features shown as "wetlands" on the property are in fact, open golf course ponds or moat-like ponds (Figures 4 and 6). Some, but not all of these ponds support wetland vegetation around their margins. Wetlands (as opposed to ponds) are present at

[1] The NWI includes errors (features that are not even aquatic),and may not be complete in some areas. The NWI is, therefore, a useful guide, but not a determiner of federal jurisdictional waters. Further, the NWI includes many aquatic features that are not wetlands at all, including nearshore marine habitats and anything USFWS thinks might be aquatic (such as lined ponds on the golf course, and treatment lagoons at the waste water treatment plant.

Punahoʻolapa Marsh, at an area east of the main entrance adjacent to Kamehameha Highway, in the lower part of the main drainage swale, and as a shallow manmade wetland/pond west of the latter (just northeast of Kulima Estates). These areas are not, or are only minimally maintained. Punahoʻolapa Marsh is the most interesting of the wetlands as it is part of a large complex of wetlands that existed in the distant past on the Kahuku Plain. The NWI indicates only the man-made moats surrounding Punahoʻolapa Marsh, despite the long history of a marsh frequently mapped in this location, (Land Study Bureau, 1963; USGS, 1965, 1983, 1998 Kahuku Quadrangle 7.5 Minute Topographic Series).

Figure 6 - Wetland interface between the golf course (Landscape vegetation) and the moat around Punahoʻolapa Marsh. Note abundance of ironwoods within Punahoʻolapa Marsh in background.

In Figure 3, the marsh is shown to consist of three areas outlined by the NWI moat-like features and the AECOS (2011) wetland delineation boundary in the area not mapped as moats (in fact, moats also occur in much of this area). Nearly all of Punahoʻolapa Marsh is overgrown with herbaceous vegetation. Many areas supporting tree growth are evident as well, including areas of *hau* forest (not mapped). There are however, extensive interior areas supporting *koa haole* shrub-scrub and ironwood forest. These areas were not visited, and therefore unknown is how much of the area enclosed by moats remains as wetland. Only one open pond area is seen in satellite images. Consequently, our map shows the extent of the former feature Punahoʻolapa Marsh, and does not further address the condition of the interior of that feature with respect to wetland function. Certainly a large portion of the outlined area remains a marsh, although densely covered with vegetation including various sedges (mostly natives), California grass (*Urochloa mutica*), *hau*, and

several patches of trees such as ironwood, and *koa haole* that might represent high (non-wetland) ground within the marsh border.

Starting along the shore, the substratum of the SEIS lands varies between consolidated limestone (rocky shore) and sand deposits (beaches; see Figure 7). Very few higher plant species can tolerate direct immersion in seawater or the shifting nature of sand deposits subjected to wave action. A number of environmental factors—brackish or saline groundwater, salt spray, absence of humus in the soil substratum, exposure to winds—are sufficiently harsh so as to limit the species that can survive in the strand. The Strand vegetation (**STr**) occupies a zone of variable width immediately inland of the ocean shore. Some of the vegetation grows on the upper part of active beaches (notably the vine, *pōhuehue* or *Ipomoea pes-caprae*) and *'aki'aki* grass or *Sporoblus virginicus*, seeding and or invading down the beach by rhizomal growth. Mostly, this vegetation is found on sand moving slowly inland under the influence of the wind (which is predominantly onshore at this location) forming dunes, which—where active (that is where sand is actively on the move)—might be mistaken for beach rather than wind (or in some cases, storm wave) deposited material. As far as plant growth is concerned, the difference is one of stability. Where the sand is actively moving about at a fairly good rate (waves constantly rework the beach sand), plants cannot get established, or are buried (or the roots exposed) and die.

Figure 7 - View of the shore showing sand and limestone substrata. All the plants visible here are part of the Strand vegetation type. Note ironwoods on right are invasive to the strand.

The distance the strand extends inland from the beach or rocky limestone shore depends upon several factors: 1) how far inland the dunes extend, 2) how marked are salt air effects on extant vegetation, and 3) disturbances that damage the vegetation or the substratum. In most areas along the coast of the SEIS lands, the width of this vegetation zone is too narrow to indicate on our map (Figure 3)[2]. The widest areas of strand vegetation occur at the rocky points (Kahuku and Kuilima) and behind the shore extending east from Kahuku Point. The typical strand plant community is one dominated by several native species—*naupaka kahakai* (*Scaevola taccada*), *'akoko* (*Euphorbia degenerí*), *'aki'aki* (*Sporobolis virginicus*), *hinahina* (*Heliotropium anomalum* var. *argenteum*), *ma'u* (*Fimbristylis cymosa*)—and at least one non-native tree (beach heliotrope or *Tournefortia argentea*). Along much of the shore, the area formerly occupied by dunes has been developed by the resort (golf course and hotel structures near the coast) or have been modified by the ironwood trees which grow nearly down to the shore; while these trees are a part of the strand vegetation, they are also a part of the ironwood and mixed forests that extend yet further inland. Thus, there is no simple way to differentiate the strand on the basis of vegetation alone where ironwoods predominate. As noted above, ironwoods can be invasive in this vegetation type.

Avian Survey

Point Counts

A total of 1735 individual birds of 27 species, representing 19 separate families, were recorded during the course of the wet and dry season point count surveys. Three of the species recorded, Common Gallinule (*Gallinula galeata sandvicensis*)[3], Hawaiian Coot (*Fulica alai*) and Hawaiian Stilt (*Himantopus mexicanus knudseni*) are endemic endangered waterbird species. One species recorded, Black-crowned Night-Heron (*Nycticorax nycticorax hoactli*) is an indigenous resident water obligate species, and four, Pacific-Golden Plover (*Pluvialis fulva*), Wandering Tattler (*Tringa incana*), Bristle-thighed Curlew (*Numenius tahitiensis*) and Ruddy Turnstone (*Arenaria interpres*) are indigenous migratory shorebird species. The remaining 19 species detected are considered to be alien to the Hawaiian Islands (Table 2).

There was very little difference between the results of the wet and dry season (spring and fall) bird surveys. We recorded two additional migratory shorebird species during the later survey that were not recorded during the course of the first survey. All of species detected during the wet season (spring) were also recorded during the dry season survey. These results were not unexpected, as the Hawaiian Islands unlike continental landmasses do not have a significant difference in avian species present during the course of a year. The significant intermonth differences in avian species usage of continental locations is a reflection of the presence and or absence of Neotropical migrant species in the Americas

[2] In reality, the strand probably does extend inland where the substratum is dune sand. However, these areas where a strand is too narrow for mapping have either development close behind the shore or ironwood forest, which interferes with defining where the strand/forest boundary occurs.

[3] The common and scientific names of this species were recently changed by the American Ornithological Union from Common Moorhen (*Gallinula chloropus*) to Common Gallinule (*Gallinula galeata sandvicensis*; Cheeser et al. 2011, Pg. 603).

and Palearctic migrants in Europe and Asia. The Pacific Islands do see some migratory shorebird and waterfowl species but no passerines.

Avian diversity and densities were in keeping with the vegetation and current usage of the site, most of which is either golf course, condos, apartments, forested lands, scrub lands or open maintained golf course. Four species, Common Waxbill (*Estrilda astrild*), Red-vented Bulbul (*Pycnonoyus cafer*), Zebra Dove (*Geopelia striata*) and Japanese White-eye (*Zosterops japonicus*) accounted for 51 percent of all birds recorded during station counts. Common Waxbill was the commonest species recorded.

Time Dependant Waterbird Counts

A total of 26 adult and two sub-adult Hawaiian Gallinule, three Hawaiian Coot, five Hawaiian Stilt and one domestic Muscovy (*Cairina moschata*) were recorded within water and wetland features on the property during the course of time dependant waterbird counts. These numbers reflect a best guess at a high count, as there are numerous water features on the property as well as on the adjacent USFWS Wildlife Refuge located to the south of Marconi Road and there is considerable temporal movement of birds between features.

Two sub-adult Hawaiian Gallinules were recorded, which may indicate on-site nesting activity. The two sub-adult birds were each seen with two separate sets of adults. No nests were observed in any of the water features, though unobserved nests could have been present with Punaho'olapa Marsh, which in it's current state is not readily searchable for nesting waterbirds.

Table 3 – Avian Species Detected During Point Counts – Turtle Bay Resort, 2011

Common name	*Scientific name*	*Status*	*Wet Season*	*Dry Season*	*Comb. RA*
	PHASIANIDAE - Pheasants & Partridges Phasianinae - Pheasants & Allies				
Domestic Chicken	*Gallus sp.*	D	0.20	0.35	**0.28**
	PELECANIFORMES ARDEIDAE - Herons, Bitterns & Allies				
Cattle Egret	*Bulbucus ibidis*	A	2.20	1.45	**1.83**
Black-crowned Night-Heron	*Nycticorax nycticorax hoacti*	IR	0.15	0.25	**0.20**
	GRUIFORMES RALLIDAE - Rails & Allies				
Common Gallinule	*Gallinula galeata sandvicensis*	**EE**	0.15	0.30	**0.23**
Hawaiian Coot	*Fulica alai*	**EE**	0.10	0.30	**0.20**
	CHARADRIIDAE - Lapwings & Plovers Charadriinae - Plovers				
Pacific Golden-Plover	*Pluvialis fulva*	IM	1.60	1.20	**1.40**
	RECURVIROSTRIDAE - Stilts & Avocets				
Black-necked Stilt	*Himantopus mexicanus knudseni*	**EE**	0.25	0.25	**0.25**
	SCOLOPACIDAE - Sandpipers, Phalaropes & Allies Scolopacinae - Sandpipers & Allies				
Wandering Tattler	*Tringa incana*	IM	0.10	0.05	**0.08**
Bristle-thighed Curlew	*Numenius tahitiensis*	IM	0.05	-	**0.03**
Ruddy Turnstone	*Arenaria interpres*	IM	1.40	-	**0.70**
	COLUMBIFORMES COLUMBIDAE – Pigeons & Doves				
Spotted Dove	*Streptopelia chinensis*	A	1.25	1.15	**1.20**
Zebra Dove	*Geopelia striata*	A	4.75	4.15	**4.45**

Table 2 – Continued

Common name	*Scientific name*	*Status*	*Wet Season*	*Dry Season*	*Comb. RA*
	PSITTACIFORMES				
	PSITTACIDAE – Lories Parakeets, Macaws & Parrots				
	Psittacinae - Typical Parrots				
Rose-ringed Parakeet	*Psittacula krameri*	A	0.65	1.40	**1.02**
	PASSERIFORMES				
	PYCNONOTIDAE - Bulbuls				
Red-vented Bulbul	*Pycnonotus cafer*	A	6.45	0.50	**5.85**
Red-whiskered Bulbul	*Pycnonotus jocosus*	A	5.25	1.00	**0.75**
	CETTIIDAE - Cettia Warblers & Allies				
Japanese Bush-Warbler	*Cettia diphone*	A	0.15	0.30	**0.22**
	ZOSTEROPIDAE – White-eyes				
Japanese White-eye	*Zosterops japonicus*	A	2.95	2.45	**2.70**
	TIMALIIDAE - Babblers				
Red-billed Leiothrix	*Leiothrix lutea*	A	0.15	0.40	**0.28**
	TURDIDAE - Thrushes				
White-rumped Shama	*Copsychus malabaricus*	A	0.85	1.05	**0.95**
	STURNIDAE – Starlings				
Common Myna	*Acridotheres tristis*	A	5.80	4.80	**5.30**
	EMBERIZIDAE – Emberizids				
Red-crested Cardinal	*Paroaria coronata*	A	1.15	1.50	**1.33**
	CARDINALIDAE – Cardinals Saltators & Allies				
Northern Cardinal	*Cardinalis cardinalis*	A	1.15	1.35	**1.25**
	FRINGILLIDAE – Fringilline and Carduline Finches & Allies				
House Finch	*Carpodacus mexicanus*	A	1.50	1.70	**1.60**
	PASSERIDAE – Old World Sparrows				
House Sparrow	*Passer domesticus*	A	0.20	0.95	**0.58**
	ESTRILDIDAE – Estrildid Finches				
Common Waxbill	*Estrilda astrild*	A	7.05	5.80	**6.43**
Nutmeg Mannikin	*Lonchura punctulata*	A	0.95	2.30	**1.67**
Chestnut Munia	*Lonchura atricapilla*	A	1.95	3.40	**2.68**

Key to Table 2.

EE	Endangered Endemic Species – Native and unique to the Hawaiian Islands, also listed as endangered under the ESA, and State HRS 195D
A	Alien Species – Introduced to the Hawaiian Islands by humans
D	Domesticated species – not considered to be established in the wild on the Island of O'ahu
IR	Indigenous Resident Species – Native to the Hawaiian Islands, but not unique to the islands, non-migratory
IM	Indigenous Migratory Species - Native to the Hawaiian Islands, but not unique to the islands, does not breed in the Hawaiian Islands
Spring	Spring Survey – Relative Abundance – Number of bird detected, divided by the number of count stations (20)
Fall	Fall Survey – Relative Abundance – Number of bird detected, divided by the number of count stations (20)
A-3	Area 3 – Relative Abundance – Number of bird detected, divided by the number of count stations (11)
Comb RA	Combined Relative Abundance - Number of bird detected during both spring and fall counts divided by the total number of count stations (40)

Mammalian Survey

Eight terrestrial and one marine mammalian species were detected on site during the course of this survey (Table 3). With the exception of endangered Hawaiian monk seals (*Monachus schauinslandi*) seen hauled out on the beach during both field surveys, all of the mammals recorded on the site are alien to the Hawaiian Islands.

Table 3 – Mammalian Species Recorded – Turtle Bay Resort, 2011

Common name	Scientific name	Status	DT
	RODENTIA - Gnawers		
	Muridae - Old World Rats & Mice		
European house mouse	*Mus musculus domesticus*	**A**	V
	CARNIVORA- Flesh Eaters		
	Canidae - Wolves, Jackals & Allies		
Domestic dog	*Canis f. familiaris*	**A**	V, A, Sc, Tr
	VIVERRIDAE - Civets & Allies		
Small Indian mongoose	*Herpestes a. auropunctatus*	**A**	V, A, Sc, Tr
	FELIDAE- Cats		
House cat	*Felis catus*	**A**	V, Tr
	PHOCIDAE - Hair Seals		
Hawaiian monk seal	*Monachus schauinslandi*	**EE**	V
	PERISSODACTYLA - Odd-Toed Ungulates		
	Equidae - Horses, Asses & Zebras		
Domestic horse	*Equus c. caballus*	**A**	V, Sc, Tr
Donkey	*Equus a. asinus*	**A**	V, Sc, Tr
Mule	*Equus asinus x Equus caballus*	**A**	V, Sc, Tr
	ATRIODACTYLA - Even-Toed Ungulates		
	Suicidae - Old World Swine		
Pig	*Sus s. scrofa*	**A**	Sc, Tr, Si

Key to Table 3

- **A** Alien – Introduced to the Hawaiian islands by humans
- **EE** Endangered Endemic – native and unique to the Hawaiian Islands, also listed as an endangered species
- V Visual – animal that was seen
- A Auditory – an animal that was recorded by hearing its call or other distinct sounds
- Sc Scat – an animal that was detected due to the presence of fecal material
- Tr Tracks – an animal that was recorded by seeing tracks or other sign

Discussion

Botanical Resources

The percentage of native plants in the area is generally typical for lowlands on O'ahu (David & Guinther, 2006: 11 percent; David & Guinther, 2010: 12 percent) at 10.5 percent. As is also typical, for most of the SEIS lands, the abundance of natives in the vegetation is far below that of non-natives. This condition is not unexpected considering the long history of disturbance of the site going back over 100 years. Exceptions to these statements involve the wetlands (specifically Punaho'olapa Marsh) and the coastal strand vegetation. In these environments, native plants remain abundant (Figures 8 and 9) and, in some places are the dominant members of their respective botanical communities. With the exception of landscaping close to the ocean shore, the Landscape, Forest, and Shrub-Scrub have minimal botanical resource value based upon occurrence of native plant species. The only endemic species recorded in the survey was 'akoko, which was found exclusively on the dunes and mostly in areas where the dune vegetation is minimally disturbed.

Figure 8 - View across a moat into Punaho'olapa Marsh showing dense growths of several native plants: *neke* fern, backed by *'uki* (saw-grass), with *hau* still further back.

Figure 9 - Area of dunes supporting native plants: mostly naupaka here, but with 'aki'aki (grass) and a few 'akoko and hinahina plants growing on sand in front of the naupaka.

From a resources conservation perspective, both the Strand vegetation and Punaho'olapa Marsh are deserving of special attention with a goal towards preservation. Other wetlands and inland aquatic environments on the SEIS lands are either well maintained ponds with wetland plants or otherwise protected as likely jurisdictional waters under the federal Clean Water Act; but in all cases, are partly or wholly integrated into the golf course landscapes on the site. Punaho'olapa Marsh is very well protected physically by moats that surround most of the former marshland. Expansion of the moat system is presently being contemplated by TBR Development to complete the ring around the marsh. Although not part of the present survey, the marsh appears to have sufficient hydrology but is overgrown with vegetation, much of it non-native and actually or potentially invasive. The majority of open water existing today in this marsh is the bordering moat system, providing habitats of value to water obligate birds. Thus, the resource value of the marsh, while not threatened, is certainly well below what it could be.

The native Strand vegetation is present but poorly represented along most of the SEIS lands coastline. However, from Kahuku Point eastward, this community is well developed, forming a broad zone in from the beach. This community is heavily invaded by non-native species further inland across the dune complex. The greatest threat to this community appears to be from off-road vehicular (ORV) traffic entering from the east. The numerous ORV trails across the beach and dunes have caused destruction of the native vegetation,

with resulting erosion (sand movement) and enhancement of the process of invasion by non-native weeds. Fortunately, strand plants are adapted to disturbances resulting from storm waves and moving sand, and tend to recover from man-made disturbances. However, there is a limit to such resilience and prevention of unwelcomed traffic on these dunes under the control of TBR Development should be made a priority.

Avian Resources

The findings of the avian survey are consistent with the current habitat present on the site and the land usage of the area surveyed. During the course of this survey 27 avian species, were recorded during the course of the wet and dry season surveys. Three of the species recorded, Common Gallinule, Hawaiian Coot and Hawaiian Stilt are endemic endangered waterbird species. The various water features on the site provide foraging and loafing habitat for these three endangered endemic waterbird species. The only areas within the property boundaries that likely support any nesting activity for any of these species is within water features which have fairly dense emergent vegetation, Punaho'olapa Marsh in particular.

One species recorded, Black-crowned Night-Heron is a commonly occurring indigenous resident water obligate species, and four, Pacific-Golden Plover, Wandering Tattler, Bristle-thighed Curlew and Ruddy Turnstone are indigenous migratory shorebird species which nest in the high Arctic during the late spring and summer months, returning to Hawai'i and the Tropical Pacific to spend the fall and winter months each year. They usually leave Hawai'i for their trip back to the Arctic in late April or the very early part of May. The remaining 19 species detected are considered to be alien to the Hawaiian Islands.

Although no seabirds were detected during the course of this survey, several seabird species potentially overfly the site on occasion. The primary cause of mortality in resident seabirds is thought to be predation by alien mammalian species at the nesting colonies (USFWS 1983; Simons and Hodges 1998; Ainley *et al.,* 2001). Collision with man-made structures is considered to be the second most significant cause of mortality in locally nesting seabird species in Hawai'i. Nocturnally flying seabirds, especially fledglings on their way to sea in the summer and fall, can become disoriented by exterior lighting. When disoriented, seabirds often collide with manmade structures, and if they are not killed outright, the dazed or injured birds are easy targets of opportunity for feral mammals (Hadley 1961; Telfer 1979; Sincock 1981; Reed *et al.*, 1985; Telfer *et al.*, 1987; Cooper and Day, 1998; Podolsky *et al.* 1998; Ainley *et al.*, 2001; Hue *et al.*, 2001; Day *et al* 2003).

Mammalian Resources

The findings of the mammalian survey are consistent with the current habitat present on the site and the land usage of the area surveyed. All of the mammalian species detected with the exception of several Hawaiian monk seals seen hauled out on the beach fronting the property are alien species.

Although no rodents were detected during the course of this survey, it is likely that the four established alien *muridae* found on O'ahu, roof rat (*Rattus r. rattus*), Norway rat (*Rattus norvegicus*), European house mouse (*Mus musculus domesticus*) and possibly Polynesian rats (*Rattus exulans hawaiiensis*) use various resources found within the general project area on a seasonal basis. These human commensal species are drawn to areas of human habitation and activity. All of these introduced rodents are deleterious to native ecosystems and the native faunal species dependant on them.

No Hawaiian hoary bats were detected during the course of this survey. Given the paucity of documented records of this species on O'ahu, this finding was not unexpected (USFWS, 1998; David, 2011).

Potential Impacts to Protected Species

Botanical

No species of plant listed as threatened or endangered under state or federal statutes was recorded during either the March or September, 2011 surveys of the SEIS lands, and none is expected to occur on this highly disturbed site. Only endemic species or subspecies are likely to be listed, and only the one endemic species (*'akoko* recorded in the strand environment) was recorded in our surveys. There are a number of Hawaiian *'akoko* species either listed or considered species of concern (USFWS, 2011), but not *E. degeneri*, the species detected. However, *E. degeneri* and *'ohelo kai* (*Lycium sandwicense*) are uncommon species on O'ahu due to limitations on habitat (these species only occur in strand environments) and disturbances that the habitat is subjected to.

Waterbirds

Potential impacts to listed waterbird species that have been and may be further attracted to the wetland features run the gamut from temporary disturbance of individual birds that may be attracted to the area as potential modifications of the ditch around Punaho'olapa Marsh are constructed, to direct physical harm of individual birds. The use of certain herbicides, insecticides and fertilizers used in landscape and golf course maintenance can also pose threats to waterbirds, as can the unintentional migration of petroleum, oils, lubricants, cleaning agents and the like into water features. Golf course operations have the potential to result in physical harm to listed waterbird species that may use resources on the active golf course. As golf is and ongoing activity on the site it is unlikely that any expansion of the resort facilities will resulting any increased threats to waterbirds by the golf operations.

Following build out, and operation of the proposed improvements to the resort, nesting waterbirds could potentially be disturbed by human activity causing abandonment of the nest, broken eggs, trampled chicks, and increased predation of eggs and chicks when adults potentially flee human disturbance and leave their nests and young unguarded. An operating Resort will by its very nature attract certain human commensal species such as cats and rats, which also pose threats to these avian species, especially to young birds and

eggs. As the site is already operated as a resort it is unlikely that the proposed expansion of the facilities will attract any predators that are not already using resources on the property.

Seabirds

The principal potential impact that further modification of this site poses to protected seabirds is the increased threat that birds will be downed after becoming disoriented by lights associated with the project during the nesting season. The two main areas that outdoor lighting could pose a threat to these nocturnally flying seabirds is if, 1) during construction, if it is deemed expedient, or necessary to conduct nighttime construction activities, 2) following build-out, the potential use of streetlights or other exterior lighting during the seabird nesting season.

Hawaiian monk seal

No direct impacts to Hawaiian monk seals are anticipated from the further development of the SEIS lands is expected. The human activities of greatest concern to monk seals are the potential for entanglement in fishing gear, impact from boats, or predation by fishermen who may view the seals as direct competitors for fish resources. None of these sources of mortality are likely to increase as a result of resort development because the anticipated clientele are not likely to engage in these activities. However indirect impacts including increased interactions with fishermen, surfers, kayakers, and other ocean recreational uses may be anticipated as a result of improved access to the public and increases in shoreline population.

Hawaiian hoary bat

The principal potential impact that the further development of the Resort poses to bats is during the clearing and grubbing phases of construction as vegetation is removed. The removal of vegetation within the project site may temporarily displace individual bats, which may use the vegetation as a roosting location. As bats use multiple roosts within their home territories, the potential disturbance resulting from the removal of the vegetation is likely to be minimal. During the pupping season, females carrying their pups may be less able to rapidly vacate a roost site as the vegetation is cleared. Additionally, adult female bats sometimes leave their pups in the roost tree while they forage. Very small pups may be unable to flee a tree that is being felled. Potential adverse effects from such disturbance can be avoided or minimized by not clearing woody vegetation taller than 4.6 meters (15-feet), between June 15 and September 15, the period in which bats are potentially at risk from vegetation clearing. Given the likely very low levels of bat use of the site it is unlikely that construction activities will result in impacts to this species.

Recommendations

- If nighttime construction activity or equipment maintenance is proposed during the construction phases of the project, all associated lights should be shielded, and when large flood/work lights are used, they should be placed on poles that are high enough to allow the lights to be pointed directly at the ground.

- If streetlights or exterior facility lighting is installed in conjunction with the project, it is recommended that the lights be shielded to reduce the potential for interactions of nocturnally flying seabirds with external lights and man-made structures (Reed et al., 1985; Telfer et al., 1987).

- Punahoʻolapa Marsh, especially one that is further restored represents a wonderful educational and outreach opportunity. Development of an I&E program centered around the marsh, it's history and the native flora and fauna that use it is encouraged.

- Develop and implement an integrated monk seal and green sea turtle education program to educate coastal users of the property of the importance of not disturbing these trust resources.

- Future developments on the SEIS lands should continue utilizing appropriate native species in landscaping.

- Thinning of ironwood trees where these are invasive of either wetland or strand plant communities should be considered as a potentially valuable conservation activity.

- Efforts should continue or be increased to limit all access (but particularly by ORVs) to strand areas where the plant community is predominantly native.

Critical Habitat

There is no federally delineated Critical Habitat present on or adjacent to the property. Thus the further development and operation of proposed development will not result in impacts to federally designated Critical Habitat. There is no equivalent statute under state law.

Glossary

Ahupuaʻa – Traditional Hawaiian land division, usually extending from the uplands to the sea.
Alien – Introduced to Hawaiʻi by humans
Allelopathic – The inhibition of growth in one species of plants by chemicals produced by another species
Domesticated – Feral species, not considered established in the wild on the Island of Oʻahu
Endangered – Listed and protected under the Endangered Species Act of 1973, as amended (ESA) as an endangered species
Endemic – Native to the Hawaiian Islands and unique to Hawaiʻi
Indigenous – Native to the Hawaiian Islands, but also found elsewhere naturally
Makai – Down-slope, towards the ocean
Mauka – Upslope, towards the mountains
Muridae – Rodents, including rats, mice and voles, one of the most diverse family of mammals
Naturalized – A plant or animal that has become established in an area that it is not indigenous to
Nocturnal – Night-time, after dark
ʻŌpeʻapeʻa – Endemic endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*)
Pelagic – An animal that spends its life at sea – in this case seabirds that only return to land to nest and rear their young
Phylogenetic – The evolutionary order that organisms are arranged by
Ruderal – Disturbed, rocky, rubbishy areas, such as old agricultural fields and rock piles
Sign – Biological term referring tracks, scat, rubbing, odor, marks, nests, and other signs created by animals by which their presence may be detected
Threatened – Listed and protected under the ESA as a threatened species

DLNR – Hawaiʻi State Department of Land & Natural Resources
DOFAW – Division of Forestry and Wildlife
ESA – Endangered Species Act of 1973, as amended
USFWS – United State Fish & Wildlife Service
USGS – U.S. Geological Survey
TMK – Tax Map Key

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APPENDIX G:

SUPPLEMENTAL ARCHAEOLOGICAL INVENTORY SURVEY PLAN

G

FINAL

PLAN FOR SUPPLEMENTAL

ARCHAEOLOGICAL INVENTORY SURVEY

LANDS OF KAHUKU, PUNALAU, ULUPEHUPEHU, ʻŌIʻO, HANAKAʻOE, KAWELA AND ʻŌPANA

KOʻOLAULOA DISTRICT

ISLAND OF OAHU

TMK: (1) 5-6-03: 040-042, 044; 5-7-01:01, 013, 016, 017, 020, 022, 028, 030, 031, 033; 5-7-06: 01-017, 019, 020

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Haun & Associates Report 822-113011

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Summary

At the request of Turtle Bay Resort Development (TBR), Haun & Associates prepared this plan for a Supplemental Archaeological Inventory Survey (SAIS) within the c. 840-acre resort property situated in Kahuku, Ko'olauloa District, Island of O'ahu. The resort area spans seven traditional land divisions (Kahuku, Punalau, Ulupehupehu, 'Ōi'o, Hanaka'oe, Kawela, and 'Ōpana) and numerous (32) tax map parcels (TMK: [1] 5-6-003:040-042, 044; 5-7-001:001, 013, 016, 017, 020, 022, 028, 030, 031, 033; 5-7-006:001-017, 019, 020).

This plan was prepared in advance of the SAIS, in accordance with the requirements for an archaeological inventory survey plan detailed in Hawai'i Administrative Rules (HAR) §13-13-284-5(c) and §13-13-276-5 (a) and (b). This plan describes the current Turtle Bay Resort (TBR) facility and the environment of the area, presents the results of historical documentary and archaeological background research for the general Kahuku area and specifically for the TBR property. The plan also provides a synthesis of the background information and provides a research design with a methodology to guide the proposed SAIS work. This plan also discusses ongoing consultation with agencies and knowledgeable individuals.

Archaeological and historical background research indicate that in late prehistory the Kahuku Point vicinity was well populated and extensively cultivated. Land Commission Awards document continued traditional Hawaiian settlement in the mid-1800s. This traditional land use was soon displaced after the establishment Kahuku Ranch in the 1850s. The ranch prospered and expanded for nearly four decades until the establishment of Kahuku Plantation Company in 1890. The first sugarcane crop from 2,800 cultivated acres was harvested in 1892. By 1899, the OR&L railroad line extended from Honolulu to Kahuku to get the cane to market. By the early 1900s there were stations at Kawela and Kahuku Ranch. By 1935, 4,490 acres were cultivated in sugarcane and the plantation employed over 1,100 workers and a plantation camp was established on the TBR property.

The U.S. Army established Kahuku Army Airfield in 1942. The facility served as an auxiliary field that was used for flight training and coastal defense. Use of the airfield was short-lived and military use ended shortly after the end of World War II. Sugarcane cultivation continued until 1971 when the Turtle Bay Resort and the first golf course were constructed. Some inland portions of the property continued to be used for vegetable farming until the late 1980s. Private beach cottages lined the shores of Kawela Bay until 1990 when the area was cleared and preliminary construction for a hotel began, but was abandoned in 1991.

Based on previous archaeological research and historical documentary evidence, expected prehistoric to early historic remains on the TBR property include subsurface cultural deposits and a variety of subsurface features including fire pits, post molds and burials. Most of these features would date to between AD 1400 and 1800. Expected historic remains dating from the 1800s to 1900s include the OR&L railroad, plantation infrastructure (camps, roads, irrigation ditches, etc.) and walls marking property boundaries and Kahuku Ranch features relating to livestock control. Military-related remains dating from World War II include runways, revetments, defensive fortifications, and a variety of support facilities.

The proposed primary SAIS fieldwork effort will consist of subsurface testing that will build on the extensive previous archaeological work that has been conducted within the project area. The areas that are proposed for further testing were previously cleared for development with archaeological monitoring required. This clearance was based on the extensive archaeological subsurface testing and data recovery work conducted between 1977 and 1991, and on the extensive prior disturbance to the property by more than a century of sugar cane cultivation, the construction and operation of Kahuku Air Airfield, and the development of resort facilities since the 1970s.

Despite the prior clearance, TBR has elected to take a proactive approach to ensure the protection of cultural resources within the proposed expansion lands as part of the SEIS process. Toward that end a combined program of extensive systematic and discretionary archaeological test excavations, both mechanical and manual, are proposed for undeveloped areas of the property where substantial construction-related excavations are planned.

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INTRODUCTION

At the request of Turtle Bay Resort Development, Haun & Associates prepared this plan for a Supplemental Archaeological Inventory Survey (SAIS) within the c. 840-acre resort property situated in Kahuku, Koʻolauloa District, Island of Oʻahu (*Figure 1*). The resort area spans seven traditional land divisions (Kahuku, Punalau, Ulupehupehu, ʻŌiʻo, Hanakaʻoe, Kawela, and ʻŌpana) and numerous (32) tax map parcels (TMK: [1] 5-6-003:040-042, 044; 5-7-001:001, 013, 016, 017, 020, 022, 028, 030, 031, 033; 5-7-006:001-017, 019, 020– *Figure 2* and *Figure 3*).

This plan was prepared in advance of the SAIS, in accordance with the requirements for an archaeological inventory survey plan detailed in Hawaiʻi Administrative Rules (HAR) §13-13-284-5(c) and §13-13-276-5 (a) and (b). This plan describes the current Turtle Bay Resort facility and the environment of the area, presents the results of historical documentary and archaeological background research for the general Kahuku area and specifically for the present project area. The plan also provides a synthesis of the background information and provides a research design with a methodology to guide the proposed SAIS work. This plan also discusses ongoing consultation with agencies and local knowledgeable individuals.

TURTLE BAY RESORT

Turtle Bay Resort is currently owned and operated by Turtle Bay Resort Development (TBR). The resort was constructed in the early 1970s by casino developer Del Webb and opened its doors in May 1972 as the Kuilima Resort and Country Club. Hyatt Hotels operated the resort in the mid-1970s. Hilton Hotels and Resorts purchased it in August 1983 and renamed it The Turtle Bay Golf and Tennis Resort.

Today the resort encompasses the Turtle Bay Hotel located at Kuilima Point, the adjacent Ocean Villas and Beach Cottages, the Kuilima Estates development, restaurants, beachside amenities, two 18-hole golf courses, a clubhouse, ten tennis courts, several swimming pools, a horseback riding facility and parking lots (*Figure 4*). Access to the resort is from Kamehameha Highway via Kuilima Drive. The proposed resort expansion plans includes two hotels, 590 resort residential units, 160 affordable housing units and additional parks, shoreline setback areas and public shoreline access.

SUMMARY OF TBR ARCHAEOLOGICAL STUDIES

The Bernice Pauahi Bishop Museum (BPBM) conducted the first systematic archaeological survey of all undeveloped TBR property (649 acres) in 1977 for Prudential Insurance Company (Dye 1977). This pedestrian survey was followed by a series of subsurface testing projects conducted by Paul H. Rosendahl, Ph.D. Inc. (PHRI) in the mid-1980s. Beginning in 1984, PHRI (Bath *et al*. 1984) conducted a subsurface reconnaissance survey of thirteen areas throughout the resort property including further investigation of subsurface deposits initially identified by Dye. The initial reconnaissance testing project was followed by three intensive subsurface testing surveys conducted in 1986 that focused on cultural deposits identified by Bath *et al*. at Kawela Bay (Walker *et al*. 1988a), Kahuku Point (Walker *et al*. 1988b), and Punahoʻolapa Marsh (Davis *et al.* 1986).

In 1987, PHRI prepared an archaeological Data Recovery Plan (DRP; Walker *et al*. 1987) to mitigate the effect of resort expansion on archaeological sites at Kawela Bay, Kahuku Point, and Punahoʻolapa Marsh. The Plan was incorporated into a Memorandum of Agreement (MOA) executed in 1988 by the U.S. Army Corp of Engineers – Honolulu District (COE), the Hawaiʻi State Historic Preservation Department (SHPD) Officer, the Office of Hawaiian Affairs (OHA), the Advisory Council on Historic Preservation (ACHP), and the City and County of Honolulu (CCHONO). In addition to implementation of the DRP, the MOA required development and implementation of plans for archaeological monitoring and for burial disinterment and reburial. PHRI prepared the plans for

Figure 1. Portion of 1998 USGS Kahuku Quadrangle showing Project Area

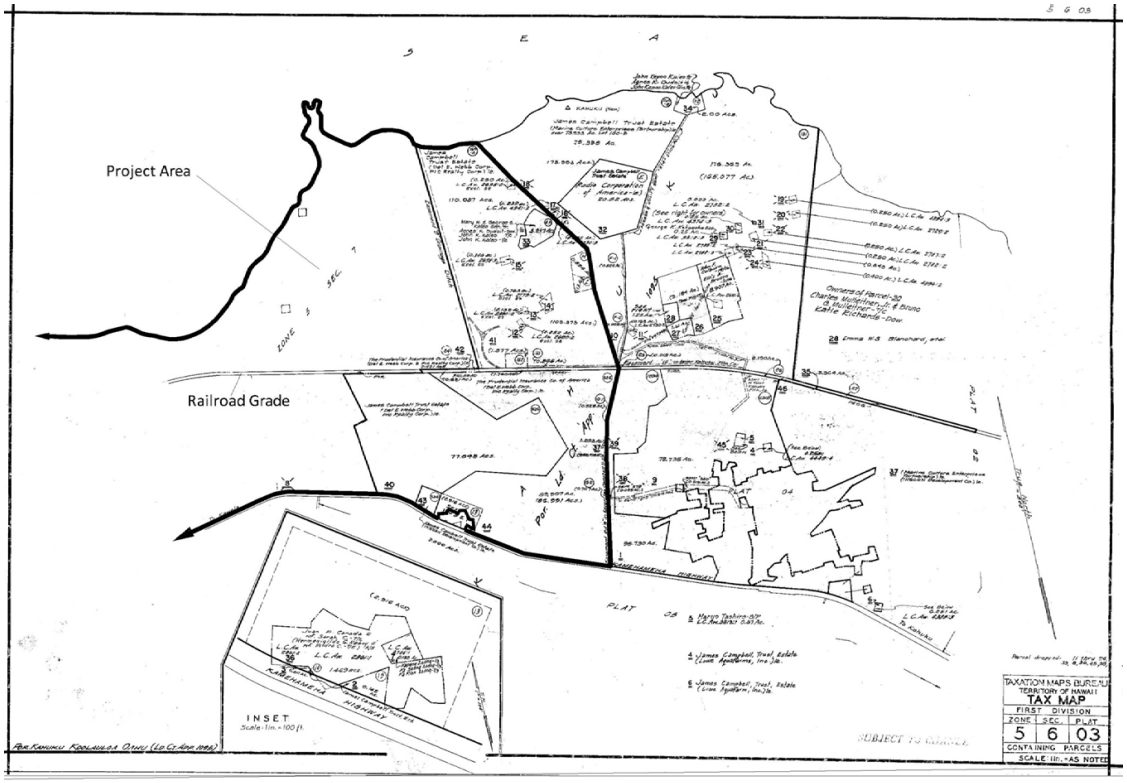


Figure 2. Tax Map Key 5-6-03 showing Portion of Project Area

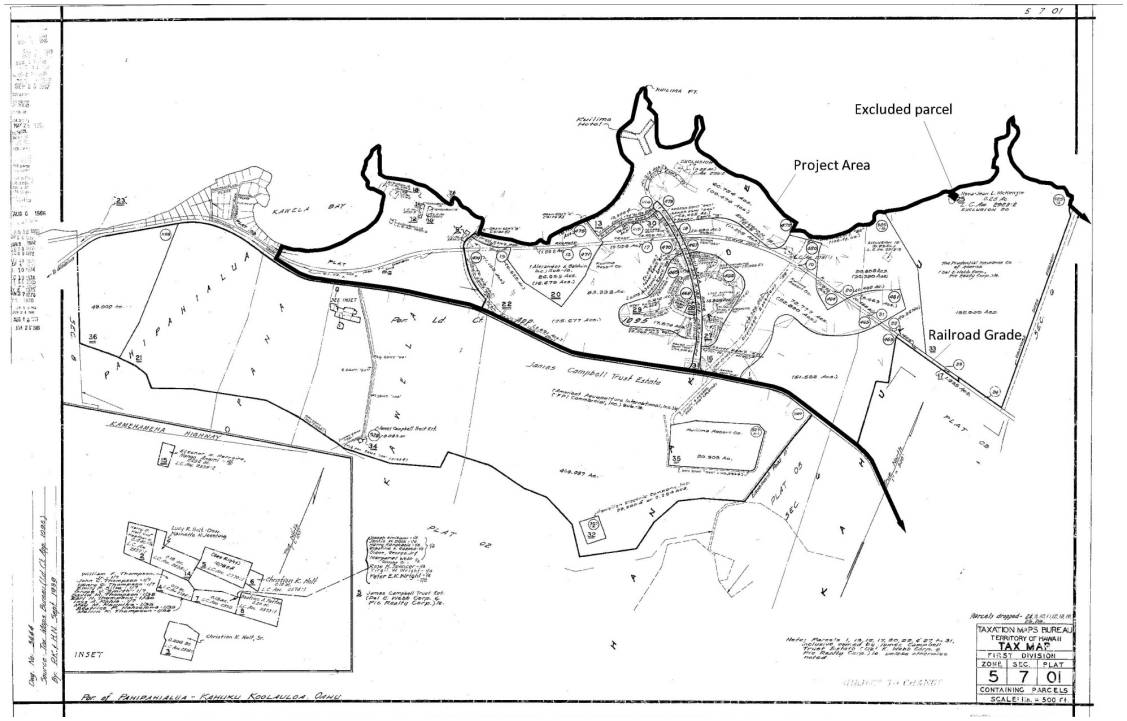


Figure 3. Tax Map Key 5-7-01 showing Portion of Project Area

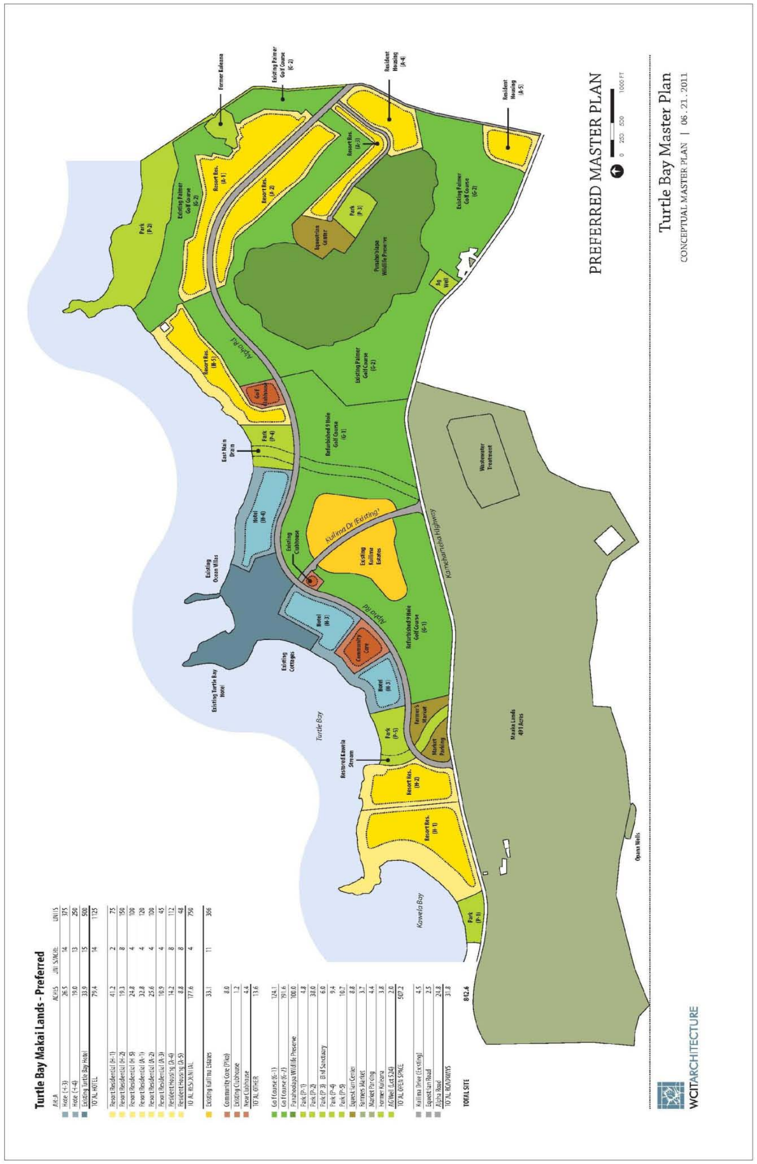


Figure 4. Turtle Bay Master Plan

monitoring and burial treatment (Jensen 1989b) that were approved by the Department of Land and Natural Resources (DLNR) State Historic Preservation Program Director in 1990 (January 9, 1990 letter from Don Hibbard to Paul Rosendahl).

The archaeological data recovery work and monitoring were conducted by PHRI from late 1990 to 1991. After initial data recovery excavations at the Kahuku Point Site were initiated, the landowner decided to halt further work and preserve the site. Monitoring fieldwork results were reported in a series of monthly status reports prepared by PHRI (Sullivan 1990, 1991; Dunn 1991; Donohue 1991). Corbin (2003) reported the full descriptive findings of the PHRI data recovery and monitoring fieldwork and subsequent analyses. DLNR-SPHD approved the Corbin (2003) report in 2005 (letter from Melanie Chinen to Paul Rosendahl March 11, 2005 LOG NO: 2005.0110; DOC NO: 0501SC05).

In 1992, PHRI prepared a Burial Treatment Plan (Maly and Rosendahl 1992) for the reburial and preservation of remains recovered during previous data recovery and monitoring. The plan was prepared to comply with legislation enacted in 1990 pertaining to the treatment of traditional Hawaiian burials under Hawai'i Revised Statutes (HRS) Chapter 6E:43, Act 306. The plan also included reburial of remains inadvertently discovered in 1992 near the resort hotel (Kennedy 1992) and in the mid-1980s at Kahuku Point (Neller 1984, 1989). MOA mandated osteological analysis of human remains by PHRI is reported by Kalima (1993).

In 1996 and 1999, a report on inadvertent discovery of additional burials was prepared by Archaeological Consultants of the Pacific (ACP) for human remains inadvertently discovered in 1996 (Carson *et al*. 1996, 1999). Cultural Surveys Hawai'i (CSH) conducted archaeological monitoring for golf course refurbishment in 2001 but encountered no cultural deposits (Borthwick *et al*. 2001).

ENVIRONMENT

The Turtle Bay Resort project area is a c. 840-acre parcel located on a broad, low-lying coastal plain at the north end of the Island of O'ahu. Kamehameha Highway borders the property on the south (inland) side. The west side terminates at the center of Kawela Bay, while Marconi Road and undeveloped land border the east side. The land is generally level, with the terrain sloping gently to the north towards the shoreline. Elevation rises from sea level at the coast to a maximum of c. 40 ft at the southeast corner of the property, extending one-quarter mile to just over a mile inland. Some dunes at the coast rise 20 ft above mean sea level (amsl), but much of the property is significantly less than 20 ft amsl, and Punahóolapa Marsh is only c. 3 ft amsl. An aerial view of the project area is depicted in *Figure 5*.

The property spans seven traditional land divisions within the Ko'olauloa District (*Figure 6*). From east to west these consist of Kahuku, Punalau, Ulupehupehu, 'Ōi'o, Hanaka'oe, Kawela and 'Ōpana. Only the boundaries of Kahuku, 'Ōpana and Kawela are individually defined on current USGS quadrangle and tax maps of the area. The Land of Kahuku occupies the largest portion of the project area, encompassing 480-acres or 57% of the total area; Kawela encompasses 68-acres (8%) and 'Ōpana 9-acres (1%). The four remaining *ahupua'a* are depicted on the maps with no boundary divisions between them. These *ahupua'a* (Punalau, Ulupehupehu, 'Ōi'o, Hanaka'oe) encompass 283-acres (34%).

Kawela Stream originates at the base of the coastal bluff in the Land of Kawela at c. 800 ft elevation and enters the property beneath the Kawela Bridge on the Kamehameha Highway and empties into the central portion of Kawela Bay; its original channel has long been covered by sediments and the stream course has been artificially channeled for quite some time. 'Ōi'o Stream originates in Waialua District 'Ōi'o Gulch at c. 1,400 ft elevation; it empties into the ocean between Kuilima and Kahuku Points. The 120-acre freshwater Punaho'olapa Marsh is located in the east half of the property. The James Campbell National Wildlife Refuge, administered by the US Fish and Wildlife Service (FWS), was established in 1976 and encompasses 1,100 acres, including Punamanō Marsh and Ki'i Pond, adjacent to the resort's east boundary.

Figure 5. Aerial View of Project Area (from Google Earth)

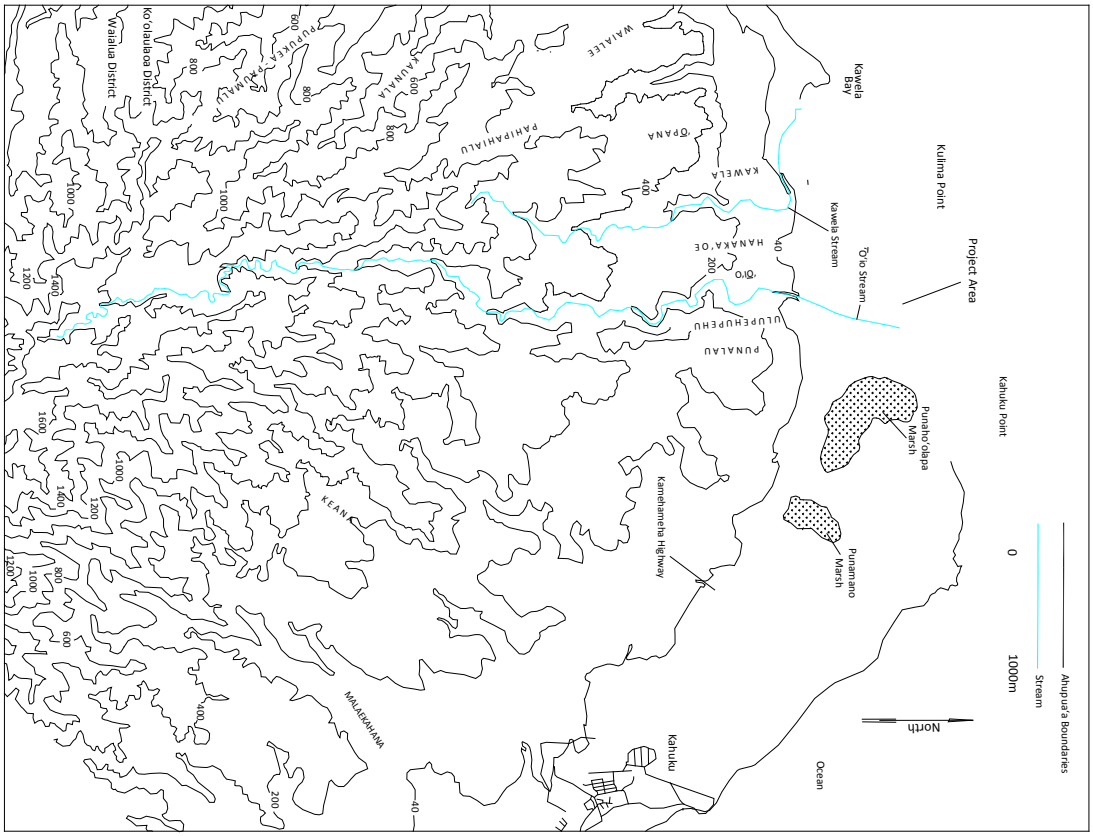


Figure 6. Ahupua'a Boundaries

Climate in the vicinity of the project area is typically mild with average year-round temperatures ranging from 71 to 79 degrees (city-data.com). Rainfall in the area varies from 30 to 40 inches along the coast and 40 to 60 inches per year in the inland areas (Juvik and Juvik 1998:56). The adjacent National Wildlife Refuge (FWS 2011) protects habitat for over 120 species, including four of six endangered native Hawaiian birds. It preserves coastal habitat for the endangered Hawaiian monk seal (*ʻilio holo i ka uaua*) and nesting habitat for threatened green sea turtles (*honu*) and important seabirds. The Refuge provides a strategic landfall for migratory birds coming from the northern Pacific Rim and wetlands birds including Northern pintail (*koloa mapu*), Northern shoveler (*koloa moha*), lesser scaup, Pacific golden plover (*kolea*) and ruddy turnstone (*ʻakekeke*). The migratory populations represent some of the largest concentrations of these species in Hawaiʻi and the Pacific. Other native species that benefit from the protected refuge habitat include the Hawaiian owl (*pueo*) and a species of rare damselfly. These fauna will probably also be found on the resort property.

Undeveloped portions of the TBR property support a variety of introduced plant species. The most prevalent are *koa haole* (*Leucaena glauca*), ironwood (*Casuarina equisetifolia*), Christmas berry (*Schinus terebinthifolius*) and banyan (*Ficus* sp.). Native plants include *hau* (*Hibiscus tiliaceus*), *naupaka* (*Scaevola sericea*), coconut palms (*Cocos nucifera*) and *milo* (*Thespesia populnea*). Sedges (*Scrious lacustris*), saw grass (*Cladium leptostachyum*) and ferns (*Cyclosoro interruptus*) dominate the Punahoʻolapa Marsh vegetation; Christmas berry and *hau* surround the perimeter. The adjacent National Wildlife Refuge marsh supports stands of bulrush and cattail. Invasive alien species targeted for removal on the adjacent refuge include California grass (*Urochloa mutica*), marsh fleabane (*Pluchea x fosbergii*), bullfrogs and feral mallards.

Geology, Hydrology and Soils

Oʻahu is just less than six million years old and encompasses two extinct shield volcanoes: Waiʻanae in the west and Koʻolau in the east (Juvik and Juvik 1998:41). The underlying bedrock on the TBR property was formed by lava deposited 1.7 to 2.5 million years ago from Koʻolau Volcano (*ibid*.:42). The Kahuku Plain is composed of an uplifted fossilized limestone reef formed underwater on the volcanic substratum. The reef formed during inter-glacial periods of higher sea level in the Pleistocene, 12,000 to 2,500,000 years ago (Macdonald *et al*. 1983). Sea level in the northern main Hawaiian Islands reached its Holocene maximum height (c. 2.00 m greater than present) 3,500 years before present (B.P.); subsequent sea level reduction, coupled with island uplifting, exposed the reef bench to high-intensity waves that eroded the reef surface and created the fossilized, stabilized and active sand dunes that formed along the shore (Grossman 1998, Grossman and Fletcher 1998).

The emerged limestone reef surface was eroded by waves and freshwater flows that created karstic features consisting of sinkholes, subterranean streams, fissures and caverns. The karst topography resulted in pools, ponds and marshes inland of the coastal dune fields on the nearly level Kahuku Plain. The water table is close to the surface. Small areas of limestone outcrop are still visible inland of Kawela Bay and Kuilima Point, where they are erroneously called "coral" outcrops (*Figure 7*).

Ground surface weathering also subsequently modified the limestone reef surface after the sea level receded. Accelerated weathering combined with alluvial deposition of sediments and rock derived from the volcanic uplands to essentially cover the Kahuku Plain's limestone surface with a mantel of silt and clay sediments. Talus and alluvial deposits are interbedded, bordered along the coast by wind and wave deposited sands, especially at Kahuku Point where extensive relict and modern dunes are present (Takasaki and Valenciano 1969; Soest 2011). At Kahuku Point, lithified dunes are "shaped by chemical weathering, intertidal bioerosion, and the northeast trade winds to which they are fully exposed" (*ibid*.). Lithified clay (laterite) covers the marine bench inland of the shore at Kahuku Point (Chapman 1946).

The north shore of Oʻahu receives the full brunt of massive waves of the North Pacific Swell in the winters, which move large quantities of sand to the shore. Beach sands are calcareous (calcium-rich) and coarse-grained, typical

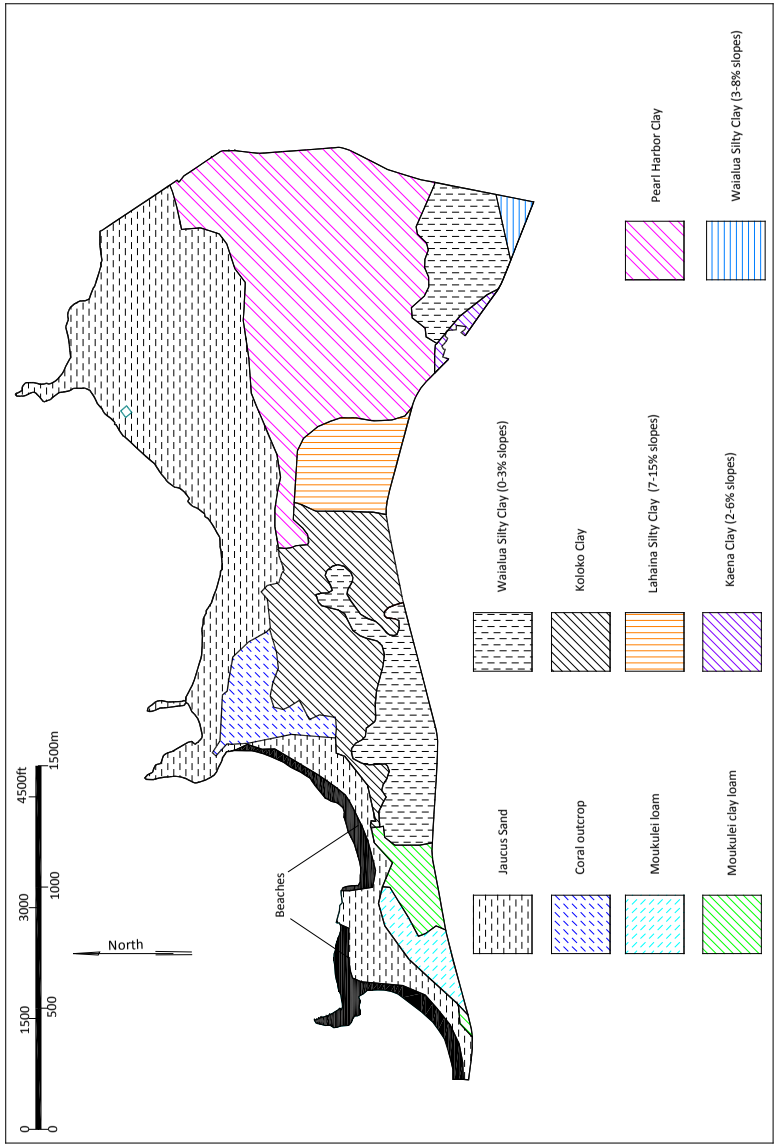


Figure 7. Distribution of Soils within Project Area

of high-energy waves that move detritus from the submerged reefs to shore. Active dunes at Kahuku Point "exist seaward of vegetated Holocene dunes" and "sand dunes and perched beaches along Kahuku Point are continuously reshaped by the persistent trade winds" (USGS 2011a). Catastrophic tidal waves and stream flooding from winter storm runoff are known hazards around the Kahuku Point coastline (*ibid.*):

> During the 1946 and 1957 tsunamis, flood inundation heights of 27 and 23 ft were recorded at Kahuku Point. The hazard associated with high waves is ranked high around the entire Kahuku Point, but...[t]he storm threat is ranked moderately low along the Kahuku coast because it is partly sheltered from the impact of the majority of tropical storms that historically track to the west and south of Oahu. Erosion is ranked moderately low for the small embayments lining the western portion of Kahuku Point, except along the rocky point immediately northeast of Kawela Bay beach where it is low.

On the Kahuku Plain, freshwater constitutes a major natural resource. Perennial and intermittent streams once provided ample water across the plain. Coastal brackish marshes on the Kahuku Plain formed in the elevated coral reef, fed by the numerous streams originating in the uplands to the south, by rainfall, springs and seeps (Hunt and De Carlo 2000; Takasaki and Valenciano 1969:48). Subterranean seawater extends inland from Kahuku west to Kawela and beyond, naturally contaminating the basal freshwater body (Takasaki and Valenciano 1969). Basal water channeled from volcanic dikes in the Kōolau Range recharges the shallow water table underlying the Kahuku Plain and is perched above the infiltrating seawater (*Ibid.*). This provides sufficient pressure for springs, seeps and artesian wells. Flooding is most prevalent in March, but can occur throughout the year (*Ibid.*:16).

Eleven soil types have been described and mapped in the property (Foote *et al.* 1972). These consist of beach sands, coral outcrops, Jaucus sand (0-15% slopes), Pearl Harbor clay, Waialua silty clay (0-3% and 3-8% slopes), Kaloko clay, Lahaina silty clay (7-15% slopes), Mokulei loam and clay loam, and Kaena clay (2-6% slopes). The distribution of these soils is shown in *Figure 7* and their characteristics are summarized in *Table 1*.

Jaucus Sand is the most widespread sediment, which encompasses 277 acres, or 33% of the property. It is exposed along the coastal margins and is characterized by well-drained single-grained sand to depths exceeding more than 60 inches. It is considered suitable for pasture, sugarcane, truck-crops, and urban development.

Pearl Harbor Clay is the next most extensive sediment, encompassing 227 acres, or 27% of the property. It largely coincides with the former extent of Punaho'olapa Marsh and consists of poorly drained, mottled clay overlying mottled clay subsoil, formed on layers of muck or peat. Pearl Harbor clay is classified as suitable for pasture, sugarcane, taro and bananas.

Waialua Silty Clay covers 105 acres, or 12% of the total on gentle slopes in the southeastern corner of the property. It is moderately well drained and characterized by a silty clay surface layer overlying a subsoil of blocky silty clay formed on a mottled silty clay substratum. It is suitable for pasture, sugarcane and truck crops.

Kaloko Clay covers 96 acres, or 11% in the central portion of the property. It is developed in alluvium derived from igneous rock and is poorly drained. It consists of clay overlying multiple layers of clay and silt clay. It is classified as suitable for pasture and sugarcane.

Lahaina silty Clay covers 39 acres (5%) in the east-central portion of the property. It is derived from weathered igneous rock and is well drained, and is typically exposed on slopes above the coastal plain. The surface layer is severely eroded and overlies a blocky silty clay and silty clay loam subsoil, formed on weathered igneous parent material. It is classified as suitable for sugarcane and pineapple.

Coral Outcrops cover 27 acres, or 2% of the area, inland of Kuilima Point. The outcrops are composed of cemented coral or calcareous sand that formed in shallow ocean waters when the sea levels were higher. It is classified as suitable for military installations, quarries and urban development.

Table 1. Summary of Soils within Project Area

Soil Type	Acres	% of Project Area	Description	Permeability	Runoff	Erozion Hazard	Suitability
Jaucus Sand (0-15% slope)	277	33	Single grained sands	Rapid	Very slow to ponded	Slight	Pasture, sugarcane, truck crops, urban development
Pearl Harbor Clay	227	27	Mottled clay surface layer over mottled clay subsoil, over muck or peat	Very slow	Very slow to ponded	Slight	Pasture, sugarcane, taro, bananas
Waialua Silty Clay (0-3% slope)	105	12	Silty clay surface layer over subsoil of blocky silty clay over mottled silty clay substratum	Moderate	Slow	Slight	Pasture, sugarcane and , truck crops
Kaloko Clay	96	11	Clay surface layer over clay and silt clay subsoils	Moderately slow to slow	Slow to very slow	Slight	Pasture and sugarcane
Lahaina Silty Clay (7-15% slope)	39	5	Severely eroded silty clay surface layer over blocky silty clay and silty clay loam subsoil over weathered igneous rock substratum	Moderate	Medium	Moderate	Sugarcane and pineapple
Coral outcrop	27	3	Cemented coral or calcareous sand	n/a	n/a	n/a	Military installations, quarries, urban development
Mokulei Clay Loam	20	2	Clay loam surface layer over sand and loamy sand subsoils	Moderate	Very slow	Slight	Pasture, sugarcane and truck crops
Beaches	19	2	Sandy, gravelly or cobbly areas	n/a	n/a	n/a	Recreation
Mokulei Loam	18	2	Clay loam surface layer over sand and loamy sand subsoils	Moderate	Very slow	Slight	Pasture, sugarcane and , truck crops
Kaena Clay (2-6% slope)	6	1	Clay surface layer over clay subsoil over highly weathered gravel	Slow	Slow	Slight	Pasture, sugarcane, homesites
Waialua Silty Clay (3-8% slope)	5	1	Silty clay surface layer over subsoil of blocky silty clay over mottled silty clay substratum	Moderate	Slow	Slight	Pasture, sugarcane and truck crops
Total	840	100					

Mokulei Clay Loam encompasses 20 acres or 2% of the project area. An area of Mokulei loam (18-acres, 2%) is located in the southwest portion of the parcel. This soil is characterized as well-drained clay loam surface layers, over sand and loamy sand subsoils (1972:96). These soils are classified as suitable for pasture, sugarcane and truck crops.

Beaches cover 19 acres or 2% of the total property area and are restricted to Turtle Bay and Kawela Bay. The coastal strands in these bays are characterized as sandy, gravelly or cobbly and are classified as suitable solely for recreation.

Kaena Clay encompasses 6 acres, or 1% of the property, and is found only along the southeast edge of the resort. The clay is very deep, poorly drained, and is exposed on alluvial fans and talus slopes. It is characterized by a clay surface layer overlying clay subsoil, formed on a highly weathered gravel substratum. It is classified as suitable for pasture and sugarcane.

HISTORIC BACKGROUND RESEARCH

Place names of prominent locales often reference memorable historic people and deities, notable events, or significant activities. These have come to encapsulate salient aspects of local Hawaiian history. Hawaiian toponymic etymology explains or elaborates on important aspects of the physical environment, such as fresh water sources, food sources and prominent natural features. Place names also reference the locations of specific structures and often persons explicitly associated with a site. Legendary history recounts mythical events in the distant past and historical events tied to genealogical lineages of a particular place or general area. These provide the basis for developing a cultural context for understanding the area's social geography.

Place Names

Pukui *et al*. (1974) offer the following translations (or possible translations) for several of the project area land divisions. The literal translation of Kahuku is "the projection" or "the hillock", and Punalau means "many springs". ʻŌiʻo is the Hawaiian word for "bonefish" and ʻŌpana, which is perhaps related to *ʻōpā* translates as "the squeeze". Kawela is translated as "the heat" which is also the name used to describe the coastal portions of the Pahipahiʻāula, the land bordering Kawela to the west. No translations for Hanakaʻoe or Ulupehupehu are presented in Pukui *et al*. (*ibid.*).

Several other natural features within the project area and adjacent lands have traditional Hawaiian names (*Figure 8*). The shoreline at Kawela Bay was referred to as "Wākiu" meaning "northwest wind sound" (Clark 1977:132). A fishpond of the same name was reportedly once located inland from this beach. The east section of Kawela Bay was called "Waikalae", or "divided water", which is likely a reference to ʻŌiʻo Stream that formerly divided in this area with one fork extending to Kuilima Bay and the other emptying into Kawela Bay. (*ibid*.:132-133). A small offshore island and reef north of the northern end of Kawela Bay is called "Pāpaʻamoi" which translates as "scorched threadfish"; "Pāpaʻamoi" was frequented by the gods Kanaloa and Kane who went there to "scoop up fish" (McAllister 1933:147).

"Kuilima" is a recent name for the area between Kawela Bay and Kahuku Point. Kuilima translates as "to go arm in arm", which is a reference to a story of three men who walked across the plains with linked arms (Clark 1977:133). The point of land at Kuilima was once referred to as "Kaleokaunui" or "the point of the altar" and the eastern end of the cove is called "Kalaekamanu" or "the point of the bird". The cove between these points is called "Kalokoiki" or "the little pool".

The traditional name for the broad bay between Kuilima and Kahuku Point was "Kaihalulu" or "roaring sea", likely in reference to the large waves that crash upon the shoreline (*ibid.*:134). "Kalaeokauna'oa" is the traditional name

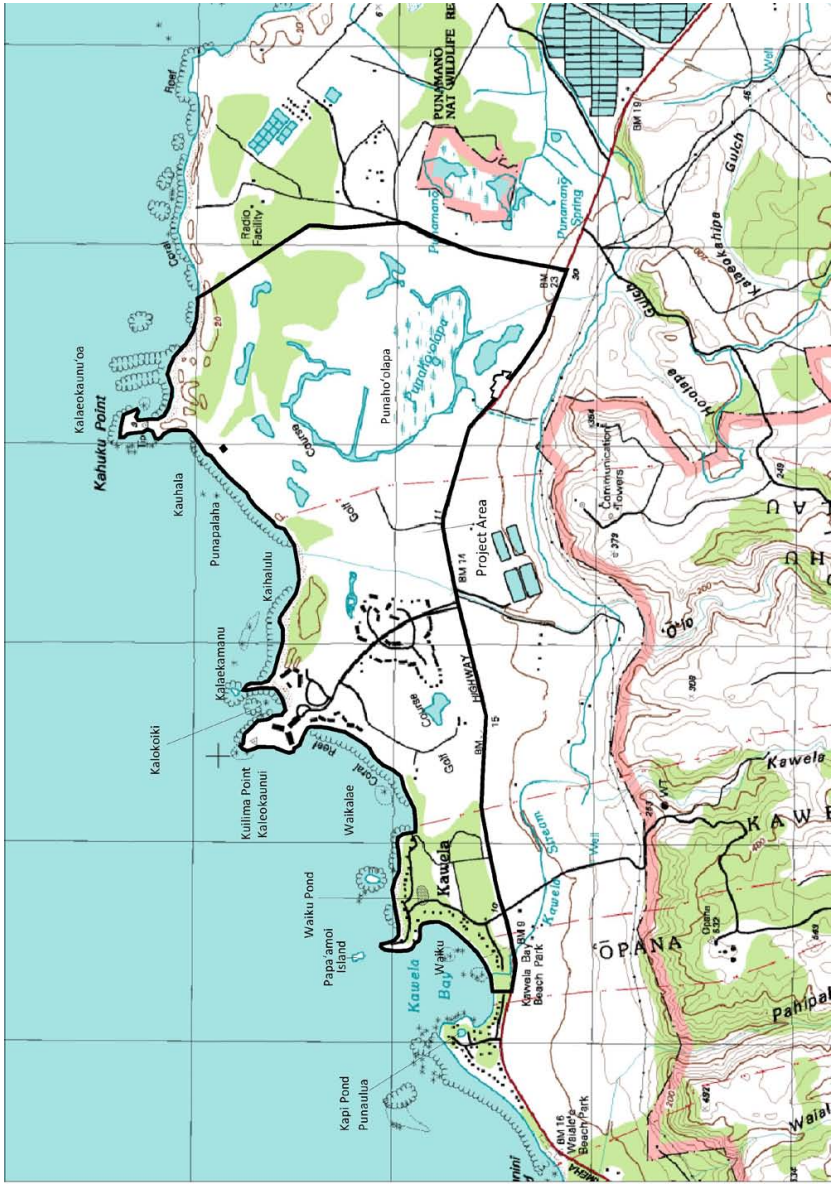


Figure 8. Named Places within and Adjacent to Project Area

for Kahuku Point, which translates as "the point of kauna'oa" (*ibid*.). The area to the west of Kahuku Point was called "Punapalaha" or "slippery spring" with the area to the east of this called "Kauhala" or "to move up and down as waves" (*ibid*.). Punaho'olapa Marsh located inland of Kahuku Point means "restless spring" (Pukui 1983:229).

Kapi Pond is located just outside the project area to the west. A spring feeding this pond is called Punáulua, which means "*ulua* (crevalle jack) spring" in reference to the abundance of *ulua* (Crevalle jack) just offshore. The abundance of this fish in this area was attributed to the mixing of salt water with the fresh water from the spring (Clark 1977:131-132).

A *heiau* once existed in the vicinity of the project area, likely situated inland of Kamehameha Highway. Although destroyed prior to McAllister's survey of Óahu, informants indicated to him that it was called Pu'uala Heiau and was "located on the ridge overlooking Kahuku Ranch" (McAllister 1933:152). According to the "Legend of Kāma'akamahi'ai", the area around Púuala Heaiu was used for sports:

> When Keaua'ula reached Pu'u-'ala in Kahuku, he met some people who were indulging in sports there....They were spear throwing and moa sliding and they urged him to stop and play (J.W.K. Kauaililinoi, originally published in Hawaiian in the newspaper *Ku'oko'a,* Nov. 5, 1870, translation in Sterling and Summers 1978:149).

Legendary History

The following discussion of the legendary background of the project area vicinity is largely derived from Lehua Kalima's research presented in Corbin (2003). Although Kahuku is an *ahupua'a* of the Ko'olauloa District, it is often referenced a district or region, with many references to its physical volatility. An example of this is presented in the following Hawaiian adage: *Kahuku 'aina lewa* (Kahuku an unstable land). O'ahu, according to legend, was once two islands that grew together; Kahuku is the part that bridges the gap (Pukui 1983:144).

There are several accounts of Kahuku once being a floating island that created a disturbance when it would collide with Oahu, causing the Ko'olauloa people to attach it to the mainland with fishhooks (Boswell 1958:68):

> Kahuku District, according to legend, was once a floating island blown about by the winds. As it banged against Oahu, it made noises, which disturbed the old women guarding the Princess Laieikawai. The old women grappled the island with fishhooks and attached it securely to Oahu. Polou pool on the sea side of the Kahuku Mill is one spot where the hook was fastened. The other end was fastened in Kukio.

The missionary Levi Chamberlain (1957:35-36) heard the following legend during a tour of the island in 1928:

> The natives tell a marvelous story respecting the origin of this district, which they say floated in from the sea, and attached itself to the ancient shore of the island, that there was a subterranean communication between the sea and the ancient shore, by which a shark used to pass and make depredation up on land. The basis of the tract, which is from 5 to 7 miles in length and from 1 to 2 miles in breadth appears to be of coral and it was evidently redeemed from the sea, as a good deal of the land, in many places along the shore around the whole circuit of the island, evidently has been.

The following legend indicates that the floating island of Kahuku was once the home of the Menehune (Paki In Silva 1984:3):

> Kahuku section of O'ahu was once a separate island...It was an islet whose people were the Menehune, or Dwarfs as they are called today. Many stories are told about the miraculous feats

> performed by the Little People of ancient Hawaii. It is known, also that they always worked from just after sunset until just before dawn.
>
> Legend tells us that Kahuku was a floating island situated several miles out to sea. For a long time, the people of O'ahu had planned to make the island a part of their land, for they say it came close to O'ahu's shores. The floating island of the Menehune did not have any fresh-water springs because there were no high mountains covered with verdure and trees to capture the rains. So, the Little Folk used to paddle their islet into the bays of O'ahu at night to haul water from the springs of the large island.
>
> One day, a resident of Kahuku suggested that all the people gather together to make strong hooks of whalebone and attach them to a stout rope made of sacred Olona fibers. This was done.
>
> The Menehune came to take water as usual, then the residents of O'ahu attached the large hooks to the floating isle while the Little Folk were off at the water-springs. When the water was loaded, the Menehune started to paddle off again, but they could not move their islet or free it from the ivory hooks and Olona ropes.
>
> Today, many people who travel Kahuku section of O'ahu and see the many islets seeming to float off shore, and hear the sea singing its songs, they say, "Listen to the Menehune grumbling while they try to move their island that used to float!" The rumbling and grumbling is heard only at night, for that is the time for the Menehune to be working at Kahuku.

Pukui (1983:239) presents a proverb that indicates that the Kahuku region was once connected to Waipahu via an underground stream: "*Pukana wai O Kahuku*" (The water outlet of Kahuku). This stream is also cited in Thrum who indicates that it flowed between Punaho'olapa Marsh in Kahuku and Waipahu Stream in Waipahu (Thrum 1910:130-131):

> A kapa-beating log of peculiar sound, unlike any other known on the island, which was placed in its waters at the close of a kapa-making season to keep it smooth and free from cracks that would impart an impression to the cloth in its manufacture, was missed, and, believing it to have been stolen, search was made all through the Koolau, Waialua, and other districts till at last it was found in use at Waipahu. Recognizing it by its resonant tone, it was claimed by the searching owner and right thereto by those in possession as vigorously maintained. To test the truth of ownership as claimed, the Ewa people accompanied the claimant back to Kahuku to visit the scene and witness a test of the underground stream theory. A bundle of ti leaves were gathered, which was wrapped together and consigned to the Waters of Punahoolapa. In the course of a few days they were lost to sight, whereupon the party set out for Ewa, and after careful watching, as predicted, the bundle of ti leaves came forth on the bosom of the waters of the Waipahu stream. The kapa log was thereupon recognized as the rightful property of the Kahuku claimant.

Handy and Handy (1974:443) support the potential existence of this legendary subterranean water course :

> It is said that Oahu's most famous burial cave was in Kanehoalani. Its name was Pohukaina. One entrance was in the northern cliffside facing Ka'a'awa and another is at a spring named Ka'ahu'ula. This great cavern was believed to run right through the Ko'olau range. There was an opening in Moanlua on the leeward side of the island, and others were in Kalihi, Puiwa, and Waipahu. Still another was in Kahuku. The "roof" of the cavern was called Kauhuhu, and this was "in the mountain Konahuanui, sloping down toward Kahuku." Many are said to have gone with *kukui* nut candles from Kona (leeward Oahu) to Kahuku. In the caves are "many creeks, rivers and streams" (*Ke Au Hou,* June 28, 1911).

Early Historic Period (Contact to 1846)

The first western description of the Kahuku region comes from Captain Clerke on February 28, 1779 (quoted in Nakamura 1981). Clerke, who had taken command of the H.M.S. Resolution following the death of Captain Cook two weeks earlier, observed a large settlement in the vicinity of Kahuku Point and described the land as “exceedingly fine and fertile” (ibid.: 1). Another member of the crew, Lieutenant James King, provided the following account of the region between Kaneohe Bay and Waialua (quoted in McAllister 1933:153):

> It [Oʻahu] is by far the finest island of the whole group. Nothing can exceed the verdure of the hills, the variety of the wood and lawn, and the richly cultivated valleys, which the whole face of the country displayed.

In 1792, the British ship Daedalus, part of Vancouver’s squadron, anchored in Waimea Bay to obtain water. The shore party, consisting of the commander, the astronomer, and two seamen, was attacked and all were killed except one seaman (Kuykendall 1967). In 1794, Vancouver (1798: Vol. III: 71) described the Kahuku region as less flourishing and inhabited than King had earlier described, a situation that Nakamura (1981) attributed to depopulation:

> …In every other respect our examination confirmed the remarks of Captain King excepting, that in point of cultivation or fertility, the country did not appear in so flourishing a state, nor to be so numerously inhabited, as he represented it have been at that time, occasioned most probably by the constant hostilities that had existed since that period.

During Levi Chamberlain’s 1828 tour of the area he stopped at several schools in the vicinity of the project area, including those in the communities of Lāʻie, Mālaekahana and Kahuku. There is however no mention of any schools in any of the other project area *ahupuaʻa*, which suggests that these communities were too small to support a school (O’Hare and Hammatt 2006:14). According to Chamberlain (1957: 35-36):

> Tuesday Feb. 5th. After breakfast I examined two schools, belonging to Laie & Malaekahana, and was pleased with the appearance of the scholars. At a quarter before 11 A.M., we set out for Kahuku, and after traveling about two hours over a level sandy country, arrived at the school house, where we found 83 scholars assembled, waiting to be examined.

Land Commission Awards (1846-1855)

A significant transition from the traditional land tenure system to the introduced concept of private land ownership occurred in Hawaii in the mid-1800s. “At that time, Kamehameha III relinquished absolute ownership of lands in the Islands and individuals were allowed to register legal verifiable claims to their households and agricultural plots” (Bath *et al*. 1984: C-15). Further, “[t]he old feudal arrangement of joint and undivided ownership had given place to the system of individual allodial tenures, and aliens had been admitted to the enjoyment of the same rights as Hawaiian subjects in the ownership and use of land” (Kuykendall 1967:298).

Ahupuaʻa within the project area are depicted in several ways depending on the source. The current USGS quadrangle maps of the area depicts seven land divisions including Kahuku, Punalau, Ulupehupehu, ʻŌiʻo, Hanakaʻoe, Kawela and ʻŌpana (see *Figure 1*); however, an 1878 Government Survey Map of the island only depicts Kahuku, Kawela and a combined area including ʻŌiʻo and Hanakaʻoe (*Figure 9*). O’Hare and Hammatt (2006:14) suggest this disparity may be the result of politics: “It seems likely that prior to the conquests of Oʻahu by the chiefs of Maui (c. 1783) and Hawaiʻi Island (1795) that Ōiʻo 1 & 2, Ulupehupehu, Punalau, Hanakaʻoe and Kawela were understood as separate *ahupuaʻa* but that they were combined for political purpose by 1848”.

Kahuku and Kawela were designated as Crown Lands of King Kamehameha III (Indices 1929:27-28) while the remaining *ahupuaʻa* in the project area were taken as government land (1929:40-44). The Waihona ʻAina (2000)

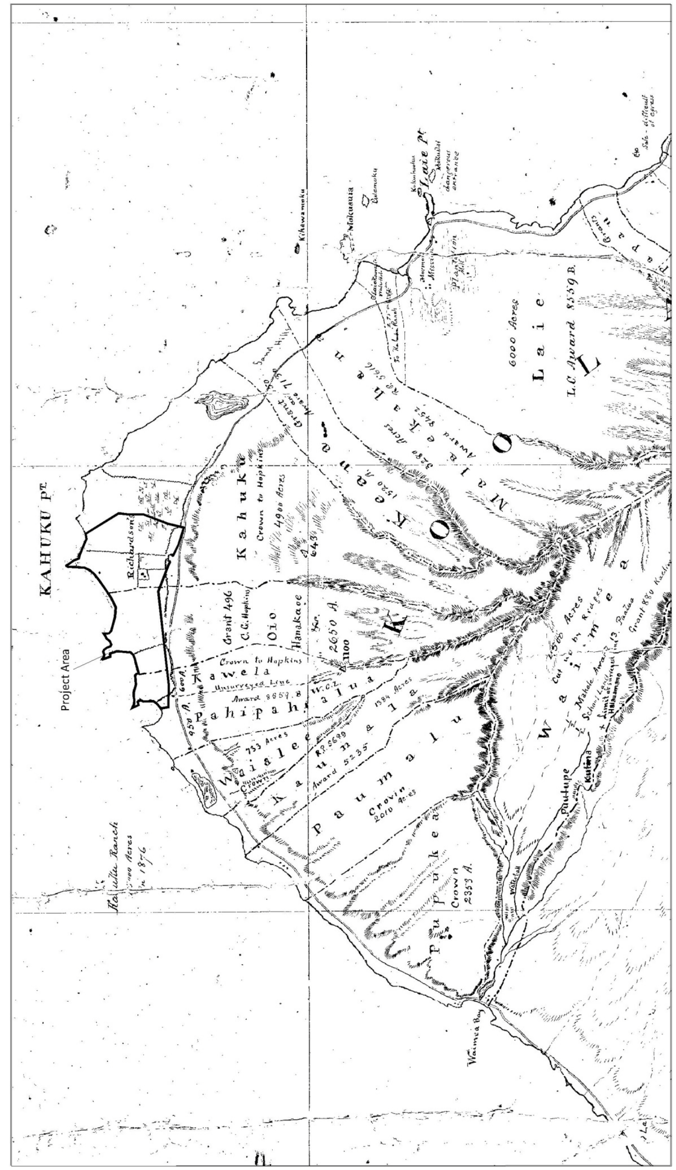


Figure 9. Portion of Lyon’s 1878 Government Survey Map of Oahu

Mahele Database is a compilation of data from the Indices of Awards (Indices 1929), Native Register (NR n.d.), Native Testimony (NT n.d.), Foreign Register (FR n.d.) and Foreign Testimony (FT n.d.). The Database lists 101 land commission award (LCA) claims for the project area *ahupua'a*. Of these 101 claims, only 88 were awarded. The Database also reflects the disparity in the names of the project area *ahupua'a* because 'Ōpana, Ōi'o, Hanaka'oe, Ulupehupehu and Punalau are sometimes referred to as separate *ahupua'a*, although in other instances are referenced as *ili* of Kahuku or Kawela.

Of the 101 LCAs, 35 are located within the boundaries of the project area and 66 are located in the surrounding area. The locations of the LCAs were determined through analysis of historic maps and tax maps. The majority of the 66 LCAs are depicted in *Figure 10* and summarized in *Table 2*. Sixty-six LCAs name 64 individuals: single claimants filed on 62 LCAs and the remaining four LCAs were awarded to two claimants (Kaio LCAs 4394 and 4396; and Uha 2681 and 3748).

Of the 66 LCA claims, most are listed in the Land of Kahuku (n=47). Of the 19 remaining claims, seven list Kawela. Three list Kahuku and Punalau. Two list Kawela and Kahuku. Two list Kahuku and Ulupehupehu. Two list Kahuku, Punalau and Ulupehupehu. One lists Ōi'o. One lists Ōi'o, Hanaka'oe and Kahuku. One lists Kahuku, Ulupehupehu, 'Ōi'o, Hanaka'oe, Kawela and 'Ōpana. The claims outside of the project area are clustered in four areas, with the majority located in Kahuku, in the vicinity of the Kamehameha Highway (see Inset 1 on *Figure 10*). A second cluster is situated seaward of the first in the central Kahuku area. Four LCAs are situated to the east of the first cluster. The fourth cluster is located in the Land of Kawela, just inland of the highway (see Inset 2 on *Figure 10*).

Thirty-five LCAs within the project area are summarized in *Table 3* and their locations are presented in *Figure 11*. Thirty-five LCAs name 31 individuals: single claimants filed on 27 LCAs and the remaining eight LCAs were awarded to four claimants (Waanui – LCA 2698, Hoolae – 2716, Pakanaka – 2744, Kaohele – 2861). Of these 31 individuals, 21 claimed parcels in areas adjacent to the project area. These additional claims are indicated by asterisk in *Table 3* and are depicted on *Figure 10.* The majority of the LCAs within the project area and several east of the project area are also depicted on the 1890 map of the Kahuku Plantation (*Figure 12*).

Most of the claimed parcels are located in Kahuku Ahupua'a (n=17). Eleven are located in Kawela. The remaining seven claims list Kahuku and one or two additional *ahupua'a*. Three list claims in Kahuku and Punalau, three list Kahuku, Punalau and Ulupehupehu and one lists claims in Kahuku and Ulupehupehu.

'Ōpana, Ōi'o, Hanaka'oe, Ulupehupehu and Punalau are sometimes listed as *ili* of Kahuku and Kawela. Claim testimonies mention additional *ili* land divisions within both Kahuku and Kawela. The *ili* in Kahuku include Aamo, Ahamau, Kakala, Kalimaloa, Lanahu, Lauhine, Mookini, Mookahi, Punama, Puaakea and Uwalakui. The *ili* in Kawela include Kamalua, Kamooiki, Kaneloko, Kaunala, Kawelaluna, Keokea and Kumpali. Most parcels were conveyed to claimants during the time of Kamehameha I (n=12). Seven were conveyed during the time of Kamehameha III and four during the time of Kamehameha II. Testimonies from two claims indicate they were conveyed in 1842.

House lots are mentioned in 24 claims. There are 36 *lo'i* (pondfields) described in the claims with three claims specifically mentioning *kalo* (taro). Testimonies refer to cultivated bananas (6 references), sweet potatoes (6), *wauke* (6), sugar cane (3), bitter melon (3), *noni* (2) and orange tree (1). Other named plants are *Pandanus* trees or *hala* or groves (2) and *koa* trees cultivated for canoes (1). One claim mentions a *puna pa'akai* or brackish spring and one mentions a fishery.

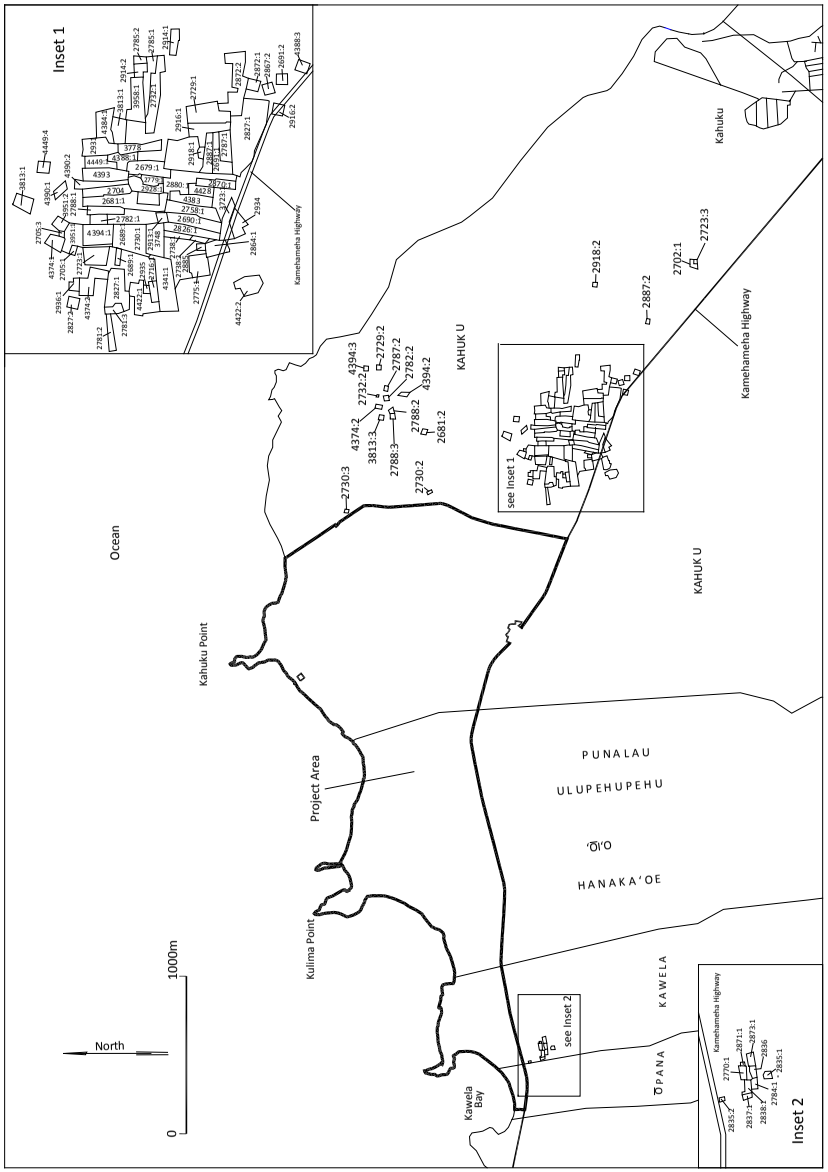


Figure 10. Land Commission Awards outside Project

Table 2. Summary of Land Commission Awards outside of Project Area

LCA	Claimant	Ahupua'a	Ili	Awarded
2681	Uha	Kahuku		Yes
2691	Luamea	Kahuku	Alamau, Kaipauba, Puulu, Kalehunui	Yes
2702	Waialua	Kahuku	Kaupoo, Koolina, Mahukini	Yes
2704	Hau'i	Kahuku		Yes
2705	Hao	Kahuku		Yes
2723	Puu	Kahuku		Yes
2729	Polena	Kahuku		Yes
2730	Paharui	Kahuku	Keahupuaa, Ahamau, Punakaipo	Yes
2732	Pukawale	Kahuku	Keelee	Yes
2758	Napoe	Kahuku	Ulupehupehu	Yes
2771	Maulua	Kahuku	Oio	Yes
2776	Mahoe	Kawela	Keolea	Yes
2778	Mahu	Kawela		Yes
2780	Muli	Kawela		Yes
2782	Makole	Kahuku, Punalau	Punalau Ahamau, Oio, Luahine, Kaiala, Amo	Yes
2785	Makakiekie	Kahuku	Ahamau	Yes
2787	Makarokalai	Kahuku	Luahine, Hanumoha	Yes
2788	Mauoli	Kahuku	Hanapaua, Poohaluhi, Waiula, Manomo	Yes
2789	Moonl	Kahuku	Waiula, Ahamau, Kakala, Haleamani, Poohaluhi, Kaea	No
2817	Kino	Kahuku		Yes
2835	Kalawearmeku	Kahuku	Moolani, Punalau, Ulupehupehu, Ahamau	Yes
2827	Kanahuna	Kahuku	Mana, Ahamau	Yes
2836	Kelemana	Kahuku	Maheolani	Yes
2864	Kiha, Josua	Kahuku	Kahuku, Punalau, Ulupehupehu	Yes
2867	Keino	Kahuku	Limalaa, Amo, Kaiholoa	Yes
2868	Kapalaala	Kahuku		Yes
2870	Kai	Kahuku		Yes
2872	Kaihikapu	Kahuku		Yes
2873	Kaunahi	Kawela		Yes
2875	Kaopuu	Kawela, Kahuku	Maheolani	No
2878	Kekua	Kawela	Kamooiki	Yes
2885	Kupihea	Kahuku, Punalau, Ulupehupehu		Yes
2887	Keawe	Kahuku	Ahamau	Yes
2888	Kauparona	Hanakaoe, Kawela, Oio, Kahuku, Opana, Ulupehupehu	Lanahu, Uwalakui	No
2889	Kekohai	Oio, Hanakaoe, Kahuku		No
2890	Kaila	Kahuku		No
2892	Kainalu	Kahuku, Punalau	Lanahu, Haleamani, Amo, Niuloiu	Yes
2906	Kaaumakua	Kahuku, Ulupehupehu	Ikemaka	Yes
2909	Kamalama	Kahuku, Punalau, Ulupehupehu	Kaunala	Yes
2914	Keakaokawai	Kahuku	Ahamau	Yes
2916	Kahuau	Kahuku	Ahamau	Yes
2918	Kawaa	Kahuku		Yes
2931	Keawelekini	Kahuku	Ahamu, Keana	Yes
2932	Kailiulu	Kahuku, Ulupehupehu	Puuakea, Oio, Hanakaoe	Yes
2934	Kalahana	Kahuku	Oio	Yes
2935	Kekuauli	Oio, Hanakaoe, Kahuku	Oio, Udakui	Yes
3712	Moku	Kahuku		No
3723	Male	Kahuku		Yes
3748	Uha	Kahuku	Keahupuaa, Makapala, Ahamau	Yes
3778	Aaiki	Kahuku	Ahamu, Poohaluhi, Puulu, Kahani	Yes
3813	Pakui	Kahuku	Ahamu, Ao, Wiwikalani	Yes
3871	Pakiu	Kahuku	Ahamau, Poohaluhi, Keakaako	Yes
3951	Niau	Kahuku		No
4329B	Kuapuhi	Kahuku	Puohaluhi, Pauwela	Yes
4374	Kuapuu	Kahuku	Makaha, Kapawa, Keana	Yes
4383	Kula	Kahuku	Ahamu, Kahauloa, Makapala, Kalimaloa, Poohaluhu	Yes
4384	Kelipi	Kahuku	Ahamu, Amo, Poohaluhu	Yes
4388	Kau	Kahuku	Ahamau, Paohaluhi	Yes
4390	Kupaihea	Kahuku	Ahamau, Poohaluhi	Yes
4393	Kauni	Kahuku	Ahamau, Poohaluhu, Wikiwikilani	Yes
4394	Kaio	Kahuku, Punalau		Yes
4396	Kaio	Kahuku		No
4422	Kaumaili	Kahuku	Nanahu, Waihokahala, Luahine, Ahamau, Ulupehupehu	Yes
4428	Kuhoopohopoho	Kahuku		Yes
4449	Kaiikaula	Kahuku	Ahamau	Yes
8810	Kawahaku	Kahuku		No
10931	Uluhao	Kahuku		No

Table 3. Summary of Land Commission Awards within Project Area

LCA	Claimant	Ahupua'a	Ili	Awarded	Section No.	Other Claims	Apana Awarded	Apana Claimed	Boundary North	Boundary East	Boundary South	Boundary West	Date Rec'd	Grver	Acreage	Royal Patent	Sources	Comment
2356I	Kaii	Kawela					1	2	Keauaula's land	Kohanaiki land	Kookoo's land	Kohanaiki land			0.41	508	FT 11: 239	Claimm died in 1849 and left property to his daughter Nahuli
2679*	Uneune	Kahuku	Punana, Meokini,	Yes	2		1	2	House lot, 5 kalo patches						0.25	259	NR 3: 679 FT 10:174	
2690*	Liiki (Liahi?)	Kahuku	Ulupehupehu	Yes	2		1	2	House lot *puna pa'akai* (Backish spring?), two hala trees	kala	kala	kala	Kam I times		0.25	339	NR 3: 591- 592 FT 10: 164	
2698*	Waanui	Kahuku, Ulupehupehu	Oio	Yes	3	2	1	3	House lot	Land fence	weed grown kala	weed grown kala	Kam I times		0.25	339	NR 3: 595- 596 FT 10:165	
									Loko's land	Kalilia's land	Kuuhaha's land	Naapo's land	Kam III times					
									Kalilia's land	Kuuhaha's land	Kalilia's land	Kalilia's land	Kam III times					
					2				House lot									
					2				*2 loi*									
					3				Open flat lands	n/d	n/d	n/d	Kam III times					
2706	Holoaa	Kahuku	Lanahu	Yes	2		1	2	House lot	Kuumaliiis land	Kuuhaha's land	Kuuhaha's land	Kam II times		0.25	244	FT 10:186	His daughter Kaleikini is Teloaa's heir
2716*	Hoolee	Kahuku	Oio, Lanahu, Hanakaoe	Yes	1		1	3	House lot	Kuumaliiis land	Kuuhaha's land	Waiheiwa's land	Kam II times		0.6	8000	NR 3: 601- 602 FT 10:161	
					2				*lot* with water, sweet potatoes, bananas, Butter melon, sugarcane, koa trees									
2724	Palai	Kawela	Kamhua, Kaumpaa	Yes	3		1	3	House lot	Kohanaiki land	Kohanaiki land	Kuheleloa's land		Kinau	0.25	514	NR 3: 608 FT 10: 156	
2734	Puiioa (Puioa)	Kawela	Opana	Yes	1	2	1	3	House lot, 2 *loi*	kala	kala	Kookoo's land					NR 3: 612, FT 10:158	
2738*	Palu	Kahuku	Oio, Ulupehupehu, Ahamau	Yes	3		1	3	House lot	kala	kala	kala	Kam II times		0.25	518	NR 3: 614 FT 10: 183	Property left to his widow Iliehei
													Kam I times		0.38	618	NR 3: 617- FT 10:177	
2744	Palanaia (Stanaia)	Kahuku	Oio	Yes	2		1	1	1 *loi*	Malaole's land	Kainalu's land	Kainalu's land	Kohanaiki land					
					2				House lot	Kuauhiaris land		1's land	Ocean					
2770*	Malaaino	Kawela	Keoleza	Yes	2	1	1	2	House lot, 1 *loi*; 1 fishery	Kohanaiki land	Kohanaiki land	Kohanaiki land	Kam II times	Keeo	0.25	513	NR 3: 628	
2775*	Malaiiia	Kahiu, Punalau		Yes	2		1	2	House lot	Land fence	hala grove	hala grove	Kam III times		0.25	534	NR 3: 630 FT 10:166	
2779*	Malilo	Kahuku		Yes	2			2	Open flat land with bananas and water	kohanaiki land	kohanaiki land	kohanaiki land	Kam III times		0.75	530	NR 3: 266 FT 10: 167	
2781*	Manuuoeleo	Kahuku, Punalau	Uwalakui	Yes	2		1	1	House lot and 4 *loi* with water, sweet potatoes, bananas, butter melon	kohanaiki land	Leno's land	Keanahuna's land	1842		1.09	533	NR 3: 632- FT 10: 177	
2786*	Moo	Kawela		Yes	2		1	2	House lot, 4 *loi*	Heeia's land	Kuhelelloa	Kuinahi	kula	Kam I times	0.13	512	NR 3: 634, FT 10: 156	
2835*	Kuhelelloa	Kawela	Opana	Yes	2	5	1	2	*2 loi*	kala	kala	kala	kala		0.5	514	NR 3: 657, FT 10: 157	
2837*	Kaeleki	Kawela	Kaunala	Yes	2		1	2	House lot	sea	pond	sandy gulch land		Keeo	0.09	507	NR 3: 658, FT 10:158	
2838*	Kauwahi	Kawela	Kaunala	Yes	2		1	2	House lot	kohanaiki land	kohanaiki land	kohanaiki land	Kam I times		0.25	510	NR 3: 368 FT 10: 159	
2850	Kawi	Kawela	Kumpaa	Yes	1		1	1		pond	Moo's house	land fence	sea			515	NR 3: 663, FT 10: 155	
2861	Kaohele	Kahuku, Punalau, Ulupehupehu	Oio	Yes	1		1	1	House lot	Malaolis land	kala	kala	Kam I times		n/d	n/d	NR 3: 667- 668 FT 10: 153	
					2				*5 loi*	Malaolis land	kala	kala	kohanaiki land					
2868	Kapaaala	Kahuku		Yes	2		1	2	House lot	kala	kala	kala	kala		0.25	531	NR 3: 670 FT 10: 153	

Table 3. Summary of Land Commission Awards within Project Area (cont.)

2878	Kekua	Kawela	Kamooiki	3	1	1	2	House lot	Kauwahi's land	Kaunahi's land	Kelemana's land	kula	1842	Kaeo	0.43	515	NR 3: 676 FT 10: 155	
2880*	Kupau	Kahuku		2	2	1	2	Cultivated land planted in sweet potato, noni, sugarcane and banana	kohanaiki land	path	kohanaiki land	kohanaiki land	Kam I times	Kahahana	0.14	338	NR 3: 675 FT 10: 164	Liuki also assumes claim as Kupau died before completion of award
2897	Kookoo	Kawela, Punalau		2	1		2	3 kalo patches, 1 house lot	Kaili's loi	kula	kula	Peelalau's land	Kam I times		0.25	506	NR 3: 683, FT 10: 159	
2913*	Kekua	Kahuku, Punalau, Ulupehupehu	Aamo, Ahamau, Mookahi	3	1	1	2	2 kalo patches with wauke, sweet potatoes, bananas, oranges	Luiki's land	Napoe's land	Luiki's land	water course	Kam I times		0.47	337	NR 3: 690-691 FT 10: 180	On Kekua's death land was left to Luiki
2928*	Kauihaiwale	Kahuku		1	1		2	House lot	Mala of wauke	Taro *loi*	kula	kula	Kam III times		0.25	251	NR 3: 697 FT 10:168	
2936*	Kauihikai	Kahuku, Ulupehupehu	Lanihau, Uwalakui, Oio, Hanakaoe	2	1		2	House lot, 5 *loi* with noni, wauke, hala, sweet potatoes, bananas, bitter melon, sugarcane	kohanaiki land	kohanaiki land	Keea's land	kohanaiki land	Kam III times		0.52		NR 3: 701 FT 10:186	Kauaihikai died in 1848, leaving land to his widow Upai
3809	Lokea (Waanui)	Kahuku	Puaakea, Kakala, Kalimaloa	1	1		1	House lot, 7 *loi*	Puu's land	Heea's land	Kaukaha's land	Pahanui's land	Kam I times		0.27	334	NR 4: 174 FT 10:165	Waanui also assumes claim as Lokea had died before completion of award
3815	Pailalau (Peelalau)	Kawela	Kaneloko, Kawelaluna, Kalimaloa, Hanakaoe	1	1		1	House lot	stone wall	Kamakai's lot	Kamakai's lot	stone wall	Kam II times	Kaeo	0.1	511	NR 4: 176, FT 10: 170	
3958*	Naukuhao (Naukuhae)	Kahuku	Ahamau, Lauhine, Kalimaloa	2	1		2	House lot	kohanaiki land	kohanaiki land	kohanaiki land	kohanaiki land	Kam I times	Parents	0.25	254	NR 4: 200 FT 10: 151	
4341*	Kaukaha	Kahuku		2	1		2	House lot	Pasture	kula	kula	kula	Kam I times		0.25	526	NR 4: 266 FT 11: 320	

2679* = Also claimed parcel outside project area but within project area ahupua'a

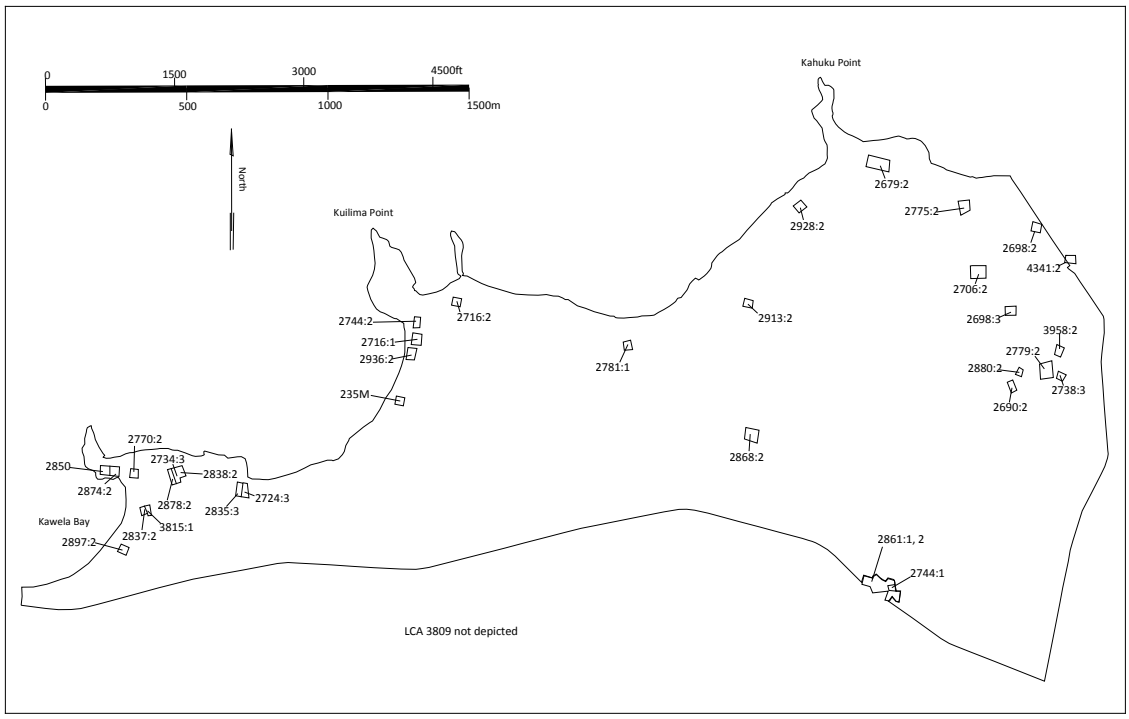


Figure 11. Land Commission Awards within Project Area

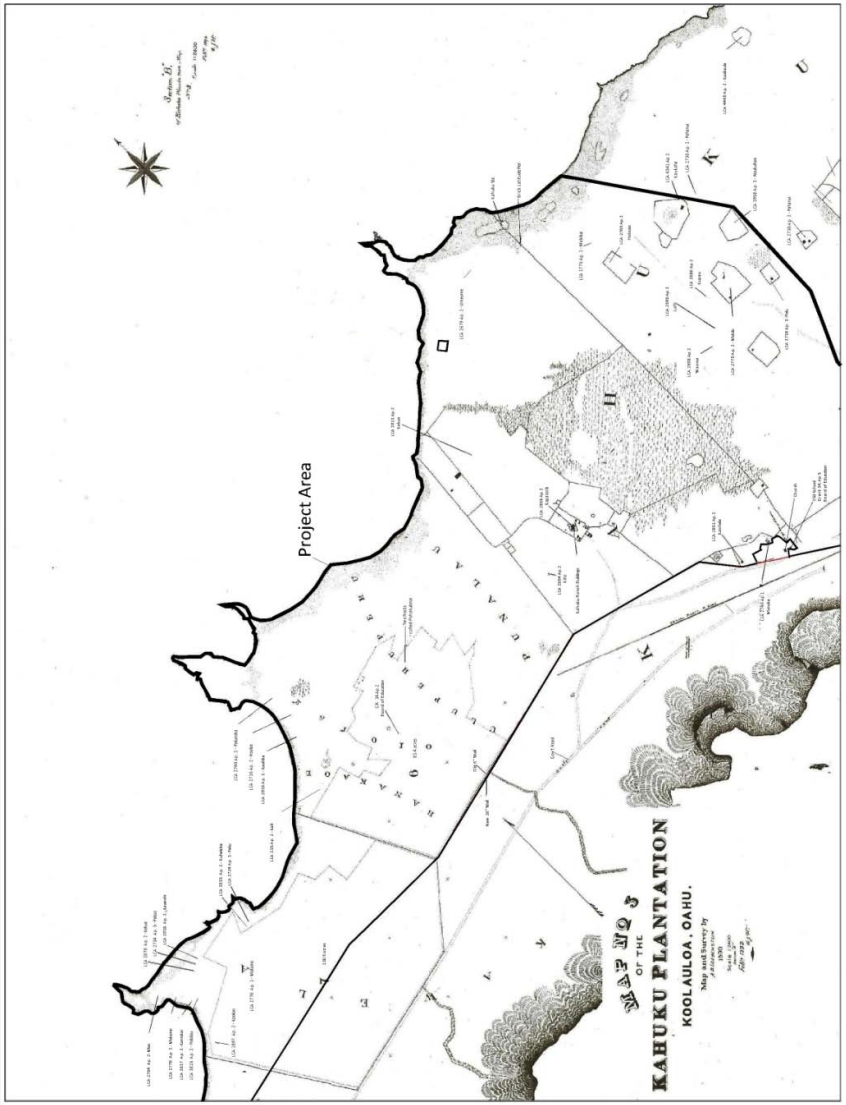


Figure 12. Portion of Loebenstein's 1890 Map of Kahuku Plantation

Kahuku Ranch (1850-1880)

Charles Hopkins, an Englishman, purchased 8,000 acres at Kahuku in 1850-1851 from Kamehameha III and established a sheep and cattle ranch, which he named Kahuku Ranch. Hopkins venture had immediate impacts on the landscape, which were particularly disturbing to the Hawaiian inhabitants of the area. According to O'Hare and Hammatt (2006:16):

> The natives became concerned for their lush and legend-filled homeland. Kahuku and the *hala* (*Pandanus*) trees in whose shade it had slept through the centuries, was being threatened by a new kind of white stranger. The herds and flocks ran over the small homesteads scattered here and there through the land, stripping it of verdure. The Hawaiians asked in vain for protection of their trees and vegetable patches. They wrote to the missionary, Emerson, who urged them to build fences and appealed to authorities on their behalf asking that government pounds be set up to enforce newly established trespass laws.

McAllister (1933:153) also cites the impact of the ranch on the Kahuku Plain during an interview with local informant Mrs. John Kaleo: "She remembers the time when trees, now found only on the mountains, covered the Kahuku plain, now a desolate, windswept area". The destruction of the native landscape was accompanied by a decline in the local Hawaiian population. According to census data there were 1,345 people in Koʻolauloa District in 1853 (Schmitt 1977:12). The population declined to 1,187 in 1860 and by 1878, only 1,082 people remained.

By 1856 a carriage road was completed between Honolulu and Kahuku (Haun and Henry 2001b). During the mid-1860s through the 1870s, the Kahuku Ranch changed hands several times. Robert Moffitt purchased the ranch from Hopkins and in 1873; H.A. Widemann gained ownership from Moffitt. In 1873 the ranch consisted of 15,000 acres including the *ahupuaʻa* of Kaunala, Pahipahíāula, ʻŌpana 1 and 2, Kawela, Hanakaʻoe, Ōiʻo, Ulupehupehu, Punalau, Kahuku, Mālaekahana, Keana, and part of Lāʻie. In 1874, Widemann sold "Kahuku and Mālaekahana Ranch" to Julius Richardson for $45,000.00. Richardson sold the ranch to James Campbell for $63,500.00 in 1876. An 1876 Government Survey Map of the Island Oʻahu depicts the extent of "Richardson's" Ranch and what appear to be a series of walled enclosures (see *Figure 9*). An article in the Hawaiian Gazette (cited in Bath *et al*. 1984:C-16) describes the ranch at the time of the 1876 sale to Campbell (excerpted from the Hawaiian Gazette, 10/4/1876, p. 3:2):

> Kahuku Ranch. This fine ranch, covering the north portion of Oahu, formerly the property of the late R. Moffitt, and more recently of Julius L. Richardson, Esq., was last week sold by the latter to James Campbell, Esq., one of the proprietors of the Pioneer Sugar Mill of Lahaina, for the sum of $63,500 cash. It includes 25,000 acres in fee simple, and large tracts of mountain land under long leases, with $34,000 worth of livestock, including 3,000 head of cattle, with the choice band of merino sheep and horses now on it. It is unquestionably the best stock ranch on these islands and it has been brought to a high state of perfection under the management of the late proprietors, who divided the plain into ten or twelve large paddocks, walled with heavy stone walls. It stretches from Laie to Waimea, a distance of thirteen miles and those who have ever visited it must have admired its lovely green pastures of manienie grass so fattening to stock. It is the intention of Mr. Campbell to increase his band of sheep to 30,000 of the choicest breed. The price paid is a handsome one, securing to its present proprietor the most desirable ranch on the Island, and to Mr. Richardson a comfortable fortune, and result in part of his industry and good management, and in part of the Reciprocity Treaty, the first fruit from which he has been so fortunate as to reap…

James Campbell operated the Kahuku Ranch until November 1889 when much of the land was leased to Benjamin Franklin Dillingham (Kuykendall 1967:69). George Bowser (1880:409) describes the extent of the ranch as it was in that year:

> Kahuku Ranch. Main Road, Kahuku: Proprietor, James Campbell, Esq., of Honouliuli: Manager, W.R. Buchanan: post office address, Kahuku, 38 miles [61 km] from Honolulu, at the northern point of Oahu: 23,608 acres [9554 hectares] occupied as a cattle ranch: extends 14 miles [22 km] along the coast, in close proximity to the sea. A valuable fishery is attached to this property.

Kahuku Plantation (1890-1971)

In 1889, Benjamin Franklin Dillingham chartered the O'ahu Railroad and Land Company (OR&L) and commissioned two hydrographic engineers to investigate the potential for a commercial sugar cane plantation at Kahuku. In that same year he leased the Kahuku lands of James Campbell for 50 years. Dillingham then subleased the lands to James Castle. Castle's Kahuku Plantation Company received its charter in 1890.

The company began commercial production of sugarcane using pumped spring water, streams and rain for irrigation. This mode of irrigation was soon found to be inadequate for the amount of land available and artesian wells became the primary irrigation water source. A total of 2,800 acres were planted in sugarcane with the first crop harvested in 1892 (Kuykendall 1967:69). The Loebenstein 1890 Map of the Kahuku Plantation (see *Figure 12*) shows the location of the Kahuku Plantation and on the east side of the ranch buildings a series of walled enclosures, which correspond to Land Commission Awards. An old school and a church are located seaward of the Old Government Road and the Kahuku Ranch buildings are located in the central portion of the TBR property, west of Punaho'olapa Marsh.

By 1898, the OR&L railroad line extended from Honolulu to Waialua; in 1899 it reached Kahuku. According to O'Hare and Hammatt (2006:21):

> No record appears to survive which gives the date the railroad was started at Kahuku Plantation. Annual reports do not appear prior to 1893. However, the road must have been started soon after the January 30, 1890 charter, for the Baldwin Locomotive Works records note an order for the first Kahuku motive power, Keana, on February 2, 1890 and a second order for Kahuku in 1891.

The Loebenstein map also depicts "Two Rocks called Pohakulanai" located in the Land of Ulupehupehu. Pohaku Lanai is also the name of a rock feature located on the west side of Kaiaka Bay Beach Park in Haléiwa, well to the northwest of the project area; the Hale'iwa site (State Inventory of Historic Places, hereafter SIHP, 80-04-0218; National Register of Historic Places, hereafter NRHP, 50-OA-226) consists of two massive balanced limestone boulders, one on top of the other (NRHP n.d.). Legendary explanation (Alameida 1994) has it that the boulders floated ashore from the distant land of Kahiki and were used as a lookout by fish spotters (*kilo i'a*). The presence of the "Two Rocks called Pohakulanai" on the 1890 map in Kahuku is unexplained. Perhaps they were destroyed by natural forces or as a result of development. McAllister did not document the two rocks in Kahuku in his 1930s inventory.

A 1906 train schedule indicates that the train ran from Waimea Station to Kahuku in 24 minutes with no stops (Mayberry and Haun 1988). The railroad is depicted on Donn's 1906 map of Óahu (*Figure 13*) and on King's 1928 map of the Kahuku Forest Reserve (*Figure 14*). The 1930 USGS Lā́ie Quadrangle depicts the railroad extending through the TBR property with stations at Kawela and Kahuku Ranch (*Figure 15*). Marconi Station was located just east of the property at Punamanō Marsh.

The Kahuku Plantation continued in operation through the 1920s and 1930s. By 1935, 4,490 acres were cultivated in sugarcane, with the plantation employing 1,137 workers (O'Hare and Hammatt 2006:21). A 1920s map of the Kahuku Plantation (*Figure 16*) depicts a series of numbered sugarcane fields occupying the inland portion of the TBR property. The extent of the sugarcane fields and a plantation workers camp (Camp 3) beside the OR&L railroad are depicted on a 1932 USGS map (*Figure 17*). The map shows sugarcane fields extending to the coast and a line of houses fronting Kawela Bay. The map also shows a rock wall extending inland from the coast approximately half

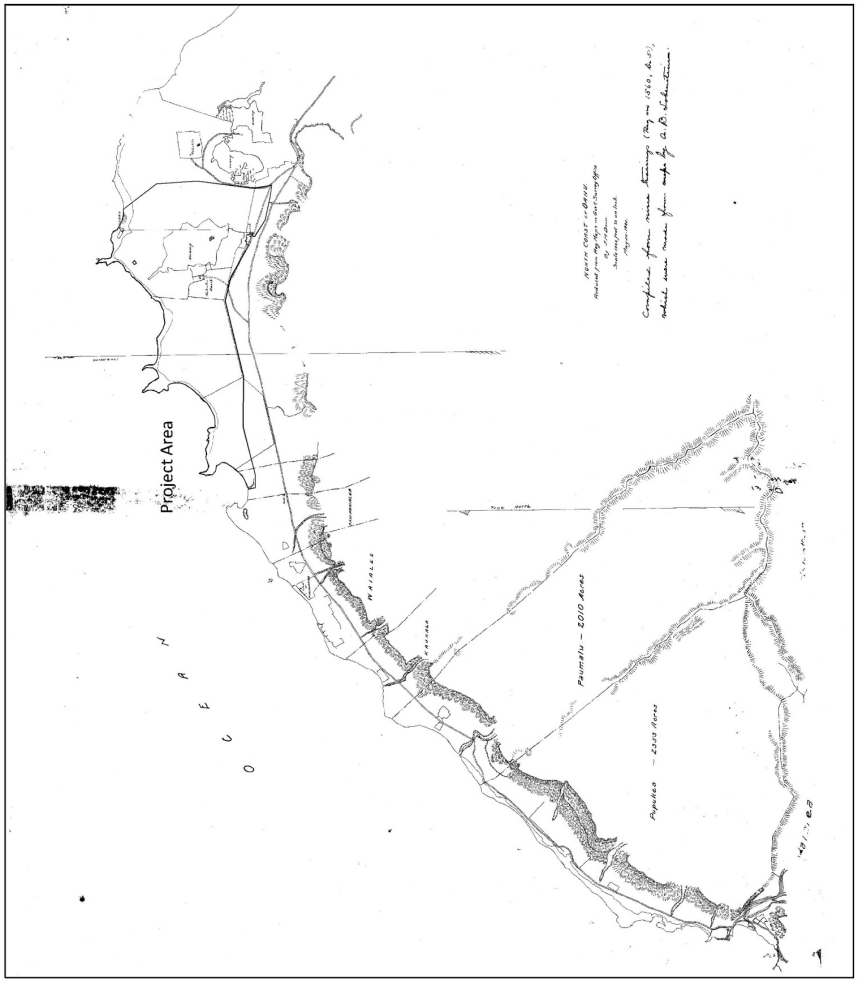


Figure 13. Portion of Donn's 1902 Map of North Coast of Oahu

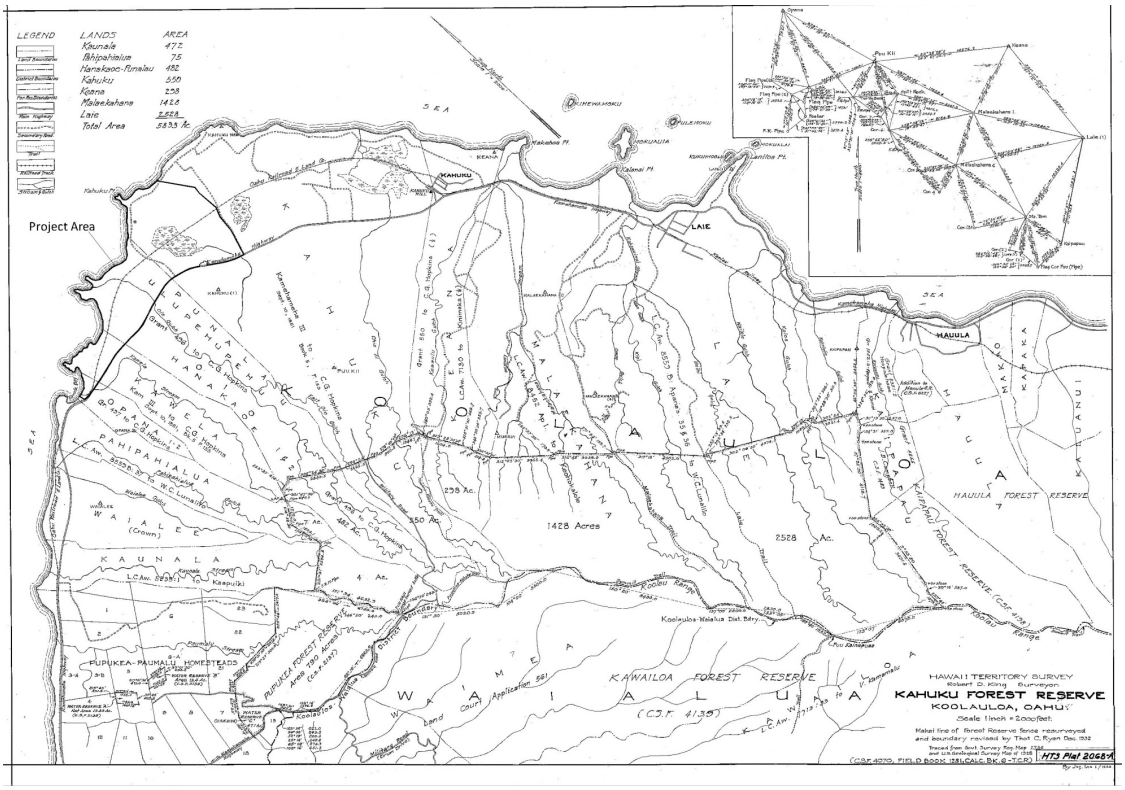


Figure 14. King's 1928 Map of Kahuku Forest Reserve

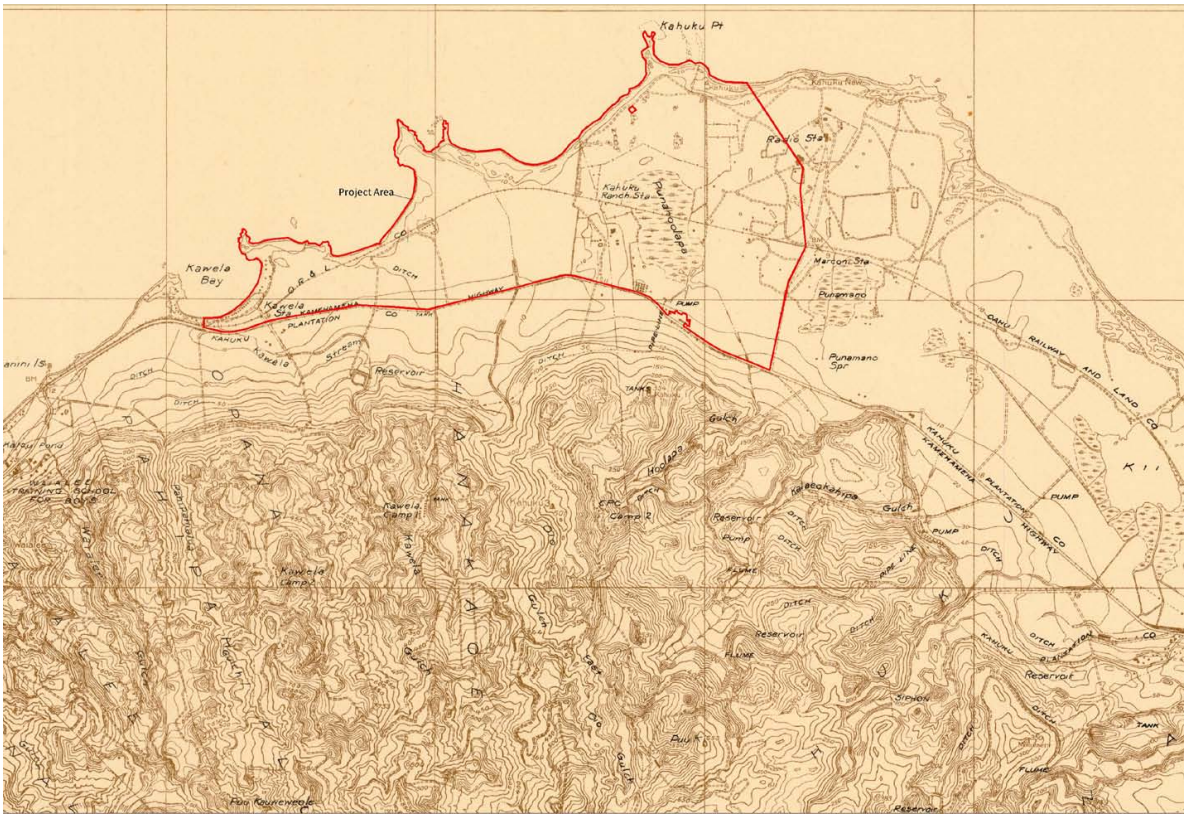


Figure 15. Portion of 1930 USGS Laie Quadrangle

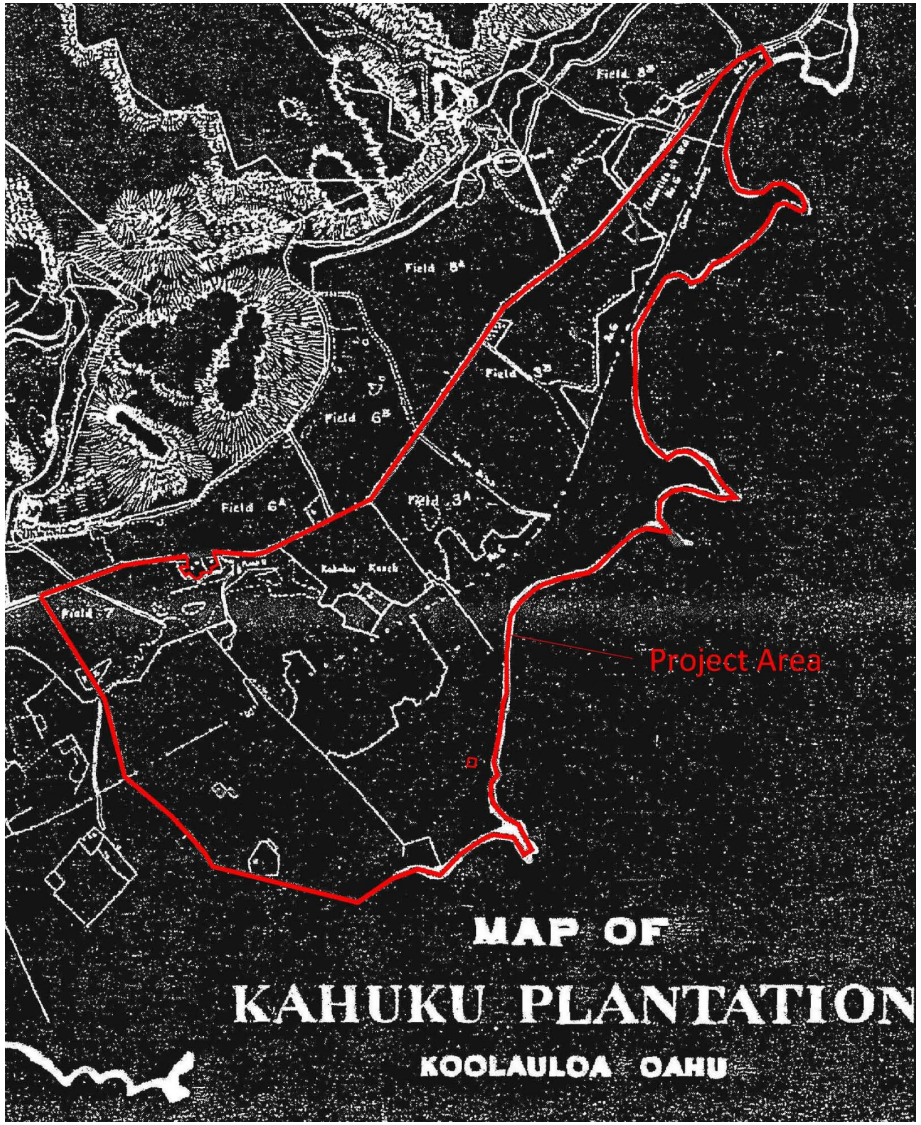


Figure 16. 1920's Map of Kahuku Plantation

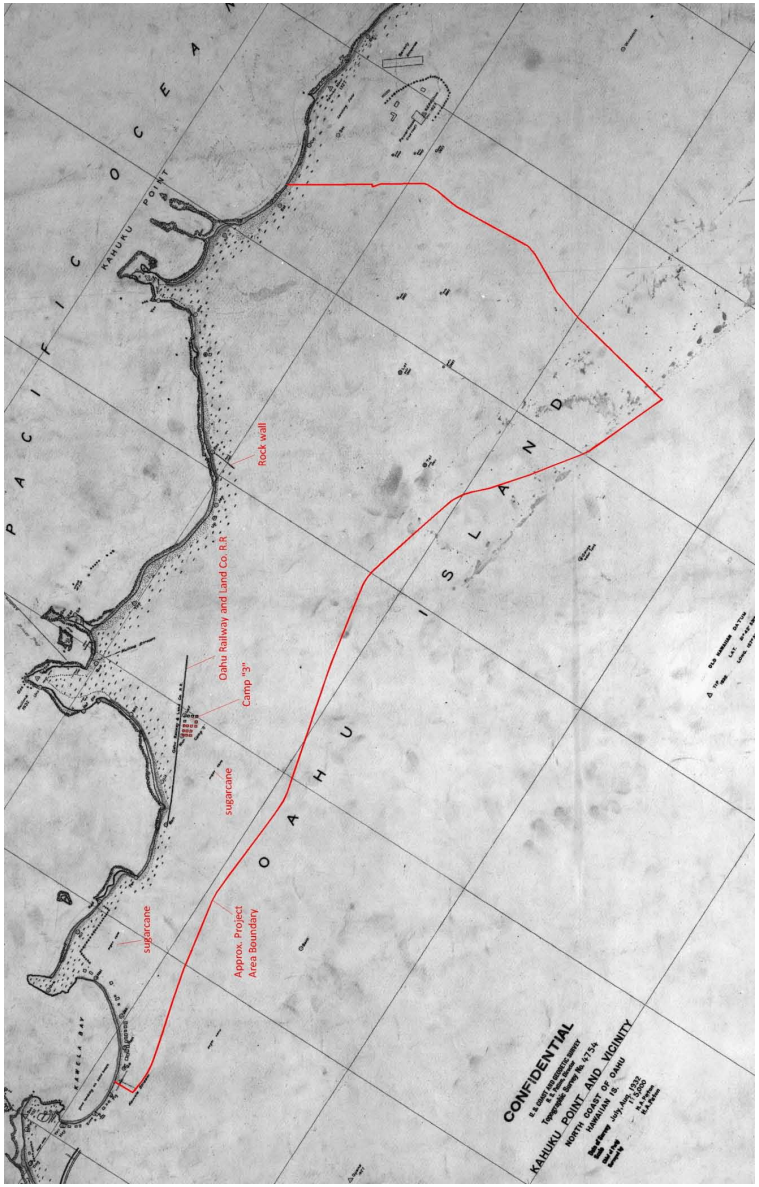


Figure 17. Portion of 1932 U.S. Coast and Geodetic Survey Map of Kahuku Point Area

way between Kahuku Point and Kuilima Point. The wall appears to correspond with one in the same location depicted on the 1890 Loebenstein map (see *Figure 12*).

In addition to sugarcane, pineapples were also extensively cultivated at Kahuku Plantation. According to Nakamura (1981:13), a lease was signed in 1916 between the plantation and C. Okuyama whereby Okuyama contracted to lease 171.5-acres for $10.00 per acre per year. Following acquisition of the leased lands, Okuyama entered into a restrictive agreement with the Hawaiian Pineapple Company:

> On November 9, 1916, Okuyama signed a "chattel mortgage" with the Hawaiian Pineapple Company Limited for a financial advance of $2,000 and further advances not to exceed $13,000. Okuyama possibly used the initial $2,000 to pay his first year's lease rent with the remainder used to buy equipment and supplies. In addition to repayment of the advance, Okuyama was obligated to contract to deal only with the Hawaiian Pineapple Co. Ltd.

Additional smaller tracts of land were also leased to pineapple growers from the OR& L Railroad Company (*ibid*.). These primarily Japanese farmers also signed "chattel mortgages" with the Hawaiian Pineapple Company. By 1934, a total of 38 mortgages had been signed between the small growers and the California Packing Corporation (CPC). Following the expiration of the leases, the Kahuku Plantation leased large tracts of land to the CPC, driving out the smaller farmers. The CPC changed its name to the Del Monte Corporation in 1967 (*ibid*.: 14).

World War II- Kahuku Army Airfield

Portions of the plantation within the TBR property were used by the U.S. Army to construct the Kahuku Airfield in 1942 (*Figure 18*). The airfield encompassed runways, taxiways, revetments, bunkers and artillery emplacements. A composite of three blueprint sheets of the airbase shows its various components (*Figure 19*); note the U-shape revetments used for airplane storage located adjacent to the runways. A recent aerial photograph of the TBR property shows the extent of the Kahuku Army Airfield facility superimposed on it (*Figure 20*) as well as a large area for barracks and other facilities inland of the airfield. According to *Figure 20*, the airfield and barracks occupied approximately 195 acres (23%) of the property.

David Trojan of the Hawaiian Aviation Preservation Society (Trojan, n.d.) presents a brief history of the construction and use of the airfield:

> There are references to Kahuku as an emergency field dating to the 1930's, but it was not until the United States entered World War II that the airfield was developed. Kahuku Army Airfield was classified as an auxiliary field and had a very short life span, from 1942 until it was closed in the late 1940's. Ground troops were stationed in the area to protect the airfield and man the shoreline fortifications. The northern tip of Oahu had a total of three airfields in close proximity during World War II. The Kahuku Point Airfield was located near the tip of Kahuku Point, and was evidently the most elaborate.
>
> The Kahuku Army Airfields were used for training of pilots from Wheeler AAF for instrument flying on different types of aircraft. The airfield was ideal for training because it had a good approach, runway length, and take off clearance. This field was not over populated like Hickam or Wheeler. It is documented that the 18th Air base Group, 47th Pursuit Squadron was stationed there along with B-24s and B-17s that were based at Kahuku for short periods of time during World War II.
>
> At the end of World War II, the military returned the Kahuku property to its owners when it was no longer needed to defend Oahu from attack and all three of the Kahuku airfields were closed.

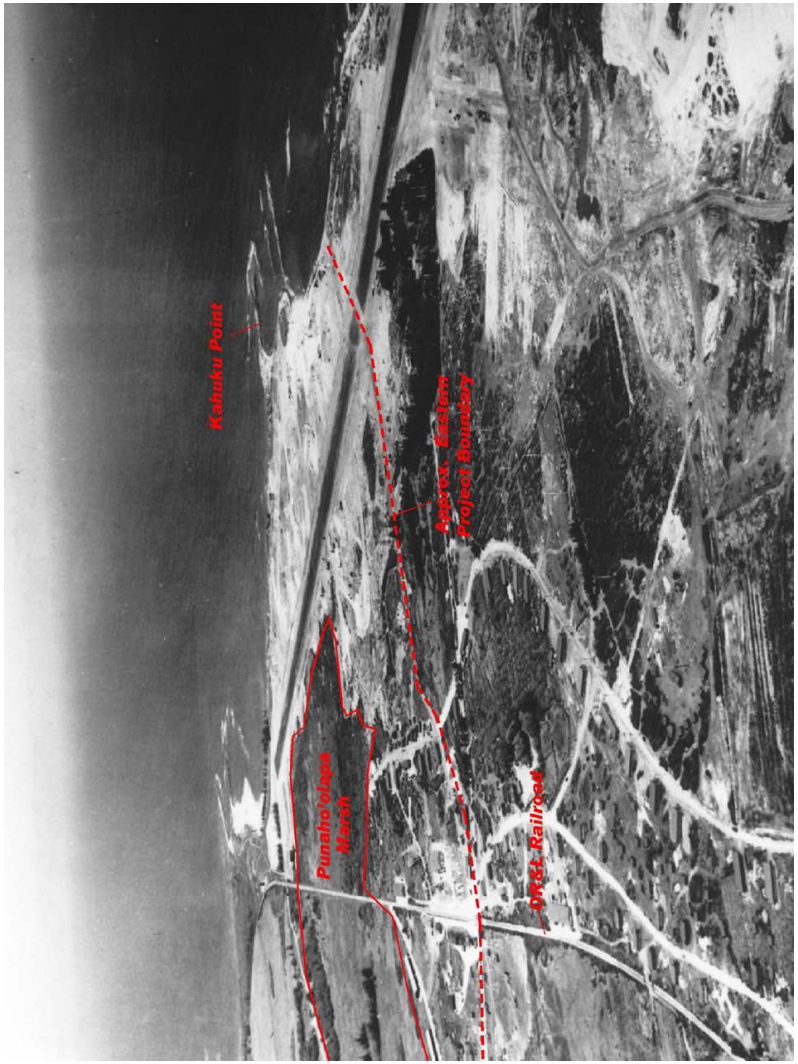


Figure 18. August 20, 1942 Photograph of Kahuku Point Airfield

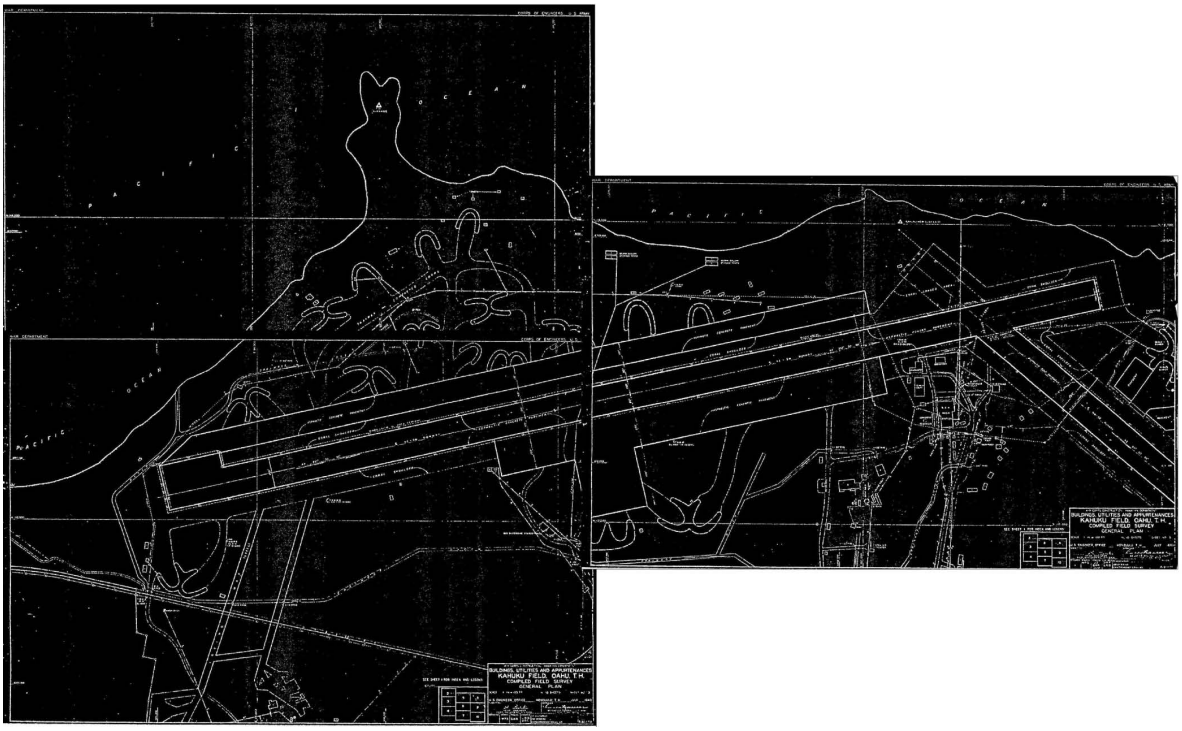


Figure 19. Composite Map of Kahuku Army Airfield (Sheets 2, 3 and 5)

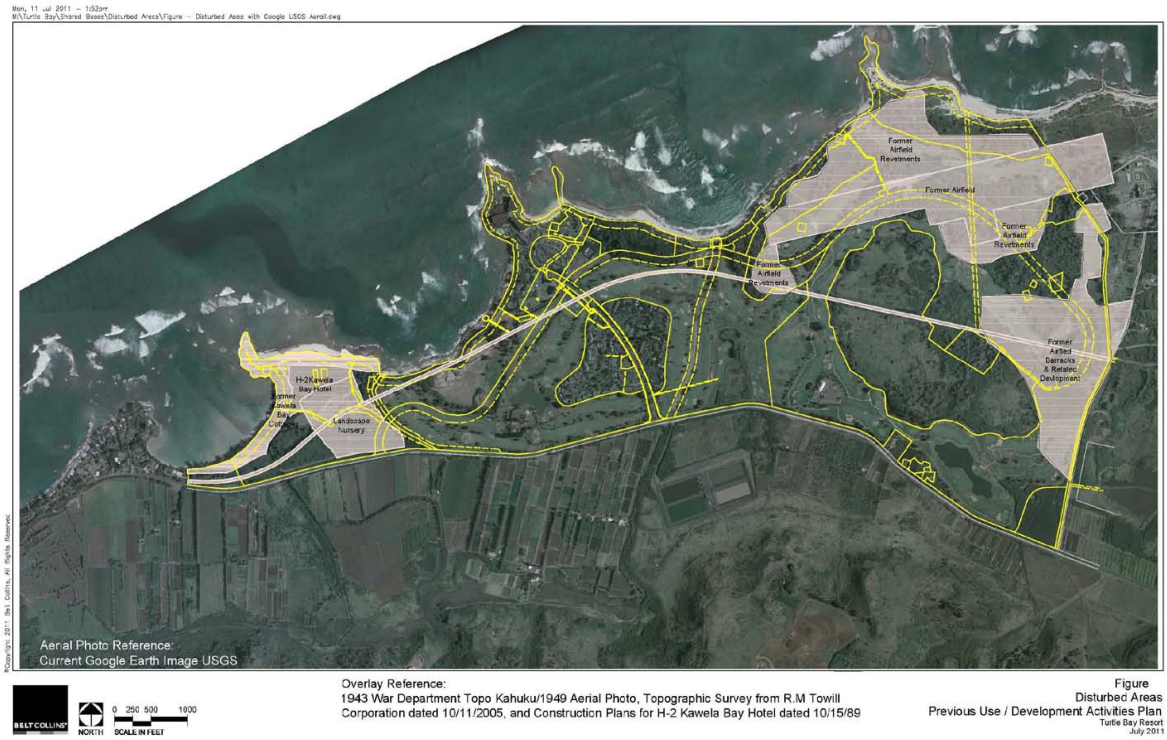


Figure 20. Aerial Photograph of Project Area showing Extent of Kahuku Army Airfield

Kahuku AAB was depicted on the 1947 Hawaiian Islands Sectional Chart as a closed airfield, having a 6,500' hard-surface runway. This was presumably the former "Kahuku Point" Airfield. The other two Kahuku airfields were not depicted at all. No airfields at Kahuku were depicted on the October 1954 Hawaiian Islands Sectional Chart. In the early 1960s prior to the opening of the Campbell Race Course, the Kahuku airfield runways were used for both drag racing & the first Hawaii Grand Prix sports car race.... At some point between 1954-77 the former Kahuku Point airfield was apparently reused as a private civil airfield, as that is how "Kuilima Air Park" was depicted on the December 1977 Hawaiian Islands Sectional Chart. It was depicted as having a single 2,700' hard-surface runway. The 1983 USGS topo map depicted a single 2,800' runway at the location of the former Kahuku Point Airfield, labeled simply "Landing Strip". However, it also depicted much longer (5,200') cleared area resembling another runway, running south of the "Landing Strip" to the south. At the site of the former Kahuku Golf Course Airfield, it depicted a 6,500' long cleared area, unlabeled.

Very little remains today of the three Kahuku Army Airfields. The Turtle Bay Hilton's golf course has absorbed two of the runways. This site is typical of a former airfield converted into a golf course. The long runways are ideal for golf fairways. Ironically, the only airfield to survive is a short length of the Kahuku Golf Course Airfield. The northwestern portion has been covered by aquaculture equipment built on the runway by a lease tenant. Very little evidence of Kahuku's World War II fortifications remain except one bunker site that is keeping its past military secrets. The entrance to the bunker is buried in sand and brush leaving only two concrete structures exposed. Scattered concrete pillboxes covered by low brush and debris can be found in the surrounding jungle. No historical markers indicating the area's past could be found. All guests and hotel staff questioned had no idea of the area's history. Currently, a small privately owned heliport for daytime VFR use only is located at the Turtle Bay Hilton next to the main hotel building.

A major catastrophic event, which is not mentioned in the preceding airfield history, but had a massive destructive impact on the recently abandoned airfield facility was the tsunami that struck Hawai'i on April 1, 1946. A recent analysis of the event's effects on the airfield at Kahuku (Keating 2008:157-168) provides a fuller understanding of the impact of such events that have influenced land use in the vicinity for centuries. The estimated 7.2 m run-up of the waves caused widespread flooding that extended 1,600 m inland and covered nearly the entire airfield facility. Following the event, standing water covered the seaward revetments and runway (see *Figure 19*). An estimated 2 million cubic meters of sand where moved by the event, both by the force of the incoming water and as it receded. Wooden buildings were destroyed and "the flood of salt water damaged vegetation and salt water infiltrated the porous soil and underlying reef rock" (ibid.:165). Massive reworking of sediments resulted from the repeated cycles of run-up and draw down that occurred with each pulse of wave energy. As many as twenty waves were recorded on a Honolulu tide gauge.

As documented, the Kahuku Army Airfield was reused as a civilian airfield after control was relinquished by the military. The civilian airport is depicted in *Figure 21*, labeled as the "Kahuku Airfield (Abandoned)". This map depicts a c. 2,250 ft long runway that extends outside the project area to the east-northeast, and a smaller 1,930 ft long runway parallel to it on the seaward side. A third runway extends southeast from the east end of the main runway for a distance of c. 3,150 ft.

Figure 21 also depicts a series of houses or beach cottages present along the east side of Kawela Bay and on the coast to the east of the bay. A second cluster of buildings inland of Kuilima Point and a row of buildings in the southeast portion of the TBR property is visible along the seaward side of Kamehameha Highway.

Figure 21. 1954 Kahuku Quadrangle

The use of the Kahuku area by the government for military training occurred between the 1950s and the early 1980s. According to Nakamura (1981:14):

> A brief investigation of the use of Kahuku land for military training purposes shows a number of leases between the United States government, C.P.C, and the Campbell Estate dating from the mid 1950s. A lease between the United States government and C.P.C is dated August 1956 and consisted of nearly 200-acres at Kahuku (TMK [Oahu] 5-6-05:1). Of more importance was the lease signed in October 1956 between the United States government and the Campbell Estate. This lease involved over 3,500 acres of land at Kahuku (TMK [Oahu] 5-6-08:1 and 5-7-02:1. Military training is practiced today at Kahuku.

The TBR property was used for sugarcane cultivation until 1971 when the property was purchased by casino developer Del Webb for the subsequent construction of the Kuilima Resort and Country Club. Aerial photographs of the TBR property taken on June 10, 1970 (*Figure 22*) and September 11, 1970 (*Figure 23*) by the Del E. Webb Corporation indicate that the majority of the parcel was under sugarcane cultivation at the time of the sale.

PREVIOUS ARCHAEOLOGICAL WORK

A search of the DLNR-SHPD archaeological report database and other sources identified 27 survey and excavation projects undertaken in the project area vicinity in the Koʻolauloa District from the Lands of Kaunala to the east and Mālaekahana to the west. These projects are summarized in *Table 4* and their locations are presented in *Figure 24*. Not included in the figure or table are the general studies by McAllister (1933), which focused on major sites throughout Oʻahu, and Sterling and Summers (1997), which also lists McAllister's sites along with information from legends and early historic observations.

Previous Archaeological Work in Vicinity of Project Area

McAllister reported nineteen sites along the coast from the Kahuku side of Waimea Bay to Kahuku Point. The sites consist of four fishing shrines, three *heiau*, six stone and rock formations with legendary significance, three fishponds, an area of saltpans, a water hole, and cliff face burial caves. Sites in the general vicinity of the project area consist of Site 255, a lava shelf with a group of lava boulders of legendary significance in the water at Pūpūkea; Site 256, a stone on the side of a bluff at Paumalū said to resemble George Washington; Site 258, Kapi Pond near Kawela Bay, and Site 262, Kukio Pond situated south of Kahuku Point.

The projects in *Table 4* cover more than 3,500 acres identifying 60 sites with 210 features. To aid in reconstructing settlement patterns, features were quantified by probable age and function, and the studies are ordered by elevation. Traditional Hawaiian features were categorized as habitation, agricultural, burial (including possible burials) and ritual. Features not assignable to these categories were categorized as miscellaneous or indeterminate. Traditional sites in this category include petroglyphs and *ahu*. Habitation sites are further subdivided into temporary and permanent for studies making this distinction. Historic features were not segregated by function in *Table 4*. The majority of the historic features are ranch walls, plantation-related features and WWII military features.

Density values are given for sites, features and habitation features. Overall, the studies have identified 5 permanent habitation features, 11 temporary habitations, 13 agricultural features and 17 burials. Density values for survey areas larger than 35 acres do not show any consistent trends by elevation. Overall feature density values for these studies vary from 0.01 to 5.0 features per acre. Habitation feature density ranges from 0.01 to 0.12

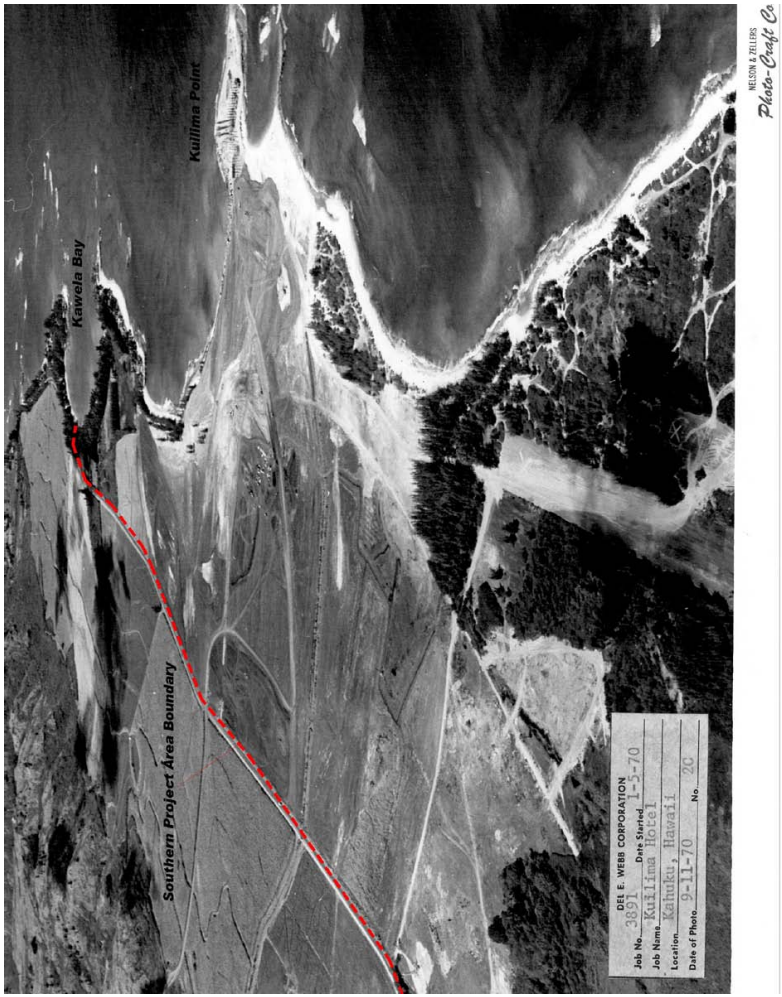


Figure 22. 1970 Aerial Photograph of Project Area

Figure 23. 1970 Aerial Photograph of Project Area

Table 4. Previous Archaeological Work in Project Area Vicinity

Author	Land	Study Type	Elevation (ft)	Historic Use	Area (ac)	Total Sites	Sites/ acre	Total Features	Features/ acre	Hab. Features	Hab. Features/ acre	Perm. Hab. Features	Temp. Hab. Features	Ag. Features	Burial Features	Historic Features	Misc. Features
Rogers-Jourdane (1982)	Kahuku	RN	0-10	Ranching, Sugarcane	45.00	0		0									
Dagher (1993), Jourdane (1994b)	Malaekahana	BR	5	?	<1	2	2.000	5	5.000						5		
Collins (1999)	Kaena	BR	5	?	<1	1	1.000	1	1.000						1		
Komori (1992)	Kahuku	BR	5	?	<1	1	1.000	1	1.000						1		
Jourdane (1994a), Hibbard (1997)	Kahuku	BR	5	?	<1	1	1.000	2	1.000						2		
Davis (1982)	Kahuku	RN	5-10	Sugarcane	1.00	0		0									
Haun and Henry (2001b)	Kaunala	IN	5-10	?	19.19	4	0.21	6	0.31	2	0.10					4	
Sinoto (1981)	Kahuku	IN	5-10	?	103.00	1	0.01	1	0.01							1	
Collins and Nees (2006)	Opana	CIA	5-10	?	<1	0		0									
Calis and Tome (2002)	Kahuku	MN	10	?	1.00	0		0									
O'Hare et al. (2004)	Kahuku	DOC	10	Processing	8.00	1	0.125	1	0.125							1	
Kennedy (1990)	Kahuku	EX	10	Processing	1.25	1	0.800	1	0.800							1	
Perzinski and Hammatt (2001)	Kahuku	IN	15-20	?	2.00	0		0									
Clark (1978), Barrera (1979), Schilt (1979), Sinoto (1986)	Kahuku and Kaena	RS	15-20	Sugarcane	57.30	10	0.175	17	0.297	7	0.12			6	3	1	
Barrera (1981, 1985), Walker and Rosendahl (1986), Jensen (1989a), Stride et al. (1992), Rechtman (2010)	Pahipahilu to Malakahana	RN, IN	20-800	Ranching, Sugarcane, Pineapple, Military	3310.00	37	0.011	148	0.045	46	0.01	5	11	7	5	72	2
Farrell and Cleghorn (1995)	Ulupehupehu and Punalau	IN	190-300	Ranching, Sugarcane, Military	18.00	1	0.07	27	1.80							27	
Hammatt (1996)	Malaekahana	RN	200	Ranching	0.50	0		0									
				Total/Average	**3566.94**	**60**	**0.20**	**210**	**0.48**	**55**	**0.08**	**5**	**11**	**13**	**17**	**107**	**2**

IN = Inventory Survey, RN = Reconnaissance Survey, MN = Monitoring Project, EX = Excavation, DOC = Documentation, CIA = Cultural Impact Assessment, BR= Burial Discovery

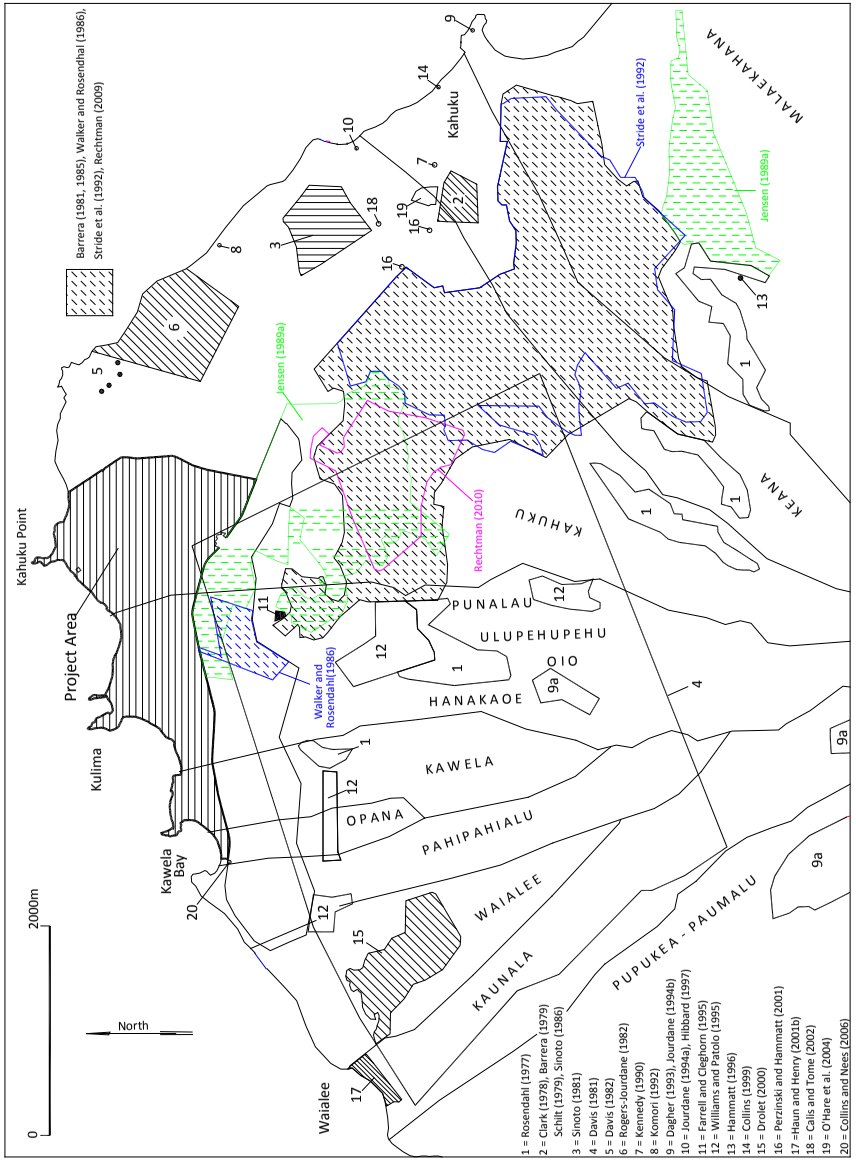


Figure 24. Previous Archaeological Work in Project Area Vicinity

features per acre. The near absence of agricultural features is also notable. The density values are extremely low compared with areas in the Kona Field System of Hawai'i Island (Haun and Henry 2000a, 2001a) where sugarcane was not cultivated historically, but are similar to values from the Hana District on Maui (Haun and Henry 2000b) where ranching and sugarcane cultivation dominated the region for over 150 years, as is the case for the project area vicinity.

Most coastal habitation sites consist of subsurface cultural deposits containing artifacts, food remains and a variety of pit features. These sites are usually interpreted as permanent habitations. Most of the temporary habitation features are overhangs along the base of cliffs at the inland edge of the coastal plain. Burials are frequently found eroding from the sand dunes along the coast and in caves in the cliff faces.

The largest survey in this area consists of a reconnaissance survey of three parcels totaling approximately 2,500 acres by Barrera (1981). Subsequent studies by Barrera (1985), Walker and Rosendahl (1986), Stride *et al*. (1992) Jensen (1989a) and Rechtman (2010) included areas within or adjacent to Barrera's (1981) study area. The combined area of these overlapping projects is approximately 3,310-acres. Thirty-six sites with 130 features are reported for this area, the majority of which are related to sugarcane agriculture. The following summaries of individual surveys are organized by land division.

The Barrera (1981) survey area was extensively impacted by sugarcane cultivation. He identified three areas containing cultural remains, all within the Land of Kahuku. In 1985, Barrera surveyed three proposed well sites in Kawela, Hanaka'oe and Kahuku but identified no sites.

In 1986, Walker and Rosendahl conducted a reconnaissance survey of a 70-acre parcel located directly inland of the TBR property on the south side of Kamehameha Highway. This project was done in conjunction with the development of a wastewater treatment plant for TBR. The survey identified an agricultural terrace and two historic irrigation ditches.

Stride *et al*. (1993) conducted an inventory survey of a 785-acre portion of the 1,666-acre Kahuku Agricultural Park located in Kahuku, Keana and Mālaekahana. Six sites consisting of four temporary habitation sites with overhangs, a temporary habitation enclosure, and a complex of permanent habitation walls, terraces, an overhang and a terrace were documented. Subsurface testing at one of the overhangs revealed a human burial.

Rechtman (2010) conducted an inventory survey of a 230-acre property for a proposed wind farm located in Kahuku. This survey identified remnants of the Kahuku Sugar Plantation (Site 4707) with individual features consisting of flumes, ditches, pipes, reservoirs, wells, pumps, markers, roads and bridges.

Jensen (1989a) surveyed two areas totaling 866 acres for proposed golf courses at Punamanō (638 acres) and Mālaekahana (228 acres). The survey identified 20 sites with 38 features consisting of temporary habitation sites, sugarcane infrastructure features and remnants of World War II military utilization.

Clark (1978) conducted an archaeological reconnaissance survey of the Ko'olauloa Housing Project and an adjacent park expansion area, located within the Lands of Kahuku and Keana. The park expansion area was subsequently developed into Kahuku Elementary School and the Kahuku District Park. Local informants identified an area referred to as "the sacred way" within the housing area. A stone platform was relocated in the park area that corresponds to Site 269 recorded by McAllister (1933). A coral slab on the platform surface was identified as a *kū'ula* or god-stone used to attract fish. Although situated outside Clark's project area, the nearby Keana Cave (McAllister Site 270) was also examined and determined to contain human remains. Schilt (1979) surveyed a 4-acre Kahuku School expansion area. The Site 269 platform and Keana Cave (Site 270) were relocated and two newly identified sites, a stone mound and an overhang, were documented.

In 1979, Barrera (1979) returned to the housing project area to conduct additional archaeological survey and subsurface testing. Five sites were identified: (1) two walls, (2) a rock-lined depression, (3) a complex of three

walls, three stone mounds and a cave, (4) a wall segment and (5) a soil mound with an attached L-shaped wall. No subsurface remains were identified during testing.

Sinoto (1981), Davis (1982), Rogers-Jourdane (1982) and Kennedy (1990) conducted archaeological reconnaissance surveys in Kahuku. The Davis and the Rogers-Jourdane surveys identified no sites. Kennedy (1990) reported no sites, although he reports that the Ki'i Ditch extended through the survey area. Sinoto (1981) identified a section of the OR&L railroad grade and documented the 100-acre Ki'i Wetlands that were assigned Bishop Museum Site No. 50-Oa-F4-10/11. The wetland also is referred to as "Kahuku Fishpond", although according to McAllister, it was always a swamp and was not used as a fishpond (1933:154).

Farrell and Cleghorn (1995) conducted an inventory survey of a 15-acre parcel situated in Ulupehupehu and Punalau. A single site with 27 features related to the agricultural and military use of the area was documented. Perzinski and Hammatt (2001) conducted archaeological inventory surveys of two detour roads to be used in conjunction with a proposed drainage improvement project. The associated drainages are located to the southwest of the Kahuku Village Subdivision and were designated as the Hospital Ditch and the Ki'i Drainage. No archaeological sites were identified in either area.

In 2001, Haun and Henry (2001b) conducted an inventory survey of a 19-acre parcel in coastal Kaunala. This project consisted of a pedestrian survey and excavation of 32 backhoe trenches. The study documented three features associated with the historic OR&L railroad, an historic house foundation and the truncated remnants of two subsurface cultural deposits. Subsequent data recovery work (Haun *et al*. 2003) documented a late prehistoric habitation deposit and the remains of a burial, both in secondary contexts.

Calis and Tome (2002) conducted archaeological monitoring for a wastewater force main replacement in the Land of Kahuku. Twelve trenches were excavated along the 670 m long corridor and exposed deposits interpreted as imported fill related to sugarcane cultivation.

O'Hare *et al*. (2004) documented the remains of Kahuku Mill. The report provides a detailed history of the mill including a summary of the various types of mill equipment used at the facility. The study included Historic Architectural and Engineering Record (HAER) photographic documentation.

Collins and Nees (2006) prepared a Cultural Impact Assessment for the replacement of the Kawela Stream Bridge located in 'Ōpana Ahupua'a. The area was surveyed during the project but no sites were identified.

On several occasions, inadvertently discovered human remains eroding from the coastal sand dunes in the Lands of Kahuku, Keana and Mālaekahana were reported to DLNR-SHPD. SHPD personnel documented the finds (Komori 1992; Dagher 1993; Jourdane 1994a and 1994b; Hibbard 1997; and Collins 1999), and the remains were returned to the original locations and stabilized to prevent further disturbance.

The studies by Walker *et al*. (1988a, b), Jensen (1989a) and Stride *et al*. (1992) report 38 radiocarbon dates. Many of the age determinations results produced multiple age ranges or long single age ranges between the 1600s and 1950. When all portions of all potential age ranges are examined, two results span the AD 1000s, three each include the 1100s and 1200s, eight span the 1300s, 18 include the 1400s, 19 span the 1500s, 28 span the 1600s and 16 each include the 1700s and 1800s. The results suggest initial use of the area occurred between A.D. 1000 and 1200, followed by a gradual increase between the 1300s and 1500s. The most intensive use dates to the 1600s with declining use in the 1700s and 1800s.

Figure 24 also depicts a series of four surveys that were conducted within the Kahuku Training Area (KTA) by Rosendahl (1977), Davis (1981), Williams and Patolo (1995) and Drolet (2000). These projects are not however included in *Table 4* as the majority were not available for review. The findings from these surveys, summarized in Drolet (2000) are presented below.

Rosendahl (1977) conducted a limited survey of several inland gulches within the KTA. This was followed by a brief reconnaissance-level survey by Davis (1981) conducted in unspecified portions of the KTA area. These studies identified nine sites associated with historic and pre-contact agricultural and habitation activities. Williams and Patolo (1995) undertook a subsequent study of inland gulches and bluff areas in the KTA. This survey identified seven sites with traditional agricultural, habitation and ritual functions and two World War II era military bunkers.

Drolet (2000) conducted an inventory survey of ac. 410-acre portion of the c. 16,000-acre Area A-1 of the KTA. This study resulted in the identification of 13 sites consisting of a burial cave, two temporary habitation rock shelter sites, two agricultural terrace sites, an *ahupua'a* boundary wall, an historic road, two World War II era bunkers and four sites that were assigned an indeterminate function.

Previous Archaeological Work within the Project Area

At least sixteen archaeological studies have been conducted within the boundaries of the TBR property. In addition, a mitigation plan, a data recovery plan and a burial treatment plan have been prepared for project area cultural resources. These studies and plans are summarized in *Table 5* and their locations are presented in *Figure 25*. Twenty-six sites have been identified, including 25 burials. These studies report a total of 654 excavations of various types consisting of 444 auger cores, 153 "test" units, 29 backhoe trenches, 21 surface exposures and 7 shovel tests. The exposures consist of places where subsurface strata were evident in eroded sand dune faces, drainage banks and old excavations. Most of the "test" units are 1 sq m excavations conducted during testing phases or work; however, the Corbin (2003) report describes 32 "test" units that actually are designations for block excavation units at Kawela Bay (Areas A and D). Eight of these "test" units are 4 sq m in area and the rest are 1 sq m, yielding a total of 71 square meters of data recovery excavations.

J. Gilbert McAllister of the Bernice P. Bishop Museum conducted the earliest archaeological investigation during his island-wide survey of O'ahu. One site in the project area was identified, consisting of Kukio Pond. According to McAllister (1933:153):

> Site 262. Kukio Pond, a natural basin filled with brackish water, located about 300 feet [90 m] from the sea, Kahuku Point. The pond was formerly much larger and contained many kinds of fish. It is said to have been surrounded by a large Hawaiian settlement. Mrs. John Kaleo is probably the only survivor and her former friends and relatives have been buried in shallow graves in the sand between the pond and the sea.

Kukio Pond was filled, probably during the construction of the Kahuku Army Airfield. The estimated location of the pond is presented in *Figure 26*, inland of Kahuku Point and seaward of the north side of Punaho'olapa Marsh. According to Handy and Handy (1972:462), taro terraces once existed around the pond, but:

> There seems no evidence of old terraces in the uplands along either branch of Kahuku Stream, but in the seaward swampland north and south of Kukio Pond [which would have included Punaho'olapa Marsh] there are such remains.

The B.P. Bishop Museum conducted an archaeological reconnaissance survey of 649-acres in the project area (Dye 1977). The study included pedestrian survey of a 98-acre area to the west of the TBR property along Kawela Bay and a 551 acre area to the east of the resort at Kahuku Point. Four sites were identified by Dye (1977): a remnant of Kapi Pond, two cultural deposits and a possible cultural deposit. The remains of Kapi Pond were identified along the west side of Kawela Bay, outside the project area. This pond was previously identified by McAllister (Site 258) and was subsequently assigned BPBM Site No. 50-OA-F3-1.

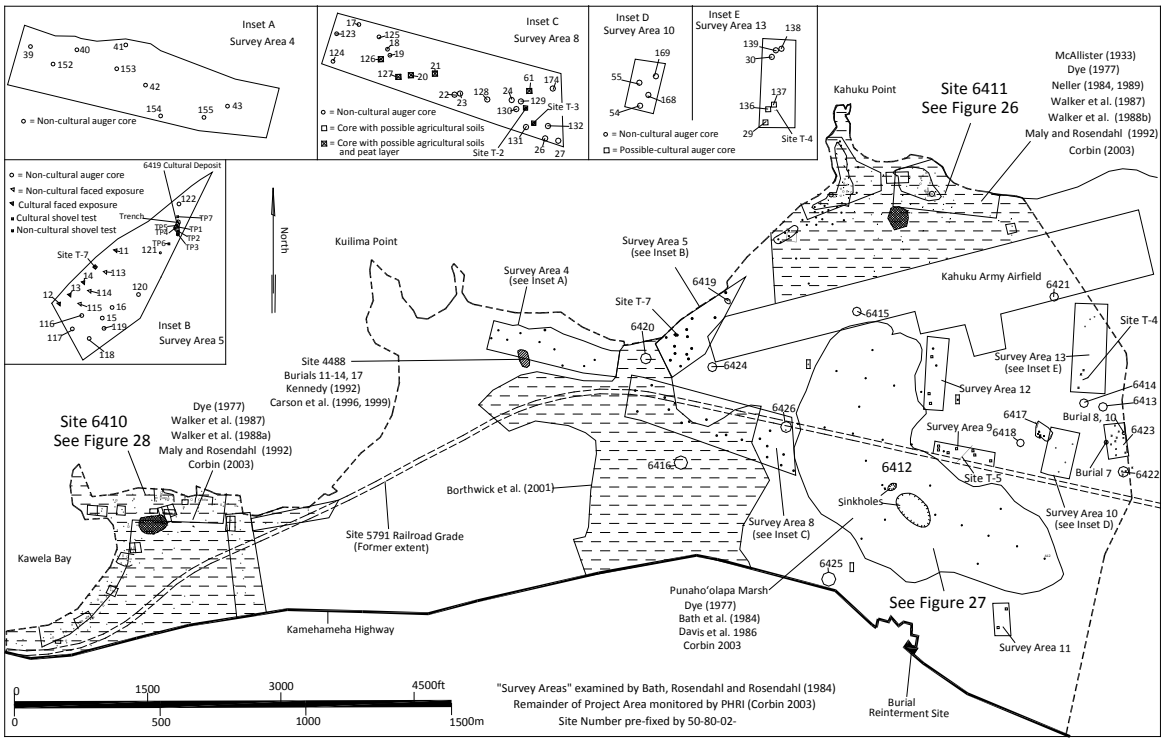


Figure 25. Location of Previous Archaeological Work in Project Area

Table 5. Previous Archaeological Work within Project Area

Author	Company/ Organization*	Location	Study Type	Excavations					Comment
				Auger Tests	Test Units	Backhoe Trenches	Exposure Examinations	Shovel Tests	
McAllister (1933)	Bishop Museum	Survey of Oahu	General Survey						Identified Kukui Pond (Site 262), filled in during construciton of Kahuku Airfiled
Dye 1977	Bishop Museum	Kawela Bay, Kahuku Point, Punaho'olapa Marsh	Reconnaissance		1	1			Identified Kapi Pond (Site 258) remnant, two cultural deposits and one poss. cultural deposit
Neller (1984)	SHPD	Kahuku Point	Osteological examination						Examination of three sets of human remains exposed in dune area
Bath et al. (1984)	PHRI	Kuilima Resort Expansion	Surface and Subsurface Testing	124			11		Examined 13 survey areas and identified four surface features and five subsurface deposits
Davis et al. (1986), Corbin (2003)	PHRI	Punaho'olapa Marsh	Subsurface Testing and Mapping of Sinkholes	27	4	3			Data recovery excavations in Punaho'lapa Marsh
Walker et al. (1987), Corbin (2003)	PHRI	Kuilima Resort	Data Recovery Plan	43	44	5			Data recovery plan and excavations at Kahuku Point and Kawela Bay
Walker et al. (1988a)	PHRI	Excavations with Kawela Bay Archaeological Area	Subsurface Testing	140	36				Identified four discrete cultural deposit areas with abundant cultural remains numerous subsurface features and two burials
Walker et al. (1988b)	PHRI	Excavations with Kahuku Point Archaeological Area	Subsurface Testing	105	38		8		Identified three discrete cultural deposit areas with abundant cultural remains numerous subsurface features and three burials
Neller (1989)	SHPD	Kahuku Point	Osteological examination						Examination of human remains exposed n dune area
Jensen (1989b)	PHRI	Kuilima Resort	Mitigation Program						Proposed four-phase mitigation program for Kawela Bay Archaeological Area and Punaho'olapa Marsh
Sullivan (1990, 1991), Dunn (1991), Donohue (1991), Corbin (2003)	PHRI	Kuilima Resort	Archaeological Monitoring	5	30	20	2	7	Identified 14 new sites
Maly and Rosendhal (1992)	PHRI	Kuilima Resort	Burial Treatment Plan						Burial treatment plan for human remains noted within project area
Kennedy (1992)	ACH	Kuilima Point Burials	Burial recovery/testing						Examination of human remains noted during construciton
Carson et al. (1996, 1999)	ACH	Kuilima Point Burials	Burial recovery/testing						Examination of human remains noted during construciton
			Total Excavations	444	153	29	21	7	

** ACH = Archaeological Consultants of the Pacific, PHRI = Paul H. Rosendahl, Inc., SHPD = State Historic Preservation Division*

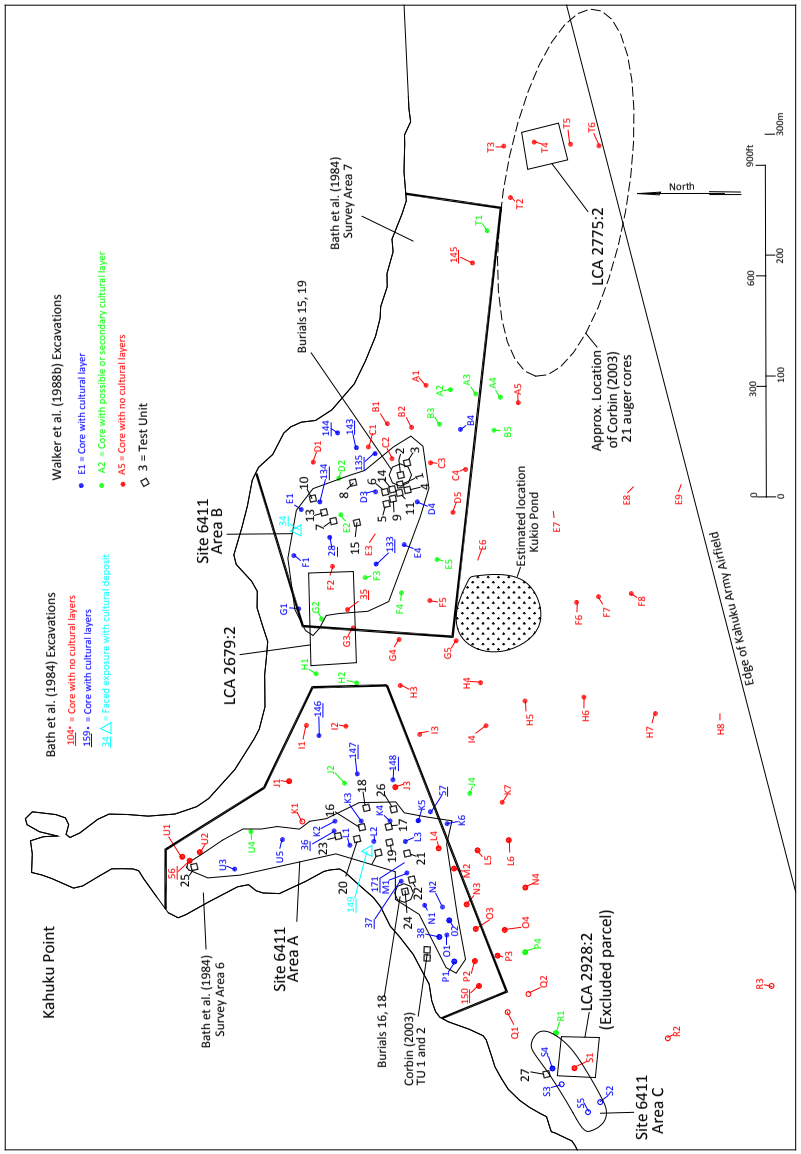


Figure 26. Excavations within Kahuku Point Archaeological Area (Site 6411)

One cultural deposit was identified along the inland side of the sand dunes at Kahuku Point (see *Figure 26*). This site was designated BPBM Site 50-OA-F4-14 and was subsequently assigned State Inventory of Historic Places (SIHP) Site 50-80-02-6411. A test unit was excavated into the deposit revealing four stratigraphic layers. No cultural remains were present in Layers I and II. Layer II contained fire pits, midden, a stone fishing sinker and metal debris. Charcoal was present in the Layer IV deposit.

BPBM Site 50-OA-F4-15 (SIHP Site 6412) is a cultural deposit located adjacent to the OR&L railroad grade near Punaho'olapa Marsh area (*Figure 27*). The deposit was evident in the wall of a backhoe trench and included a black clay layer that was interpreted as the remnant of a prehistoric agricultural plot. It is likely that this deposit corresponds to the cultivated swampland described for this area by Handy and Handy cited previously.

The fourth site reported by Dye (1977) consisted of two layers of gray sand noted in the eroded face of a dune west of Kahuku Point in the vicinity of Kahuku Army Air Field. These soil layers were considered to be a "possible site", but were not assigned a site designation because no test excavation was conducted to confirm the nature of the deposit (*ibid.*: 3).

In 1984, the discovery of human remains in the dunes east of Kahuku Point was reported to DLNR-SHPD. Sand vehicles using the area disturbed the remains. Earl Neller (1984) of the SHPD visited the site and examined the remains that had been collected. These remains consisted of two complete human skeletons and a partial skeleton. The site was subsequently designated "Burial 15" of Site 6411 (see *Figure 26*).

Later in 1984, Paul H. Rosendahl, Ph.D. Inc. (PHRI) conducted an archaeological reconnaissance survey of the Kuilima Resort Expansion Area (Bath *et al*. 1984). The survey area included a proposed golf course adjacent to the existing TBR and a proposed hotel at Kawela Bay.

The PHRI survey work consisted of seven specific tasks (*ibid*.:3):

1. Inspection of all existing subsurface exposures for presence of cultural deposits or features (especially burial features with skeletal remains);
2. Subsurface testing of proposed drainage and stream alignments or realignments passing through both the Kuilima Resort property and the adjacent shoreline area (State Conservation District);
3. Subsurface testing in vicinity of Site F3-1, Kapi Fishpond, for presence of buried cultural deposits (Dye 1977:2);
4. Subsurface testing of the previously identified "possible site" to determine if exposed gray deposit is cultural (Dye 1977:3);
5. Subsurface testing of Site F5-15 to determine if the exposed black layer represents evidence of prehistoric wetland agriculture (Dye 1977:6);
6. Subsurface testing at Site F-4-14 to clarify the nature, age and horizontal extent of previously identified buried cultural deposits (Dye 1977:3-5); and
7. General subsurface reconnaissance testing to sample remaining areas within the expansion project area.

Task 3 subsequently was deleted from the scope of work because the area was outside the resort expansion property. This task was replaced with additional subsurface testing in several areas bordering Punaho'olapa Marsh. The subsurface testing work included excavation of 124 auger tests and the documentation of 11 exposures along berms, road cuts and sand dunes. The auger tests were located in 13 "Survey Areas" (Nos. 1-13; see *Figure 25*). Several discretionary test units were also excavated. The survey identified seven new sites (T-1 through T-7), of which five were tested in addition to subsurface testing at two previously identified sites (F4-14, -15). The tested sites are described below in the order as originally presented by Bath *et al*. (1984). The untested sites consist of an enclosure of wooden posts and corrugated sheet metal (Site T-3) in Survey Area 8 and a stacked limestone wall (Site T-5) in Survey Area 9.

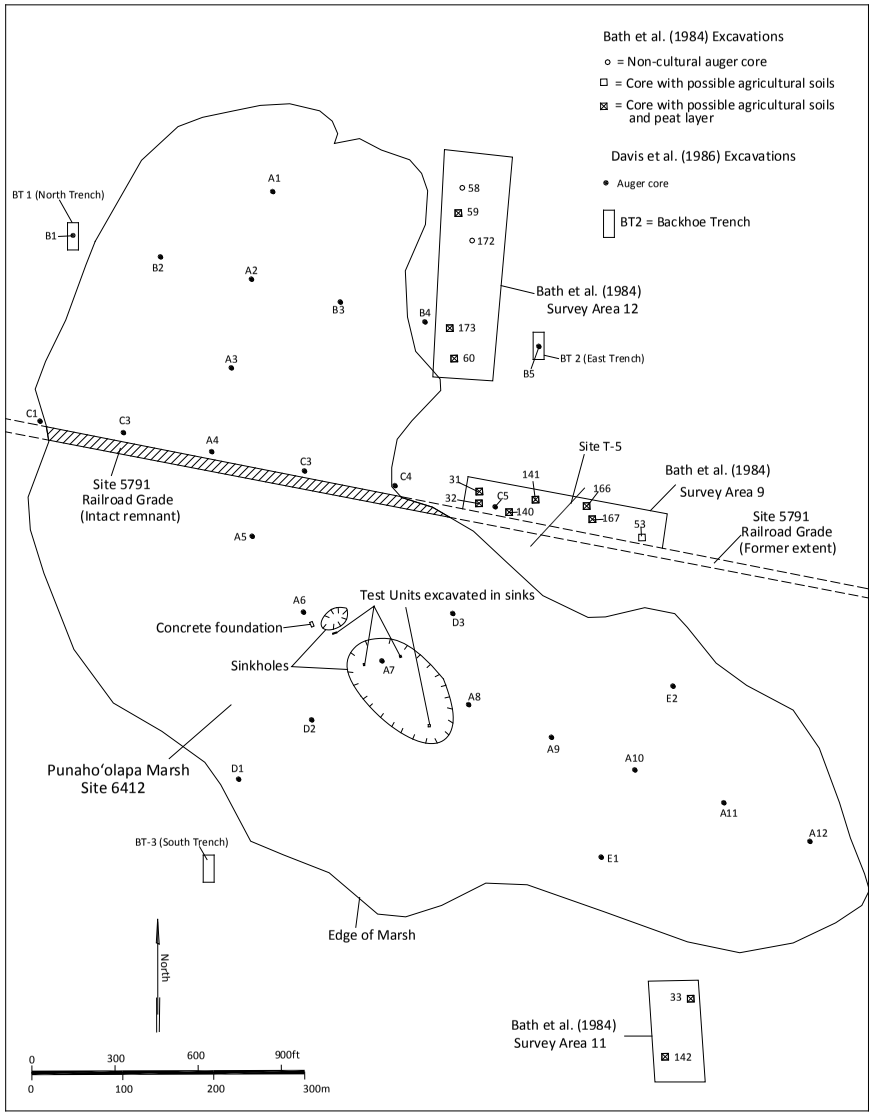


Figure 27. Location of Excavations within and adjacent to Punaho'olapa Marsh (Site 6412)

Site T-6 (subsequently assigned SIHP Site 6410) is located in Survey Area 1 (*Figure 28*). It consists of a subsurface cultural deposit identified as a result of the excavation of 20 auger tests along the east shore of Kawela Bay and the shoreline north of the bay. The cultural deposit was evident in 17 of the tests. The deposit is described as a 0.12 to 0.56 m deep surface layer of a brown to black silty sand containing large quantities of marine shells, charcoal and a bone fishhook. One auger test (TU-112) penetrated a "capped underground solution chamber" and recovered a piece of human bone and three basalt flakes (Bath *et al*. 1984:22). The site was determined to likely extend west along the bay outside the project area, but not inland of the "coastal fringe" to the east where the land had been plowed for farming since at least 1927, based on review of aerial photographs.

Site T-7 is the "possible site" noted by Dye (1977) located in Survey Area 5 between Kuilima and Kahuku Points (see *Figure 25*). Nine auger tests and seven faced exposures were documented in this area (Bath *et al*. 1984: 25); four exposures encountered two cultural layers in the seaward face of coastal dune. The cultural layers overlie a non-cultural sand deposit (Layer IV). One auger test, which was excavated on the inland side of the dune where the two cultural layers were absent, recovered ironwood tree needles and cones from beneath Layer IV. Based on the assumption that the Layer IV deposits on the seaward and inland sides of the dune were contemporaneous, Bath *et al*. (1984) indicated that the two cultural layers were likely historic in origin because ironwood trees were introduced to Hawaii in the 19th century.

Site 50-Oa-F4-14 (SIHP Site 6411, Area B) is a cultural deposit documented by Dye (1977) at Kahuku Point that is located in the Bath *et al*. (1984:27-29) Survey Area 6, where 11 auger tests and one faced exposure were documented (see *Figure 26*). Nine of the auger tests encountered two to three cultural layers containing charcoal, bone and shell midden. The uppermost cultural layer was considered to be historic in age and the lower ones attributed to prehistoric occupation.

Site T-1 (subsequently assigned SIHP Site 6411, Area A) is located in the Bath *et al*. (1984) Survey Area 7, east of Kahuku Point (see *Figure 26*), where eight auger tests and one exposed face were documented. Two cultural layers, encompassing an area 240 m long (east-west) by 140 m wide, were identified in the auger tests. Marine shells, bones (bird, fish, and mammal), charcoal and a single volcanic glass flake were recovered from the auger tests. Several of the auger tests were excavated in the vicinity of the three burials reported by Neller (1984) and one test exposed additional human remains.

Site T-2 is an L-shaped wall made of limestone in Survey Area 8, where 23 auger tests were excavated without encountering any cultural material. A single test (TU 25) was excavated next to the T-2 wall that Bath *et al*. (1984:23) noted might correlate with walls depicted on Loebenstein's 1890 map of Kahuku Plantation (see *Figure 12*).

Five auger tests were excavated and two exposed faces were documented in Survey Area 9, near Punaho'olapa Marsh where Site 50-OA-F4-15 (SIHP Site 6412), a cultural deposit initially identified by Dye (1977), is located (see *Figure 27*). Three of the auger tests identified a layer of dark gray clay over a black peat deposit. This formation is typical of the Pearl Harbor clay soil type and led Bath *et al*. (1984) to re-interpret it as natural deposit instead of an agriculturally modified soil, as originally suggested by Dye (1977).

Site T-4 is a military feature in Survey Area 13 where six auger tests were excavated without encountering cultural material. The feature is described as an octagonal, formed concrete structure with no roof that is 2.25 m in diameter and 1.22 m high (Bath *et al*. 1984:37). A second concrete structure was located nearby but not recorded.

Bath *et al*. (1984) identified an isolated human incisor on the ground surface in Survey Area 12 and a burial was observed eroding from a dune to the west of Kahuku Point. The burial was reported to the Honolulu Police Department, who disinterred it on April 3-4, 1986. These remains were subsequently examined by Neller (1989) and were eventually designated as Feature 16 of Site 6411 (see *Figure 26*).

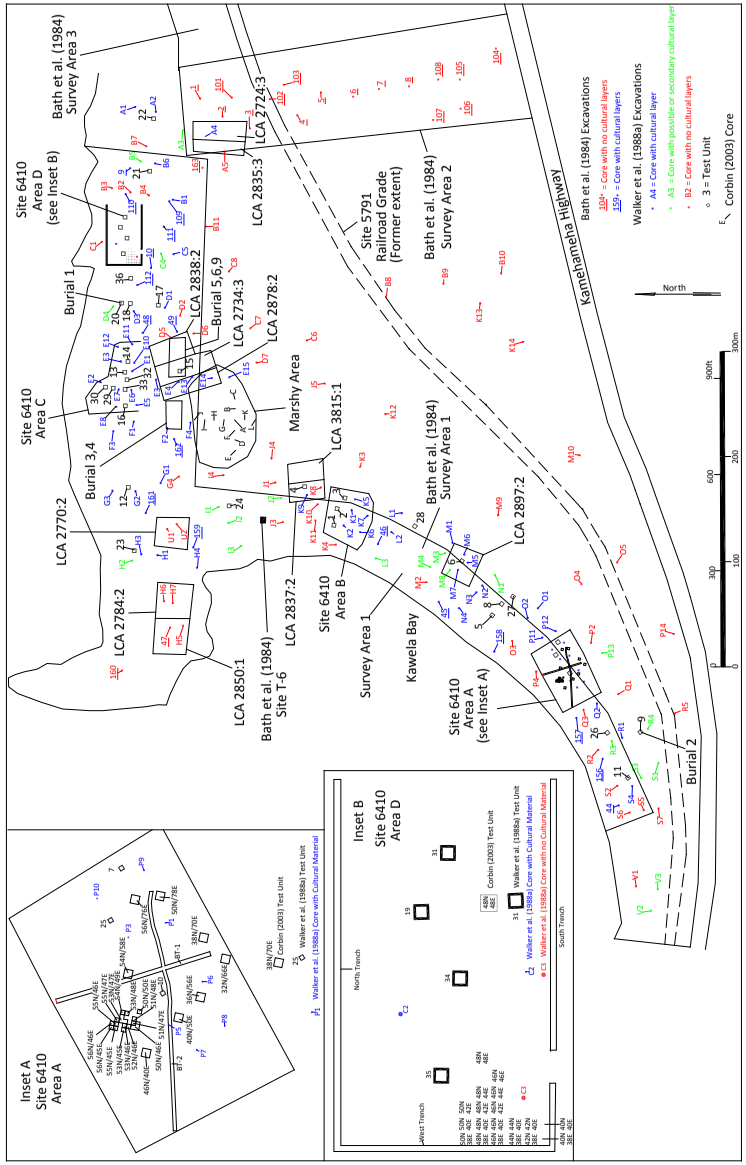


Figure 28. Excavations within Kawela Bay Archaeological Area (Site 6410)

In January and February of 1986, PHRI (Walker *et al*. 1988a) undertook a survey at the Bath *et al*. (1984) Site T-6 at Kawela Bay. The site was named the Kawela Bay Archaeological Area and assigned the BPBM Site No. 50-Oa-2899. The site was subsequently assigned SIHP Site No. 6410 and was determined to be eligible for nomination to the NRHP in an August 13, 1985 letter from Susumu Ono of SHPD to Everett A. Flanders of the U.S. Army Engineer District.

Walker *et al*. (1988a) excavated 140 auger cores and 36 test units along the east side of Kawela Bay and the shoreline to the north (see *Figure 28*). The testing effort extended inland from the coast approximately 300 m. Cultural deposits were identified in 64 cores, primarily in cores located seaward of a dirt road that paralleled the beach. Thirty-six test units were excavated along the shoreline to define four cultural deposits, designated A-D (see *Figure 28*). Area A is on the east-central portion of the bay, Area B is on the east side of the bay, and Areas C and D are on the shoreline north of the bay. Large quantities of food remains consisting of marine shells and bones (bird, fish, and mammal), and 454 artifacts of shell, bone and stone were recovered from the excavations. The excavations also documented 50 subsurface features including post molds, rock alignments, fire pits, ash lenses and charcoal lenses. Several historic artifacts were recovered and charcoal samples from 17 locations were submitted for radiometric age determination.

Walker *et al*. (1988a: 67-69) documented human remains in two locations. A stone-lined burial cist was identified in TU-20, between Deposit Areas C and D. The cist was encountered at the base of the excavation unit, capped by large limestone slabs. A complete human skeleton (Burial 1) was interred within the cist. The burial cist corresponds to the location of the "natural solution cavity" where Bath *et al*. (1984) discovered a human bone fragment in an auger test (TU-112). A subsurface pit (HF 45) was identified in Test Unit 9 (TU-9), situated southwest of Deposit Area A. Human remains (Burial 2) were present within the pit. Both the cist burial and the pit burial were left in place and the excavations were backfilled. Subsequently, in 1990 or 1991, the burials were moved.

From March to April of 1986, PHRI conducted test excavations at the Kahuku Point Archaeological Area (Walker *et al*. 1988b; see *Figure 26*). This area corresponds to Site 50-Oa-F4-14 recorded by Dye (1977) and was subjected to auger coring by Bath *et al*. (1984). The area examined by Bath *et al*. (1984) east of Kahuku Point designated as Site T-1, and Site 50-Oa-F4-14 on the east side of Kahuku Point were combined into a single site by Walker *et al*. (1998b), designated Site 50-Oa-2911. This site was subsequently designated SIHP Site 6411.

Walker *et al*. (1998b) documented eight stratigraphic exposures in the dunes at Kahuku Point and excavated 105 auger cores and 38 test units there. The cores extended from the coast up to 100 m inland. Cultural deposits were identified in 20 of the cores, all within 50 m of the coast. These deposits were noted in three discrete areas designated Areas A-C. Area A is located on the west side of Kahuku Point, Area B east of the point and Area C west of Area A (see *Figure 26*).

The test units were excavated in the three areas. Excavation yielded food remains consisting of marine shells and bones (bird, fish and mammal); stone, shell and bone artifacts; and 44 subsurface features including post molds, charcoal concentrations and fire pits. Charcoal samples collected from 21 locations were submitted for radiometric age determination. Three human burials were identified during the test unit excavations. Two burial pits, designated Burial 19, were identified in TU-2 in Area B and one burial pit was indentified in TU-24 in Area A (Burial 18). The burials were left in place and the units were backfilled.

Concurrent with the Walker *et al*. (1988b) survey at Kahuku Point, PHRI also undertook testing at Punaho'olapa Marsh (Davis *et al*. 1986; see *Figure 27*). This area was previously documented as Site 50-Oa-F4-15 by Dye (1977) and portions were tested by Bath *et al*. (1984) in Survey Area 9. During the Davis *et al*. (1986) study, the marsh was designated BPBM Site 50-Oa-2912; the site was subsequently designated SIHP Site 6412. Davis *et al*. (1986) released a preliminary report of the testing results and the full descriptive account of the work was included in the Archaeological Mitigation Report for the Kuilima Resort Expansion Project (Corbin 2003).

According to Corbin (2003:193), initial examination of the marsh area identified three large limestone sinkholes and several associated walls in the vicinity of the Bath *et al*. (1984) Survey Area 8. The sinkholes varied in size from 5.0 to 15.0 m and in depth from 2.0 to 3.0 m. The largest was partially filled with alluvium. The second sinkhole had been used as a trash dump and contained rusted metal, bottles and jars dating between the 1870s and 1890s. The floor of the third sinkhole was flooded.

Four test units were excavated at the sinkholes. Two test units were excavated within the largest sinkhole (Units 1 and 4), one was excavated in the sink used as a dump (TU-2) and one was located adjacent to the water-filled sink next to a stone wall (TU-3). According to Corbin (2003:197), "these test units appear to have been excavated into a generally heavily disturbed area, as evidenced by surface and subsurface historic artifacts, trash in subsurface layers and bulldozer tracks in the area".

Additional subsurface testing undertaken by Davis *et al.* (1986) included three backhoe trenches and 27 sediment cores obtained with a modified Livingston coring device used for sampling submerged sediments. The typical stratigraphy observed in the cores consisted of seven strata overlying limestone bedrock. Three major stratigraphic units were defined: (1) a 1.0 to 1.5 m thick organic root and rhizome mat submerged under 0.1 to 0.2 m of water, (2) an unconsolidated peat-like organic deposit 3-3.5 m thick, and (3) a 0.04 to 0.1 m thick layer of "diagenetic carbonate silt" overlying limestone bedrock (Corbin 2003: 202). Charcoal was collected from three of the cores (A1, B1 and B3).

The three backhoe trenches were excavated around the perimeter of the marsh. These excavations revealed five to nine layers of clays to peaty clay deposits and were terminated within the water table. Land snails and charcoal were present in all three of the backhoe trenches. Twelve charcoal samples were submitted for radiometric age determination, nine from the backhoe trenches and three from the cores. Two hundred and twenty pollen samples were submitted for analysis from two of the trenches and all of the cores. These samples yielded a "record of the vegetation for the past 7,000 years of for this area of the Kahuku plain of northeastern Oahu" (*ibid*.:209). Based on the testing with the marsh, Corbin states, "…prehistorically, the marsh may have supported a more open and wetter environment than at present, with loulu palms [Pritchardia] being a dominant element" (*ibid*.:210).

In 1987 Walker *et al*. (1987) prepared a Data Recovery Plan (DRP) for the Kuilima Resort, to mitigate Site 2899 at Kawela Bay and Site 2911 at Kahuku Point. These sites were subsequently assigned SIHP Sites 6410 and 6411, respectively. Three research questions were proposed to guide the data recovery work:

1. What is the nature of the intra-site spatial organization or site structure?
2. What is the social composition (age, sex and relative social status) of the site occupants? and;
3. What is the nature and sequence of site occupation?

Walker *et al*. (1987) proposed excavation of six backhoe trenches at the Kawela Bay Site (6410), with two trenches in Area A and four within Area D. A similar approach was proposed for the excavations at the Kahuku Point Site (6411). Additionally it was proposed that excavations be undertaken in a small marsh inland of Kawela Bay and at the buried Kukio Pond at Kahuku Point.

This data recovery work fieldwork commenced in November 1990 shortly after SHPD approval of the Walker *et al*. (1987) DRP and was completed in July 1991; however, analysis and reporting of the work was suspended for nearly a decade and was not completed until 2003. The data recovery findings were reported in the Corbin (2003) Archaeological Mitigation Report for the Kuilima Resort Expansion Project. According to Corbin the data recovery field work included excavation of 44 excavation units totaling 102 sq m in extent, 5 backhoe trenches and 40 auger cores (see *Figure 28*).

The excavations at the Site 6410, Kawela Bay Archaeological Area consisted of 42 excavation units (99.94 sq m), five backhoe trenches and 12 auger cores. Twenty-three of the excavation units and two of the backhoe trenches were situated within Area A. These excavations revealed a stratified subsurface cultural deposit that encompassed

an area 60 m long by 46 m wide. Fifty hearth features and 8 postholes were documented, and a large assemblage of subsistence remains and artifacts was recovered for analysis.

The remaining 19 excavation units and three trenches were excavated in Area D. These excavations indicate that Area D is c. 60 m long by 30 m wide and also characterized by stratified cultural deposits. Excavations documented 63 hearths and earth ovens (*imu*) and 80 postholes. Large quantities of subsistence remains and artifacts were recovered.

Twelve auger cores were excavated in a marshy area inland of the northern end of Kawela Bay. The area was the reported location of Waikū Pond, depicted in *Figure 8*. The coring was undertaken to identify evidence of pre-contact agricultural use of the marshy area; however, it was determined that the marsh was a sinkhole that had been filled in and compacted by contractors (Corbin 2003:88). No cultural remains were present in the cores.

Data recovery work at the Site 6411 Kahuku Point Archaeological Area included excavating 21 auger cores and two test units. The excavations were not as extensive as outlined in the DRP because shortly after the fieldwork began, Kuilima Resort Development Co. decided that the area would not be developed and all work was terminated. The excavated test units recovered substantial quantities of food remains and several stone artifacts. Ten soil features including five hearths or fire pits, four postholes and a large pit of undetermined function were documented. Marine shells, metal and glass were present in the cores.

In 1989, Jensen (1989b) prepared Phases I and II of a four-phased mitigation program for the Kawela Bay Mitigation Project. The four phases consisted of a Monitoring Plan (Phase I), a Burial Treatment Plan (Phase II), Field Monitoring (Phase III) and Data Recovery (Phase IV). This program proposed archaeological monitoring of all construction work at the Kawela Bay Archaeological Area and construction of a moat around the Punaho'olapa Marsh. Collection of bulk soil samples for dating and pollen analysis was also proposed. The Burial Treatment Plan detailed procedures for the treatment of human remains identified during future work, along with the proposed disinterment of two burials identified at Kawela Bay by Walker *et al*. (1988a).

PHRI subsequently monitored all construction activity within the TBR property (late 1990 into 1991) as outlined in the Jensen (1989b) mitigation program. Archaeological monitoring included areas within the existing golf course, the new golf course, the sod farm area, the proposed hotel site at Kawela Bay, the 'Ōpana wells site, Borrow Area 3 located on lands owned by the Campbell Estate, a wastewater line trench along Kamehameha Highway, and a wastewater pumping station near the existing Turtle Bay Hotel.

The monitoring work was preliminarily reported in a series of 17 Status Reports prepared by Sullivan (1990, 1991), Dunn (1991) and Donohue (1991). These status reports briefly document 14 newly identified archaeological sites (Temporary Monitoring Sites [TM] 1 through 14) and ten burials (Burials 1-10). The complete descriptive findings of the monitoring work are presented in Corbin (2003).

The 14 sites identified during monitoring were assigned SIHP Site numbers by Corbin (2003; Sites 6413 thru 6426; *Table 6*). The sites include nine cultural deposits (Sites 6413, 6414, 6416-6419, 6422, 6423 and 6425), two stone walls (Sites 6424 and 6426), an enclosure (Site 6415), an alignment (Site 6420) and a pool divided into three sections by discontinuous stone walls (Site 6421). Subsurface testing was conducted at 10 of the 14 sites including 30 test units, 20 backhoe trenches, 7 shovel tests, 5 auger cores, and documentation of two exposed faces in the banks of a lake in the golf course. These sites and excavations are summarized in the following section.

In 1992 human remains were discovered in sand fill that was excavated from a dune area south of Kuilima Point. The remains were transported to the Kahuku Police Station and eventually to the Medical Examiner's office in Honolulu. Kennedy (1992) examined the sand fill and the dune area. The sand fill was screened to recover all of the skeletal material. The dune area was examined and no additional remains were observed. The recovered remains were analyzed and four individuals were identified, consisting of an adult female and three sub-adults of indeterminate sex. These remains were assigned SIHP Site No. 4488 and were transferred to SHPD for curation. The burials were subsequently designated as Burials 11-14.

In 1996, additional human remains were discovered in the Site 4488 area (Carson *et al*. 1996, 1999). SHPD collected an adult scapula and facial bones, and a sub-adult tibia epiphysis from the area. The area was excavated and sand from the area was screened to recovering additional skeletal remains; in addition wood fragments and square nails were recovered. The wood and nails were inferred to be the remnants of a coffin. The skeletal remains were designated Burial A. A second set of remains was identified 3 m from Burial A, consisting of disarticulated adult long bones (Burial B). The skeletal remains were turned over to SHPD for curation and collectively were designated Burial 17.

In 2001, Cultural Surveys Hawai'i conducted archaeological monitoring of modifications to seven existing golf course holes, construction of two new holes and of a new driving range in the central portion of the project area (Borthwick *et al*. 2001). No surface or subsurface archaeological sites were identified.

Summary of Previously Identified Sites

Studies discussed above document 18 SIHP sites within the TBR property (Sites 4488 and 6410-6426). Site locations are illustrated in *Figures 25-28* and are summarized in *Table 6*. Bath *et al*. (1984) assigned temporary site designations to several additional identified sites that were not addressed in subsequent studies (Sites T-2 through T-5). The remains of two historic sites, the OR&L railroad grade and Kahuku Army Airfield, are present within the project area, but were not explicitly treated as historic properties by any previous study.

To date, three sites have been preserved: Kahuku Point Archaeological Area (Site 6411), Punaho'olapa Marsh (Site 6412) and Site T-5 documented by Bath *et al*. (1984) that is included within the boundary of 6412. Fifteen sites were mitigated through data recovery excavation or burial disinterment and relocation (Sites 4488, 6410, 6413-6420, 6422, 6423, 6423, Kukio Pond and Bath *et al*. 1984 Site T-7). The current disposition of the remaining sites (5791 railroad grade, the airfield, 6421, 6424, 6426, and T-2, T-3, and T-4) is unclear. It is proposed that the disposition of these sites can be determined during the SAIS fieldwork. The previously identified sites are summarily described below.

Site 4488 is located inland of Kuilima Point. Human remains of at least eight individuals were discovered in 1992 and 1996 during sand mining operations (Kennedy 1992; Carson *et al*. 1996, 1999). These remains were designated as Burials 11-14 and 17. Following analysis the remains were temporarily curated by SHPD until they were reinterred on the TBR property. The location of the reinterment site is shown on *Figure 25*.

A portion of the OR&L railroad grade extended through the TBR property. The alignment of the railroad is depicted on current tax maps (see *Figures 2 and 3*) and on several historic maps (see *Figures 13-16*). None of the previous investigations documented this historic transportation route or assigned the railroad grade an SIHP site designation. The 1946 tsunami destroyed the railroad and it was abandoned in 1954 (Haun and Henry 2001b).

A portion of the railroad grade west of the project area in the Land of Kaunala and was assigned SIHP Site 5791 by Haun and Henry (2001b:15). A 525-meter long section of the railroad grade was recorded, along with several bridge foundations. Another section of the railroad grade in the vicinity of Ewa Beach was documented as SIHP Site 9714 and that segment of the OR&L mainline railroad grade was enrolled on the NRHP on December 1, 1975 (NRHP n.d.).

Formerly, a c. 3,950 m segment of the railroad grade spanned the TBR property, extending from inland of Kawela Bay across Kahuku Plain in a northeasterly direction for c. 2,120 m and then to the east-southeast for an additional 1,830 m where it exited the property. The railroad continued east to Kahuku Mill. The SAIS fieldwork will attempt to locate any extant remnants of the railroad grade.

Table 6. Summary of Previously Identified Sites in Project Area

SIHP Site No.	Bishop Museum Site No.	Other Site No. /Name	Site Type	McAllister (1933)	Dye (1977)	Bath et al. (1984)	Neller (1994)	Walker et al. (1988a)	Walker et al. (1988b)	Davis et al. (1986)	Kennedy (1992)	Kennedy (1996)	Sullivan (1990, 1991), Dunn (1991), Donohoe (1991)	Haun and Henry (2001)	Carson (2003)	Excavations: Auger Tests	Test Units	Backhoe Trenches	Exposure Examinations	Shovel Test Pits	Current Status
4488	-	-	Cultural deposit with burials								X	X									Burials removed as reinterred
5791/ 9714	-	-	Railroad Grade											X							To be determined
6410	50-Oa-2899	-	Cultural deposit with burials			X		X							X	179	78	5			Mitigated through Data Recovery; Burials removed and reinterred
6411	50-OA-F4-14 50-OA-2911	T-1	Cultural deposit with burials	X	X	X	X		X						X	145	41	1	11		Preserved
6412	50-OA-F4-15 50-OA-2912	-	Cultural deposit in Marsh with 3 sinkholes	X	X					X						35	4	3	1		Preserved
6413	-	TM-1	Cultural deposit												X			1			Mitigated through Data Recovery
6414	-	TM-2	Cultural deposit												X		4	1			Mitigated through Data Recovery
6415	-	TM-3	Enclosure												X		1				Mitigated through Data Recovery
6416	-	TM-4	Cultural deposit												X			11			Mitigated through Data Recovery
6417	-	TM-5	Cultural deposit												X		5	3	2		Mitigated through Data Recovery
6418	-	TM-6	Cultural deposit												X			1			Mitigated through Data Recovery
6419	-	TM-7	Cultural deposit												X			1		7	Mitigated through Data Recovery
6420	-	TM-8	Alignment												X	5	1				Mitigated through Data Recovery
6421	-	TM-9	3 pools with walls												X						To be determined
6422	-	TM-10	Cultural deposit												X		4	1			Mitigated through Data Recovery
6423	-	TM-11	Cultural deposit with burials												X		15	3			Mitigated through Data Recovery; Burials removed and reinterred
6424	-	TM-12	Stone wall												X						To be determined
6425	-	TM-13	Cultural deposit												X						Mitigated through Data Recovery
6426	-	TM-14	Stone wall												X						To be determined
-	-	Kahuku Air Base																			To be determined
		262	Kukio Pond	X					X												Mitigated through Data Recovery
		T-2	Stone wall			X															To be determined
		T-3	Cattle enclosure			X															To be determined
		T-4	Military structure			X															To be determined
		T-5	Stone wall			X															Preserved
-		T-7	Gray sand layer in dune (determined to be historic)		X	X										9			7		Mitigated through excavation
Additional excavations conducted in Non-site locations						X										71					
Totals																**444**	**153**	**29**	**21**	**7**	

Site 6410 is a cultural deposit designated as the Kawela Bay Archaeological Area, located in the east portion of the TBR property. This site has been subjected to extensive subsurface excavation (Bath *et al*. 1984; Walker *et al.* 1988a; Corbin 2003). Excavations consisted of 179 auger cores, 78 excavation units and five backhoe trenches (see *Figure 28*). These excavations documented four concentrations of cultural deposits designated as Areas A-D.

Area A excavations typically identified a single cultural layer that varied in thickness from 0.15 to 0.58 m (Walker *et al*. 1988a); however, data recovery excavations by Corbin (2003) in this area documented as many as three cultural layers (Layers II, III and IV). These cultural deposits are overlain by a disturbed sand deposit (0.03 to 0.28 m thick) and are underlain by pre-cultural sand layers. Layer II averaged 0.18 m in thickness, Layer III averaged 0.11 m and Layer IV averaged 0.2 m. Large quantities of subsistence debris, artifacts and numerous subsurface features were identified in these excavations.

Area B excavations documented a single prehistoric cultural deposit that varied in thickness from 0.1 to 0.25 m (Walker *et al*. 1988a). One to two sand layers typically overlie the cultural layer, with the upper deposit containing historic debris. Marine shells, artifacts and charcoal were recovered from the prehistoric cultural deposit.

Area C excavations documented a single cultural layer that varied in thickness from 0.15 to 0.55 m (Walker *et al*. 1988a). Recent fill and a beach sand deposit overlies the cultural deposit, which is characterized by fire pits, ash lenses, marine shells, stone and shell tools, modified mammal bones and fire-altered rock.

Area D excavations encountered a discontinuous 0.15 to 0.45 m thick cultural deposit with fire pits and ash lenses, marine shells, shell and stones tools, charcoal and modified bone (Walker *et al*. 1988a). Subsequent data recovery in this area by Corbin (2003) revealed two cultural layers: the upper cultural layer (Layer II) varied in thickness from 0.08 to 0.45 m and contained numerous fire pits, hearths, postholes, marine shells and charcoal, while the lower cultural deposit (Layer III) varied in thickness from 0.07 to 0.35 m and contained hearth, postholes, shells and charcoal. Both cultural layers were overlain by a disturbed sand deposit with modern debris (Layer I) and were underlain by multiple layers of pre-cultural sand.

Eight LCAs are present in the Kawela Bay area (see *Figures 11 and 28*). Several of the LCAs are located in close proximity to Areas A-D, but none correlate exactly to the any of the cultural deposits documented.

Historic documentary research indicates that Waikū Pond once existed in the vicinity of Site 6410 south of Area C (see *Figures 8 and 28*). It was proposed in the Walker *et al*. (1987) data recovery plan that coring be undertaken in the "marshy area" labeled on *Figure 28*, which was thought to correspond to the former location of Waikū Pond. Twelve cores were excavated in the "marshy area", none of which yielded cultural remains or pond deposits. The core samples were interpreted to indicate that the "marshy area" represented a sinkhole filled and compacted by contractors.

Site 6410 has been subjected to extensive survey and data recovery excavations. No human burials were found during the excavations in Areas A-D; however, seven burials have been identified at Site 6410 during excavations adjacent to these areas (Bath *et al*. 1984; Walker *et al*. 1988a; Sullivan 1991). These burials were excavated and reinterred in the reinterment site adjacent to Kamehameha Highway. These burials are discussed in more detail in the following section. The data recovery at the site was considered sufficient to mitigate adverse effects from development and the site has subsequently been altered by resort-related construction.

Site 6411 is the Kahuku Point Archaeological Area located to the east, west and south of Kahuku Point. Extensive archaeological inventory survey and data recovery excavations were undertaken in this area (Dye 1977; Bath *et al*. 1984; Neller 1984; Walker *et al*. 1988b; Corbin 2003). Three concentrations of cultural deposits (Areas A-C) were identified at the site, potentially representing remnants of a single habitation area impacted by wind erosion and damage by unrestricted sand vehicle activity.

Area A excavations identified a 0.15 to 0.55 m thick cultural deposit in an area 230 m long by 30-75 m wide (Walker *et al*. 1988b). Large concentrations of midden material and artifacts were present in the central portion of Area A. This deposit is located in the dunes to the west of Kahuku Point.

Area B is located east of Kahuku Point and covers an area 180 m long by 45-90 m wide. A discontinuous cultural deposit that varied in thickness from 0.05 to 0.3 m, characterized by subsurface features, artifacts and food remains, was documented. Area B appears to correspond to LCA 2678:2 (see *Figure 26*)

Area C is located to the south of Area A, in an area 90 m long by 25 m wide. Excavations documented a cultural deposit 0.1 to 0.25 m thick, characterized by midden debris, artifacts and subsurface features. Area C appears to correspond to LCA 2928:2 (see *Figure 26*).

Limited data recovery work was conducted at 6411 before it was determined that the area was to be preserved. The auger cores identified no intact cultural deposits; disturbance was inferred from historic and/or modern debris in a subsurface context. However, two test units excavated in the south portion of the site documented a disturbed surface layer overlying a prehistoric cultural deposit with subsurface features, artifacts and marine shells.

Site 6411 was subjected to extensive survey excavations, but with limited data recovery. Four burials consisting of seven individuals were identified at Site 6411. Two burials were exhumed by either SHPD or the Honolulu police and were interred at the reinterment site (Neller 1984, 1989). The two remaining burials, noted by Walker *et al*. (1988b) were left following their identification and the units were backfilled. These are discussed in more detail in a following section. The Site 6411 was preserved as a park area shortly after the data recovery at the site was suspended.

Site 6412 encompasses Punahoʻolapa Marsh, the large freshwater marsh area located in the east portion of the TBR property (see *Figure 27*). Dye (1977), Bath *et al.* (1984), Davis *et al*. (1988) and Corbin (2003) examined the marsh and its perimeter. A total of 35 auger cores, four test units, three backhoe trenches and the examination of one exposed soil profile have been documented within and adjacent to the marsh. A complex of sinkholes was noted within the marsh itself. The majority of the subsurface tests were located in the wet marshy area, yielding no cultural remains. However, these excavations documented pre-contact floral biota through pollen analysis (Corbin 2003). The presence of possible marsh deposit in excavations conducted outside the current boundary of Punahoʻolapa Marsh suggest that the wetlands was likely once much larger. Punahoʻolapa Marsh has been preserved because it is a wetland. The T-5 rock wall (discussed below), noted by Bath *et al.* (1984) is located within the preserve.

Site 6413 is a surface and subsurface historic and prehistoric cultural deposit located along the east-central edge of the TBR property, found within the TBR sod farm and greenhouse nursery (see *Figure 25*). Prehistoric and historic surface artifacts were collected (Corbin 2003). Subsurface testing consisted of excavating one backhoe trench to document a subsurface profile of two subsurface features, consisting of a hearth and posthole. Charcoal, shells, coral and fire-cracked rock were collected from the features but not analyzed. Site documentation and testing were considered sufficient to mitigate data loss from resort-related construction. The site was subsequently destroyed.

Site 6414 is a subsurface cultural deposit located near the east-central edge of the TBR property, on the west side of Site 6413. This site was first documented in a TBR equipment yard as a subsurface cultural layer exposed in profile in a mechanically excavated pit for a fuel tank (Corbin 2003). The pit was expanded into a trench. Four 1.0 by 1.0 m test units were excavated to the southwest to determine the areal extent of the deposit (*Figure 29*). Excavation documented 8 hearths, 3 pits, 4 postholes, marine shells, debitage, charcoal and a variety of historic debris. Charcoal from the trench was submitted for radiometric age determination. Site documentation and testing were considered sufficient to mitigate data loss from resort-related construction. The site was subsequently destroyed.

Site 6415 is a small enclosure located near the west-central edge of the Kahuku Air Base, on the northern periphery of Punaho'olapa Marsh. The structure is built of coral cobbles and small boulders and is 2.96 m long, 2.29 m wide by 0.47 m high (*Figure 30;* Corbin 2003). A test unit was excavated in the center of the enclosure; only wire and metal were recovered. After documenting the site, it was cleared for destruction. According to Corbin (*ibid*.:230):

> The function of the enclosure is unknown. The enclosure may predate the construction of the Kahuku Air Base, having survived the construction because of its proximity to the edge of Punaho'olapa Marsh. The Air Corps appears to have excavated a drainage ditch running parallel to the edge of the marsh; the site is on the marsh side of this ditch, making it fairly inaccessible.

Site 6416 is a subsurface cultural deposit located west of Punaho'olapa Marsh in the central portion of the TBR property. The site was documented during excavation of a sewer line #2 trench (Corbin 2003). Eleven trenches were excavated in order to determine the extent of the cultural deposit (*Figure 31*). A total of 103 feet of trench was profiled to document four hearths, a possible earth oven (*imu*), a dog burial, a historic or modern pit and a pit of undetermined function. Charcoal from the site was submitted for radiometric age determination. Artifacts include modified bone fragments (medium-sized mammal, artiodactyl, *Bos*) and a possible urchin abrader. Site documentation and testing were considered sufficient to mitigate data loss from resort-related construction. The site was subsequently destroyed.

Site 6417 is a subsurface cultural deposit located on the east edge of the TBR property on the eastern periphery of Punaho'olapa Marsh and west of the TBR sod farm. The site was initially encountered during construction of a golf course lake (*Figure 32*) and its areal extent was determined through test excavations of two backhoe trenches, five test units and profiling two exposures along the lake cutbank. A series of six concrete pads located north of the lake were interpreted as barrack foundations. Test excavations documented six fire pits and possible subsurface floor characterized by flat coral stones, marine shells, coral, basalt flakes, charcoal, and historic and modern debris (Corbin 2003). Several basalt adze fragments, a basalt flake and piece of slate were collected from the surface of the site. Several fragments of charcoal were submitted for radiometric age determination. Site documentation and testing were considered sufficient to mitigate data loss from resort-related construction. The site was subsequently destroyed.

Site 6418 is a subsurface cultural deposit located at the east end of the TBR property, on the east side of Punahóolapa Marsh and west of Site 6417. A concentration of charcoal was noted in a pit during the removal of a coconut tree (*Figure 33*). The site was extensively impacted by "earthmoving equipment associated with the Kahuku Army Air Corp Base" (Corbin 2003:262-264). Site testing consisted of excavation of a backhoe trench that did not encounter cultural remains. The location of the backhoe trench was not depicted on the site map. Site documentation and testing were considered sufficient to mitigate data loss from resort-related construction. The site was subsequently destroyed.

Site 6419 is a subsurface cultural deposit located along the shoreline between Kuilima Point and Kahuku Point. The site was initially encountered during sand mining activity on the south side of a beach berm within Survey Area 5 (Corbin 2003). Testing consisted of excavating a backhoe trench and seven shovel tests, which indicated that portions of dune had been highly disturbed (Corbin 2003; *Figure 34*). Site documentation and testing were considered sufficient to mitigate data loss from resort-related construction. The site was subsequently destroyed.

Site 6420 is an oval alignment of coral and basalt boulders located along the central bay front mid-way between Kahuku and Kuilima Points. The site was initially identified in 1990 during monitoring activities (Corbin 2003). The alignment is 3.5 m long by 2.87 m wide, with the interior measuring 0.45 m in depth below the surrounding ground surface (*Figure 35*). Site testing consisted of excavating a 1.0 by 1.0 m test unit and five auger cores. Charcoal from a possible *imu* was recovered from the test unit and one of the cores, along with a modern penny and several recent nails from the test unit. The site was inferred to be modern. Site documentation and testing were considered sufficient to mitigate data loss from resort-related construction. The site was subsequently destroyed.

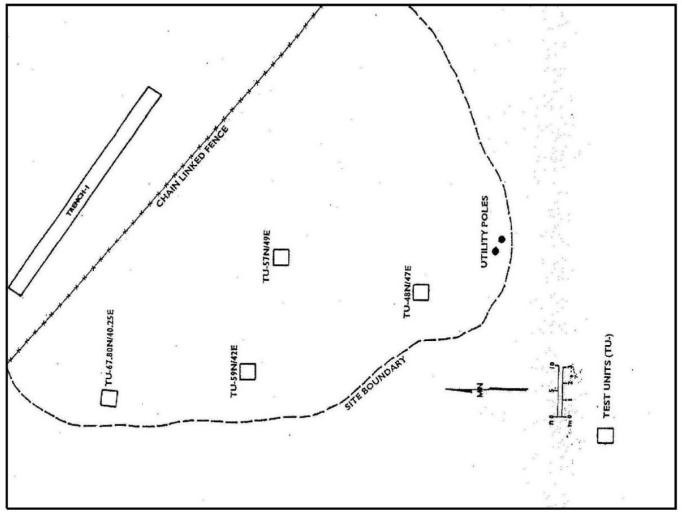


Figure 29. Site 6414 Plan Map (from Corbin 2003:222

Figure 30. Site 6415 Plan Map (from Corbin 2003:231

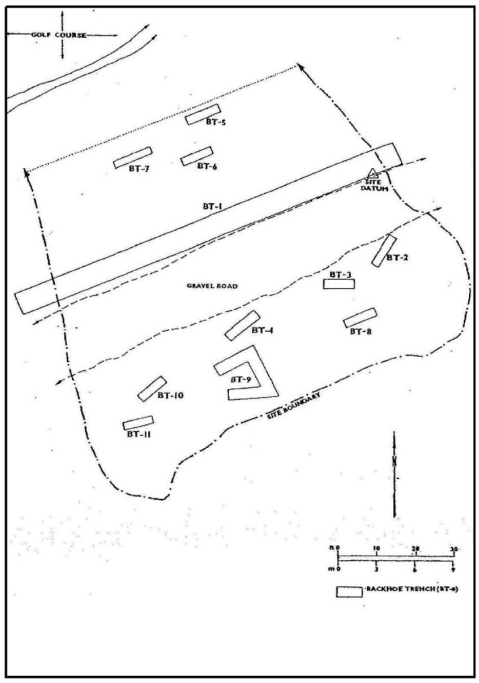


Figure 31. Site 6416 Plan Map (from Corbin 2003:234

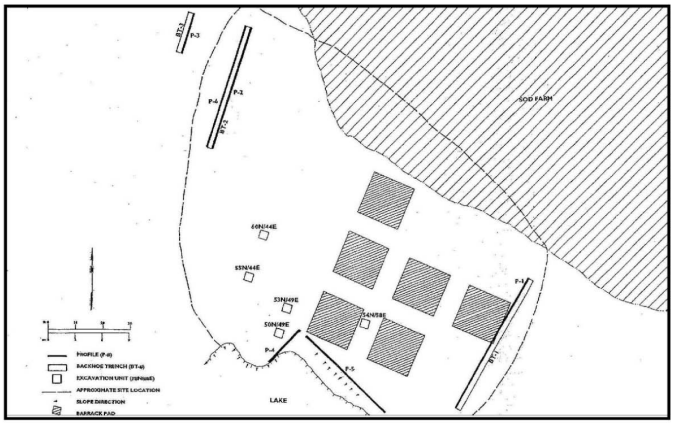


Figure 32. Site 6417 Plan Map (from Corbin 2003:249)

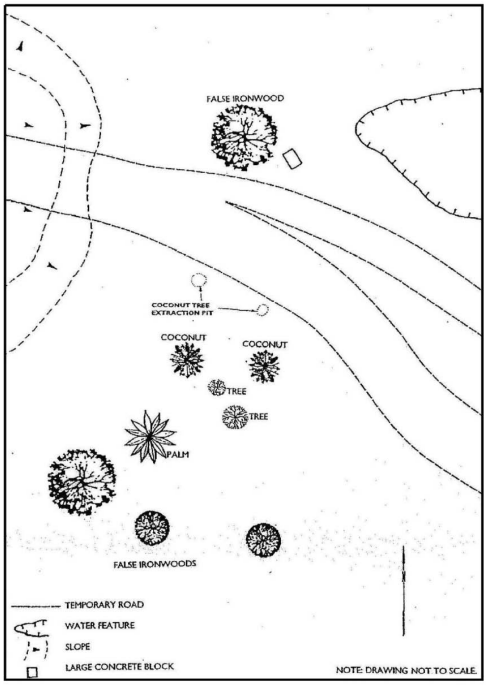


Figure 33. Site 6419 Plan Map (from Corbin 2003:266)

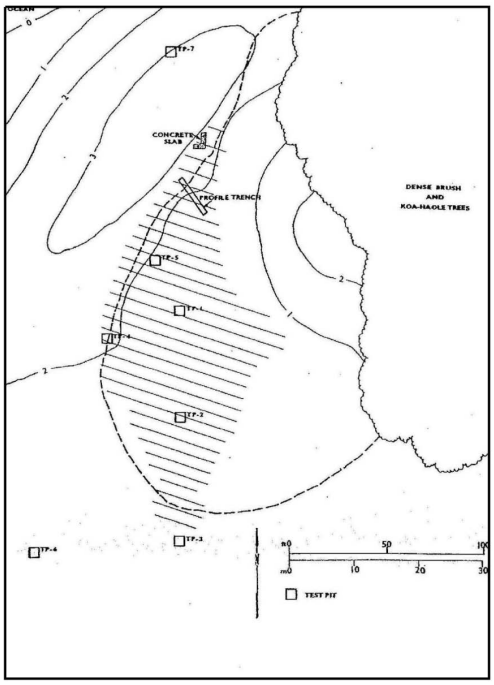


Figure 34. Site 6418 Plan Map (from Corbin 2003:263)

Site 6421 is a pool divided into three sections located on the southeast edge of the Kahuku Army Airfield in an area designated as wetlands along the east boundary of the TBR property. The US Army Corp of Engineers identified the site for PHRI to document (Corbin 2003). The pool is located in an area 10.8 m long by 10.8 m wide. Pool depth varies from 0.45 to 3.0 m (*Figure 36*). Basalt boulders are stacked to form a retaining wall on the east-central edge and aligned discontinuously around the pool perimeter and across the pool to divide the central pool from the south pool. A metal pipe and hose extend into the south pool. No testing was undertaken, but the site was interpreted as possibly historic. The current condition of the site is unknown.

Site 6422 is a subsurface cultural deposit located on the east-central boundary of the TBR property on the north side of the OR&L Railroad grade within the O'ahu Construction Company's yard (*Figure 37*). The site was identified during excavation of a waterline trench. Site testing consisted of excavating a backhoe trench and four test units to determine the areal extent of the deposit. The backhoe trench (BT-1) was excavated on the west side and parallel to the west fork of Marconi Road and extended north beyond the boundaries of the site into Site 6423. A hearth was documented and excavated in the trench wall. Cultural remains from the hearth fill consisted of marine shells, burned coral and charcoal. A charcoal sample was submitted for radiometric age determination. A basalt adze fragment was noted on the ground surface near the site and collected from near TU-4, but its location was not mapped. The east, west and south areal extent of the site was not determined. Site documentation and testing were considered sufficient to mitigate data loss from resort-related construction. The site was subsequently destroyed.

Site 6423 is a subsurface cultural deposit located on the east-central boundary of the TBR property at the north end of the waterline trench (BT-1) that originated at Site 6422, on the west side of Marconi Road. Testing consisted of excavation of an additional backhoe trench (BT-2) and 15 test units (see *Figure 37*). Excavations documented 11 subsurface features consisting of hearths, fire pits, a pit and possible postholes. A human burial (Burial 8) was identified in the wall of BT-1 and a second human burial (Burial 7) was encountered in Test Unit-12. The burials were disinterred and reinterred at the TBR burial reinterment site. Cultural material collected during testing consisted of marine shells, basalt and volcanic glass flakes, groundstone, a game stone (*'ulu maika*), pieces of coral, fire-altered rocks, crab exoskeleton fragments, urchin spines, burned small mammal bones and charcoal. Several fragments of charcoal were submitted for radiometric age determination. A railroad spike, a shell button and metal, glass and ceramic fragments were also recovered. Site documentation and testing were considered sufficient to mitigate data loss from resort-related construction. The site was subsequently destroyed.

Site 6424 is a surface feature located at the southwest corner of the Kahuku Army Airfield and was initially documented during monitoring in 1991. The site consists of a short section of wall 2.36 m long by 1.4 m wide, represented by aligned coral boulders and interpreted as a possible *ahupua'a* boundary wall between Kahuku and Punalau (Corbin 2003; *Figure 38*). The site map depicts a concrete block, a coated copper wire, an ash deposit and a fragment of melted bottle glass that are not mentioned in the site description. The status of this site is unknown.

Site 6425 is a subsurface charcoal deposit exposed in a cutbank on the north side of Kamehameha Highway along the southeast boundary of the TBR property and was initially document during monitoring in 1991. The charcoal deposit was 2.0 m long and 0.45 m thick (Corbin 2003). The context of the exposure suggested that the deposit was impacted during construction of the highway. No subsurface testing was undertaken. The site is presumed destroyed.

Site 6426 is a rock wall located south of the OR&L railroad grade (Site 5791) on the western perimeter of Punahóolapa Marsh in the central portion of the TBR property and was initially documented in 1991 (Corbin 2003). The wall was constructed of stacked coral limestone boulders and is 40 m long by 0.7 m wide and 0.85 m high. A post and remnant of a wire fence are located adjacent to the north end of the wall. No cultural remains were observed in association with the wall and its function was not determined. The current condition of the site is unknown.

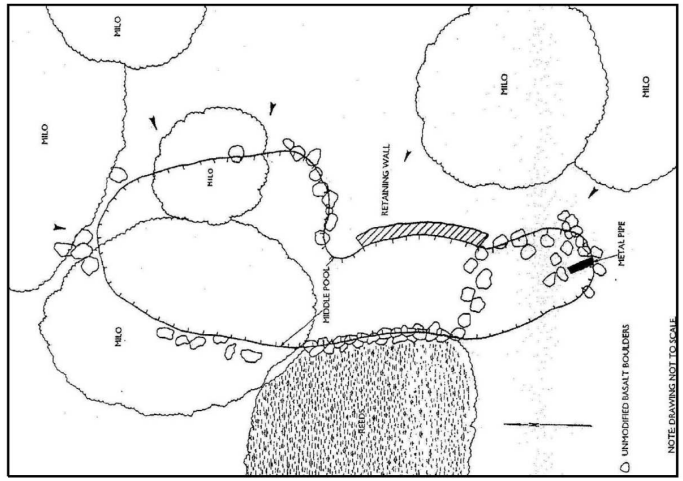


Figure 36. Site 6421 Plan Map (from Corbin 2003:272)

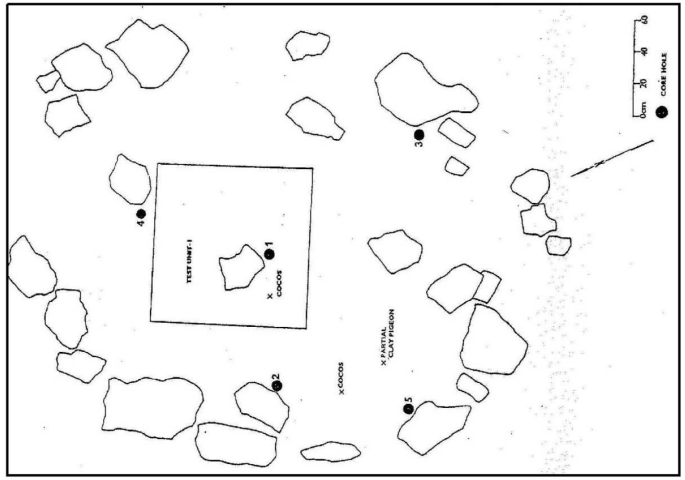


Figure 35. Site 6420 Plan Map (from Corbin 2003:269)

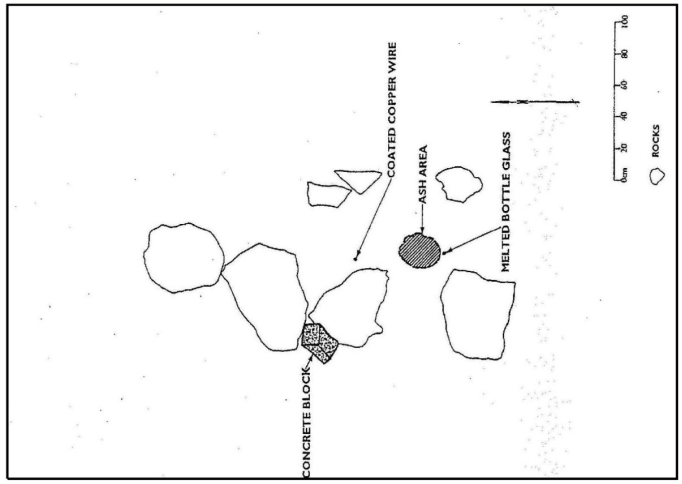


Figure 38. Site 6424 Plan Map (from Corbin 2003:304)

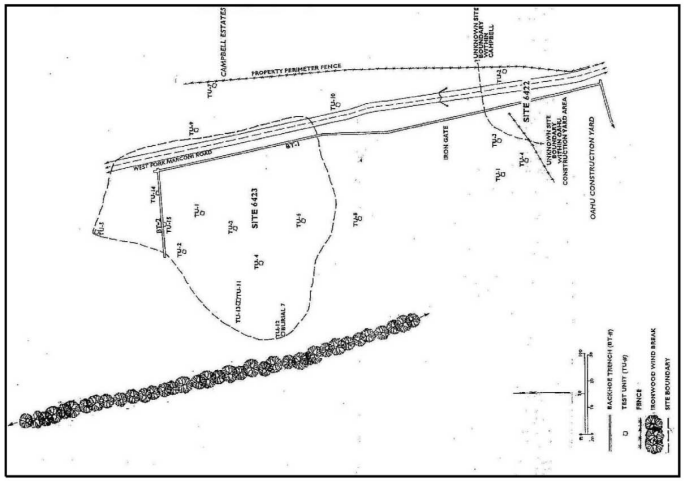


Figure 37. Site 6422 and 6423 Plan Map (from Corbin 2003:274)

Other sites were identified on the TBR property during earlier studies that were not assigned SIHP site designations during subsequent studies (Bath *et al*. 1984; see *Figure 25*). These include two rock walls, an enclosure, and a military structure. One wall (Site T-2) is located on the western periphery of Punahóolapa Marsh in Survey Area 8; the other (Site T-5) is located in Punahoʻolapa Marsh. A cattle enclosure (Site T-3) is located near the Site T-2 wall on the west side of Punahoʻolapa Marsh, also in Survey Area 8. A military structure (Site T-4) is located near the east-central boundary of the TBR property in Survey Area 13. The current status of these four sites is unknown. The wall designated Site T-5 will be preserved within the Punahoʻolapa Marsh wetlands.

Kahuku Army Airfield has been noted by a number of researchers within the project area, but it has not been assigned an SIHP site designation or fully recorded. Small portions of the airfield have been documented (Bath *et al*. 1984; Corbin 2003), but not in a comprehensive fashion. A series of concrete foundations interpreted as barrack foundations in Survey Area 10, a buried asphalt surface interpreted as a runway apron in Survey Area 12 and the Site T-4 concrete military structure were summarily recorded (Bath *et al*. 1984). A second structure similar to Site T-4 was noted but not documented (*ibid*.). Corbin (2003:249) mapped and noted six barracks foundations during documentation of Site 6417 (see *Figure 32*). Although much of the airfield has been impacted by resort development, it is unclear if any remnants of the Kahuku Army Airfield are extant. The status of the airfield is unknown.

Summary of Project Area Burials

Various archaeological projects for the TBR property resulted in the identification of 25 human burials, designated as Burials 1 through 19. These burials are summarized in *Table 7* and their locations are presented in *Figure 39*. All the burials were identified during subsurface testing (Bath *et al*. 1984; Neller 1984, 1989; Walker *et al.* 1988a, 1988b; Sullivan 1990; Kennedy 1992; Carson *et al*. 1996, 1999). Most burials consist of a single set of human remains, however, Burials 11-14 and 17 contained a total of eight individuals and Burials 15 and 19 contained five individuals. Kalima (1993) reported the osteological analyses of Burials 3-6 from Site 6410 and Burial 8 from Site 6423. These analyses resulted in the identification of additional individuals that were subsequently designated as Burials 9 and 10. Burials are known from four locations on the property.

The greatest concentration of burials was associated with the area inland of Kuilima Point, where eight individuals (Burials 11-14 and 17) were buried in the dunes at Site 4488. These burials were initially encountered during sand mining operations (Kennedy 1992; Carson *et al*. 1996, 1999). Seven individuals were identified near the shoreline of Kawela Bay in association with Site 6410. Each burial contained the remains of a single individual, identified during data recovery excavations. Burial 1 was initially documented in 1984 (Bath *et al*. 1984; Walker *et al*. 1988a), Burial 2 was identified a few years later (Walker *et al*. 1988a), and Burials 3-6 and 9 were identified a few years after that (Sullivan 1990).

Seven individuals from four burials were also identified at Site 6411 near the shoreline on either side of Kahuku Point. Five burials were located in the sand dunes east of the Point (Burials 15 and 19) and two were located in dunes to the west (Burials 16 and 18). Burial 15 was exhumed by SHPD after its discovery in 1984 by recreational sand vehicle operators who were using the area. Neller (1984) identified three individuals from the location designated as Burial 15. Two individuals were identified during excavation at the location designated as Burial 19 (Walker *et al*. 1988b). The Honolulu Police exhumed Burial 16 after its discovery in 1986; the remains were turned over to SHPD and examined by Neller (1989). Burial 18 was encountered during subsurface testing (Walker *et al*. 1988b).

The fourth concentration of burials is located east of Punahoʻolapa Marsh (Site 6423), where Burials 7, 8 and 10 each contain the remains of a single individual. These remains were encountered during archaeological monitoring of resort-related construction activity (Sullivan 1991).

Table 7. Summary of Burials Previously Identified within Project Area

Burial Number	Site Number	Location	Number of Burials	Researchers	Description	Final Disposition of Remains
1	6410	TU-20	1	Bath et al. (1984), Walker et al. (1988a), Jensen (1989), Maly and Rosendahl (1992), Kalima (1993)	Adult female burial in wooden coffin within stone-lined cyst noted 1st by Bath et al. (1984), then Walker et al. (1988a). Burial disinterred following guidelines in (1989b) mitigation program. Osteological analysis by conducted by Kalima (1993). Burial reinterred at Reinterment Site as specified in Maly and Rosendahl (1992) Burial Treatment Plan (BTP).	Reinterred
2	6410	TU-9	1	Walker et al. (1988a), Jensen (1989), Maly and Rosendahl (1992), Kalima (1993)	Adult male burial in flexed position noted in pit feature (HF-45) by Walker *et al.* (1988a). Burial disinterred as part of Jensen (1989b) mitigation program. Osteological analysis by Kalima (1993), Burial reinterred following Maly and Rosendahl (1992) BTP.	Reinterred
3, 4, 5, 6, 9	6410	Inland of Area C	5	Sullivan (1991), Jensen (1989), Maly and Rosendahl (1992), Kalima (1993)	Human remains noted during monitoring of grading for Hotel H-2. Two clusters of two burials found 15 m apart. Burial 3 is a juvenile, Burial 4 is a infant, Burials 5 and 6 are adults. Burials disinterred following guidelines in Jensen (1989b) mitigation plan. During osteological analysis of Burials 5 and 6 by Kalima (1993), single humerous of third individual was noted, designated as Burial 9. Burial reinterred following Maly and Rosendahl (1992) BTP.	Reinterred
7	6423	BT-1, TUs 11 and 13	1	Sullivan (1991), Jensen (1989b), Maly and Rosendahl (1992), Kalima (1993)	Human remains noted during monitoring at Site 6423 area, found within a natural sinkhole feature used as a burial pit (HF-12). Cranium and infracranial skeletal remains interpreted as those of female adult from 25 to 30 years of age. Burials disinterred following guidelines in Jensen (1989b) mitigation plan and analysis conducted by Kalima (1993). Burial reinterred following Maly and Rosendahl (1992) BTP.	Reinterred
8, 10	6423	TU-14	2	Sullivan (1991), Jensen (1989b), Maly and Rosendahl (1992), Kalima (1993)	Human remains noted during monitoring at Site 6423 area, beneath resort access road and west fork of Marconi Road. Remains were partially articulated and are those of adult female. Burials disinterred following guidelines in Jensen (1989b) mitigation plan and osteological analysis conducted by Kalima (1993). During analysis, fragmentary remains of an additonal sub-adult were found and designated as Burial 10. Both sets of remains reinterred following Maly and Rosendahl (1992) BTP.	Reinterred
11-14, 17	4488	Inland of Kuilima Point	8	Kennedy (1992), Maly and Rosendahl (1992), Carson *et al.* (1996, 1999)	Burials 11-14 consist of 4 disturbed burials (3 sub-adults, 1 adult female) removed from dune south of Kulima Point (Kennedy 1992). Disturbed remains of 3+ adults and 1 bone from sub-adult noted by Carson *et al.* (1996, 1999) in same area and designated as Burial 17. Wood and nails suggesting a coffin were found in associated with one set of the Burial 17 remains. Burials 11-14 reinterred following Maly and Rosendahl (1992) BTP. Burial 17 curated with SHPD in 1996 and subsequently reinterred	Reinterred
15, 19	6411	East Kahuku Point Burial Area	5	Neller (1984), Walker *et al.* (1988b), Maly and Rosendahl (1992)	Burial 15 noted in dunes to east of Kahuku Point that were exhumed and examined by SHPD (Neller (1984) and determined to be two complete skeletons and one partial skeleton. Walker *et al.* (1988b) identified two burials (Burial 19) in pits in TU-2 in Area B. Burial 19 was re-buried in original location.	Reinterred (Burial 15), Left *in situ* (Burial 19)
16, 18	6411	West Kahuku Point Burial Area	2	Neller (1989), Walker *et al.* (1988b), Maly and Rosendahl (1992)	Burial 16 noted in dunes to west of Kahuku Point and exhumed by Honolulu Police. Remains were subsequently examined by SHPD (Neller (1989). Burial 18 identified by Walker *et al.* (1988b) in TU-24 in Area A. Burial 18 was re-buried in its original location.	Reinterred (Burial 16), Left *in situ* (Burial 18)
		Total	**25**			

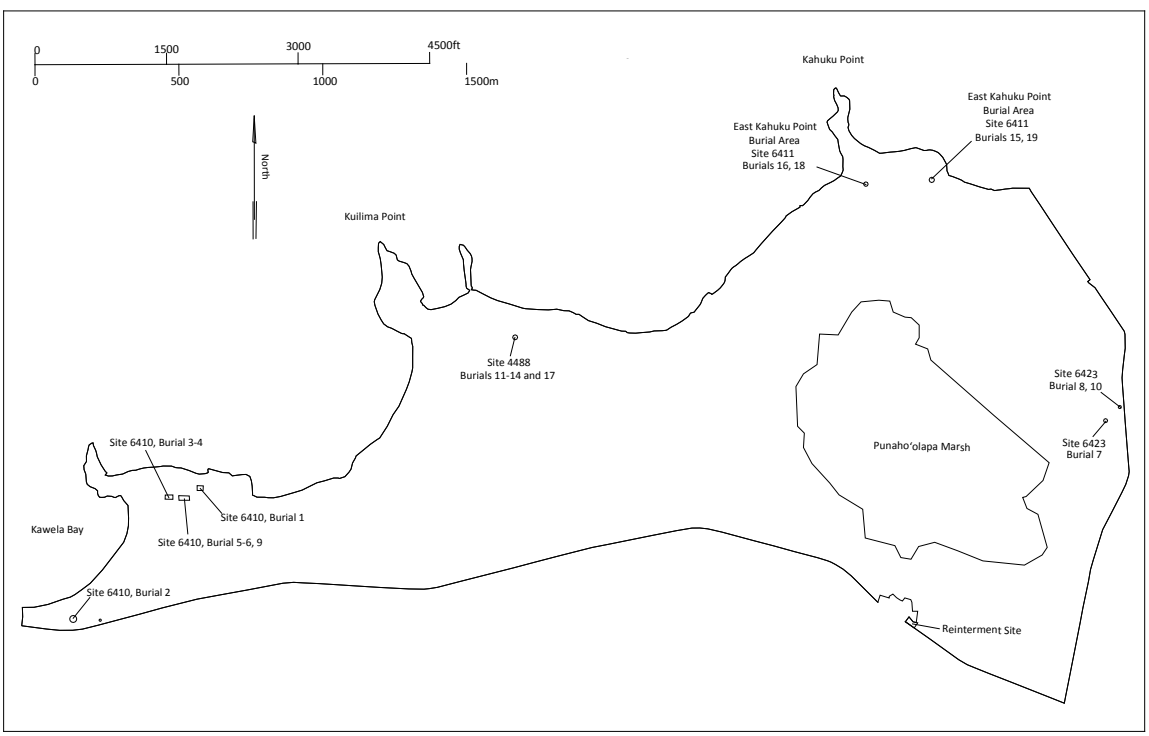


Figure 39. Location of Burials within Project Area

The majority of the burials identified on the TBR property are probably native Hawaiians interred prior to Contact or during the early post-Contact period. The exceptions are Burials 1 and 17, which contained remnants of wooden coffins, indicating the interment took place sometime after c. 1820.

A Burial Treatment Plan (BTP) was prepared for the human remains on the TBR property. Maly and Rosendahl (1992) prepared a BTP for Burials 1-10 recovered by PHRI archaeologists, for Burials 11-14 recovered by Kennedy (1992) and for Burials 15-16 recovered from the Kahuku Point area by Neller (1984, 1989). The remains of four individuals designated Burial 17, reported by Carson *et al.* (1996, 1999), were curated by SHPD and subsequently reinterred. Excavations that encountered the two remaining burials (Burials 18 and 19) were terminated on identification of the remains (Walker *et al*. 1988b). The three individuals designated Burials 18 and 19 were left in place and the excavation units were backfilled.

Project Area Chronology

Ninety-four charcoal samples from nine sites have been previously submitted for radiometric age determinations. *Table 8* lists the radiocarbon analysis results by site and *Table 9* is a graph with the age determinations ordered chronologically. The graph excludes all of the results that predate A.D. 600, since these are not considered to be determinations of cultural occupation. Six modern results were obtained which are not included in this analysis. *Figure 40* shows the mapped locations of deposits containing cultural material from AD 800 to 1800.

Nine age range determinations resulted in ranges that span 5760 to 54 B.C. These age determinations predate the arrival of Polynesian settlers, but could be pertinent to the timing of the Holocene emergence of the Kahuku Plain. The earliest age range determination (5760-5480 B.C.) was obtained from a sample excavated along Kawela Bay (Site 6410 Area A). Five other early age range determinations, spanning 5509-45 B.C., were obtained from Punahoʻolapa Marsh (Site 6412), two spanning 3865-845 B.C. were obtained from the southern periphery of the Marsh (Survey Area 11), and one spanning 210-165 B.C. was obtained from Kahuku Point (Site 6411 Area B). Two additional results, A.D. 2 to 601, obtained from Site 6422 on the eastern periphery of Punahoʻolapa Marsh, and A.D. 179 to 687 from Site 6423 in the same area, are probably too early to reflect cultural activity.

Of the 77 age range determinations that fall within the timeframes associated with Polynesian cultural occupation and later, 23 (30%) are from the Kawela Bay Archaeological Area (Site 6410). Twenty-five (32%) are from the Kahuku Point Archaeological Area (Site 6411). Twenty-nine (38%) are from Punahoʻolapa Marsh (Site 6412) and its environs (Sites 6414, 6416, 6417, 6422, and 6423). The earliest cultural deposits (*i.e*. prior to c. A.D. 1000) are to be found on the periphery of the Marsh. These early age ranges support the inference that the wetland was a highly desirable locale for initial settlement. The earliest cultural age range determinations were recovered from Site 6412 where a sample obtained from the east trench spans A.D. 645 to 979 and a sample from the north trench spans A.D. 785 to 1160 (see *Figure 27*). A second early cluster was obtained within and east of the Marsh from Site 6423. Age ranges from Site 6423 span A.D. 793 to 1105.

The A.D. 1000 to 1200-age ranges show continued use of the area east of Punahoʻolapa Marsh, along with settlements in the sand dunes east and west of Kahuku Point and around Kawela Bay. Settlement in these areas intensified in the period between A.D. 1200 and 1400. The earliest cultural deposits sampled along Turtle Bay post-date A.D. 1200. Sites dating to the period between A.D. 1400 to 1600 have been documented on the west and southwest of Punahoʻolapa Marsh, as well as southwest of Kahuku Point. Use of the area east of Punahoʻolapa Marsh, Kawela Bay and Kahuku Point continued as a population focal point into the A.D. 1600 to 1800s.

The central portion of the TBR property was developed in 1971, prior to state requirements for archaeological inventory and mitigation. Nearly 200 acres of the property were developed by the time of the first archaeological inventory survey undertaken by the Bishop Museum in 1977, and therefore almost no sites are known from this area. The single exception is Site 6416 in the approximate center of the property.

Table 8. Summary of Radiocarbon Dates from Previous Testing within Project Area

Site	Provenience	Layer/ Feature	Depth (cm)	C-14 Age in Years BP (one sigma)	C-13/C-12 Ratio	C-13 Adjusted C-14 Ages Years BP	Calendric Age Range	Researcher	Beta Analytic's Lab No.
6410	TU-158	II	12-68	less than 150	n/d	180+/-60	AD 1630-1950	Bath et al. (1984)	10633
6410	Area A - TU-25	II	28-45	70+/-60	-15.02 o/oo	230+/-60	AD 1505-1675 AD 1710-1805	Walker et al. (1988a)	16860
6410	Area B - TU-3	II	14-40	510+/-60	-24.95 o/oo	520+/-60	AD 1330-1480	Walker et al. (1988a)	16857
6410	Area C - TU-33	I	20-31	370+/-80	-25.50 o/oo	360+/-80	AD 1400-1660	Walker et al. (1988a)	15857
6410	Area C - TU-16	III	87-97	170+/-60	-20.23 o/oo	250+/-60	AD 1495-1800	Walker et al. (1988a)	16853
6410	Area C - TU-32	I	29-43	110+/-50	-26.92 o/oo	80+/-50	AD 1665-1940	Walker et al. (1988a)	16858
6410	Area C - TU-13	III	46-66	110+/-60	-26.72 o/oo	80+/-60	AD 1665-1940	Walker et al. (1988a)	15859
6410	Area D - TU-34	I	0-56	310+/-80	-20.75 o/oo	380+/-80	AD 1395-1660	Walker et al. (1988a)	15855
6410	Area D - TU-31	I	0-47	330+/-60	-23.18 o/oo	360+/-60	AD 1415-1645	Walker et al. (1988a)	15856
6410	TU-26	III	18-41	410+/-70	-26.61 o/oo	380+/-70	AD 1410-1635	Walker et al. (1988a)	15861
6410	TU-6	II	18-25	250+/-60	-26.91 o/oo	220+/-60	AD 1510-1680	Walker et al. (1988a)	16854
6410	TU-4	II	13-40	180+/-50	-25.06 o/oo	180+/-50	AD 1630-1950	Walker et al. (1988a)	16856
6410	TU-8	III	Lower	170+/-60	-25.79 o/oo	160+/-60	AD 1645-1950	Walker et al. (1988a)	15858
6410	Area A - 54N/58E	IIa, HF-2	60-70	280-240 230-70 40-0	-24.4 o/oo	n/d	AD 1650-1950	Corbin (2003)	171517
6410	Area A - 56N/45E	Ib, HF-4	n/d	Post 0 BP	-24.4 o/oo	n/d	AD 1650-1950	Corbin (2003)	171518
6410	Area A - 54N/58E	III/2, HF-6	n/d	900-850 810-750	-25.2 o/oo	n/d	AD 1030-1240	Corbin (2003)	171519
6410	Area A - 56N/76E	IV/5	n/d	7660-7480	-25.8 o/oo	n/d	5760-5480 BC	Corbin (2003)	171520
6410	Area D - 40N/38E	IV, HF-18	68-69	490-310	-20.9 o/oo	n/d	AD 1440-1660	Corbin (2003)	171521
6410	Area D - 46N/38E	IV	72-82	700-670	-24.9 o/oo	n/d	AD 1210-1290	Corbin (2003)	171522
6410	Area D - 50N/42E	IV/2, HF-66	79-88	630-600 560-520	-25.9 o/oo	n/d	AD 1300-1450	Corbin (2003)	171523
6410	Area D - N46/E40	V	75	530-500	-24.2 o/oo	n/d	AD 1410-1480	Corbin (2003)	171524
6410	Area D - N44/E40	III/IV/V, HF-106	71-101	510-450	-26.5 o/oo	n/d	AD 1430-1530 AD 1560-1630	Corbin (2003)	171525
6410	Area D - N44/E40	V, HF-110	75-89	630-600 560-500	-27.6 o/oo	n/d	AD 1290-1520 AD 1590-1620	Corbin (2003)	171526
6410	Area D - N48/E38	V	68-108	550-460	-24.1 o/oo	n/d	AD 1300-1650	Corbin (2003)	171527
6410	Area D - N48/E42	V, HF-78	49-63	80+/- 50	-25.9 o/oo	n/d	Modern	Corbin (2003)	171528
6411	Area A - TU-34	II	42-62	130+/-60	n/d	110+/- 60	AD 1655-1950	Bath et al. (1984)	10536
6411	Area A - TU-17	II	100-108	220+/-70	-24.75 o/oo	220+/-70	AD 1510-1950	Walker et al. (1988b)	16375
6411	Area A - TU-17	III	105-114	190+/-60	-14.04 o/oo	360+/-60	AD 1415-1645	Walker et al. (1988b)	16848
6411	Area A - TU-17	III	114-130	130+/-70	-23.60 o/oo	150+/-70	AD 1645-1950	Walker et al. (1988b)	16373
6411	Area A - TU-17	IV	130-135	500+/-100	-25.25 o/oo	490+/-100	AD 1315-1520	Walker et al. (1988b)	16849
6411	Area A - TU-17	IV	135-145	710+/-60	-18.92 o/oo	810+/-60	AD 1400-1525	Walker et al. (1988b)	16372
6411	Area A - TU-19	IV	22-40	100.3+/-0.07%	-21.25 o/oo	40+/-50	AD 1065-1285	Walker et al. (1988b)	16367
6411	Area A - TU-19	VIII	45-65	460+/-70	-27.11 o/oo	420+/-70	AD 1670-1715 AD 1800-1930	Walker et al. (1988b)	16731
6411	Area A - TU-23	IIA	60-88	110+/-70	-20.00 o/oo	190+/-70	AD 1620-1890 AD 1910-1950	Walker et al. (1988b)	16376
6411	Area A - TU-24	HF-14	67-105	270+/-60	-26.06 o/oo	260+/-60	AD 1490-1670 AD 1725-1790	Walker et al. (1988b)	16846
6411	Area A - TU-28	Ivb	99-118	50+/-70	-17.78 o/oo	160+/-70	AD 1645-1950	Walker et al. (1988b)	16850
6411	Area A - FP-3	HF-18	0-10	180+/-70	-24.66 o/oo	190+/-70	AD 1620-1890 AD 1910-1950	Walker et al. (1988b)	16366
6411	Area B - TU-149	IV	54-59	2070+/-50	n/d	1990+/- 50	210-165 BC	Bath et al. (1984)	10537
6411	Area B - TU-2	II	23-25	640+/-70	-25.78 o/oo	630+/-70	AD 1260-1405	Walker et al. (1988b)	16378
6411	Area B - TU-5	Ia	0-8	760+/-100	-26.40 o/oo	740+/-100	AD 1070-1390	Walker et al. (1988b)	16377
6411	Area B - TU-10	II	18-50	300+/-50	-25.80 o/oo	290+/-50	AD 1435-1665	Walker et al. (1988b)	16365
6411	Area B - TU-12	I	0-6	350+/-50	-25.08 o/oo	350+/-50	AD 1420-1650	Walker et al. (1988b)	16369
6411	Area B - TU-14	I	0-9	550+/-70	-23.60 o/oo	570+/-70	AD 1305-1420	Walker et al. (1988b)	16374
6411	Area C - TU-27	VIII	112-132	420+/-70	-27.90 o/oo	370+/-70	AD 1415-1640	Walker et al. (1988b)	16379
6411	TU-2	II, HF-10	42-60	370+/-70	-23.7	390+/-70	AD 1411-1652	Corbin (2003)	44943
6411	TU-1	III, HF-3	16-21	112.7+/-0.7%	-26.5	113.1+/-0.7%	Modern	Corbin (2003)	44948
6411	TU-1	IV, HF-3	21-31	107.3+/-0.7%	-26.3	107.5+/-0.7%	Modern	Corbin (2003)	44949
6411	TU-1	IV, HF-3	n/d	110.0+/-0.7%	-26.1	110.2+/-0.7%	Modern	Corbin (2003)	44950
6411	TU-1	I	10-16	430+/-60	-24.3	440+/-60	AD 1402-1526 AD 1556-1631	Corbin (2003)	44951
6411	TU-1	II, HF-2	30-38	670+/-130	-25.8	660+/-130	AD 1060-1086 AD 1122-1138 AD 1156-1470	Corbin (2003)	44953
6411	TU-1	II	5-16	340+/-60	-26.2	320+/-60	AD 1442-1668 AD 1782-1796	Corbin (2003)	44955
6411	TU-2	I	25-48	130+/-60	-27.6	90+/-60	AD 1665-1784 AD 1789-1955	Corbin (2003)	44956
6411	TU-2	I	15-25	101.1+/-0.7%	-24.3	101.0+/-0.7%	Modern	Corbin (2003)	44958
6411	TU-2	II, HF-8	36-95	70+/-70	-24.5	80+/-70	AD 1662-1955	Corbin (2003)	44959
6411	TU-2	II, HF-9	38-84	110+/-70	-26.3	90+/-70	AD 1659-1955	Corbin (2003)	44960
6412	Auger core A4	IV	n/d	100+/-80	-26.74 o/oo	70+/-80	AD 1659-1955	Davis et al. (1986), Corbin (2003)	16569
6412	South trench	I	n/d	170+/-60	-17.33 o/oo	280+/-60	AD 1446-1679 AD 1740-1752 AD 1756-1804 AD 1935-1947	Davis et al. (1986), Corbin (2003)	19371
6412	East Trench	IIb	n/d	640+/-70	-22.40 o/oo	680+/-70	AD 1220-1410	Davis et al. (1986), Corbin (2003)	19373

Table 8. Summary of Radiocarbon Dates from Previous Testing within Project Area (cont).

Site	Provenience	Layer/ Feature	Depth (cm)	C-14 Age in Years BP (one sigma)	C-13/C-12 Ratio	C-13 Adjusted C-14 Ages Years BP	Calendric Age Range	Researcher	Beta Analytic's Lab No.
6412	Auger core B1a	IV	n/d	1120+/-70	-29.99 o/oo	1040+/-70	AD 883-1160	Davis et al. (1986), Corbin (2003)	16571
6412	East Trench	III	n/d	1250+/-80	-24.76 o/oo	1250+/-80	AD 645-979	Davis et al. (1986), Corbin (2003)	16568
6412	South trench	II	n/d	2240+/-90	-25.47 o/oo	2230+/-90	410-45 BC	Davis et al. (1986), Corbin (2003)	16566
6412	Auger core B3a	V	n/d	3650+/-70	-25.67 o/oo	3640+/-70	2200-1875 BC 1842-1811 BC 1800-1777 BC	Davis et al. (1986), Corbin (2003)	16572
6412	East Trench	IV	n/d	3790+/-60	-25.20 o/oo	3790+/-60	2458-2032 BC	Davis et al. (1986), Corbin (2003)	19374
6412	East Trench	V	n/d	3950+/-60	-26.81 o/oo	3920+/-60	2573-2513 BC 2502-2267 BC 2261-2203 BC	Davis et al. (1986), Corbin (2003)	19375
6412	East Trench	IX	n/d	6320+/-130	-25.75 o/oo	6310+/-130	5509-5500 BC 5484-4940 BC 4868-4861 BC	Davis et al. (1986), Corbin (2003)	16573
6414	Trench 1	II	n/d	60+/-80	-19.8	140+/-80	AD 1640-1955	Sullivan (1990), Corbin (2003)	n/d
6414	Trench 1	II	n/d	370+/-130	-27.2	330+/-130	AD 1322-1340 AD 1390-1950	Sullivan (1990), Corbin (2003)	n/d
6414	Trench 1	II	n/d	550+/-100	-23.1	580+/-100	AD 1260-1470	Sullivan (1990), Corbin (2003)	n/d
6414	Trench 1	II	n/d	460+/-100	-26.1	450+/-100	AD 1290-1650	Sullivan (1990), Corbin (2003)	n/d
6414	Trench 1	II	n/d	770+/-100	-24.9	770+/-100	AD 1030-1400	Sullivan (1990), Corbin (2003)	n/d
6416	TR 1	II, HF-5	90-100	400+/-90	-27.3	360+/-90	AD 1410-1670 AD 1750-1796 AD 1945-1954	Sullivan (1990), Corbin (2003)	42154
6416	TR-2	II, HF-6	5-15	110+/-80	-25.5	100+/-80	AD 1650-1955	Sullivan (1990), Corbin (2003)	42155
6416	TR-9	I, HF-8	23-32	290+/-70	-20.5	360+/-70	AD 1420-1660	Sullivan (1990), Corbin (2003)	42156
6417	Profile 4	V, HF-1	n/d	1060+/-70	-22.1	1100+/-70	AD 920-1045	Sullivan (1990), Corbin (2003)	38668
6417	Profile 5	IVa	n/d	1200+/-130	-27.3	1170+/-130	AD 890-1105 AD 825-873 AD 793-815	Sullivan (1990), Corbin (2003)	38669
6417	BT-1	Iva, HF-6	n/d	600+/-100	-26.2	580+/-100	AD 1350-1470	Sullivan (1990), Corbin (2003)	38670
6417	Profile 4	Iva, HF-1	n/d	100+/-80	-21.9	150+/-80	AD 1527-1556 AD 1630-1955	Sullivan (1990), Corbin (2003)	38713
6422	Profile 4	IIIa, b, HF-1	55-74	180+/-80	-20.3	250+/-80	AD 1452-1891 AD 1908-1950	Sullivan (1990), Corbin (2003)	39987
6422	Trench	E Face, W. wall, IIIa, b	50-60	1056.4+/-1.8%	-25.4	105.4+/-1.8%	Modern	Sullivan (1990), Corbin (2003)	40129
6422	Trench	IIb	20-30	-	-21.0	1740+/-130	AD 2-601	Sullivan (1990), Corbin (2003)	44937
6423	TU-2	III, IV, HF-7	12-35	320+/-80	-25.1	320+/-80	AD 1433-1679 AD 1710-1752 AD 1756-1804 AD 1936-1947	Sullivan (1990), Corbin (2003)	40132
6423	Trench 1	III, IV, HF-9	10-20	620+/-130	-25.6	610+/-130	AD 1165-1167 AD 1187-1516 AD 1599-1616	Sullivan (1990), Corbin (2003)	39993
6423	Trench 2	III, HF-11	02-42	250+/-60	-25.4	240+/-60	AD 1489-1603 AD 1609-1693 AD 1726-1813 AD 1852-1859	Sullivan (1990), Corbin (2003)	39994
6423	Trench 2	IIb	43-53	790+/-100	-26.0	770+/-100	AD 1028-1334 AD 1336-1401	Sullivan (1990), Corbin (2003)	44938
6423	TU-5	IIb	53-63	250+/-70	-24.4	260+/-70	Ad 1466-1693 AD 1776-1812 AD 1853-1859 AD 1919-1949	Sullivan (1990), Corbin (2003)	44939
6423	TU-5	IIb	63-73	520+/-80	-24.6	520+/-80	AD 1295-1492 AD 1603-1609	Sullivan (1990), Corbin (2003)	44940
6423	TU-5	VIII	73-83	350+/-80	-24.3	360+/-80	AD 1415-1668 AD 1782-1796	Sullivan (1990), Corbin (2003)	44941
6423	TU-5	IV	42-46	430+/-70	-27.1	390+/-70	AD 1411-1652	Sullivan (1990), Corbin (2003)	44942
6423	TU-12	V, HF-12	89-94	1570+/-130	-25.0	1570+/-130	AD 179-189 AD 214-687	Sullivan (1990), Corbin (2003)	44944
6423	TU-13	V, HF-12	94-104	300+/-130	-26.0	290+/-130	AD 1405-1954	Sullivan (1990), Corbin (2003)	44945
6423	TU-13	V, HF-12	104-114	380+/-70	-24.4	1130+/-110	AD 663-1071 AD 1079-1131 AD1136-1158	Sullivan (1990), Corbin (2003)	44946
6423	TU-13	V, HF-12	114-124	1120+/-110	-24.4	1130+/-110	AD 663-1071	Sullivan (1990), Corbin (2003)	44947
Survey Area 11	TU-142	IV	84-94	3090+/- 130	n/d	2990+/-130	1575-845 BC	Bath et al. (1984)	10534
Survey Area 11	TU-33	III	120-215	4840+-130	n/d	4750+/- 130	3865-3165 BC	Bath et al. (1984)	10535

Table 9. Project Radiocarbon Age Determinations Ordered Chronologically

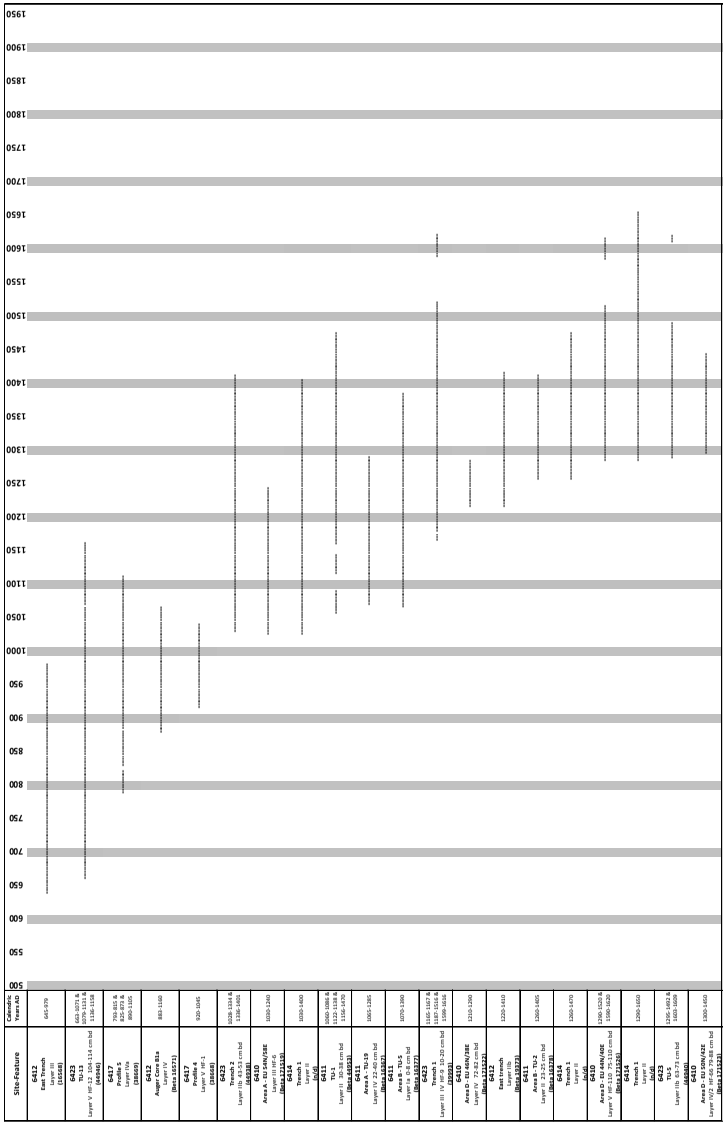


Table 9. Project Radiocarbon Age Determinations Ordered Chronologically (cont.)

Site-Feature	Calendric Years AD
6410 **Area D - EU 48N/38E** Layer V 68-108 cm bd **(Beta 171527)**	1300-1650
6411 **Area B - TU-14** Layer I 0-9 cm bd **(Beta 16376)**	1305-1420
6411 **Area A - TU-17** Layer IV 130-135 cm bd **(Beta 16849)**	1315-1520
6414 **Trench 1** Layer II (a/d)	1322-1340 & 1390-1950
6410 **Area B - TU-3** Layer II 14-40 cm bd **(Beta 16857)**	1330-1480
6417 **RT-1** Layer IVa HF-6 **(38670)**	1350-1470
6410 **Area D - TU-34** Layer I 0-56 cm bd **(Beta 15855)**	1395-1660
6411 **Area A - TU-17** Layer IV 135-145 cm bd **(Beta 16372)**	1400-1525
6410 **Area C - TU-33** Layer I 20-31 cm bd **(Beta 15857)**	1400-1660
6411 **TU-1** Layer I 10-16 cm bd **(Beta 44951)**	1402-1526 & 1556-1631
6423 **TU-13** Layer V HF-12 94-104 cm bd **(44945)**	1405-1954
6410 **Area D - EU 46N/40E** Layer V 75 cm bd **(Beta 171524)**	1410-1480
6410 **TU-26** Layer III 18-41 cm bd **(Beta 15861)**	1410-1635
6416 **Tr 1** Layer II HF-5 90-100 **(42154)**	1410-1670 & 1750-1796 & 1945-1954
6411 **TU-2** Layer II HF-10 42-60 cm bd **(Beta 44943)**	1411-1652
6412 **East trench** Layer III **(Beta 14568)**	1411-1652
6423 **TU-5** Layer IV 42-46 cm bd **(44942)**	1411-1652
6411 **Area C - TU-27** Layer VIII 112-132 cm bd **(Beta 16379)**	1415-1640
6410 **Area D - TU-31** Layer I 0-47 cm bd **(Beta 15856)**	1415-1645
6411 **Area A - TU-17** Layer III 105-114 cm bd **(Beta 16848)**	1415-1645
6423 **TU-5** Layer VIII 73-83 cm bd **(44941)**	1415-1668 & 1782-1796

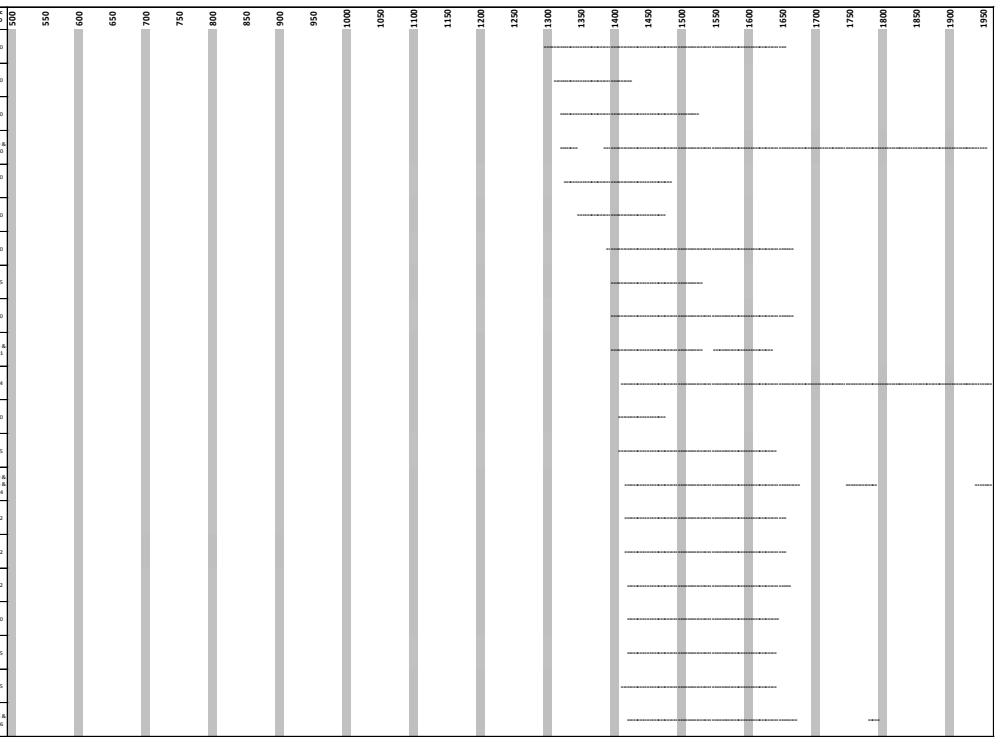


Table 9. Project Radiocarbon Age Determinations Ordered Chronologically (cont.)

Site-Feature	Calendric Years AD
6411 **Area B - TU-12** Layer I 0-6 cm bd **(Beta 16369)**	1420-1650
6416 **Tr 9** Layer I HF-8 23-32 **(42156)**	1420-1660
6410 **Area D - EU 44N/40E** Layer III/IV/V HF-106 71-101 cm bd	1430-1530 & 1560-1638
6423 **TU-2** Layer III IV HF-7 12-35 cm bd **(40132)**	1433-1679 & 1710-1752 & 1756-1804 & 1936-1947
6411 **Area B - TU-10** Layer II 18-50 cm bd **(Beta 16365)**	1435-1665
6410 **Area D - EU 40N/38E** Layer IV HF-18 68-69 cm bd **(Beta 171521)**	1440-1660
6411 **TU-1** Layer II 5-16 cm bd **(Beta 44955)**	1442-1668 & 1782-1796
6412 **South trench** Layer I **(Beta 19371)**	1446-1679 & 1740-1752 & 1756-1804 & 1935-1947
6422 **Profile 4** Layer IIIa, b HF-1 55-74 cm bd **(39987)**	1452-1891 & 1908-1950
6423 **TU-5** Layer IIb 53-63 cm bd **(44939)**	1466-1693 & 1776-1812 & 1853-1859 & 1919-1946
6423 **Trench 2** Layer III HF-11 2-42 cm bd **(39994)**	1489-1603 & 1609-1693 & 1726-1813 & 1852-1859
6411 **Area A - TU-24** HF-14 67-105 cm bd **(Beta 16846)**	1490-1670 & 1725-1796
6410 **Area C - TU-16** Layer III 87-97 cm bd **(Beta 16853)**	1495-1800
6410 **Area A - TU-25** Layer II 28-45 cm bd **(Beta 16860)**	1505-1675 & 1710-1805
6410 **TU-6** Layer II 18-25 cm bd **(Beta 16854)**	1510-1680
6411 **Area A - TU-17** Layer II 100-108 cm bd **(Beta 16375)**	1510-1950
6417 **Profile 4** Layer IVa HF-1 **(38713)**	1527-1556 & 1630-1955
6411 **Area A - TU-23** Layer IIa 60-88 cm bd **(Beta 16376)**	1620-1890 & 1910-1950
6411 **Area A - FP-3** HF-18 0-10 cm bd **(Beta 16366)**	1620-1890 & 1910-1950

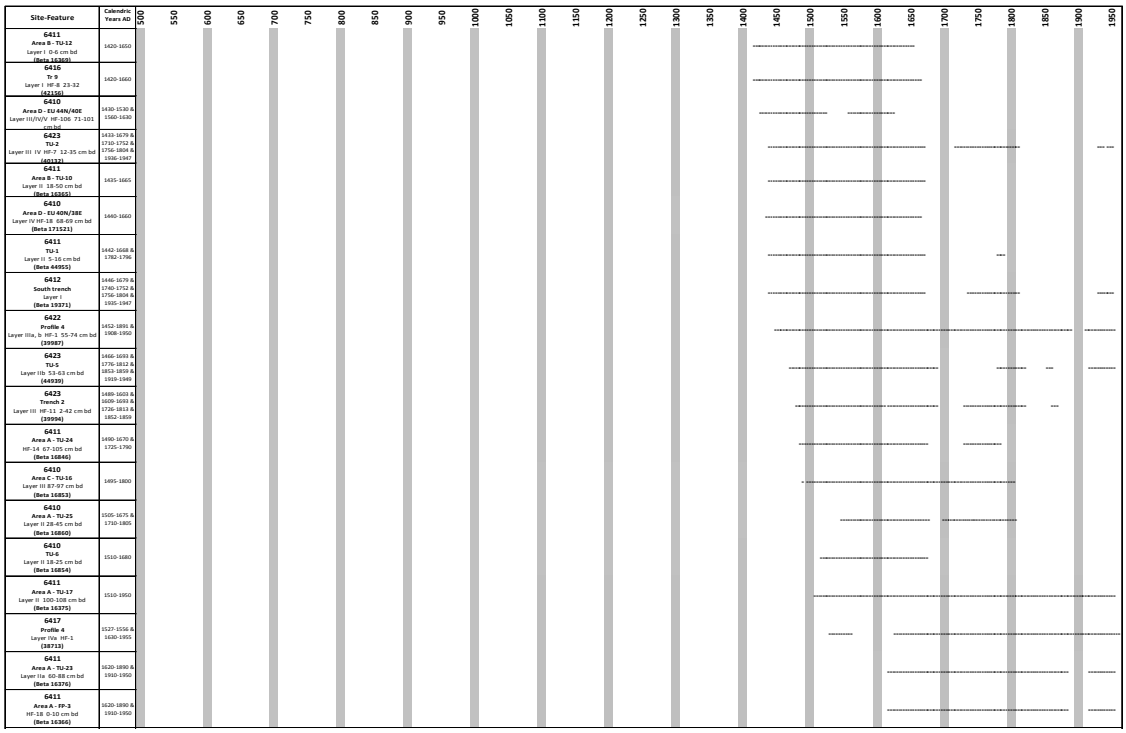
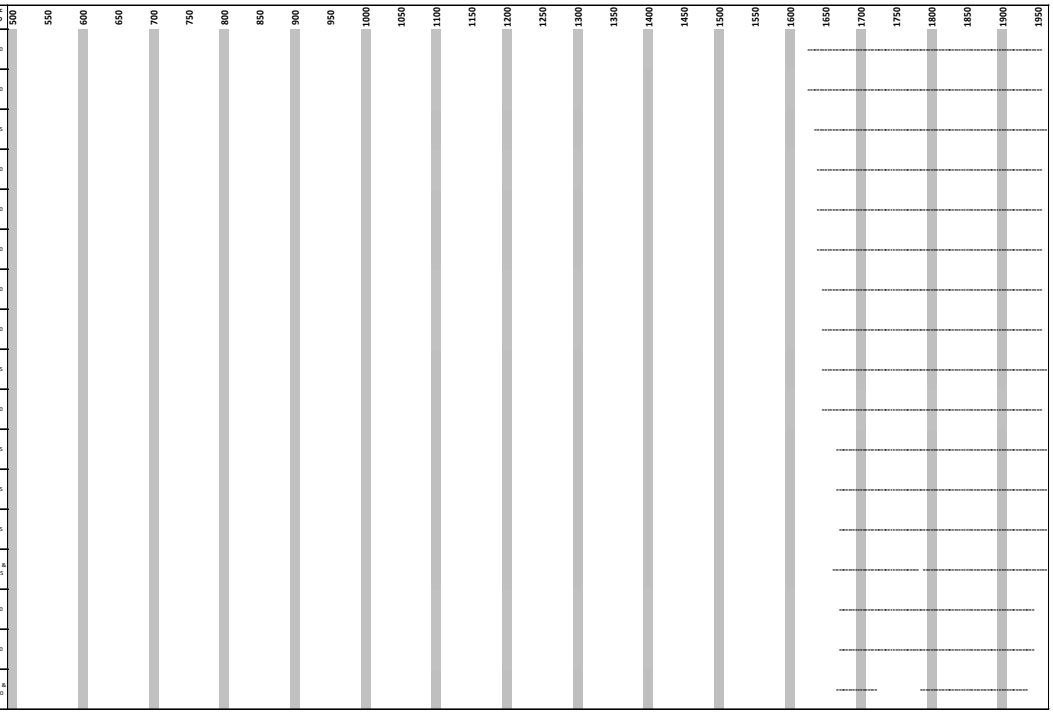


Table 9. Project Radiocarbon Age Determinations Ordered Chronologically (cont.)

Site-Feature	Calendric Years AD
6410 TU-158 Layer II - 12-68 cm bd **(Beta 10633)**	1630-1950
6410 **TU-4** Layer II 13-40 cm bd **(Beta 16856)**	1630-1950
6414 **Trench 1** Layer II **(n/d)**	1640-1955
6410 **TU-8** Layer III **(Beta 16858)**	1645-1950
6411 **Area A - TU-17** Layer III 114-130 cm bd **(Beta 16373)**	1645-1950
6411 **Area A - TU-28** Layer IVb 99-118 cm bd **(Beta 16850)**	1645-1950
6410 **Area A - EU 54N/58E** Layer IIa HF-2 60-70 cm bd **(Beta 171517)**	1650-1950
6410 **Area A - EU 56N/45E** Layer IIb HF-4 **(Beta 171518)**	1650-1950
6416 **Tr 2** Layer II HF-6 5-15 **(42155)**	1650-1955
6411 **Area A - TU-34** Layer II 42-62 cm bd **(Beta 10536)**	1655-1950
6411 **TU-2** Layer II HF-9 38-84 cm bd **(Beta 44960)**	1659-1955
6412 **Auger Core A4** Layer IV **(Beta 16569)**	1659-1955
6411 **TU-2** Layer II HF-8 36-95 cm bd **(Beta 44959)**	1662-1955
6411 **TU-2** Layer I 25-48 cm bd **(Beta 44956)**	1665-1784 & 1789-1955
6410 **Area C - TU-32** Layer I 29-43 cm bd **(Beta 16858)**	1665-1940
6410 **Area C - TU-13** Layer III 46-66 cm bd **(Beta 15859)**	1665-1940
6411 **Area A - TU-19** Layer VIII 45-65 cm bd **(Beta 16731)**	1670-1715 & 1800-1930



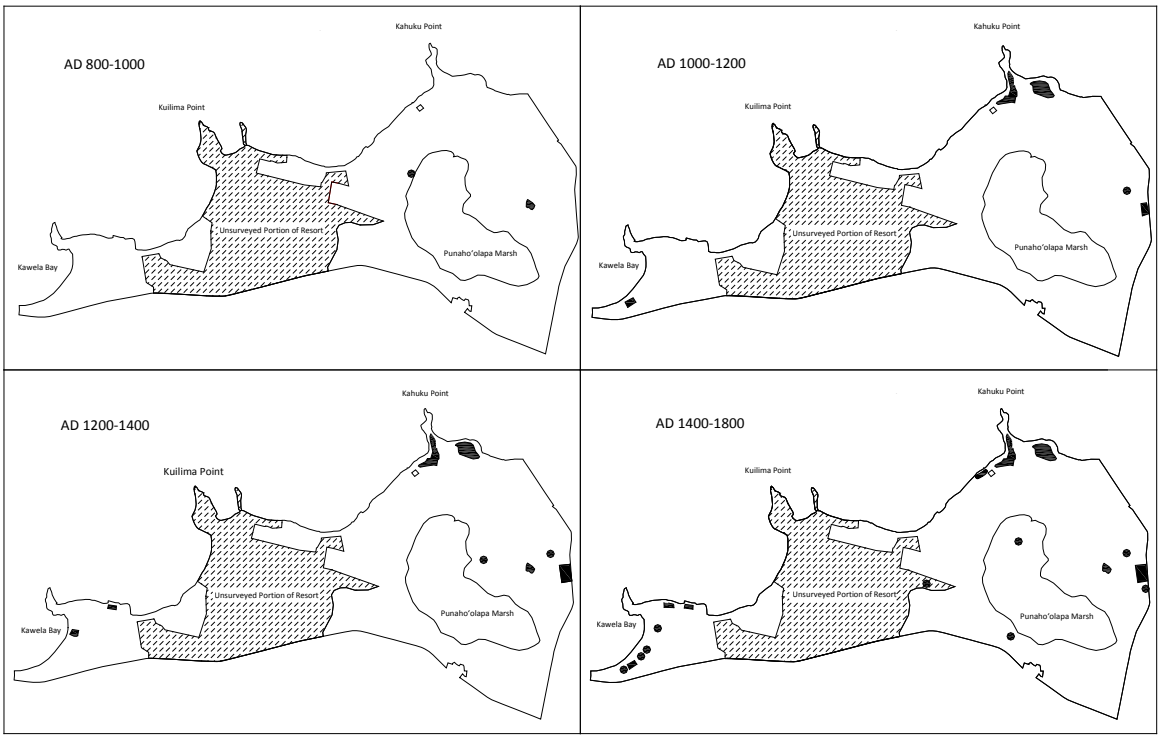


Figure 40. Pre-1800 Chronology of Occupation within Project Area

This developed portion of the property includes portions of the Turtle Bay beachfront, Kuilima Point and the west end of Kaihalulu Beach. The absence of data in this portion of the property should not be used to infer the absence of prehistoric use. Rather, the absence of data reflects the limits of archaeological data, combined with more than a century of agricultural use and subsequent resort development.

Figure 41 presents the distribution of deposits that post-date A.D. 1800, along with other evidence of the historic use of the TBR property. These historic elements consist of Land Commission Awards, the Kahuku Ranch facilities, areas planted in sugarcane, the former location of the OR&L railroad grade and the Kahuku Army Airfield. As indicated by this figure, nearly the entire property was affected by various historic activities and facilities.

SYNTHESIS AND EXPECTED SITE TYPES

Archaeological and historical background research indicates that in late prehistory the Kahuku Point vicinity was well populated and extensively cultivated. There were permanent residences scattered along the coast. Larger settlements were present in areas such as Kahuku and Kawela Bay where sheltered ocean access was available. Temporary habitation, probably associated with agricultural activity and natural resource exploitation, occurred in inland overhangs, caves, and walled shelters. Fishponds were present in sheltered areas and salt was collected from depressions along the shore. Fishing shrines and rock formations of legendary, and probably ritual significance were scattered along the coast.

Heiau were sited on prominent topographic features overlooking the coast. Sand dunes and cliff face caves were used for burial. Agricultural use included cultivation of taro in pond fields wherever topographically suitable locations could be provided with sufficient freshwater. The abundance of fresh water around Punaho'olapa Marsh provided Ideal conditions for wet taro cultivation with minimal labor investment compared to pond field development of stream drainages. Dryland gardens were present around the coastal residences and on the lower volcanic slopes. Upland areas were also cultivated. Food remains from archaeological excavations include dog, pig, birds, and a wide variety of fish and marine invertebrates, documenting technologies for fishing, collecting, hunting, and animal husbandry. Radiocarbon dates for the area indicate settlement by at least the A.D. 1000s to 1200s with the most intensive use occurring after A.D. 1400.

Observations of Vancouver and early 1800s missionary censuses suggest depopulation affected the region shortly after European contact as postulated by Nakamura (1981). Some depopulation undoubtedly occurred as a result of introduced diseases following the onset of more frequent visits by whalers and missionaries in the early 1800s. However, the disparity in the initial descriptions of a flourishing well-cultivated settlement at Kahuku from Captain Cook's expedition in 1779 and those from Vancouver's fifteen years later in 1794 of a much diminished state of cultivation and population probably predates the onset of disease-inducted population decline. Captain King, who reported the observations during Vancouver's expedition, conjectured that the decline was the result of internal warfare. Another explanation might be that the region was struck by a tsunami. While this would have resulted in a dramatic decline in cultivation of the coastal plain, the effects would rapidly diminish, allowing the area to return to a high level of settlement and cultivation as indicated by mid-Nineteen Century land claim testimony.

More than 100 LCA claims were awarded in the mid-1800s in the area spanning the region from Kawela to Kahuku. Thirty-five LCA claims with at least 24 house lots were awarded in the project area. The LCA testimonies refer to numerous lo'i and cultivated plots of bananas, sweet potatoes, *wauke*, sugar cane, bitter melon, *noni* and an orange tree. Other named plants are *hala* groves and *koa* trees for canoes. A brackish spring and a fishery also are mentioned in the testimonies.

Charles Hopkins purchased 8,000 acres at Kahuku in 1850-1851 from Kamehameha III and established the Kahuku Ranch. Forests were cleared for pasture for free-ranging herds of sheep and cattle, which soon plagued the small Hawaiian farms that were scattered throughout the area, eventually displacing many of the farmers.

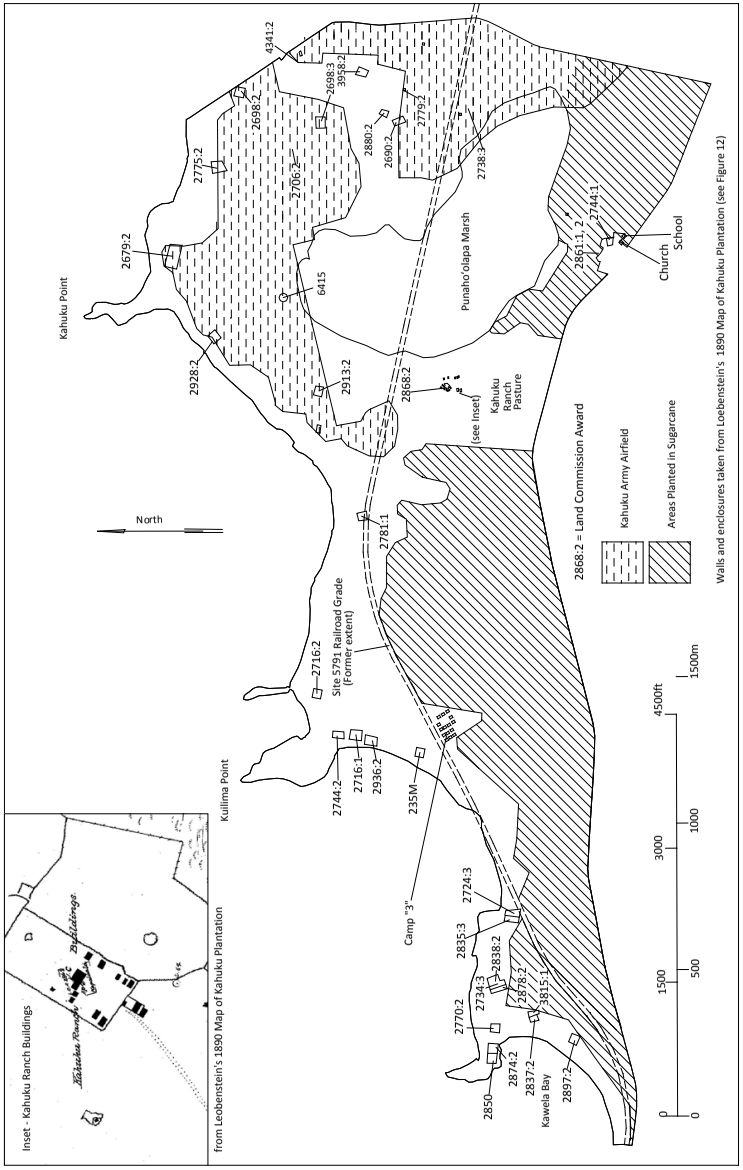


Figure 41. Post-1800 Use of Project Area

By 1856 a carriage road had been completed between Honolulu and Kahuku. The ranch changed ownership several times during the 1860s and 1870s. By 1873 the ranch consisted of 15,000 acres including the lands of Kaunala, Pahipahi'āula, 'Ōpana 1 and 2, Kawela, Hanaka'oe, Ōi'o, Ulupehupehu, Punalau, Kahuku, Mālaekahana, Keana, and part of Lā'ie. In 1874, the ranch was sold to Julius Richardson, who then sold it to James Campbell in 1876 by which time it encompassed nearly 25,000 acres with 3,000 head of cattle and herds of sheep and horses. In 1889, most of the ranch was leased Benjamin Franklin Dillingham who chartered OR&L in the same year. Dillingham then subleased the lands to James Castle who chartered Kahuku Plantation Company in 1890.

The Kahuku Plantation began commercial production of sugarcane relying on water from springs, streams and rain for irrigation, but this was soon considered insufficient and artesian wells were drilled to augment the irrigation water supply. The first sugarcane crop from 2,800 cultivated acres was harvested in 1892. By 1899, the OR&L railroad line extended from Honolulu to Kahuku to get the cane to market. By the early 1900s there were stations at Kawela and Kahuku Ranch. Marconi Station was located just east of the property at Punamanō Marsh. By 1935, 4,490 acres were cultivated in sugarcane and the plantation employed over 1,100 workers. A plantation camp was established on the TBR property to house plantation workers by at least 1932.

In addition to sugarcane, pineapples were also cultivated beginning in the 1930s at Kahuku Plantation and on lands leased by the OR&L Railroad Company including small tracts leased to Japanese farmers. When the farmers' leases expired Kahuku Plantation leased large tracts of land to the California Packing Corporation (CPC), driving out the smaller farmers. The CPC became Del Monte Corporation in 1967.

The U.S. Army established Kahuku Army Airfield in 1942. The airfield encompassed runways, taxiways, revetments, bunkers, emplacements, barracks and support facilities. The facility served as an auxiliary field used for flight training and costal defense. Use of the airfield was short-lived and military use ended shortly after the end of World War II (September, 1945). The April 1946 tsunami devastated much of the facility shortly after the Army abandoned it. Subsequent use of the airfield runways included civilian aircraft and auto racing.

Sugarcane cultivation continued until 1971 when the Turtle Bay Resort and golf course were constructed. Some inland portions of the property continued to be used for vegetable faming until the late 1980s. Private beach cottages lined the east shores of Kawela Bay until 1990 when the area was cleared and preliminary construction for a hotel began, but was abandoned in 1991.

Based on previous archaeological research and historical documentary evidence, expected prehistoric to early historic remains in the project area include subsurface cultural deposits and a variety of subsurface features including fire pits, post molds for residential structures, and burials. Some cultural deposits will predate A.D. 1400, but most features will date between A.D. 1400 and 1800. Expected historic remains dating to the 1800s to 1900s include the OR&L railroad, plantation infrastructure (camps, roads, irrigation ditches, etc.) and walls marking property boundaries and serving to control livestock. Military-related remains dating from World War II will include runways, revetments, defensive fortifications and a variety of support facilities.

RESEARCH DESIGN

Professional archaeologists who meet or exceed the State of Hawai'i and U.S. Secretary of the Interior's qualifications will supervise the proposed SAIS work. Alan Haun, Ph.D. will function as the Principal Investigator for the SAIS project. Haun has conducted work in Hawai'i since 1978. Prior to founding Haun & Associates in 1999, he was the Senior Archaeologist for PHRI for 15 years. During his tenure with PHRI, Haun oversaw archaeological testing, data recovery and monitoring fieldwork on the TBR property between 1986 and 1990. As the firm's Principal Archaeologist, Dr. Haun will be directly involved with all aspects of project performance.

Other staff will include Haun & Associates' laboratory director and curation specialist Dianne Berrigan, M.A., project supervisors Juliana Kailihiwa, B.A. and Solomon Kailihiwa III, B.A. and Jack Dave Henry, B.S. who is responsible for fieldwork, AutoCAD drafting and preparation of technical reports. Henry also worked in a supervisory capacity during the PHRI data recovery and monitoring work in 1990-1991. The SAIS fieldwork would be completed within approximately two months following DLNR-SHPD approval of the SAIS plan.

The proposed primary fieldwork effort will consist of subsurface testing that will build on the extensive previous archaeological work that has been conducted on the property. Areas proposed for further testing and described below were previously cleared for development, with the stipulation that a professional archaeologist would monitor construction. This provision was based on the results of extensive archaeological subsurface testing and data recovery work conducted between 1977 and 1991, and on the extensive prior disturbance to the property by more than a century of sugarcane cultivation, the construction and operation of Kahuku Air Airfield, and the post-1971 development of resort facilities.

Despite prior archaeological clearance, TBR has elected to take a proactive approach to ensure the protection of cultural resources within the proposed expansion lands as part of the SEIS process. Toward that end a combined program of extensive systematic and discretionary archaeological test excavations, both mechanical and manual, are proposed for all areas within the resort property where substantial construction-related excavations are planned.

Figure 42 depicts the extent of proposed test excavation areas, labeled Test Areas A-G, on an aerial photograph of the TBR property. The majority of areas excluded from testing are already developed with golf courses and other resort facilities. Most of the proposed test areas are densely vegetated with *koa haole*, ironwood, Christmas berry and *hau*. Two forested areas, a proposed hotel site at Kawela Bay and a proposed golf clubhouse site in the central coastal portion of the property overlooking Kaihalulu Beach were graded to bedrock and filled during construction activity in 1990-1991. These areas are considered to lack any potential for significant intact subsurface cultural remains.

Figure 43 is an overlay of the proposed test excavation areas on the updated TBR master plan preferred alternative map. The combined test area extent is 173.2 acres. Test areas are located where future development is planned. No additional testing is proposed for parks and other open spaces where development impacts are anticipated to be minimal, primarily consisting of landscaping that would have very shallow, less than 1 ft (30 cm) deep impact. All ground disturbing activity in the open space areas would be subject to archaeological monitoring done in accordance with a new Monitoring Plan prepared for SHPD review and approval.

Portions of the proposed test areas were sampled during the PHRI survey in 1984 (Bath *et al*. 1984) and during the subsequent intensive survey and testing projects at Kahuku Point and Kawela Bay (Walker *et al*. 1988a, 1988b); however, testing generally was limited to widely spaced small diameter (10-15 cm) auger tests. Data recovery excavations at sites identified during monitoring (Corbin 2003) were conducted in the vicinity of SAIS Test Areas D and E. Several burials were inadvertently discovered in SAIS Test Area C (Kennedy 1992; Carson *et al*. 1996, 1999).

Figure 42. Aerial View of Project Area showing Proposed Test Excavation Areas

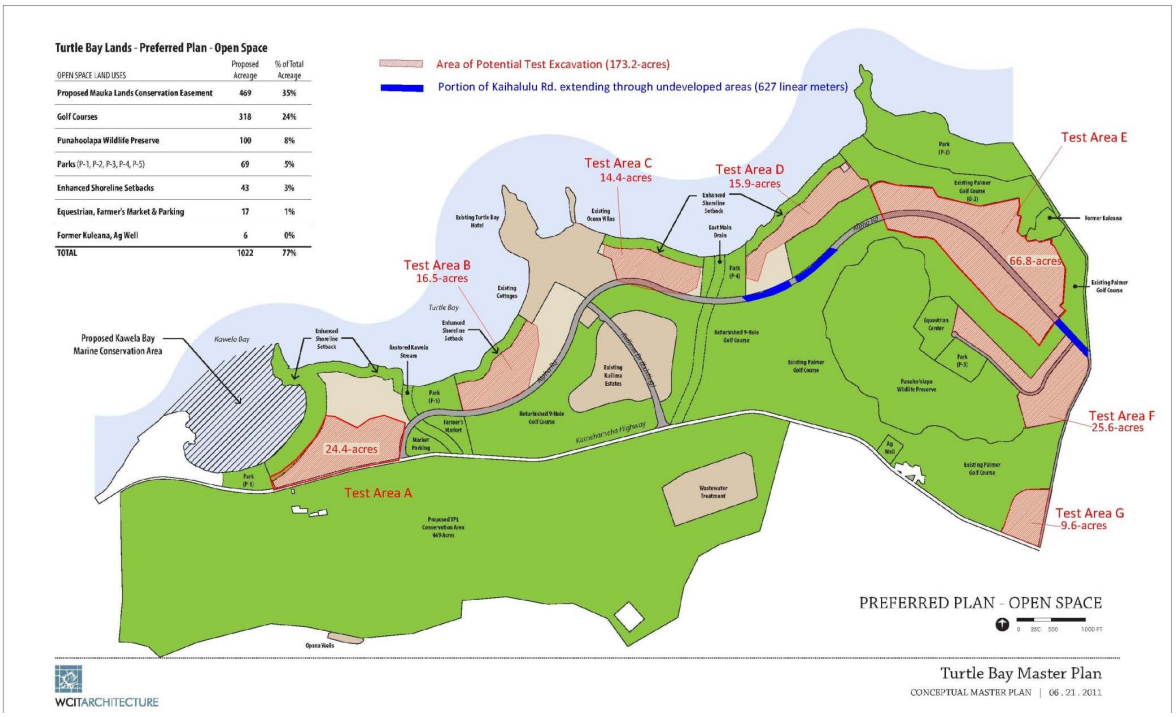


Figure 43. Potential Test Excavation Areas and Turtle Bay Lands - Preferred Plan - Open Space Lands

Previous archaeological studies for the TBR property have established the higher potential for encountering subsurface cultural remains including burials in mapped Jaucus Sand and Pearl Harbor Clay deposits (*Figure 44*). It is proposed that these two soil types will be subject to higher intensity testing. Lower intensity testing is proposed for the various clay and loam soil types elsewhere on the TBR property.

Backhoe-excavated trenches will be systematically placed along a series of uniformly spaced transects. A test trench density of two 5 m (16 ft) long trenches per acre for high-intensity testing and one trench per acre for low-intensity testing is proposed (*Figure 45*). *Figures 46 through 59* (at end of Consultation section) depict the proposed test areas. There are two figures for each area. The first shows the distribution of soil types and depicts previous test excavations within, or adjacent to each test area. The results of prior testing are presented in a tabular inset that shows one or more typical stratigraphic profiles for each area derived from the previous testing data. Stratigraphic information includes layer designation, layer thickness, Munsell color, sediment texture and soil type. The second figure for each test area depicts historic land use and the proposed placement of systematic test trenches. Also shown are proposed discretionarily placed trenches designed to sample areas missed by the systematically placed trenches, where subsurface deposits could potentially be present based on documented past land use or previous archaeological work.

Low density testing, consisting of 35 trenches, is proposed for the 24.4 acres of Waialua/Mokulei Clay soils at Kawela Bay (Test Area A; see *Figures 46-47*) and the residential housing area (Test Area G, 9.6 ac; see *Figures 58-59*). Five additional discretionary trenches will be placed along the northwest margin of Test Area A where Jaucus Sand deposits are present.

The remaining test areas consist of Jaucus Sand and Pearl Harbor Clay soils, where high-intensity testing will consist of a test trench density of 2 trenches per acre (139.2 ac = 279 trenches). The systematic sampling strategy would yield excavation and examination of a total of 314 trenches including both high and low density test areas.

Additional trenches for discretionary placement will be used for:

- Specific areas that might be missed by the systematic transect trenching such as LCAs (see *Figures 49 and 55*);
- The location of former plantation worker housing (Camp 3; see *Figure 49*);
- Areas were subsurface cultural remains were documented by previous archaeological studies (see *Figures 51 and 53*);
- Segments of the proposed Kaihalulu Drive outside the potential test excavation areas that are undeveloped (see *Figure 43*); and
- Defining the extent of subsurface cultural deposits identified in the systematic trenches.

Prior archaeological excavations in and adjacent to **Test Area A** reached a maximum depth of 1.15 m below surface with no cultural layers identified (see *Figure 47*). The prior testing identified two to three non-cultural sand layers in the seaward portion of Area A and three non-cultural sandy clay and clay loam layers in the inland portion. Evidence of plowing was observed in the eastern portion of the area where the test excavations reached the water table. The plow zone is a 0.35 m thick clay loam underlain by two layers of sand. Five discretionary trenches will be excavated along the northwest margin of this low density test area due to the presence of sand deposits (see *Figure 48*). Two of these discretionary trenches will test areas adjacent to LCA parcels.

No cultural layers were observed in prior excavations conducted adjacent to the west side of **Test Area B**. These excavations extended to a maximum depth of 2.1 m below surface exposing 3-4 layers of sand (see *Figure 48*). At least two discretionary trenches will be excavated in the eastern portion of the area where an LCA parcel (LCA 235M) and Kahuku Plantation Camp 3 were formerly located (see *Figure 49*).

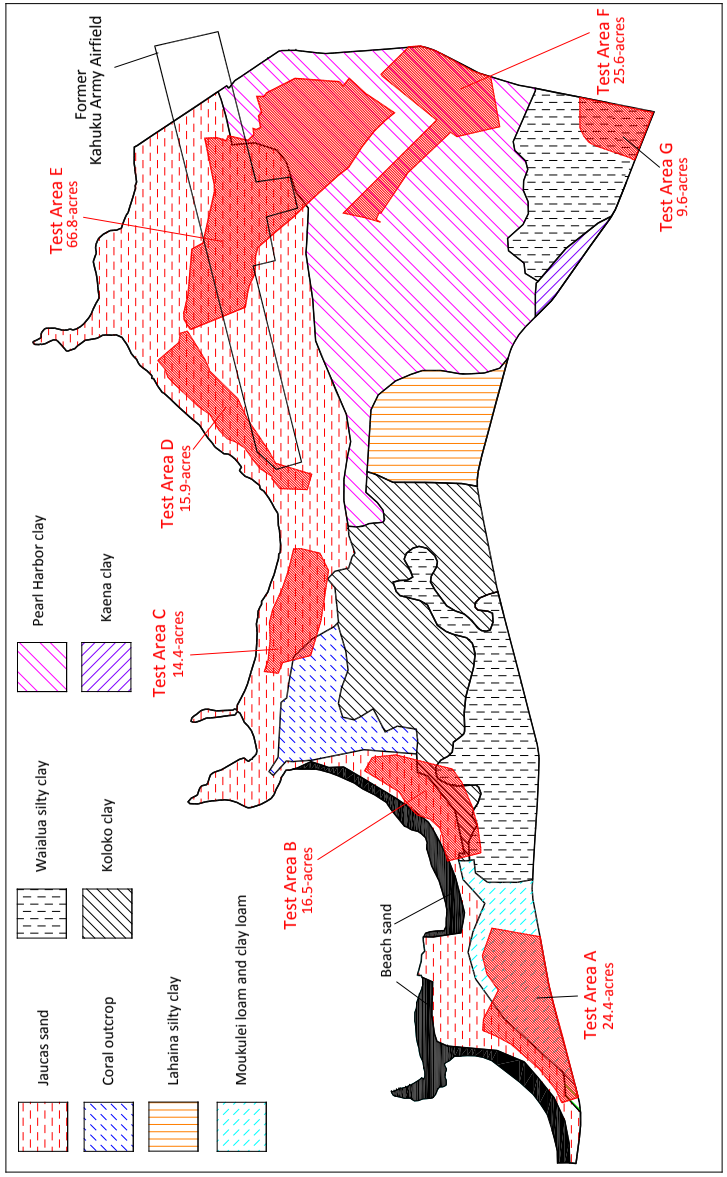


Figure 44. Potential Test Excavation Areas and Distribution of Soils within Project Area

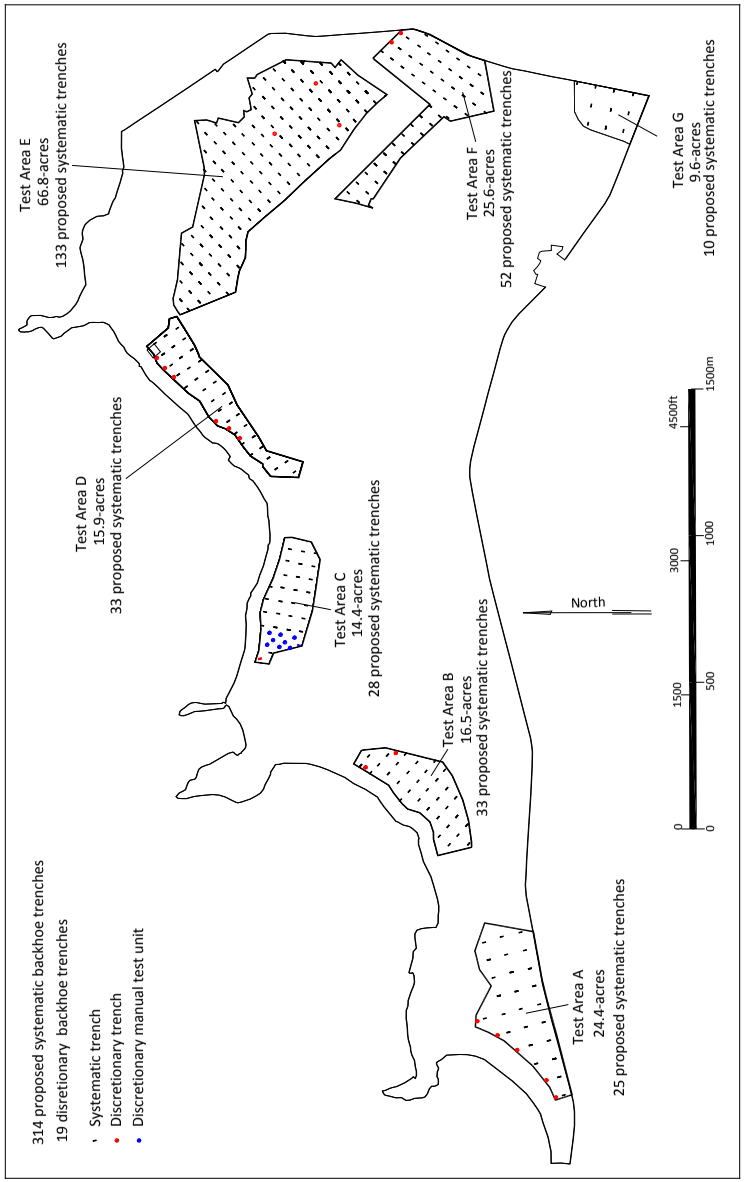


Figure 45. Proposed Test Areas and Trench Locations

Previous excavations in **Test Area C** documented three sand layers extending to a depth of 2.1 m below surface (see Figure 50). These sand deposits were highly disturbed with mixed prehistoric and modern debris. Site 4488, where several burials were recovered, is located in the western portion of this test area. Eight or more test units will be excavated in the vicinity of the site (see Figure 41). These test units will be excavated manually until the stratigraphy in this area is well documented and the potential for encountering additional burials is evaluated. Manually excavated fill will be screened with 1/8th-inch mesh to recover cultural remains. If no burials are identified, then mechanical excavation of the surrounding systematically-placed trenches will proceed. If a burial is identified all work in the immediate vicinity will cease and the procedures discussed below will be followed. A discretionary trench will also be excavated at the west end of Area C.

Previous excavations within and adjacent to **Test Area D** documented multiple (2-6) sand layers extending to a maximum depth of 1.6 m below surface (see *Figure 52*). An intact cultural deposit was indentified at the northeast end of the area (Site 6411, Area C), consisting of black loamy sand that varied in depth from 1.16 to 1.41 m. The central portion of Area D contains highly disturbed sand deposits with at least some cultural material, although Corbin (2003) does not indicate which layer(s) contained cultural material. The southwest portion of Test Area D was characterized by two non-cultural sand layers. At least three discretionary trenches will be excavated in the eastern and central portions of the Test Area to further examine the previously identified cultural deposits (see *Figure 53*).

Previous excavation in and adjacent to **Test Area E** attained a maximum depth of 3.6 m below surface. Most of the test excavations reached bedrock. An intact cultural layer was identified in the southeast portion of the area (Site 6414; see *Figure 54*). This deposit consists of dark brown silty clay loam that varies in depth from 0.59 to 0.89 m. Remnant wetland deposits are present at the northwest and west ends of the area, where soils were impacted by airfield construction at the northern end. Relatively shallow Pearl Harbor Clay deposits border Area D to the east, west and south. At least three discretionary trenches will be excavated in this Test Area in the locations of three former LCA parcels (LCA 2698:3, 2880:2, and 3958:2; see *Figure 55*). Additional discretionary trenches may be excavated in the vicinity of Sites 6414 and 6417 if the systematically placed trenches near these sites do not encounter cultural material.

Prior excavations adjacent to **Test Area F** extended to a maximum depth of 4.93 m below surface. Most of these excavations extended to bedrock or the water table. Stratified cultural deposits were identified in excavations adjacent to the northeast end of the area (Site 6422; see *Figure 56*). The upper cultural deposit consists of a very dark grayish brown silty clay loam that is 0.12 to 0.31 m in depth. It is directly underlain by a brown silty clay loam cultural layer that is 0.31 to 0.42 m in depth. At least two discretionary trenches will be excavated next to the reported location of these deposits (see *Figure 57).* Remnant wetland deposits associated with Punahoʻolapa Marsh are located west of the area and non-cultural Pearl Harbor Clay is present to the north and northwest.

No previous excavations were conducted in or near **Test Area G**; the closest test excavations consist of two cores located more than 100 m to the northwest (see *Figures 58* and *59*). These cores extended to a depth of 3.6 m and identified multiple layers of loam, clay and silt with an intervening peat layer. No cultural deposits were present.

When cultural deposits are encountered mechanical excavation will be suspended and further excavation will be conducted manually with shovels or trowels, as appropriate, to determine the horizontal extent of the deposit in the trench. Additional mechanically and manually excavated trenches would surround the trench where cultural deposits are exposed, halfway between the trench where the deposit is identified and the next systematic trench on all four sides. Additional trenches or manually excavated test pits will be used to fully define the horizontal extent of any subsurface cultural deposit.

In areas where previous archeological studies have identified remnant cultural deposits and subsurface features (post molds, fire pits and burials), and for subsurface deposit extent determination testing, a combination of mechanical and manual excavation techniques would be employed. Mechanized equipment will be used to remove non-cultural deposits overlying intact cultural deposits, followed by manual excavation methods to

determine the vertical extent of the cultural deposit. Fill from manually excavated cultural deposits and will be screened with 1/8th-inch mesh to recover cultural remains. After the cultural deposit is excavated within the trench additional mechanical excavation will be used to reach the water table or bedrock to determine if deeper cultural deposits are present.

Extensive vegetation clearing of test trench transects will be required prior to backhoe trench excavation. This can best be accomplished by using a mechanical flail attachment on an excavator. Use of this device reduces the vegetation to mulch that is broadcast over the ground surface eliminating the need for collection and removal. Trench excavations will be carefully monitored in the event that human remains or cultural deposits are encountered. Trenches will be excavated deeply enough (usually to the water table or limestone bedrock) to ensure that all buried cultural deposits are observed. Trench dimensions will be compliant with appropriate Occupational Safety and Health Administration (OSHA) standards.

Upon completion of each backhoe trench excavation, a representative trench face will be manually scraped to aid in recording the stratigraphy. The face will then be profiled and described using Munsell soil colors and U.S. Soil Conservation Service terminology and the GPS coordinates of all profiles will be recorded. Artifacts, food remains and charcoal samples will be collected from the trench walls as appropriate and the GPS coordinates of all collections will be documented. The completed trench will be photographed and immediately backfilled.

Another fieldwork task will consist of the relocation and potential documentation of specific sites previously identified on the TBR property. As discussed in a preceding section, the current disposition of seven sites needs to be determined. These consist of sites that were assigned SIHP site designations and those that have not (see *Table 6*). The SIHP sites consist of the Site 5791 OR&L railroad grade, the Site 6421 walled pool, and the Sites 6424 and 6426 rock walls. Sites with no SIHP site designation consist of remnants of the Kahuku Army Airfield, including the Site T-4 military structure, the Site T-2 wall and the Site T-3 cattle enclosure. The reported locations of these sites will be examined and if any are extant, they will be fully documented.

Site documentation will consist of preparation of scaled plan maps, photographic documentation, preparation of standardized site and feature forms, and evaluation of site condition and physical integrity. The location of any surface or subsurface sites or features identified during the SAIS will be determined with the aid of a hand-held Magellan Mobile Mapper Global Positioning System (GPS) device using the NAD 83 datum. The accuracy of this GPS device for a single point is less than one meter. Sites identified during the survey will be marked and their locations plotted on a scaled project area map. If any burials or subsurface features are identified that require in-place preservation, their locations will be plotted by a licensed land surveyor.

SHPD staff will be periodically briefed on the SAIS fieldwork findings and status. The agency and TBR management will be notified immediately in the case of any unusual or highly significant findings. If human remains are identified during the fieldwork, all work in the vicinity of the find will cease and the proper authorities, including DLNR-SHPD and TBR, will be contacted immediately. No further work including screening of fill, cleaning or excavating the remains, or other investigation in the immediate vicinity will take place until agency consultation is completed, except measures necessary to protect the remains from the elements and other disturbance. Following initial agency consultation and approval, the remains will be reburied or otherwise protected to ensure the safety and security of the remains until appropriate treatment is determined. All remains will be treated as "previously identified" in accordance with HAR §13-13-300-31(b). Appropriate treatment will be determined through the preparation of a Burial Treatment Plan for review and approval by the DLNR-SHPD and the O'ahu Island Burial Council (OIBC).

Following completion of fieldwork, analysis of all recovered remains and data will use standard archaeological methods. All recovered artifacts will be analyzed to determine morphological type, condition/degree of completion and material. Metric measurements will include weight, length, width, and thickness. Standard typological classifications will be used for all artifacts. Food remains will be identified to the Family level, or to the Genus/species level, when possible. Quantitative analysis will include a determination of total weight and total number of fragments (TNF) per taxon. If suitable charcoal samples are recovered that have the potential to

contribute to the extensive chronology that has been developed for the project area, they will be submitted to Beta Analytic, Inc. for analysis.

The resulting data will be presented in a draft SAIS Report in conformance with regulatory agency requirements for archaeological inventory survey reports contained in HAR §13-13-276-5. The draft report will include significance assessments and specific recommendations for any further archaeological work.

CONSULTATION

This SAIS Plan will be prepared in consultation with DLNR-SHPD and the Office of Hawaiian Affairs (OHA). The consultation will ensure that the work complies with applicable laws, regulations and rules. This consultation also will ensure that the Plan reflects a mutually acceptable scope of work for the SAIS fieldwork prior to implementation. Consultation with the OIBC is planned to provide an informational briefing regarding the SAIS work, to solicit input regarding the study, and to identify additional interested parties.

The consultation process, which is an ongoing process that will continue concurrently with the SAIS tasks, also will require input from interested organizations and individuals, including the local community, Hawaiian cultural organizations, recognized lineal and cultural descendants, and individuals knowledgeable about the TBR property cultural resources and land use history. This interested party consultation is part of the ongoing Cultural Impact Assessment (CIA) work currently in preparation by Pacific Legacy, Inc. for the TBR property and is being conducted in accordance with HAR §13-13-284-(c)-(3) and §13-13-276-5-(g). Results of the consultation process will be incorporated into the SAIS Report.

Consultation already has included TBR management meetings with the Kahuku Burial Committee, composed of families who have a connection to TBR lands and who have expressed a desire to take an active role in caring for ancestral remains on the property. Consultation also has included TBR management meetings with OHA and with the Ko'olauloa and Ko'olaupoko Hawaiian Civic Clubs. TBR management has invited cultural practitioners, *kūpuna*, and knowledgeable individuals to be part of a cultural advisory council to share their *mana'o* on the cultural issues and opportunities associated with TBR.

Public notices seeking to identify interested parties, including lineal and cultural descendants, have been published in Honolulu Star-Advertiser (May 5, 2011) and the monthly OHA newsletter *Ka Wai Ola* (June 2011; APPENDIX A). Two responses to the notices were received, including one individual who owns a *kuleana* parcel within the TBR property.

Profile	Layer	Depth (cm)	Color	Texture	Soil Type
1	I	0-75	Pale brown	Very fine sand	Jaucus sand
	II	75-140	Light grey	Very fine sand	
2	I	0-90	Reddish brown to dark reddish brown	Sandy clay loam	Mokulei loam and Clay loam
	II	90-100	Yellowish red	Sandy clay loam	
	III	100-115	Yellowish red	Sandy clay	
3	I	0-35	Dark brown to dark reddish brown	Clay loam - Plow zone	Mokulei loam and clay loam
	II	35-80	Yellowish red	Calcareous sand	
	III	80-90	Very pale brown	Calcareous sand	

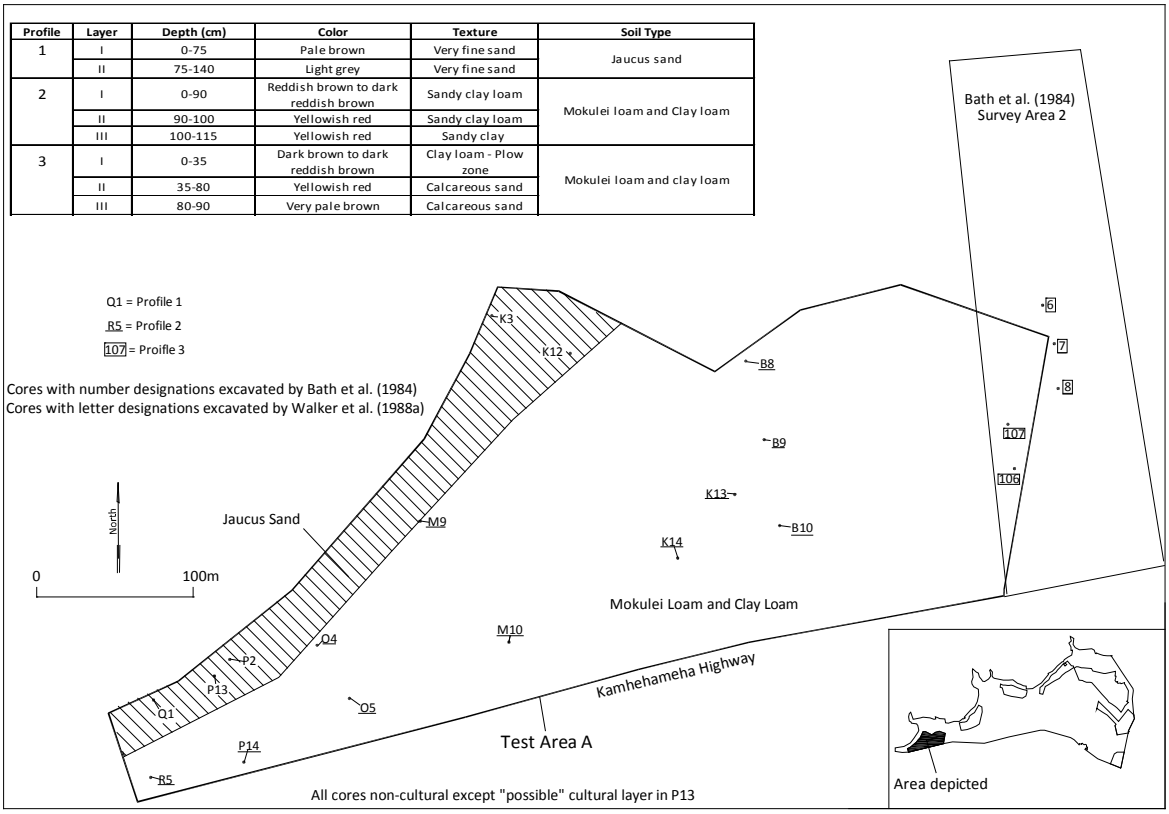


Figure 46. Test Area A, Soil Types and Previous Testing Results

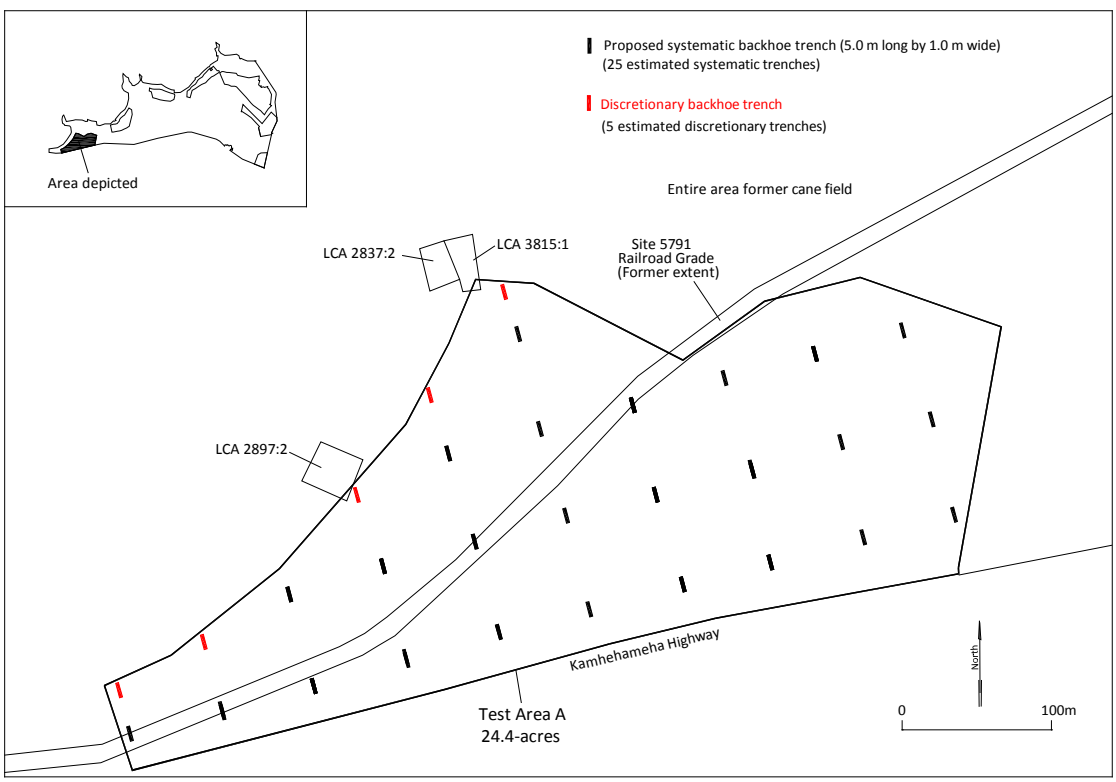
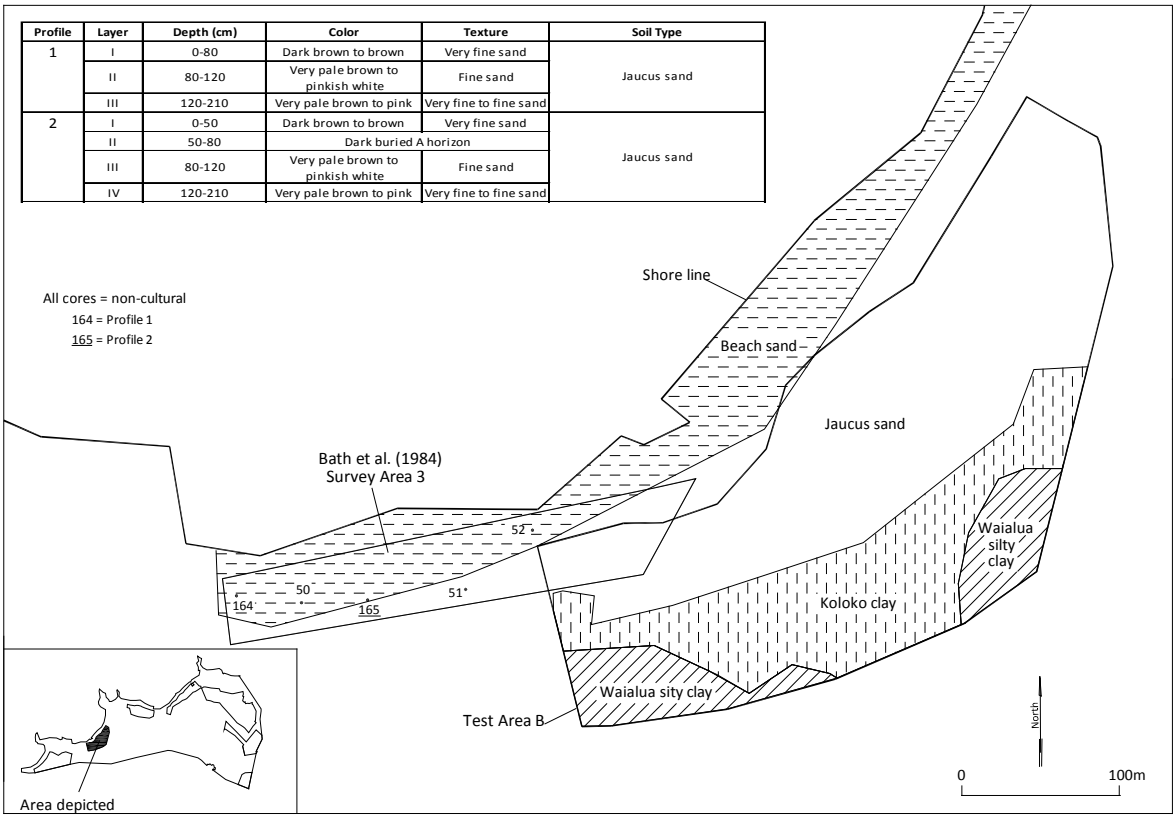


Figure 47. Test Area A, Proposed Trench Locations and Historic Land Use



Profile	Layer	Depth (cm)	Color	Texture	Soil Type
1	I	0-80	Dark brown to brown	Very fine sand	Jaucus sand
	II	80-120	Very pale brown to pinkish white	Fine sand	
	III	120-210	Very pale brown to pink	Very fine to fine sand	
2	I	0-50	Dark brown to brown	Very fine sand	Jaucus sand
	II	50-80	Dark buried A horizon		
	III	80-120	Very pale brown to pinkish white	Fine sand	
	IV	120-210	Very pale brown to pink	Very fine to fine sand	

Figure 48. Test Area B, Soil Types and Previous Testing Results

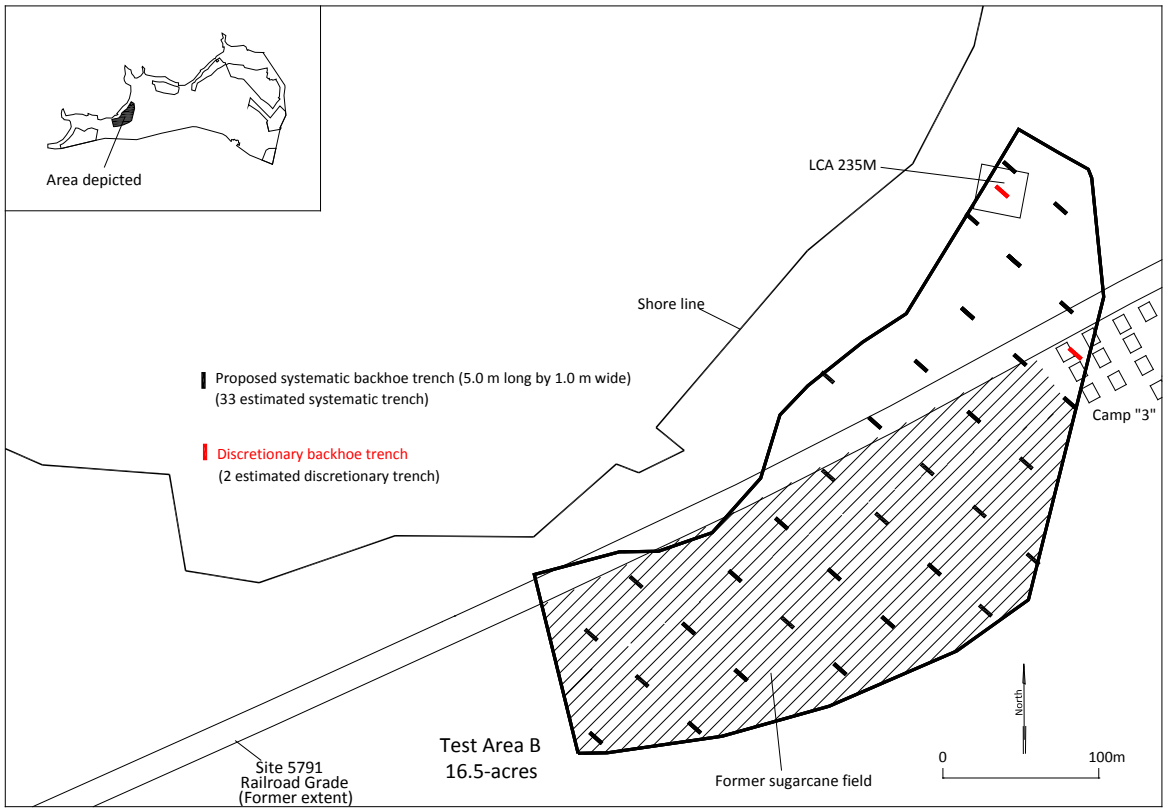
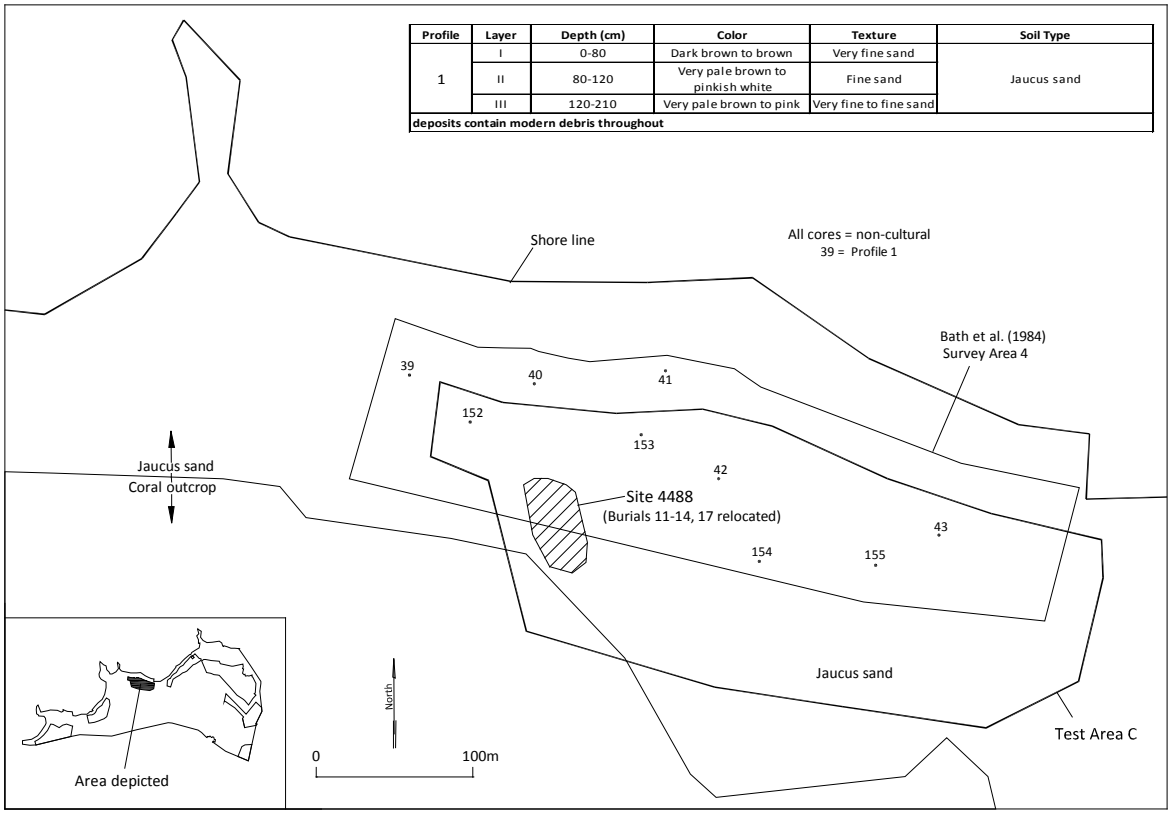


Figure 49. Test Area B, Proposed Trench Locations and Historic Land Use



Profile	Layer	Depth (cm)	Color	Texture	Soil Type
1	I	0-80	Dark brown to brown	Very fine sand	Jaucus sand
	II	80-120	Very pale brown to pinkish white	Fine sand	
	III	120-210	Very pale brown to pink	Very fine to fine sand	
deposits contain modern debris throughout					

Figure 50. Test Area C, Soil Types and Previous Testing Results

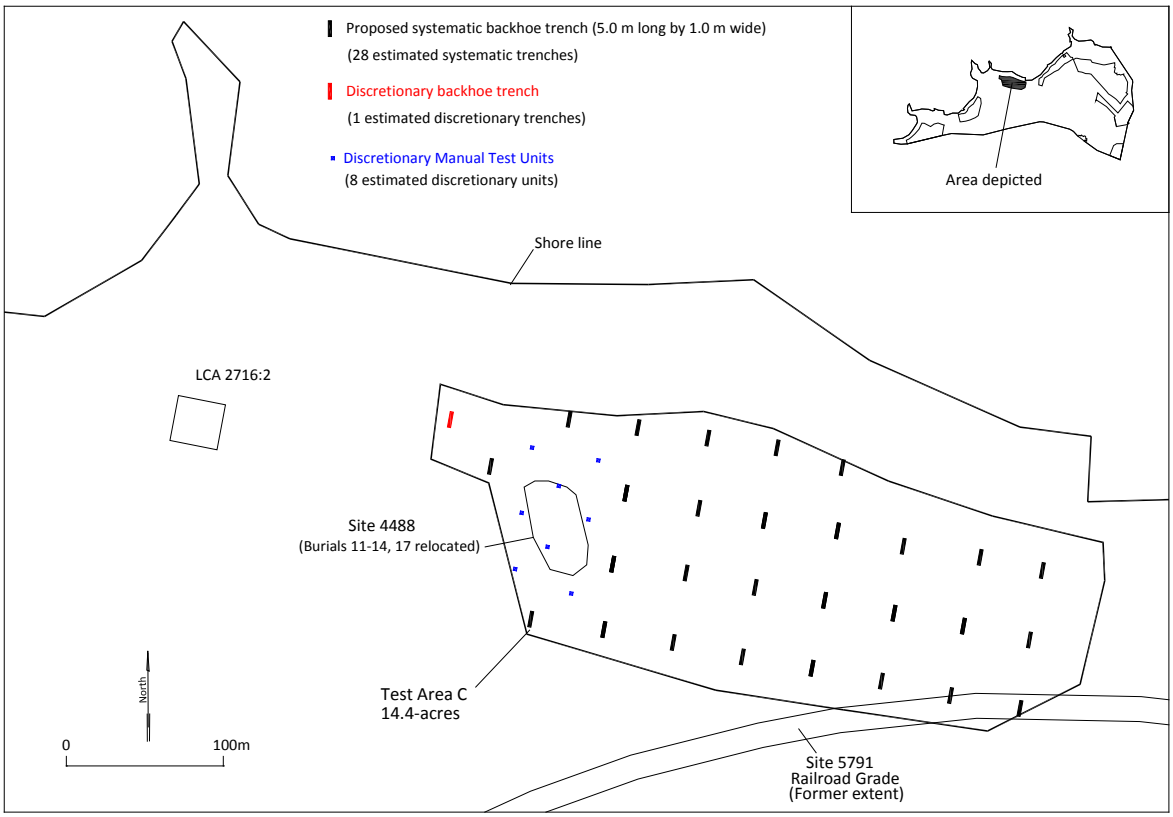


Figure 51. Test Area C, Proposed Trench Locations and Historic Land Use

Profile	Layer	Depth (cm)	Color	Texture	Soil Type
1	I	n/d	n/d	Aoelian sand	Jaucus sand
	II	n/d	n/d	n/d	
	III	n/d	Grayish black	n/d	
	IV	100	n/d	Sterile beach sand	
2	I	n/d	Light brown	Sand	Jaucus sand
	II	250	White	Sand	
3	I	0-30	Very pale brown	Sand	Jaucus sand
	II	30-44	Brown to dark brown	Loamy sand	
	III	44-78	Very pale brown	Very fine sand	
	IV	78-116	Yellowish brown	Loamy sand	
	V*	**116-141**	**Black**	**Loamy sand**	
	VI	141-160	Very pale brown	Very fine sand	
*** = Cultural layer**					
4	I	n/d	Very dark brown	Loamy fine sand	Jaucus sand
	II	n/d	Light brownish gray	Course sand	
	III	n/d	Pale brown	Course sand	
	IV	n/d	Pale brown	Very fine sand	
	V	n/d	Grayish brown	Very fine sand	
	VI	n/d	Pale brown	Very fine sand	
	VII	n/d	Grayish brown	Very fine sand	
	VIII	n/d	Brown	Very fine sand	
	IX	n/d	Very dark grayish brown	Very fine sand	
	X	n/d	Very pale brown	Very fine sand	
	XI	n/d	Very pale brown	Very fine sand	
Highly disturbed deposit					

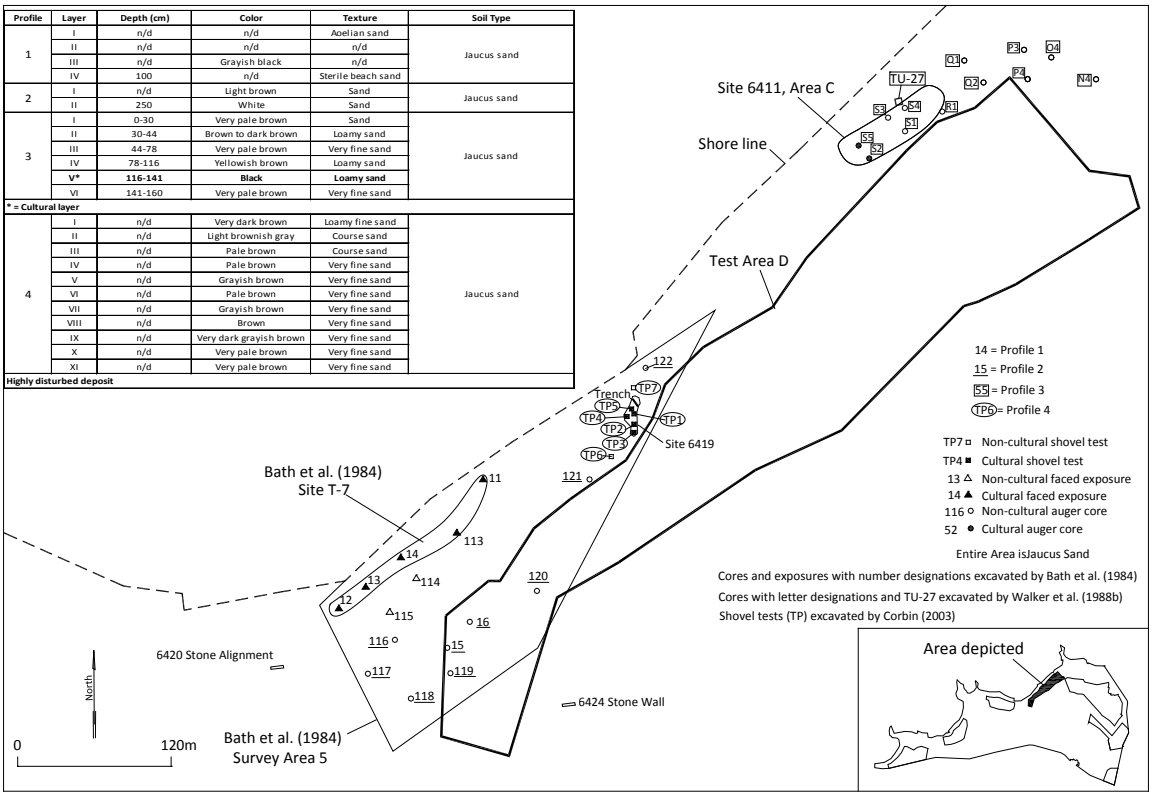


Figure 52. Test Area D, Soil Types and Previous Testing Results

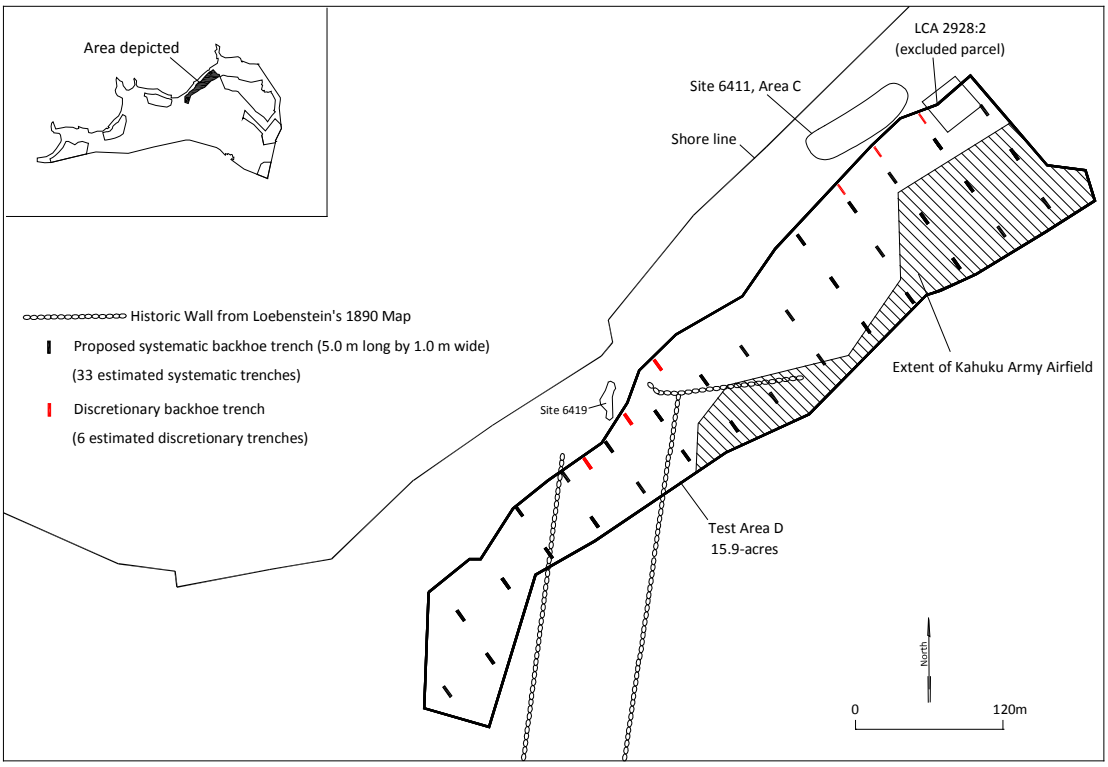
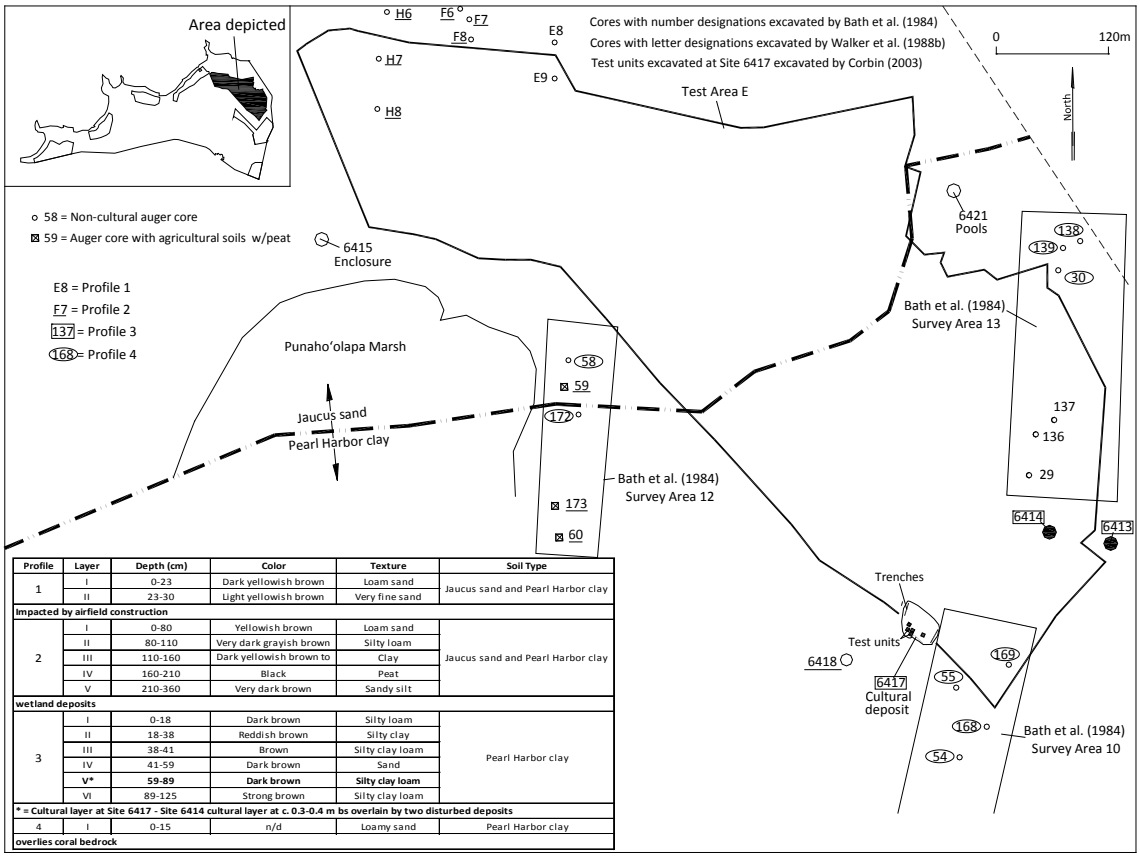


Figure 53. Test Area D, Proposed Trench Locations and Historic Land Use



Profile	Layer	Depth (cm)	Color	Texture	Soil Type
1	I	0-23	Dark yellowish brown	Loam sand	Jaucus sand and Pearl Harbor clay
	II	23-30	Light yellowish brown	Very fine sand	
Impacted by airfield construction					
2	I	0-80	Yellowish brown	Loam sand	Jaucus sand and Pearl Harbor clay
	II	80-110	Very dark grayish brown	Silty loam	
	III	110-160	Dark yellowish brown to	Clay	
	IV	160-210	Black	Peat	
	V	210-360	Very dark brown	Sandy silt	
wetland deposits					
3	I	0-18	Dark brown	Silty loam	Pearl Harbor clay
	II	18-38	Reddish brown	Silty clay	
	III	38-41	Brown	Silty clay loam	
	IV	41-59	Dark brown	Sand	
	V*	**59-89**	**Dark brown**	**Silty clay loam**	
	VI	89-125	Strong brown	Silty clay loam	
*** = Cultural layer at Site 6417 - Site 6414 cultural layer at c. 0.3-0.4 m bs overlain by two disturbed deposits**					
4	I	0-15	n/d	Loamy sand	Pearl Harbor clay
overlies coral bedrock					

Figure 54. Test Area E, Soil Types and Previous Testing Results

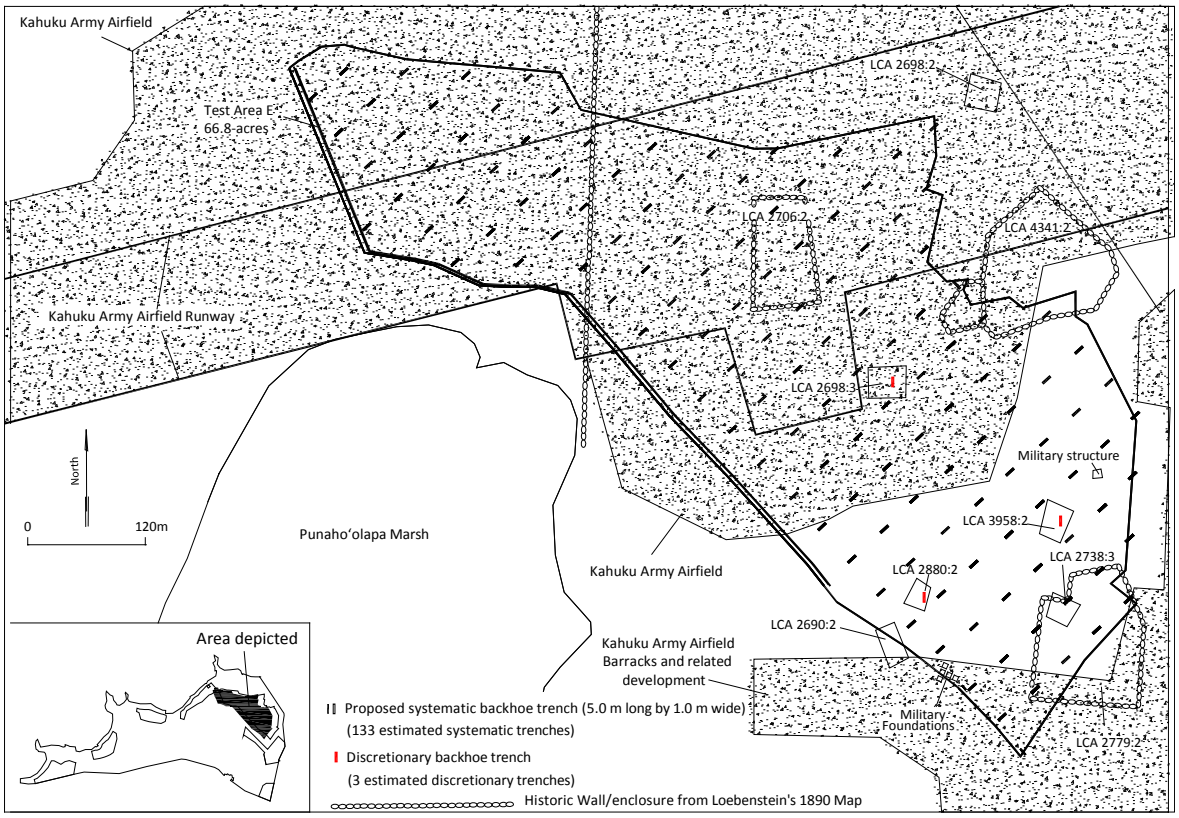
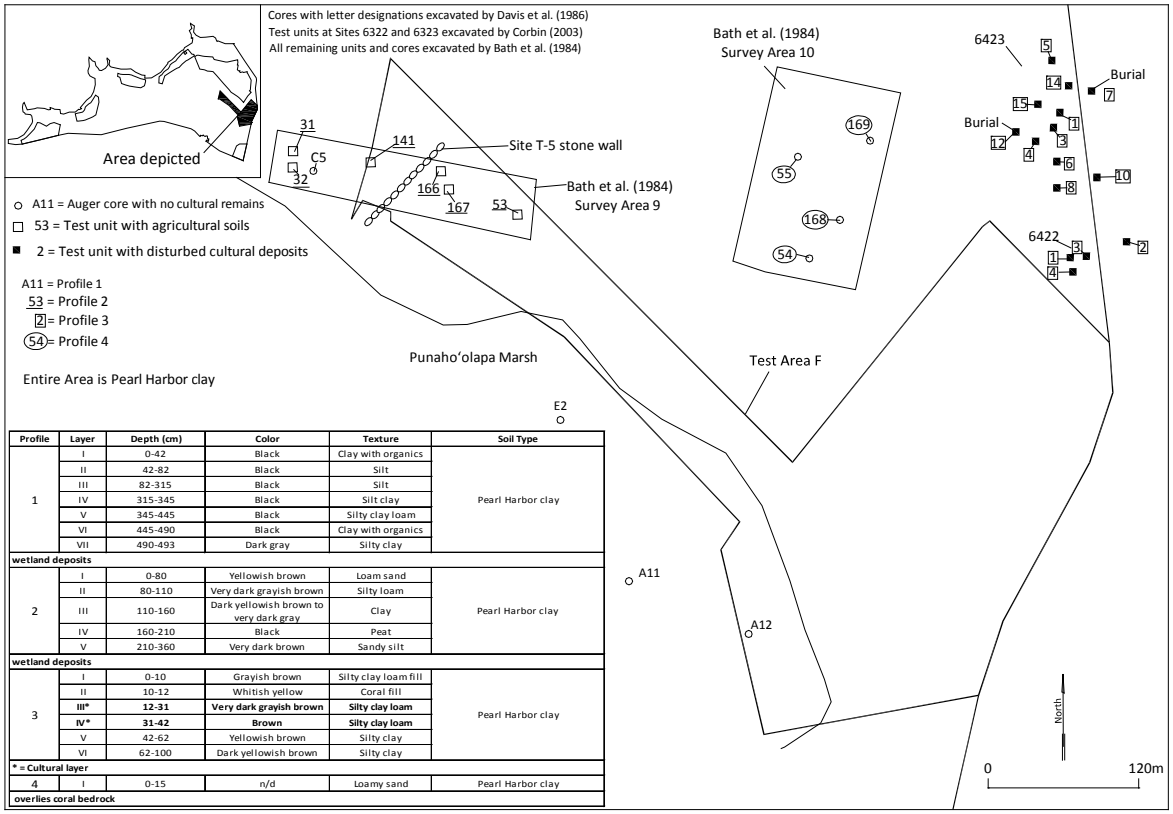


Figure 55. Test Area E, Proposed Trench Locations and Historic Land Use



Profile	Layer	Depth (cm)	Color	Texture	Soil Type
1	I	0-42	Black	Clay with organics	Pearl Harbor clay
	II	42-82	Black	Silt	
	III	82-315	Black	Silt	
	IV	315-345	Black	Silt clay	
	V	345-445	Black	Silty clay loam	
	VI	445-490	Black	Clay with organics	
	VII	490-493	Dark gray	Silty clay	
wetland deposits					
2	I	0-80	Yellowish brown	Loam sand	Pearl Harbor clay
	II	80-110	Very dark grayish brown	Silty loam	
	III	110-160	Dark yellowish brown to very dark gray	Clay	
	IV	160-210	Black	Peat	
	V	210-360	Very dark brown	Sandy silt	
wetland deposits					
3	I	0-10	Grayish brown	Silty clay loam fill	Pearl Harbor clay
	II	10-12	Whitish yellow	Coral fill	
	III*	**12-31**	**Very dark grayish brown**	**Silty clay loam**	
	IV*	**31-42**	**Brown**	**Silty clay loam**	
	V	42-62	Yellowish brown	Silty clay	
	VI	62-100	Dark yellowish brown	Silty clay	
*** = Cultural layer**					
4	I	0-15	n/d	Loamy sand	Pearl Harbor clay
overlies coral bedrock					

Figure 56. Test Area F, Soil Types and Previous Testing Results

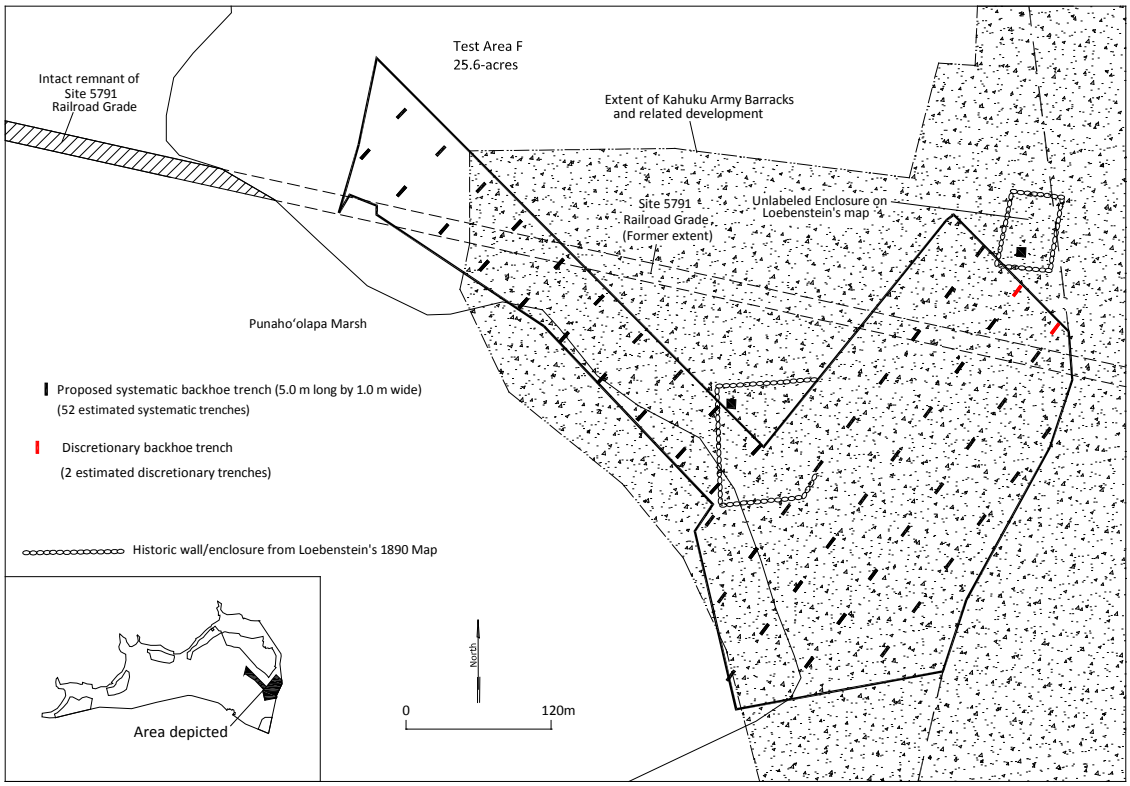
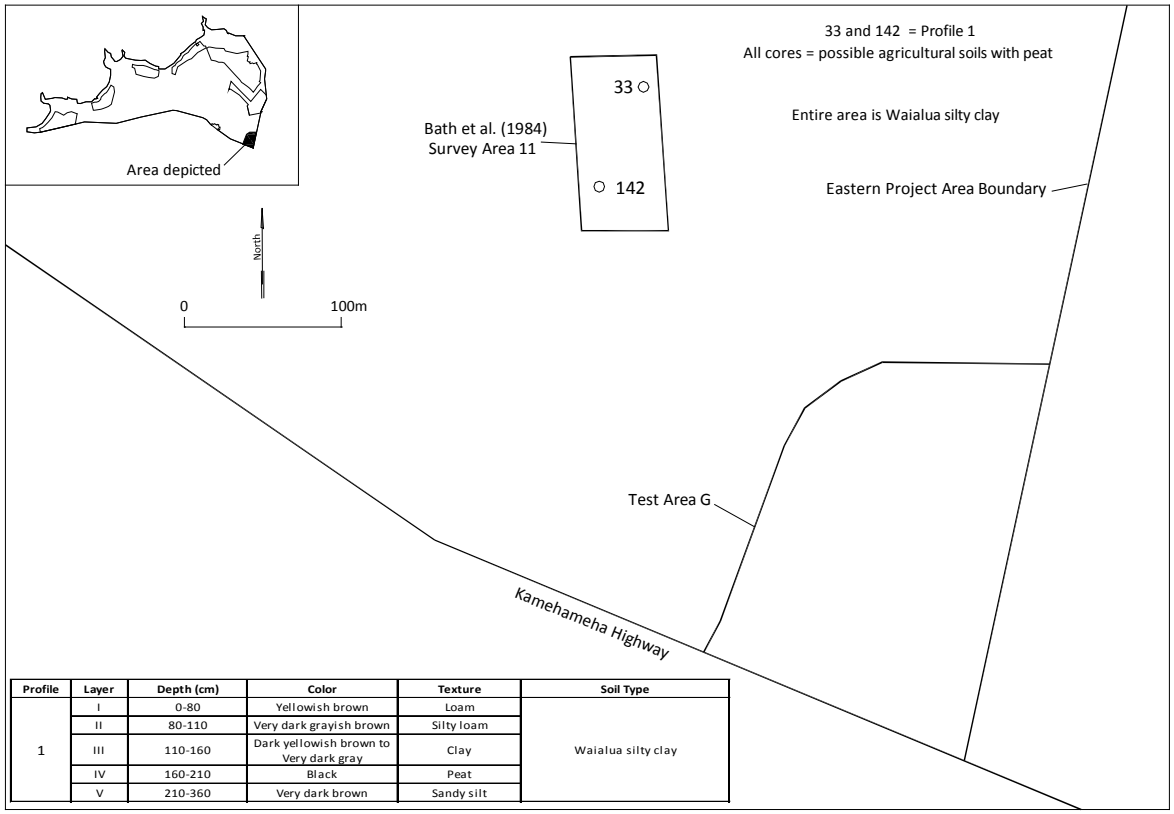


Figure 57. Test Area F, Proposed Trench Locations and Historic Land Use



Profile	Layer	Depth (cm)	Color	Texture	Soil Type
1	I	0-80	Yellowish brown	Loam	Waialua silty clay
	II	80-110	Very dark grayish brown	Silty loam	
	III	110-160	Dark yellowish brown to Very dark gray	Clay	
	IV	160-210	Black	Peat	
	V	210-360	Very dark brown	Sandy silt	

Figure 58. Test Area G, Soil Types and Previous Testing Results

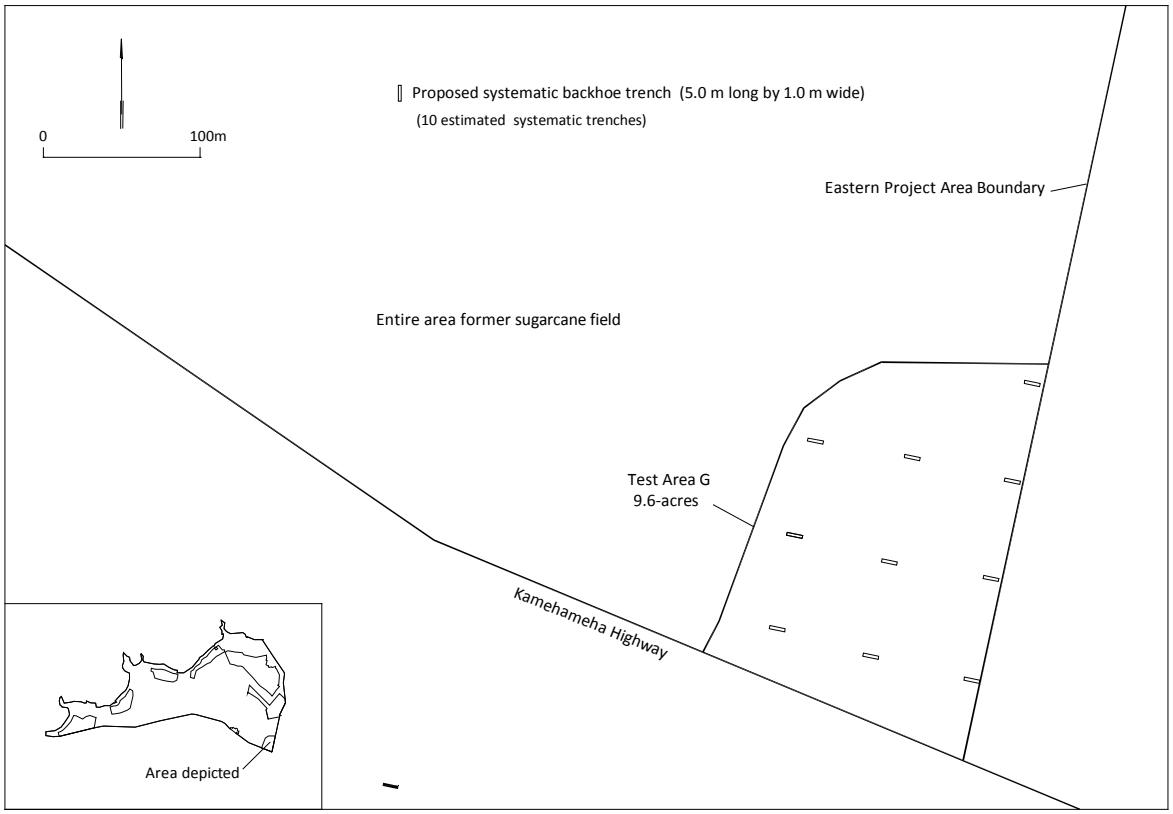


Figure 59. Test Area G, Proposed Trench Locations and Historic Land Use

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APPENDIX A – PUBLIC NOTICES

Public Notice | Public Notice | Public Notice | Legal Notices | Legal Notices | Legal Notices

Public Notice

NOTICE IS HEREBY GIVEN that Turtle Bay Resort LLC (TBR) is preparing a Supplemental Environmental Impact Statement for its revised Master Plan which covers approximately 840 acres within the Ahupua'a of Kahuku, Punalau, Ulupehupehu, 'O'io, Hanaka'oe, Kawela, and 'Opana within the Ko'olauloa District, Island of O'ahu (Project Area TMKs: [1] 5-6-003:041, 044; 5-7-001; 013, 016, 020, 022, 031, 033; 5-7-006:001, 002).

A total of 19 burials representing a minimum of 24 individuals were discovered from 1984 to 1996 within the project site; three burials were left in situ and the remaining burials were disinterred and reinterred within the burial preservation site within the former location of Land Commission Award 2744:1. In 1992, a Burial Treatment Plan was prepared (Maly 1992) for these burials.

The current project area consists of approximately 840 acres and includes the makai portions of seven ahupua'a: Kahuku, Punalau, Ulupehupehu, 'O'io, Hanaka'oe, Kawela and 'Opana. The subject property extends east from roughly the midpoint of Kawela Bay to Marconi Road. The existing resort consists of the 443-unit Turtle Bay Hotel, which opened in 1972, as the Ku'ilima Hotel, augmented by the 57-unit Ocean Villas Condominiums, two 18-hole golf courses, and the 368 multi-family unit Ku'ilima estates.

Hawaiian legends tell the story that the land of Kahuku from the shore to the middle of Waiale'e was once a floating island blown around by the trade winds. During ancient times, the area was known for many cultural resources, but in particular, it was known for its rich fishing resources including ulua and moi as there are fishing koa (altars), names reflect types of shores and reefs, including modern day use of salt collection. Over 80 land commission awards were awarded from 1846-1855 covering the seven Ahupua'a and most of these awards were for cultivation and habitation. The following is a list of LCA awarded for the project area; 2679:2 to Umeume; 2690:2 to Luiki; 2698:1-3 to Waanui; 2706:2 to Koloaia; 2716:2 to Hoolae; 2724:3 to Paku; 2734:3 to Paukoa; 2738:3 to Palu; 2744:1 to Pakanaka; 2770:2 to Makaino; 2774 awardee unknown; 2775:2 to Malailua; 2779 to Makilo; 2781:1 to Manukaokeo; 2784:2 to Moo; 2835:3 to Kaheleloa; 2837:2 to Kamakai; 2861:1 to Kaohele; 2868 to Kapaiaala; 2878:2 to Kekua; 2880:2 to Luiki; 2897:2 to Kookoo; 2913:2 to Kekua; 2928:2 to Kauihawale; 2936:2 to Kauaihikai; 2938 awardee unknown; 3815:1 to Pailalau; 3958:2 to Nauluhao; 4341 to Kaukaha.

From 1850 to 1880, the project area was used for large-scale cattle ranching operations known as Kahuku Ranch. In 1876, James Campbell purchased Kahuku Ranch. Campbell leased much of the land for sugar and railroad operations. During World War II in 1942, the United States took control of much of the land for the Kahuku Army Airfield and other military uses. Finally in 1972, Ku'ilima Hotel was built and the current use remains resort.

All persons having information about family or individuals that may be found in unmarked burial sites or would like to share information about any traditional and customary practices that they may be exercising on the project sites should respond within thirty (30) days of this notice to Dawn N.S. Chang, Ku'iwalu, Pauahi Tower 1003 Bishop Street, Suite 750 Honolulu, Hawai'i 96813 (808-539-3580).
(SA303890 5/11, 5/18/11)

CULTURAL IMPACT ASSESSMENT NOTICE

Kōloa Ahupua'a

Information requested by SCS of cultural resources or ongoing cultural activities on or near this parcel near the Omao Bridge, Kōloa Ahupua'a, Kōloa District, Kaua'i Island, Hawai'i [TMK: (4) 2-7-002:001; 2-7-007:001; and 2-5-001:008].

Please respond within 30 days to SCS at (808) 597-1182.

PUBLIC NOTICE

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H

APPENDIX H: (revised)

SOCIO-ECONOMIC IMPACT ANALYSIS

Socio-Economic Impact Assessment

Turtle Bay Resort Development

City and County of Honolulu, Hawai‘i

***Revised** Final Report: ~~August 16, 2012~~ March 2013*

Prepared by

Belt Collins Hawaii LLC

Prepared for

Lee Sichter LLC

Turtle Bay Resort LLC

EXECUTIVE SUMMARY

Proposed Action and Alternatives

This socio-economic impact assessment deals with the resort expansion proposed for Turtle Bay Resort by Turtle Bay Resort LLC. The expansion would add up to 625 hotel units, 590 resort residential and 160 community affordable housing units over time. The expansion is much smaller than the development proposed in the 1980s and currently permitted under 1986 approvals. That larger development is considered in this report as the Full Build-Out Alternative. Other alternatives studied include a Resort Residential Alternative (without any hotel units), a Conservation Partner Alternative (with development restricted to the center of the resort lands, and the feasibility of the alternative supported by funding from a hypothetical outside partner), and a No Action Alternative.

The development alternatives would be built as warranted by market demand. TBR estimates that the Proposed Action could be built and absorbed by 2025. The Full Build-Out Alternative would take much longer, with absorption estimated through 2053. The Resort Residential Alternative is estimated to be absorbed by 2025, and the Conservation Partner Alternative by 2022.

Approach

The report deals with impacts on-site at the resort, in the surrounding region, defined as the combined Ko‘olau Loa and North Shore Sustainable Communities Plan areas, and, for fiscal impacts, in the City and County of Honolulu and in the State of Hawai‘i. Impacts are estimated on the basis of Census data, current and anticipated trends in the region, data from the resort and other, comparable resorts in Hawai‘i, and economic models developed and refined by the State’s Department of Business, Economic Development and Tourism. Regional trends and impacts are estimated using forecasts by the City and County Department of Planning and Permitting and assumptions based on current conditions at the resort and in the region.

Existing Conditions

The Turtle Bay Resort currently stands as the only master planned resort community and one of the major economic drivers on the northern side of O‘ahu. The surrounding Ko‘olau Loa/North Shore (KNS) region has a population of more than 34,000 residents. Its economic base is no longer agriculture, but now anchored by visitor-oriented industries The seven mile coastline to the west of the resort is recognized as the premier destination for surfing and surf competition in the world. Its surf breaks, beaches, marine life, and Hale‘iwa town are major visitor attractions. Hale‘iwa town has prospered significantly with increased visitor traffic resulting in new commercial development. On the east side of the resort, small towns dot the coastline. Lā‘ie the largest and most developed community stands out as distinctive with the Hawai‘i Temple of the

Church of Jesus Christ of Latter-day Saints, a church-based university, and the Polynesian Cultural Center (PCC), a visitor attraction that supports the Brigham Young University – Hawaii (BYUH) university campus. The entire region is characterized as "country" but is a series of rural residential communities with visitor industry businesses and pockets of agricultural production.

As is typical in a coastal area offering opportunities for surfing, sightseeing and water sports, the local housing supply includes many homes held for vacation use, as second homes or as rentals. Affordable primary homes are limited in number. Each winter, visiting surfers and the surf industry also create demand for housing in the region, competing with island residents for rental housing.

Regional unemployment rates are somewhat higher than the island average. With many residents commuting outside their home districts, average commute times are longer than the island average indicating a need for more jobs in the area. (In Lāʻie, however, the average commute was short, only 17.9 minutes in 2010 due to employment opportunities from the Polynesian Cultural Center and BYUH.) The region's share of persons living below the federal poverty level was slightly above the island level, according to data from 2006 through 2010.

Traffic congestion along Kamehameha Highway has been of concern to residents for many years. The road is narrow and has been occasionally closed due to rock falls or high surf. During the winter season there is a sharp increase in surf activity – along with visits by Honolulu residents and tourists – and resulting congestion.

Many residents' reactions to further development at Turtle Bay are generally based on both their perceptions of how it may affect their lifestyle and of challenges already facing the region: traffic, job and population growth, adequate human and health services. For some, new development is valuable as a source of jobs, both at the resort and throughout the region. Others are wary of an increase in the number of tourists or new residents in the region. All are concerned about how to manage traffic congestion effectively.

The data reviewed for the current socio-economic impact analysis indicates that local job sources fail to meet the current employment needs of many KNS residents, forcing many either to commute long distances or to leave the region to find work. Major themes of the regional socio-economic analysis provided in the 1985 Kuilima EIS (lack of employment opportunities and distance from existing employment centers) prepared 27 years ago remain valid today.

Trends Affecting the KNS Region

The island's population is expected to increase slowly in the coming decades. The O`ahu General Plan directs most new housing development to Honolulu and Leeward Oʻahu. Little change in population is expected for the region surrounding Turtle Bay. New development could occur at Lāʻie, where a proposal for an enlarged Lāʻie Inn has gained City Council approval, and plans have been put forward for expansion of Brigham Young University – Hawaii. Concept plans include renovation and expansion of BYUH, the PCC, and new residential areas to support these expansions.

Other development under way includes a few small commercial redevelopment projects in Haleʻiwa, a major wind farm in Kawailoa, agricultural and small residential subdivisions. Further proposed commercial developments appear to be stalled.

Socio-Economic Effects of the Proposed Action

This Executive Summary lays out the specific effects or impacts associated with the **Proposed Action**. Similar analyses of the alternatives are in Chapter 5 of this report.

Population

When the new development is built and occupied – by about 2025 – the Proposed Action would substantially increase the on-site population, bringing not only visitors but new resort residents and community residents to Turtle Bay Resort. (The built area and park resources would expand, so the population increase does not point to an increase in density.) The population on-site during the daytime would include visitors and residents staying at Turtle Bay, resort employees, and day visitors:

Table ES-1: Population at Turtle Bay Resort, with Proposed Action

	Existing Resort	Proposed Action, 2025	Combined
Staying at the Resort			
Visitors and Part time Residents	1,044	2,206	3,251
Full-time Resort Residents	223	55	278
Community Residents	-	638	638
Total	1,267	2,900	4,167
On-Site Daytime Population			
Visitors and Part time Residents	783	1,655	2,438
Full-time Residents	167	520	688
Operations Workers	439	561	1,000
Day Visitors	96	180	276
Daytime Total	1,485	2,916	4,401

NOTE: From Tables 4-5, 4-6. All tables in this summary bring together estimates and calculations from the body of this report. Methodology and references are shown in Chapters 4 and 5 and Appendix B. The numbers in the table are rounded, so totals may differ slightly from the sum of the numbers shown.

As of 2025, the daytime population of the existing Turtle Bay Resort (including visitors, residents, and workers on-site) would amount to 34% of the total resort population with the Proposed Action. (As of 2025, the existing resort population would amount to, 35% with the Full

Build-Out Alternative, 67% with the Resort Residential Alternative, and 46% with the Conservation Partner Alternative. When the Full Build-Out Alternative is completely absorbed (as of approximately 2053), the existing resort would account for only 14% of the total resort daytime population.

Nearly all of the resort's workers and community residents could come from the KNS region. For the purposes of impact assessment, a share of the workforce and on-site community resident population was assumed to come from other locations on O'ahu. The new population associated with the Proposed Action would account for about 3 percent of the regional resident population, or 37 percent of the projected growth in regional population by 2025.

Employment and Wages

The Proposed Action will bring both construction jobs and continuing operations jobs, and will significantly increase payrolls in the KNS region. Construction will involve an estimated 3,263 direct jobs over 11 years. Construction wage impacts will total about $475 million. Construction workers on-site at the resort during that period will number annually about 237 on average. The number of new continuing operations positions at the resort will climb to about 753, an increase of 72 percent. In addition, visitor spending will support jobs outside the resort as well as on-site, so the attraction of additional visitors, part-time and full time residents to Turtle Bay will support an estimated 443 additional jobs in Hawai'i by 2025. Of these, some 177 are estimated to be located in the KNS region.

In sum, visitor spending will support at least 930 new continuing jobs in the KNS region when the project is fully occupied The new jobs figure is approximately six percent of the current regional civilian labor force. Regional residents can be expected to absorb nearly all of these jobs. (Potential hires include resident workers who are now un- or underemployed and new graduates of local high schools or college programs.)

Wages from both construction and continuing jobs will support island households. After construction is completed, the regional increase in wages is expected to be at least $31 million (2011 dollars, based on $23.8 million in operations wages and $7.4 million in the KNS region for off-site tourism-related work).

Table ES-2: Employment and Wages Associated with the Proposed Action

	Cumulative, through 2025	Annual Average
Construction		
Direct Jobs	3,263	297
On-Site Direct Jobs	2,611	237
Indirect and Induced Jobs	5,482	498
Total	8,746	795
Direct Wages	$225.3	$20.5
Indirect and Induced Wages	$247.7	$22.5
Total	$473.0	$43.0
		Annual, 2025 on
Continuing Operations		
Direct Jobs at Resort		753
Indirect and Induced Jobs		785
Jobs from Off-Site Visitor Spending (Direct and Indirect)		443
Total		1,981
Continuing Jobs in KNS Region		930
Wages from Direct Jobs		$23.8
Wages, Indirect and Induced Jobs		$35.5
Wages, Off-Site Visitor Spending		$18.4
Total		$77.6
Wages, Jobs in KNS Region		$31.1

NOTES: From Tables 4-2, 4-3, 4-4, 4-14. All dollar figures are millions of 2011 $s. The numbers shown are rounded, so totals may differ slightly from the sum of the individual numbers in the table. Regional wages are for direct jobs at the resort plus a regional share of jobs from off-site visitor spending.

Housing

Regional effects would include new housing at the resort and, over time, income to support new households elsewhere in the region. By 2025, operations-related jobs (both on-site and off-site) are expected to support some 556 households in the region. While many employees will remain in the same household or succeed their parents as household heads, others will form new households. The result is estimated as formation of some 83 to 167 additional households in the

KNS region over time. The Proposed Action includes some 160 community housing units (271% of the 59 units required), so the net effect would be a significant increase in workforce housing for the regional community in the short term, and probably a reduction in housing demand over the long term.

Public Services

Population growth would bring demand for public services. Based on current service levels, that new demand from the Proposed Action would justify small increases in local public services. Table ES-3 shows the potential demand, calculated on the basis of current demand and staffing on island:

Table ES-3: New Demand for Public Services in the KNS Region with the Proposed Action

		Proposed Action, 2025
Public Schools		
2011 KNS region enrollment	4,826	
New Project-Related Enrollment, 2025		
Low Estimate		49
High Estimate		123
As share of 2011 Enrollment		
Low Estimate		**1%**
High Estimate		**3%**
Other Public Services		
Police: current number of officers/1,000 persons	1.56	
Fire: current number of officers/1,000 persons	1.07	
Emergency Medical Service: per 1,000	0.30	
Hospital Beds per 1,000 persons	2.70	
New regional demand associated with Project (New residents and visitors)		3,157
Police		4.9
Fire		3.4
Emergency Medical Services		0.9
Hospital Beds		8.5

NOTES: From Tables 4-7 and 4-15 and estimates provided in Sections 4.4.2 and 4.4.5.

Recreation

The Proposed Action includes the creation of five (5) parks all of which are open to the public. Four (4) are required by the City & County and the Master Developer is voluntarily adding an additional park; two (2) will be public parks dedicated to the City and County of Honolulu and three (3) are private parks open to the public. Four (4) of the parks are along the shoreline and are linked by a continuous shoreline easement. Up to 12 public shoreline access points, along with new parking areas, would significantly increase access to the ocean and beachfront along the resort's coastline.

A new golf clubhouse and a new equestrian center are planned to replace existing recreation facilities at the resort. The Proposed Action calls for refurbishing the Fazio Course at Turtle Bay as a nine-hole course. With the number of visitors staying at the resort expected to increase while the number of golf holes is reduced from 36 to 27, golf tee times would likely become less available to visitors and residents on O'ahu.

Fiscal Impacts

New development brings capital to Hawai'i for construction. Resort facilities attract visitors and new resort residents, whose spending continues for the lifetime of the resort. These cash flows are taxed both immediately (e.g., General Excise Tax on construction and on goods sold to visitors, Transient Accommodations Tax, Real Property Tax on new development) and over time (e.g., Income taxes paid by workers in direct, indirect and induced jobs supported by visitor spending).

The City and County and the State both spend considerable amounts on services that benefit residents and visitors. Government costs for services to new visitors and new resort residents at Turtle Bay Resort can be estimated based on the size of these populations. (Community housing residents will already be island residents. This component of the Proposed Action would not generate new costs for local government.)

Currently, the City and County of Honolulu collects about $12.4 million in real property taxes annually from residential and resort properties in the KNS region. As of 2025, real property taxes on residential and resort units within the Proposed Action would amount to an addition of about $8.3 million annually, a major increase (67%) in funds available to support municipal services.

The Proposed Action will result in a cumulative net benefit – i.e., total benefits minus total costs – for the period 2014 to 2025 estimated as $163.4 million for the State of Hawai'i and as $45.6 million for the City and County of Honolulu (in 2011 dollars). After full occupancy has been reached, the annual net benefit for the State will amount to $14.6 million, while the annual net benefit for the City and County will be about $6.6 million.

Table ES-4: Revenues and Costs Associated with the Proposed Action

	Cumulative, through 2025 *Million $ (2011)*
State Revenues	
Excise Tax	$84.1
Income Tax	$55.5
Transient Accommodations Tax	$32.9
Transient Occupancy Tax	$16.3
Conveyance Tax	$5.1
	$193.9
Costs for State	
For Visitors	$27.6
For New Residents	$2.8
	$30.5
Net Benefit (Revenues > Costs)	$163.4
Ratio of Benefits to Costs	6.4
City and County Revenues	
Excise Tax	$9.3
Real Property Tax	$50.3
	$59.7
Costs for City and County	
For Visitors	$13.5
For New Residents	$0.6
	$14.1
Net Benefit (Revenues > Costs)	$45.6
Ratio of Benefits to Costs	4.2

NOTES: All dollar values are in constant 2011 dollars.. See Tables 4-8 through 4-13 for details. The numbers shown are rounded, so totals may differ slightly from the sum of the individual numbers in the table.

Impacts on Community Life in the KNS Region

The Ko‘olau Loa-North Shore region is famed for “country” atmosphere along with its beaches and surf spots. The Turtle Bay Resort currently fits into that atmosphere in many ways. Its beaches and waters are enjoyed by residents as well as visitors. It provides amenities enjoyed by

regional residents. It provides jobs on-site. With wages and benefits protected by union contracts, the resort sets the bar for local employment practices. Its guests contribute to visitor spending for goods and services throughout the region.

The Proposed Action would have several results that would generally be considered beneficial for local communities, above all:

- Job-creation.
- New housing designed for community residents.
- Development of new amenities which could be used by residents and tend to increase visitors’ time at the resort (vs. on the North Shore roadways), notably:
  - New beach parks with parking and shoreline access, greatly improving access to both open coastline and an enclosed bay;
  - A Gathering Place combining performance space, stores and other uses; and
  - An on-site Farmers’ Market.
- Attraction of upscale visitors who value the North Shore as a place to stay, not just to visit for a few hours.
- Attraction of resort residents and homeowners, a few of whom would likely contribute their support to community causes. (Elsewhere in Hawai‘i, such contributions can range for funds for local hospitals to fervent support of environmental groups.)

All of these can contribute to a more prosperous regional community. With shorter commutes, many residents have more time to spend with family and neighbors, and to participate in community life.

Drawbacks of new development may include increased traffic and more visitors in regional communities. The traffic impact assessment for the SEIS estimates both existing traffic congestion and the impact of new resort development. It identifies traffic management strategies to reduce the project’s contribution to this regional problem.

Mitigation of Adverse Impacts

Mitigation measures are part of the Proposed Action and all the development alternatives. The Master Developer and City have entered into an Unilateral Agreement (UA) associated with the resort expansion which requires park development, workforce housing development, employment training to insure that jobs go to regional residents, child care, and traffic management measures. The Master Developer has always agreed to implement the UA conditions. As stated previously, the Master Developer has voluntarily agreed to exceed the UA requirements by adding parks, more access points to the shoreline and additional community housing in the Proposed Action. (The Proposed Action includes 160 community housing units, 101 more than the 10% share of resort residential units mandated by the UA.) Specific programs

for employee training and child care will need to be designed to meet the needs of the workforce in the next years.

The developer is working with the State Department of Transportation and their traffic engineer team to identify traffic impacts and find traffic management strategies to minimize them.

Addressing those impacts calls not just for technical solutions, but for a process of community dialogue. Effective mitigation measures involve consultation and shared assessment of what works.

The vision of the future presented to the community by TBR in the SEIS combines a holistic view of the land and people, an emphasis on stewardship, and a commitment to consultation with elders, neighbors, and other stakeholders. It identifies relationships and discussions that seem well suited to mitigation as an ongoing process of sustaining the land and people of the area. TBR has already discussed plans with a wide range of community members, and is continuing both consultation with elders and involvement others in the community. In sum, TBR has identified, and taken steps to put in place, a promising framework for effective mitigation and responsible development.

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ABBREVIATIONS AND ACRONYMS

ACS	American Community Survey (annual survey of a sample of the population). The ACS may be reported in annual, three-year, and five-year increments, with smaller areas reported for the longer periods. ACS data in this report comes from the 2006-2010 surveys. The ACS includes the "long-form" data sets that had been gathered from a sample of the population in the decennial census before 2010.
BCH	Belt Collins Hawaii
BYUH	Brigham Young University – Hawaii
CDP	Census Designated Place
CT	Census Tract
DI	Direct and indirect (in Input-Output Analysis)
DII	Direct, indirect and induced (in Input-Output Analysis)
DBEDT	Hawai'i State Department of Business, Economic Development and Tourism
DPP	City and County of Honolulu Department of Planning and Permitting
EIS	Environmental impact statement
FT	Full-time (used for full-time resort residents, treated as Hawai'i residents)
KNS	Ko'olau Loa/North Shore combined area
KNSSPC	Kuilima/North Shore Strategy Planning Committee
Kuilima EIS	Group 70. *Revised Environmental Impact Statement, Kuilima Resort Expansion.* Honolulu, HI 1985.
PCC	Polynesian Cultural Center
PT	Part-time (used for part-time residents and second homeowners, treated as visitors to Hawai'i in economic analyses)
SCP	Sustainable Communities Plan. The City and County of Honolulu recognizes seven regional planning areas: two Development Plan areas and five SCP areas.
SIA	Socio-economic impact assessment
SEIS	Supplemental environmental impact statement
SEIS lands	Land area covered by the SEIS for Turtle Bay Resort; smaller than the TBR landholdings, but also including portions of right-of-way along Marconi Road.. Area shown in SEIS and SEISPN.
SEISPN	Supplemental Environmental Impact Statement Preparation Notice. For Turtle Bay, the SEISPN was prepared by Lee Sichter LLC and published via *the Environmental Notice* on August 23, 2011.
TBR	Turtle Bay Resort LLC
UA	Unilateral Agreement (by developer, in connection with zoning decisions by the City and County of Honolulu). The Kuilima UA (No. 86-99) was recorded in September 1986.

1 Introduction

1.1 Purpose of the Analysis

The Turtle Bay Resort, located at the northern point of the island of O'ahu, consists of (a) developed lands, including the Turtle Bay Hotel (with 500 units, including hotel rooms, cottages, and the Ocean Villas condominiums), two townhouse developments (Kuilima Estates East and Kuilima Estates West, totaling 368 units), and two 18-hole golf courses (Fazio and Palmer), along with (b) additional areas for which development has been proposed and land use permits and approvals were granted~~, and (c)~~. [1] A separate entity owns additional agricultural land on the *mauka* (inland) side of Kamehameha Highway.

The major land use permits for proposed development were issued in the mid-1980s. The proposed development included additional hotel properties, resort residential housing, parks, and public shoreline access ways. In the intervening years, only modest development and redevelopment has occurred. In 2006, the resort's owner received preliminary City and County of Honolulu approval to subdivide approximately 700 acres to implement the previously approved Master Plan. This was a necessary step towards further development of the land. The subdivision approval was then challenged in court, on the grounds that the 1985 Environmental Impact Statement (the "Kuilima EIS") was no longer an adequate basis for government decision-making. The Hawai'i Supreme Court ruled in 2010 that a Supplemental Environmental Impact Statement (SEIS) had to be prepared and accepted before subdivision could occur.

Turtle Bay Resort LLC (TBR) is preparing an SEIS for their newly Proposed Action, the project. This report, a socio-economic impact assessment, has been prepared as part of the SEIS and will be presented as an appendix to that document.

Typically, a socio-economic impact assessment (SIA) deals with proposed development of lands from less intensive use to new, more intensive uses. A typical SIA report deals with impacts of new development, and of conversion of non-urban lands to urban uses. The current situation is different, in at least four respects:

- The site is not a physical or legal green field: the majority of the site is disturbed with parts of the resort developed from 1970 to 2005. The larger area covered by a 1986 agreement and zone change ordinance has been recognized as a future resort destination for decades.

[1] The resort was known as the Kuilima Resort in the 1970s and 1980s. In this assessment, the "Kuilima EIS" refers to the *Kuilima Resort Revised Final Environmental Impact Statement* published in 1985 and accepted by the City and County of Honolulu Department of Land Utilization. Any reference to the "Kuilima" development similarly deals with the plans accepted in the 1980s.

Words and names of Hawai'ian origin are spelt here with diacriticals to mark long vowels and glottal stops, except when referring to a source or agency that omits these.

- The 1985 Kuilima EIS provides assessments of potential impacts of development that may or may not be relevant to the current Proposed Action and Alternatives or to the current and emerging context;

- A 1986 Unilateral Agreement (UA) identified specific actions to mitigate adverse impacts of the Kuilima development. The developer agreed to implement those mitigations as part of the new development proposed at that time.[2]

  The UA runs with the land, meaning that it must be implemented as agreed when development takes place, unless formally amended by the Honolulu City Council. The UA mitigations will be assessed in the course of this report in relation to various development scenarios.

- The SEIS considers a Proposed Action, ~~and~~ three development alternatives (summarized in Section 2.1), and a No Action alternative, not just a Proposed Action and a No Action Alternative.

Figure 1-1 shows the resort's location on O'ahu. Figure 1-2 shows the zoning of the Turtle Bay lands and the location of the Turtle Bay Hotel and Kuilima Estates townhouse development. The Turtle Bay SEIS deals with areas *makai* (seaward) of Kamehameha Highway, and not the agricultural lands *mauka* (inland) of the highway.

An Environmental Impact Statement (EIS) is a disclosure document, intended to help decision-makers and the general public consider the implications of new development. The Turtle Bay SEIS provides analysis of a Proposed Action and three development alternatives. This SIA will evaluate not only effects of the Proposed Action, but also ones associated with the other alternatives considered in the SEIS as well as the No Action alternative.

1.2 Objectives and Approach

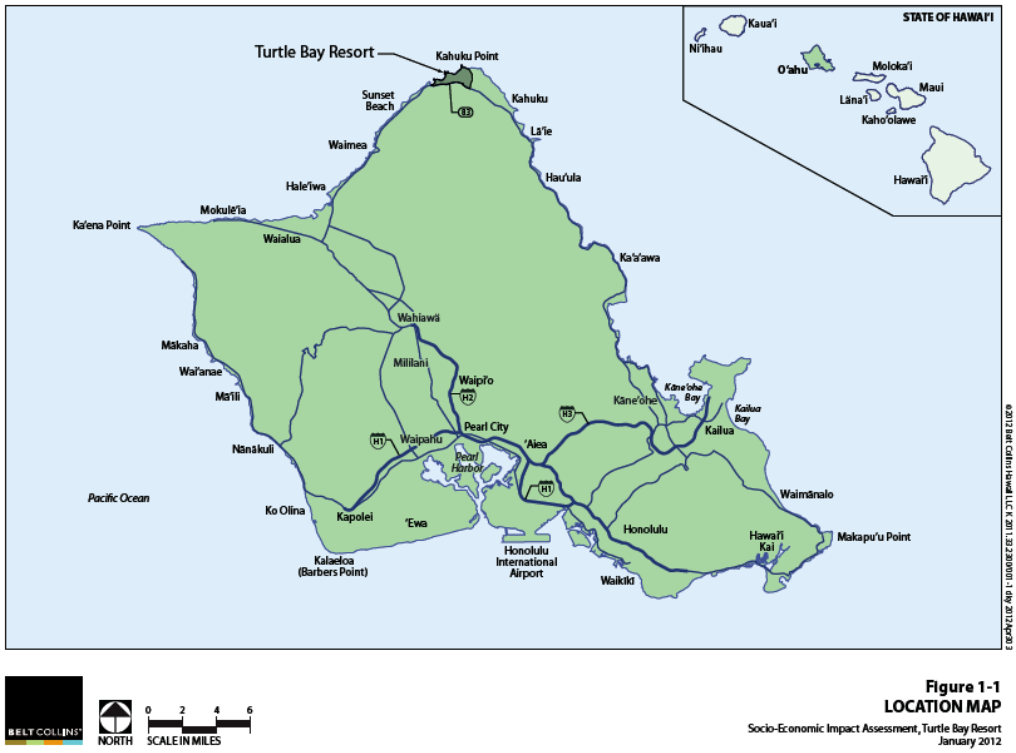
The Kuilima EIS included a lengthy SIA. This report updates that SIA by dealing with current proposals and conditions. Major issues and concerns discussed in the Kuilima SIA will be reviewed here, to assess their relevance to the new proposed action and alternatives.

Sources for the report include public records, information from interviews with Turtle Bay stakeholders and members of the surrounding community, and accounts of alternatives provided by TBR. The report also draws on other studies conducted for the SEIS, notably an updated market study and an updated traffic impact assessment.

[2] "The developer" is here understood to be Kuilima Development Company, which built the Turtle Bay Hotel and the Kuilima Estates townhouses, along with its successors, including Kuilima Resort Company, which obtained further development permits in the 1980s, eventually culminating in Turtle Bay Resort LLC. While these are different entities, the differences among them are not at issue herein.

The approach taken here is intended to provide the SEIS authors with information sufficient to identify and disclose the anticipated socio-economic impacts of the Proposed Action. However, the term "impact" should be understood in relation to the project's history.

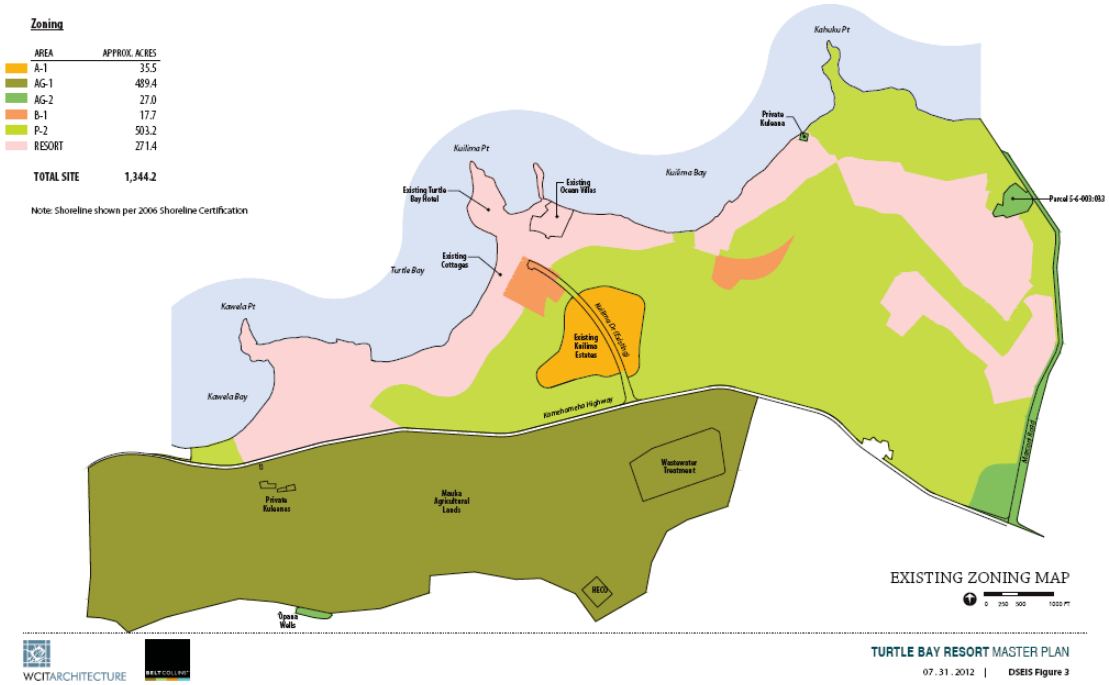
Figure 1-1: Location Map



NORTH SCALE IN MILES 0 2 4 6

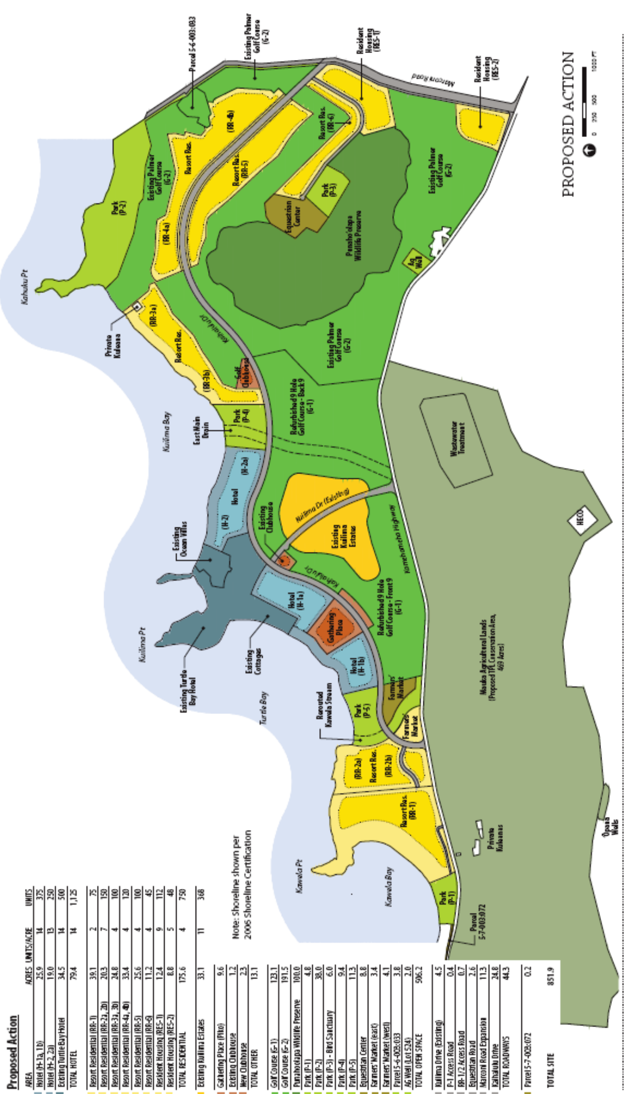
Figure 1-1
LOCATION MAP
Socio-Economic Impact Assessment, Turtle Bay Resort
January 2012

Figure 1-2: Existing Zoning Map



SOURCE: Lee Sichter LLC. *Turtle Bay Resort Environmental Assessment & Supplemental Environmental Impact Statement Preparation Notice.* August 2011.

Figure 1-3: Proposed Action



SOURCE: Lee Sichter LLC. *Turtle Bay Resort Environmental Assessment & Supplemental Environmental Impact Statement Preparation Notice*. August 2011.
Figure updated August 2012.

Normally, an impact is understood as an effect of proposed development measured as the difference between the future with project and the likely future without the project. Information about ongoing trends in the surrounding community and consideration of the No Action Alternative normally are enough to sketch the relevant future without the project. In the present case, the future is not so simple. The Hawai'i Supreme Court ruled that a supplemental EIS is needed *before subdivision can be approved* by the City and County of Honolulu. The ruling calls for new information and analysis, but does not void existing permits. Once the SEIS is accepted, those permits could allow for development of what is termed here the Full Build-Out Alternative. Strictly speaking, then, the "impact" of the Proposed Action involves reducing the amount of development from that allowed under the Full Build-Out Alternative, rather than increasing development over the level found in the No Action Alternative.

The situation is further complicated by the Unilateral Agreement (UA) associated with the 1986 rezoning. The developer agreed to make roadway improvements, to assure beach access, to provide housing and parks, and to provide transportation management mitigations and a child care center in connection with planned development. These actions are part of the likely future under all development alternatives unless the Honolulu City Council amends the UA.

The accepting agency for the SEIS (in this case, the City's Department of Planning and Permitting) will determine whether the SEIS has fulfilled the process and content requirements specified by law. The developer and the City and County of Honolulu will ultimately review the proposed development in light of the UA, and seek to implement or adapt the UA to the new proposal and circumstances as seems appropriate to them.

TBR has planned the Proposed Action after careful consideration of the range of actions possible under existing permits. It has chosen the Proposed Action in light of the resources of the property along with concerns about the quality of visitors' experiences, community-resort relations, market conditions and financial return.

For the rest of this report, contrasts will be identified for the Proposed Action, three Development Alternatives, and the No Action Alternative. Effects of the Proposed Action will be discussed mainly in contrast to the Full Build-Out Alternative (i.e., development according to existing permits) and to the No Action Alternative. "Effects" point to contrasts between the Proposed Action, current conditions, and alternatives under study, while "impacts" suggests that the Proposed Action must be considered in relation to a single current or future baseline.

1.3 Organization

The report consists of:

- This introduction;
- A brief account of the Proposed Action and Alternatives;

- An account of existing and anticipated conditions in the area surrounding the proposed development;
- Assessment of potential social and economic effects of the Proposed Action for the resort, nearby properties, the surrounding Ko‘olau Loa/ North Shore region, and the economies of O‘ahu and the state of Hawai‘i;
- Similar assessment of effects for the other alternatives;
- Consideration of the application of the SIA analysis in the 1985 Kuilima EIS to the existing context of development and the Proposed Action and alternatives currently under study, with assessment of the relevance of socio-economic mitigations in that EIS to the Proposed Action and the new alternatives; and
- Discussion of potential mitigation measures suggested in the course of the study, taking into account the extent to which they may mitigate effects of the Proposed Action and each development alterative.

2 Action and Alternatives Considered

Turtle Bay Resort LLC (TBR) has identified a Proposed Action and alternatives for consideration. The Proposed Action involves less development and less dense development than the Full Build-Out alternative. (The Full Build-Out alternative corresponds to the Kuilima development presented in the 1985 Kuilima EIS and subsequently granted land use approvals.) The *Supplemental Environmental Impact Statement Preparation Notice* (published on August 8, 2011 to commence the SEIS process) identified a total of five concepts:

1. Proposed Action
2. Full Build-Out Alternative
3. Resort Residential Alternative
4. Kawela Conservation Alternative
5. No Action Alternative

The Kawela Conservation Alternative was intended to respond to some residents' interest in limiting the scale of development. As discussions have continued, it has become clear that some stakeholders wanted an alternative that restricts new development on both the Kawela and Kahuku sides of the property. Accordingly, the developer worked with these groups to define a new alternative and now the SEIS includes a Conservation Partner Alternative, instead of the Kawela Conservation Alternative. It is called the "Conservation Partner Alternative" because it would depend on involvement of a future, as yet unknown, financial partner who is prepared to provide economic consideration in return for preservation: Turtle Bay Resort could not implement it without outside support.

Table 2-1 provides a summary of resort development and the park spaces in the various alternatives. Figures 2-1 through 2-5 are reduced versions of the alternative concept plans developed for TBR by its design consultants.

The summary in Table 2-1 and much of the discussion in this section treats alternatives as varying types and densities of development within the resort lands as a whole. Planning for the proposed action has included consideration of the resources, opportunities and constraints of subareas within the SEIS lands, and a vision of the TBR properties in terms of *ahupua‘a*. Three areas within the SEIS lands are viewed as parts of separate *ahupua‘a*, as shown in the map in Figure 2-3.

Table 2-1: Development Summary

	Proposed Action	Full Build Out Alt.	Resort Residential Alt.	Conservation Partner Alt.	No Action Alt.	Kawela Conser-vation Alt.
Existing						
Hotel Units	500	500	500	500	500	500
Residential Units	368	368	368	368	368	368
Proposed						
Hotel Units	625	2,500	-	440	-	625
Resort Residential Units	590	910	454	252	-	565
Resident Housing Units	160	90	46	48	-	160
Park (acres)	69.5	50.8	50.8	59.7	-	73.3
Preserve (acres)	100.0	100.0	100.0	100.0	N/A	120.2
Golf Courses (Holes)	27	36	36	18	36	27

NOTE: The Kawela Conservation Alternative is listed here because it was considered during interviews for the report. It is not treated as an alternative in the SEIS; the Conservation Partner Alternative replaces it.
SOURCE: Adapted from SEIS Preparation Notice and information from TBR.

2.1 Proposed Action

The Proposed Action as shown in Figure 1-3 is based on a Revised Master Plan that includes two hotel parcels adjacent to the Turtle Bay Hotel,[3] resort residential development on the Kawela and Kahuku sides of the property, a Gathering Place including shops, restaurants, and an ocean sports club integrated with one of the hotel parcels, parks, and day care center for employees' children. Also, a farmers' market is proposed.

The UA calls for 10 percent of housing developed to be available for the local community, at rates affordable to families earning 80 percent or more of the area median income. The Proposed Action would trigger an obligation of 59 affordable housing units. However, the Proposed Action provides for 160 "community residential" units, including units built on-site and lots developed for self-help housing construction, along with 590 resort residential units. This is an appreciably larger share of new homes for community residents than in the UA requirement. While the "community residential" units would meet the income criteria in the UA, TBR hopes that their cost could be lower, in line with the needs of local residents.

A new golf clubhouse is proposed near the 18th green of the Palmer Course. The Fazio course would be reconfigured as a nine-hole course. Parks and the wildlife preserve would be developed as shown in Figure 1-3. Additional information about the developers' concepts, open space and infrastructure is provided in the SEIS.

[3] The two hotels could be operated as a time share and a condominium property. The specifics of their operations will depend on market conditions.

~~The Proposed Action is part of a comprehensive property, natural and cultural resources management plan created by the developer, entitled "Tomorrow's Ahupua'a," for all the TBR lands, including agricultural lands inland from the resort.~~ The Proposed Action was informed by an overarching philosophy of responsible and sustainable development embraced by the developer entitled "Tomorrow's Ahupua`a." Elements of that plan include environmental stewardship, farm-to-table programs, and "respectful" planning for Kawela Bay and Punaho'olapa Marsh. The plan includes continuing review of and input on operations and design by community stakeholders and experts. It aims to integrate the resort into the local community as "equally welcoming to locals from neighboring communities as to visitors from afar," as "sensitive to the environment and respectful to the host Hawaiian culture" and as a source of employment and business for local residents.[4] Tomorrow's Ahupua`a provides responsible guidelines for action to preserve and enhance environmental, social and cultural resources.

TBR forecasts absorption of a total of 1,375 new hotel and residential resort units, 61% less than current approvals, as of 2025. Accordingly, construction is expected to occur from 2014 through 2024. (For all development alternatives, construction is assumed to end the year before full absorption.)

2.2 The Full Build-Out Alternative

The Full Build-Out Alternative realizes the land use entitlements approved in the 1986 rezoning and Unilateral Agreement (five new hotel parcels totaling 2,500 new units, 1,000 new residential units, with both resort and local resident housing on-site, new Palmer golf clubhouse, a beach club and a commercial area). (The UA would allow the local resident housing to be off-site.)

TBR forecasts absorption of a total of 3,500 new hotel and residential resort units in the Full Build-Out Alternative as of 2053. Construction is expected to occur from 2014 through 2052.

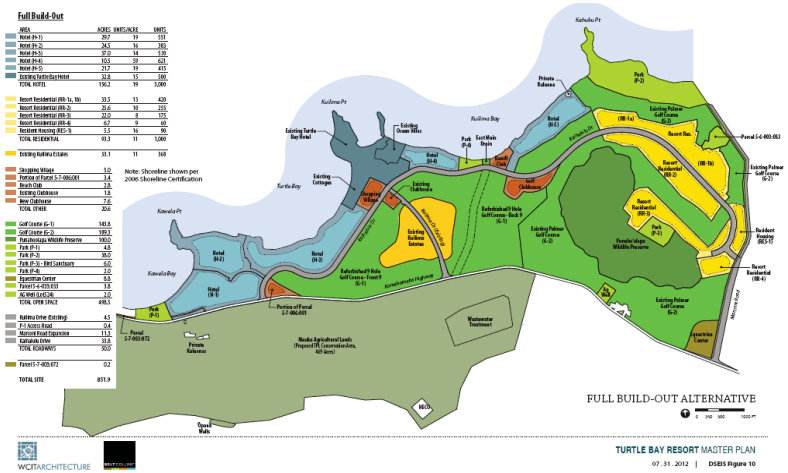
2.3 Resort Residential Alternative

The Resort Residential Alternative involves development of the resort with no additional hotels. The count of resort residential units is only 454; many would be large-lot homes. Some 46 community residential homes would also be developed, representing ten percent of the market housing.

TBR forecasts absorption of the new residential units in the Resort Residential Alternative as of 2025. Construction is expected to occur from 2014 through 2024.

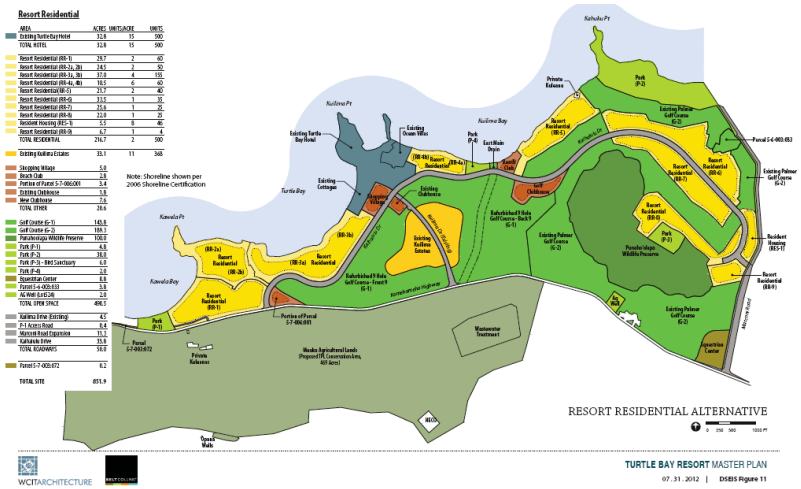
[4] Lee Sichter LLC. *Environmental Assessment & Supplemental Environmental Impact Statement Preparation Notice*. Prepared for Turtle Bay Resort LLC. Page 12. Posted at http://oeqc.doh.hawaii.gov/Shared%20Documents/EA_and_EIS_Online_Library/Oahu/2010s/2011-08-23-FEA-SEISPN-Turtle-Bay-Expansion.pdf.

Figure 2-1: Full Build-Out Alternative



SOURCE: TBR.

Figure 2-2: Resort Residential Alternative



SOURCE: TBR.

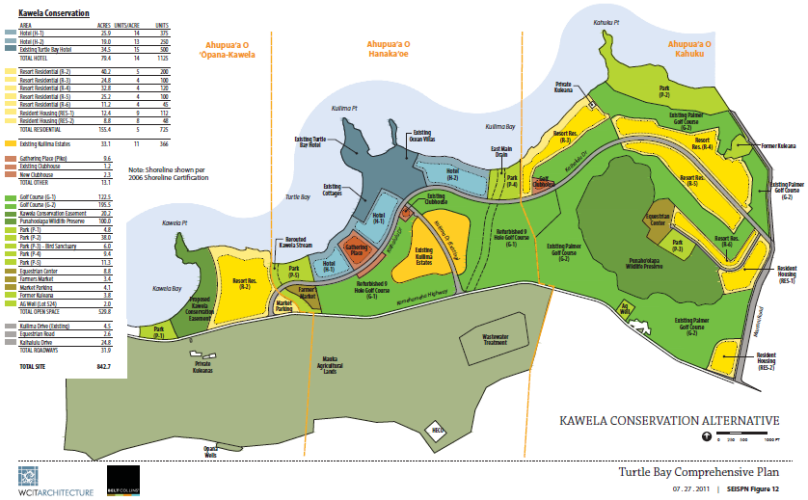
2.4 Conservation Alternatives: The Kawela Conservation Alternative and the Conservation Partner Alternative

The Kawela Alternative was conceived as a conservation alternative, since it kept new development away from Kawela Bay. The Conservation Partner Alternative goes farther than the Kawela Alternative, increasing the conservation area acreage near Kawela Bay and limiting new development on the Kahuku side of the property to open space, recreation and community residential homes.

The Conservation Partner Alternative includes large areas of open space at the east and west sides of the SEIS lands. No plan for the use and maintenance of that space has been advanced. Turtle Bay Resort LLC has indicated that this concept could be realized only with the active financial participation of a partner able to contribute significant funds to compensate the owner for extinguishing development rights, to achieve both conservation and the success of the scaled-down resort.

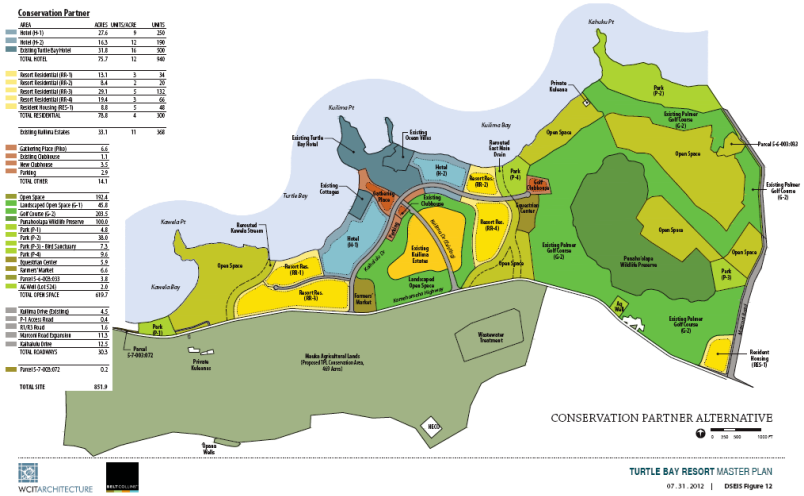
TBR forecasts absorption of 440 new hotel units and 300 new residential units in the Conservation Partner Alternative as of 2022. Construction is expected to occur from 2014 through 2021.

Figure 2-3: Kawela Conservation Alternative (Now Superceded)



SOURCE: Lee Sichter LLC. *Turtle Bay Resort Environmental Assessment & Supplemental Environmental Impact Statement Preparation Notice.* August 2011.

Figure 2-4: Conservation Partner Alternative

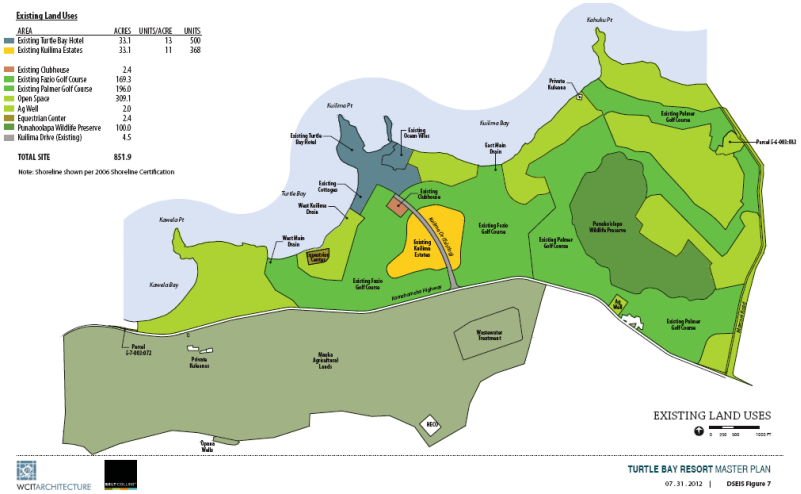


SOURCE: TBR.

2.5 No Action Alternative

The No Action Alternative would involve no further development of the lands in the SEIS. The No Action Alternative would result in the continuation of the resort in the form that exists today Golf and equestrian facilities would not be redeveloped. The parks and housing identified in the 1986 UA are not included, since these are tied to new development.

Figure 2-5: Existing Conditions / No Action Alternative



SOURCE: TBR.

3 Socio-Economic Context

3.1 Regions Potentially Affected

The Turtle Bay Resort is located outside the town of Kahuku and near the boundary between the Koʻolau Loa and Waialua (or North Shore) Districts. In this report, the combined districts – the Koʻolau Loa/North Shore (KNS) region – will be treated as the area most likely to be affected by change at the Resort. Attention is given to effects on the existing resort, on Kahuku, and other communities, and on particular groups within the region. In this introductory chapter, characteristics of the region and some of its geographic variation are highlighted.

The economic consequences of development would extend beyond the region to the remainder of the City and County of Honolulu and the State of Hawaiʻi. These are charged to provide public services to the region; they would collect taxes and fees from the development.

Figure 3-1 shows the region, major communities, and subareas recognized by the U.S. Census and local government. It shows also a source of possible confusion: State and City definitions of local regions diverge. The City and County of Honolulu recognizes Sustainable Communities Plan (SCP) Areas, with a boundary just west of the Resort; the State of Hawaiʻi recognizes judicial districts – and, following the state, the U.S. Census identifies census tracts – with Waimea Bay at the western limit of the Koʻolauloa District.[5]

In most of this section, the discussion deals with the KNS Region, and with particular Census Tracts or communities within it. The two SCP Areas can be contrasted, with Koʻolau Loa characterized as a network of small, rural communities, while the North Shore is deeply affected by its role as the surfing capital of the world. However, in many ways, residents of the region as a whole share a commitment to their area and to a rural lifestyle. Also, differences among adjacent communities within each Area also deserve notice, so a two-Area approach to the region misses important differences within each Area and similarities among some of the communities along the coastline.

[5] Appendix A, Table A-1 identifies the relationship between specific communities and the various federal, state and county boundaries. The City and County of Honolulu uses the spelling Koʻolau Loa, while the State uses Koʻolauloa. The former spelling is used here except when referring to the State's judicial district. The City's approach, which treats Sunset Beach and Pupukea as part of the North Shore, rather than of Koʻolau Loa, seems to fit most regional residents' views better than the State's boundaries.

Figure 3-1: Regional Map

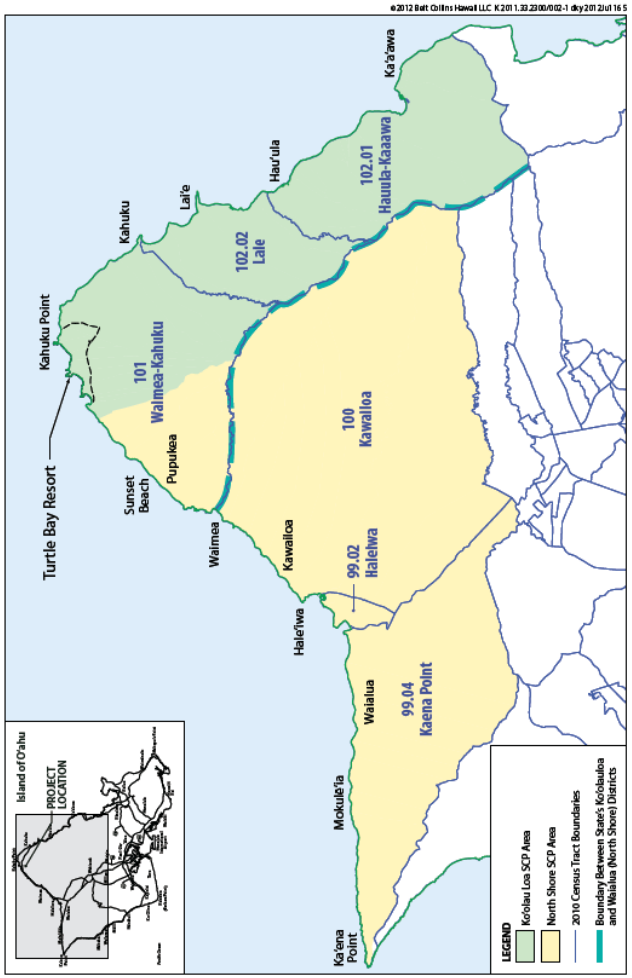


Figure 3-1
REGIONAL MAP
Socio-Economic Impact Assessment, Turtle Bay Resort
July 2012

NOTE: Census Tract boundaries follow the State division: Census Tract 101 includes Sunset Beach and Pupukea as well as Kahuku.

The recognized communities of the KNS region vary in ways rooted in their histories. Two – Kahuku and Waialua – once were the centers of sugar plantations. They retain remnants of mill infrastructure. They have public secondary schools. Their residents include retirees from the plantations, and the children and grandchildren of plantation workers. Lāʻie was acquired as a center for the Church of Jesus Christ of Latter-day Saints in 1865. It remains the center of Mormon worship and education in Hawaiʻi. Haleʻiwa and Sunset Beach have become famous as the home of North Shore surfing. They are mainly tourist and surf industry destinations, especially during the winter season, and are the base for major surfing contests.

Much of the SEIS site was once in sugar cultivation. Along Kawela Bay, cottages were placed above the beach area. During World War II, an airfield, revetments and barracks occupied most of the lands on the Kahuku side of the property. (See SEISPN Figure 13.)

The Turtle Bay Hotel opened in 1972. The two Kuilima Estates townhouse projects were built soon afterwards. The hotel provided a much-needed source of jobs, since the Kahuku Sugar plantation had just closed in 1971.

The Kuilima EIS process, in the mid-1980s, sought permits for development of a "critical mass" of hotels and vacation homes that would succeed as a separate resort destination as envisioned by the 1977 O`ahu General Plan. While permits were obtained and some initial work occurred, the new hotels were not built. In the intervening years, development has involved redevelopment of the Ocean Villas next to the hotel, a new 18-hole Palmer golf course and Fazio golf course renovations, and the construction of a new wastewater treatment plan mauka of Kamehameha Highway.

3.2 Socio-Economic Trends, 1980 to 2010

3.2.1 Population Characteristics

The KNS region has experienced population growth in every decade since 1980. However, that growth has been largely on the Koʻolau Loa side and in the Kawailoa area between Waimea and Haleʻiwa (Census Tract [CT] 100, labeled in Figure 3-1). The resident population of Haleʻiwa has declined, while the population of the Waialua area has been stable. For the entire KNS region, the result has been population growth at much the same rate as for the island as a whole over thirty years. (See Table 3-1.)

As Table 3-2 indicates, some characteristics of the population of the regional census tracts vary greatly. Lāʻie and Kawailoa stand out as having young populations. In Lāʻie, youths form a large part of the population. In Kawailoa, the young demographic is mostly over 18 years old. Throughout the region, the share of seniors in the population is lower than for Oʻahu as a whole.

The racial data in Table 3-2 reflects (a) broad Federal categories and (b) multiple claims to racial identity. Region-wide, White claims are more frequent, and Asian identification less frequent, than island-wide. The share of residents claiming Native Hawaiian or Pacific Islander status is much higher in Koʻolau Loa than island-wide. The Native Hawaiian or Pacific Islander share of the population is highest in the Hauʻula-Kaʻaʻawa and Lāʻie CTs. Claims to more than one racial

identity are higher in the former tract (CT 102.01). The share of the population identifying as Hispanic is higher in the three North Shore Census Tracts than the island average.

Schools assign a single ethnicity to each student for statistical purposes. The secondary school data in Table 3-3 show significant numbers of Native Hawaiians and Samoans at Kahuku High & Intermediate School (i.e., in Koʻolau Loa). At Waialua High & Intermediate School, Filipinos form the largest recognized population. Only about a fifth of the population in either school is categorized as White.

Table 3-1: Population Trends, 1980 to 2010

	1980	1990	2000	2010
City and County of Honolulu	762,565	836,231	876,156	953,207
KNS Region	27,352	29,992	32,926	34,452
Koʻolualoa District	14,195	18,443	18,899	21,406
CT 102.01 [Hauula-Kaaawa]	3,952	4,608	5,312	5,882
CT 102.02 [Laie]	5,752	6,926	6,100	7,643
CT 101 [Waimea-Kahuku}	4,491	6,909	7,487	7,881
Waialua District	13,157	11,549	14,027	13,046
CT 100 [Kawailoa]	1,879	1,801	4,338	3,320
CT 99.02 [Haleiwa]	5,350	3,956	3,958	3,740
CT 99.04 [Kaena Point]	5,928	5,792	5,731	5,986
	Average Annual Increase, over the decade ending in:			
		1990	2000	2010
City and County of Honolulu		0.9%	0.5%	0.8%
KNS Region		0.9%	0.9%	0.5%
Koʻolualoa District		2.7%	0.2%	1.3%
CT 102.01 [Hauula-Kaaawa]		1.5%	1.4%	1.0%
CT 102.02 [Laie]		1.9%	-1.3%	2.3%
CT 101 [Waimea-Kahuku}		4.4%	0.8%	0.5%
Waialua District		-1.3%	2.0%	-0.7%
CT 100 [Kawailoa]		-0.4%	9.2%	-2.6%
CT 99.02 [Haleiwa]		-3.0%	0.0%	-0.6%
CT 99.04 [Kaena Point]		-0.2%	-0.1%	0.4%

SOURCE: U.S. Census, as reported in State Data Center reports and Data Books.

Table 3-2: Selected Population Characteristics, 2006 to 2010

	City and County of Honolulu	KNS Region	Census Tract 102.01 Hauula-Kaaawa	Census Tract 102.02 Laie	Census Tract 101 Waimea-Kahuku	Census Tract 100 Kawailoa	Census Tract 99.02 Haleiwa	Census Tract 99.04 Kaena Point
Population	936,984	32,700	5,286	6,940	7,408	3,179	3,729	6,158
Median Age	37.5	NA	32.0	23.8	33.3	24.5	37.5	39.0
Racial/Hispanic Identification (1)								
White	36.8%	56.2%	58.2%	46.1%	64.3%	77.5%	46.2%	51.4%
Black or African American	3.4%	2.6%	4.5%	0.5%	0.9%	8.4%	1.9%	3.0%
American Indian and Alaska Native	2.1%	4.4%	6.7%	2.1%	5.0%	7.9%	4.2%	2.9%
Asian	61.8%	37.7%	34.4%	25.1%	37.9%	20.8%	53.3%	53.8%
Native Hawaiian and Other Pacific Islander	23.1%	37.0%	55.0%	61.2%	30.3%	7.1%	27.9%	23.3%
Some Other Race	2.4%	1.5%	1.3%	0.7%	1.2%	4.0%	1.7%	1.7%
Hispanic	7.9%	9.3%	8.4%	4.5%	9.8%	13.6%	9.9%	12.1%
Persons below Poverty Level Share of Population	8.8%	10.4%	14.1%	10.0%	9.2%	19.5%	7.8%	6.2%
Population 16 and over	752,343	24,982	4,020	4,885	5,889	2,158	2,936	5,094
In Labor Force	501,779	17,106	2,580	3,382	3,935	1,516	2,217	3,476
In Civilian Labor Force	462,843	16,079	2,566	3,372	3,822	977	2,208	3,134
Civilian Labor Force Participation	61.5%	64.4%	63.8%	69.0%	64.9%	45.3%	75.2%	61.5%
Mean Travel Time to Work, Civilian Labor Force (minutes)	27.0	NA	37.4	17.9	35.1	23.7	27.4	32.2
Unemployment Rate, Civilian Labor Force	5.0%	6.5%	6.7%	3.5%	6.2%	9.8%	15.2%	5.1%
Households	304,827	9,135	1,546	1,225	2,297	1,034	1,091	1,942
Median Household Income	$70,093	NA	$66,500	$75,417	$64,623	$40,441	$74,719	$73,883
Population in households	902,832	31,111	5,236	5,978	7,277	3,096	3,729	5,795
Population in group quarters	34,152	1,589	50	962	131	83	-	363

NOTE:
(1) Based on "Race alone or in combination with other races" tally. Percentages add up to more than 100% since persons may claim more than one race.
SOURCE: U.S. Census, American Community Survey combined samples for 2006 through 2010, downloaded from American FactFinder at www.census.gov.

The difference between the racial data in Table 3-2 and in Table 3-3 is due in part to methodology and in part to the fact that many of the Whites in the region are young adults, not school-aged youth.

Table 3-3 also shows that very few students have limited English proficiency, while nearly half of the students in either school can qualify for free or reduced-priced lunch because of low family income. These indicators point to a low-income family population with a small number of immigrants from non-English-speaking lands.

Table 3-3: School Population Characteristics, 2011

	Kahuku	Waialua
Major recognized ethnicities (Percentage of student body)		
Filipino	6.1%	35.8%
Native Hawaiian	40.0%	27.3%
Samoan	13.5%	1.6%
White	20.7%	19.5%
Students with Limited English Proficiency	3.6%	6.2%
Students qualifying for Free or Reduced Price Lunch	49.2%	45.0%

SOURCE: School Status and Improvement Reports, 2011, for Kahuku High and Intermediate School and for Waialua High and Intermediate School, posted at http://doe.k12.hi.us/.

The group-quarters population in Lāʻie consists of students at Brigham Young University – Hawaii (BYUH) in dormitories. The persons in group-quarters in the Kaena Point tract (CT 99.04) are largely military (at Helemano). Both nursing homes and other, not categorized, facilities house the group-quarters population of CT 101.

3.2.2 Housing Characteristics

The region has seen growth in both households and housing units since 1980 (as shown in Table 3-4). Much of the housing is dedicated to vacation or part time resident housing due to the surfing and other recreational attractions of the area. (The large majority of the "vacant" units counted by the various Censuses in the region are second homes or vacation rentals.) Rentals form a larger share of the housing stock than in the rest of Oʻahu, especially in the Kawailoa Census Tract (as shown in Table 3-5). This is due in part to the area's appeal to surfers, many of whom rent for longer periods than other vacationers.

Limited availability of affordable housing for local working families has been a concern for decades in the region (and island-wide). Key reasons include limited availability of zoned residential land, and the high cost of land and construction. General housing trends for the area include an increase in the total number of units in both districts of the KNS region since 1980, with a decline in the Waialua district after 2000. The number of occupied housing units grew throughout the period in the Koʻolau Loa District, but only through 2000 in Waialua District. Housing has increased at a faster rate than the resident population in the region, but increased housing prices have made most new homes too expensive for working families. This phenomenon is understandable in light of the North Shore's appeal as a surfing destination with broad expanses of beaches that are attractive year round.

Vacation rentals affect the availability of housing for residents. The City and County of Honolulu recognizes some 70 units with Non-Conforming Use Certificates in Koʻolau Loa and 10 in the North Shore. These are vacation rentals or bed-and-breakfast establishments that have received legal transient accommodation permits. Many more units are rented illegally. One resident has estimated that the Haleʻiwa or North Shore area includes 450 illegal rentals.[6]

[6] Outside of resort districts, housing can be rented for six months or more at a time. Shorter rentals – "transient vacation rentals" – are sources of income for some homeowners, but may be irritants for others in their neighborhoods. Only long-standing transient vacation rentals can be recognized as legal so long as the use continues from before current zoning rules were enacted. The count of recognized Non-Conforming Uses is from http://honoluludpp.org/HotIssues/NUCreport.pdf. The resident cited in the text is B. Ready, "Illegal Vacation Rentals behind Opposition to Haleiwa Inn?" *Hawaiʻi Free Press*. June 26, 2012. Posted at http: www.hawaiifreepress.com/ArticlesMain/Tabid/56/ArticleType/CategoryView/categoryID/47/Oahu-News.aspx.

Table 3-4: Housing and Occupancy, 1980 to 2010

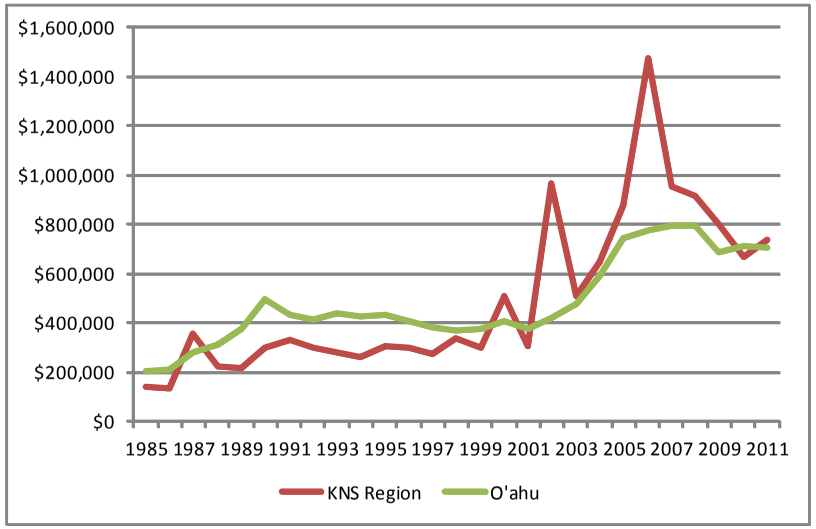
	1980	1990	2000	2010
Total Housing Units				
City and County of Honolulu	250,864	281,683	315,988	336,899
KNS Region	7,877	9,709	11,121	11,562
Koʻolualoa District	4,679	5,939	6,199	6,808
CT 102.01 [Hauula-Kaaawa]		1,826	1,932	2,098
CT 102.02 [Laie]		1,517	1,452	1,560
CT 101 [Waimea-Kahuku}		2,596	2,815	3,150
Waialua District	3,198	3,770	4,922	4,754
CT 100 [Kawailoa]		559	1,517	1,309
CT 99.02 [Haleiwa]		1,187	1,247	1,231
CT 99.04 [Kaena Point]		2,024	2,158	2,214
Occupied Housing Units (Households)				
City and County of Honolulu	230,214	265,304	286,450	311,047
KNS Region	6,586	8,403	9,575	9,675
Koʻolualoa District	3,742	4,935	5,172	5,483
CT 102.01 [Hauula-Kaaawa]	1,166	1,458	1,571	1,684
CT 102.02 [Laie]	1,080	1,350	1,274	1,342
CT 101 [Waimea-Kahuku}	1,496	2,127	2,327	2,457
Waialua District	2,844	3,468	4,403	4,192
CT 100 [Kawailoa]	478	491	1,375	1,163
CT 99.02 [Haleiwa]	753	1,113	1,145	1,112
CT 99.04 [Kaena Point]	1,613	1,864	1,883	1,917
Vacant Units as Share of Total Units				
City and County of Honolulu	8.2%	5.8%	9.3%	7.7%
KNS Region	16.4%	13.5%	13.9%	16.3%
Koʻolualoa District	20.0%	16.9%	16.6%	19.5%
CT 102.01 [Hauula-Kaaawa]		20.2%	18.7%	19.7%
CT 102.02 [Laie]		11.0%	12.3%	14.0%
CT 101 [Waimea-Kahuku}		18.1%	17.3%	22.0%
Waialua District	11.1%	8.0%	10.5%	11.8%
CT 100 [Kawailoa]		12.2%	9.4%	11.2%
CT 99.02 [Haleiwa]		6.2%	8.2%	9.7%
CT 99.04 [Kaena Point]		7.9%	12.7%	13.4%

SOURCES: Kuilima EIS, Appendix J and American FactFinder (www.census.gov).

In the period from 1985 through 2010, a total of 1,077 new single family homes were built in the KNS region.[7] On average, some 18 houses were built each year in the area from Ka‘a‘awa through Kahuku, 12 in the area from Turtle Bay through Waimea Bay, and 11 in the remaining North Shore area.

Average single family housing prices in that time increased faster in the KNS region than island-wide, as shown in Figure 3-2. The increase in average single family prices since 2000 is consistent with rapid growth of a non-resident market in the region. At the peak of the recent high sales period, KNS single family sales averaged 189% of island-wide sales. (In 2006, the regional average was $1,472,726, and the island average was $778,393. Since then, the regional average has returned to levels close to the island average.)

Figure 3-2: Average Annual Sales Prices, Single Family Homes, KNS Area and O‘ahu



NOTE: Average (mean) prices are used rather than medians in order to compare data from different sources. For small areas, average prices can be affected significantly by outliers, i.e., a few extreme cases. This obviously occurred in 2002 and 2006. Still, the overall trend is that the KNS average, once below the island average price, now tends to exceed the island average.
SOURCES: Honolulu Board of Realtors; download from Hawaii Information Service.

[7] Hawaii Information Service download, analyzed by Belt Collins Hawaii. Only single family units were analyzed because information about the year condominium units were built was not consistently available.

Table 3-5: Households and Household Size, 2010

	City and County of Honolulu	KNS Region	Census Tract 102.01 Hauula-Kaaawa	Census Tract 102.02 Laie	Census Tract 101 Waimea-Kahuku	Census Tract 100 Kawailoa	Census Tract 99.02 Haleiwa	Census Tract 99.04 Kaena Point
Population in Households	917,907	31,656	5,531	5,776	7,848	3,170	3,683	5,648
Households	311,047	9,675	1,684	1,342	2,457	1,163	1,112	1,917
Owner-occupied	56.1%	47.0%	50.8%	44.7%	52.3%	18.9%	53.5%	51.5%
Rented	43.9%	53.0%	49.2%	55.3%	47.7%	81.1%	46.5%	48.5%
Average household size								
All households	2.95	3.27	3.28	4.30	3.19	2.73	3.31	2.95
Owner-occupied	3.11		3.59	4.60	3.58	2.79	3.64	3.15
Rented	2.75		2.97	4.06	2.78	2.71	2.94	2.73

SOURCE: U.S. Census, 2010 Census. Download from www.census.gov.

In most of the region, about half of the occupied households are owner-occupied, except in CT 100. (See Table 3-5.) Household sizes for owner-occupied households are larger than the island average (again, except in CT 100), with households in Lā‘ie appreciably larger than elsewhere. Renters in Lā‘ie also have large households. In other tracts in the region, average renter household sizes are close to the island average.

The Kawela Bay Census Designated Place (CDP) includes the Turtle Bay Resort and some neighboring residential sites. In 2010, it was home to 330 persons in 153 households: the average household size was 2.16 persons per household. Owners lived in 87 (56.9 %) of these units; renters occupied the remaining 66 units. The CDP included a total of 518 housing units, so the occupied units accounted for only 29.5 percent of the housing stock.[8]

By 2012, the Honolulu Real Property Tax files recognized 366 parcels with taxable housing units within Kuilima Estates[9]. Of these, some 52 (14.2 %) were listed as owner-occupied. This share is slightly lower than the share counted by the Census in 2010 for the CDP as a whole (87 of 518 units, or 16.8%).[10]

The TMK database shows that less than half of dwellings in the region are registered as owner-occupied for tax purposes, and the share of all housing units registered as owner-occupied is especially low in the region between Turtle Bay and Waimea Bay. In other words, rentals, second homes and vacation units are more prevalent in this area than elsewhere in the region.[11]

[8] US Census, Summary File 1. Data posted at http://hawaii.gov/dbedt/info/census/Census_2010/SF1/DEC_10_SF1_GCT_CDP.xls.
[9] There are 368 total units in the Kuilima Estates, but two of them are management units.
[10] Information for TMK 1-5-7:27 and 1-5-7:29, downloaded from Hawaii Information Service in June 2012.
[11] The count of single-family dwellings in the TMK database is much smaller than the housing units counted in the 2010 Census. As a result, only the general statement of findings noted in the text seems warranted.

Illegal rentals are also said to be common. All of these uses for housing, which tend to limit the supply affordable for residents, are consistent with the North Shore's appeal as a surfing and beach destination.

3.2.3 Economic Characteristics of the Resident Population

Table 3-6 shows basic data on residents' economic situation captured by the American Community Survey (ACS) for 2006 to 2010. (The ACS data consist of samples collected in each of five years, and cannot be treated as occurring in any single year. It is the most recent data available at the CT level.)[12]

Two indicators of prosperity tell distinct stories. On the one hand, the median household income is about the same as island-wide in all of the KNS Census Tracts except Kawailoa (CT 100). On the other hand, the share of the population with incomes below the poverty level was elevated in both the Hauʻula-Kaʻaʻawa and Kawailoa CTs.

Labor force participation was low in the Kawailoa CT, but equal to or higher than the island average in the rest of the region. Unemployment in Kawailoa and Haleʻiwa was high compared to the island average.[13] Lāʻie, with some of the region's major employment centers, had very low unemployment.

[12] This section deals with the economic situation of KNS residents; Section 3.3.8 discusses the situation of the various industries in the region.

[13] Census unemployment rates are based on different definitions than the rates commonly reported. Also, since ACS data are drawn over a five-year period, the ACS rates cannot be compared to other unemployment rates for any given date or year.

Table 3-6: Selected Economic Characteristics, 2006-2010 ACS

	City and County of Honolulu	KNS Region	Census Tract 102.01 Hauula-Kaaawa	Census Tract 102.02 Laie	Census Tract 101 Waimea-Kahuku	Census Tract 100 Kawailoa	Census Tract 99.02 Haleiwa	Census Tract 99.04 Kaena Point
Population	936,984	32,700	5,286	6,940	7,408	3,179	3,729	6,158
Median Age	37.5	NA	32.0	23.8	33.3	24.5	37.5	39.0
Persons below Poverty Level Share of Population	8.8%	10.4%	14.1%	10.0%	9.2%	19.5%	7.8%	6.2%
Population 16 and over	752,343	24,982	4,020	4,885	5,889	2,158	2,936	5,094
In Labor Force	501,779	17,106	2,580	3,382	3,935	1,516	2,217	3,476
In Civilian Labor Force	462,843	16,079	2,566	3,372	3,822	977	2,208	3,134
Civilian Labor Force Participation	61.5%	64.4%	63.8%	69.0%	64.9%	45.3%	75.2%	61.5%
Mean Travel Time to Work, Civilian Labor Force (minutes)	27.0	NA	37.4	17.9	35.1	23.7	27.4	32.2
Unemployment Rate, Civilian Labor Force	5.0%	6.5%	6.7%	3.5%	6.2%	9.8%	15.2%	5.1%
Households	304,827	9,135	1,546	1,225	2,297	1,034	1,091	1,942
Median Household Income	$70,093	NA	$66,500	$75,417	$64,623	$40,441	$74,719	$73,883

SOURCE: American Community Survey, 2006 to 2010, downloaded from American FactFinder at www.census.gov.

About 80% of the Turtle Bay Resort workforce lives in the KNS Region. While more than a hundred live in Kahuku, resort employees are found throughout the region.

3.2.4 Public Facilities and Natural Resources

Public Safety: Police

The KNS region is within two police districts, with stations in Kāneʻohe and Wahiawā, outside the region. A substation in Kahuku, about five (5) miles from the resort, serves the Koʻolau Loa side of the region. Island-wide, recruitment is adequate to keep police staffing constant, but not to expand to fill vacancies. The Kahuku substation is authorized to have five officers but has only three or four at a time.

Public Safety: Fire

Fire stations are located in the KNS region at Kaʻaʻawa, Hauʻula, Kahuku, Sunset Beach, and Waialua. The Kahuku station is about five (5) miles from the resort. The Fire Department plans to relocate the Hauʻula and Waialua stations to sites outside of the flood plain.

Medical Facilities

Kahuku Medical Center is the only hospital in the region. It is approximately four (4) miles from the resort. It provides 24-hour emergency care. It is part of the Hawaii Health Systems Corporation, a state organization providing primary care in underserved areas. Koʻolauloa Community Health and Wellness Center, a federally qualified health center, has a clinic in

Hau‘ula and offices at the Kahuku Medical Center. Wahiawa General Hospital, in Central O‘ahu, also serves North Shore patients, while Castle Medical Center in Kailua serves some Ko‘olau Loa patients. Honolulu hospitals provide specialty services and care.

In the Kahuku area, Kahuku Medical Center has 31 beds, and Crawford’s Convalescent Home has 55. Kahuku Medical Center’s occupancy varied by bed type: surgical care (11 beds, 5% occupancy in 2009), acute/specialized nursing care (11 beds, 55% occupancy), and intensive care (10 beds, 98% occupancy).[14]

On the Behavioral Risk Factor Surveillance survey, KNS respondents usually report high levels of health care coverage, although an indicator of usage (“Visited doctor for a routine checkup during the past year”) shows mixed results from 2005 through 2010.[15]

Schools

Two high schools catchment areas cover the region. Table 3-7 lists these and their current enrollment.

Table 3-7: Enrollment in KNS Public Schools, September 2011

	Enrollment
Leilehua-Mililani-Waialua Complex Area	
Waialua High and Intermediate School	642
Haleiwa Elementary School	180
Waialua Elementary School	506
Castle-Kahuku Complex Area	
Kahuku High and Intermediate School	1,491
Hauula Elementary School	267
Kaaawa Elementary School	141
Kahuku Elementary School	490
Laie Elementary School	658
Sunset Beach Elementary School	451
Total Enrollment, KNS public schools	*4,826*

SOURCE: Hawaii Department of Education website.

St. Michael’s School in Waialua and Sunset Beach Christian both provide private elementary education. Plans for a high school near Hale‘iwa, Aloha Ke Akua, have been advanced, but the initiative appears to have stalled for lack of financial support.

[14] Occupancy estimates for 2009 from Hawaii State Department of Health, posted at http://hawaii.gov/shpda/resources-publications/health-care-utilization-reports/updates-and-results/2009-data/table-6. The figures for acute and long-term care are below the county averages for that year.

[15] Hawaii State Department of Health website, http://hawaii.gov/health/statistics/brfss/HBRFSS-IA9/atlas.html accessed April 26, 2012.

A new school based in Hau‘ula, Hawaii Active Learning Academy, combines on-line classes with projects led by teachers. Its application for charter school status was denied in 2011. It functions now as a private school.

Kahuku High School graduated 250 students in 2009, while Waialua High School graduated 98.[16] Over 80 percent of graduating students from Kahuku have planned to continue schooling, but most planned to combine school and work.[17]

Preschools

Early child-care facilities in Hawai‘i are licensed or, if small, license-exempt. Ten licensed programs are located in the KNS region: four Head Start programs, two programs associated with local churches, two non-denominational private programs, a Hawaiian language preschool and a preschool run by a charity serving low-income families. All run day programs only.

In recent years, preschools in the region have not operated at capacity (personal communication, Steve Albert, Rainbow Schools, October 2011). With the economic downturn, state funds to support preschools were cut and family budgets tightened.

Recreation Facilities

The North Shore’s beaches and harbors support surfing, boating activities, swimming and, in calm weather, snorkeling and scuba diving. The region is host to the Triple Crown of Surfing competition and the Quiksilver in Memory of Eddie Aikau surfing competition held at Waimea Bay only when waves are consistently over 20 feet (measured from behind the wave). The North Shore surf attracts tourists, whether as beachgoers or observers, throughout the year, but especially during the winter season.

In 2010, some 1.5 million beachgoers were counted by Water Safety Officers at guarded beaches in the KNS region, 9.6% of the total O‘ahu beach count.[18] Some 17% of the surfing accidents and rescues reported island-wide were at KNS beaches.

These counts do not cover the Turtle Bay Resort beaches. Kawela Bay is currently used by a few people for beach going, fishing and water sports (as documented in the SEIS Appendix on Marine Resource Impacts).

In recent years, turtle and seal populations have increased in Hawai‘i. Turtles are sighted regularly by visitors along the KNS coastline. A marine resources impact analysis conducted for the SEIS documents an increase in turtle and seal populations at Kawela Bay since 1985.

[16] Hawaii State Department of Education report posted at http://doe.k12.hi.us/reports/highschoolcompleter0809.pdf

[17] Based on School Exit Plans Survey, last conducted in spring 2008, for Kahuku High School, http://arch.k12.hi.us/PDFs/resources/archive/seps/2008/SEPS307.pdf.

[18] KNS guarded beaches are Hale‘iwa Ali‘i, ‘Ehukai, KeWaena, Sunset and Waimea. Other popular beaches are found throughout the region. DBEDT, *2010 State of Hawaii Data Book*, Table 7.51.

Laniākea Beach (also known as Turtle Beach), approximately nine miles west of Turtle Bay Resort, has become an extremely popular destination for tour buses and free-and-independent (F.I.T.) visitors to view turtles basking on the shore and swimming in the near shore area.

The KNS region has a wide range of recreation sites. Beach parks are dotted along the entire coast, notably near famous surf breaks. District parks at Kahuku and Waialua include sports fields. (Kahuku District Park, about three miles from the resort, has baseball and softball fields, and a volleyball court.) Malaekahana State Recreation Area supports camping by the beach. The Friends of Malaekahana provide patrolled camping sites, yurts, and other overnight shelters for rent. Within Koʻolau Loa, the Ahupuaʻa o Kahana State Park is an entire valley dedicated as a cultural park, with marked trails for walkers. Waimea Valley, on the North Shore, has extensive horticultural plantings and cultural exhibits. It is operated as a visitor attraction. Dillingham Airfield has glider rides.

In addition to the golf courses at Turtle Bay, Kahuku has a nine-hole public course.

The Polynesian Cultural Center is a visitor destination, with "villages" representing several island societies, *luʻau* dinners, and an evening show. The PCC reported 692,081 visitors in 2010.[19] Just south of the KNS region, Kualoa Ranch offers a range of outdoor activities for visitors, including horse rides and all-terrain vehicle tours.

3.2.5 Social Trends

Community Decision-Making and Cohesion

While all of Oʻahu is a single political entity, the City and County of Honolulu, smaller areas have representatives on the City Council and in the State Legislature. Local decision-making and advisory bodies that express and shape local views include two Neighborhood Boards. Neighborhood Board No. 28 (Koʻolau Loa) covers the Koʻolau Loa SCP area (i.e., Kaʻaʻawa to Kawela), and Neighborhood Board No. 27 (North Shore) serves communities from Sunset Beach to Kaʻena Point. The Neighborhood Boards are elected, meet regularly, and post minutes (at http://www1.honolulu.gov/nco/boards.htm). Board members on Oʻahu often are recognized local stakeholders, and many go on to serve in political offices. The Boards' role is defined as advisory, but they are regularly asked to comment on development proposals. They provide an arena for local issues and debates.

Community Advisory Committees were formed in support of updates for the North Shore and Koʻolau Loa Sustainable Communities Plans. Members carefully reviewed both the existing SCPs and proposals for development or new regulatory frameworks in each area. The North Shore revised SCP was adopted in 2011. A Public Review Draft of the Koʻolau Loa SCP was published and reviewed in the region in 2010. The City and County Department of Planning and Permitting (DPP) is responsible for finalizing the SCP and forwarding it to the City Planning Commission and City Council.

[19] DBEDT, *2010 State of Hawaiʻi Data Book*, Table 7.43.

The Public Review Draft of the Koʻolau Loa Plan includes support for small-scale visitor facilities in keeping with the area's "country" character. The draft reflects community concerns about traffic and stress on local infrastructure with regard to expansion of the Turtle Bay Resort, while expressing support for existing operations. The draft can be taken as reflecting the views of a range of local leaders, but its contents are determined by DPP.

The North Shore Chamber of Commerce has grown from Haleʻiwa Main Street to represent local commercial interests throughout the KNS region. It arranges events such as the annual Arts Festival.

Other local groups include community associations, which vary greatly in their level of activity. The Waialua Community Association was incorporated in 1937. It built the WCA gymnasium in Haleʻiwa and continues to operate this facility, serving the entire North Shore. A separate group, Friends of Waialua, sponsored a master plan for the Waialua Town Center (developed with City and County funding). The Lāʻie Community Association has participated extensively in the Envision Lāʻie process, supporting expansion of BYUH and the building of a larger hotel to replace the Laie Inn. (The Kahuku Community Association has written to the City and County in support of the Envision Lāʻie process.) Other community associations deal with issues of concern in the towns along the coast. Local institutions may have active groups of associates and supporters. Waimea Valley has provided a venue for Hawaiian cultural practitioners in the region. Kahuku High & Intermediate School has active community support, most visibly for its winning football team.

Concerns about development have been voiced by groups of local stakeholders. Keep the North Shore Country was a plaintiff, along with the Sierra Club, in the suit challenging the Kuilima EIS as outdated. It is part of the Koʻolau Loa/North Shore Alliance and works with the Defend Oʻahu Coalition to oppose development at Turtle Bay and in Lāʻie.

The Kuilima/North Shore Strategic Planning Committee was formed in the 1980s to identify ways in which redevelopment of the resort could benefit regional residents. It was involved in planning for community benefits after the Kuilima EIS was approved. It continues to meet and provide community input to redevelopment planning for the Turtle Bay Resort.

Quality of Life

Residents of the KNS region are proud of their communities. The North Shore is renowned for its surf and surfing lifestyle. Koʻolau Loa is less well known. Both areas are viewed as "country" by Oʻahu residents, and many agree that they should be protected from urbanization.

These "country" areas are far from isolated. Many workers commute daily outside the region. The North Shore exports surfboards and agricultural products worldwide. Retail and recreational businesses in Haleʻiwa cater to tourists traveling around the island. During the winter surf season, local traffic is even more congested than usual because of the influx of spectators to surfing competitions. Koʻolau Loa includes both major visitor facilities (the PCC and Turtle Bay) and institutions central to Hawaiʻi's Mormon community. BYUH has attracted students and residents from the island communities of Polynesia as well as Hawaiʻi.

Few useful generalizations about quality of life can be made for the entire region. Persons, families and communities vary over time as they encounter challenges or enjoy prosperity and wellbeing. A few indicators may help to suggest ways that the region's reputation, economy and community life inform residents' lives:

- Unemployment is higher in the KNS region than the island average, and average wages (as distinct from household income as a whole) are lower;

- Surveys of students, parents and teachers indicate that family ties and family involvement in schools are strong in the Kahuku High School catchment area (i.e., mainly Koʻolau Loa). Young people report that they have close neighborhood ties. When data from schools throughout Hawaiʻi were compiled, the Kahuku community was ranked ninth of 42 communities in "protective factors" tending to support young people's success in life.[20]

  Responses from the Waialua High School area are closer to the island and state average. The summary report suggests some of the strengths of the area:

  > In a Statewide survey of students, more than half of the adolescents responding in the Waialua Area reported problems in family relationships. However, most of the adolescents reported strong neighborhood ties and that their schoolwork was interesting and meaningful. The graduation rate in this community is high, and most high school seniors plan to attend college.[21]

- Respondents to the Behavioral Risk Factor Surveillance Survey from the KNS region were more likely than ones from any other community in Hawaiʻi to report their general health status as good to excellent. They also ranked highest as experiencing social and emotional support. On the other hand, the community also ranked high in reports of high blood pressure.[22]

Emerging Regional Trends

Long-term projections are for slow population growth (at a rate of about 0.5 percent annually) and slightly faster job growth for the KNS region, as shown in Table 3-8. The City and County's Department of Planning and Permitting developed these projections based on a State forecast issued in 2009. The projections were based on information available to the Department about permitted development, including the new development permitted at Turtle Bay Resort, as allowed under the Full Build-Out alternative. Figure 3-3 shows the areas as defined by DPP.

[20] Center on the Family, University of Hawaiʻi, *Kahuku Area Community Profile*. Honolulu, HI: 2003

[21] Center on the Family, University of Hawaiʻi, *Waialua Area Community Profile*. Honolulu, HI: 2003. Waialua ranked 21st of 42 on the scale mentioned above, with protective factors slightly outweighing risk factors.

[22] Hawaiʻi State Department of Health, interactive database with data for 2005 to 2010, posted at http://hawaii.gov/health/statistics/brfss/HBRFSS-IA9/atlas.html. The region's respondents had less extreme results for asthma and other health problems.

Table 3-8: Population and Employment Projections, KNS Region, to 2035

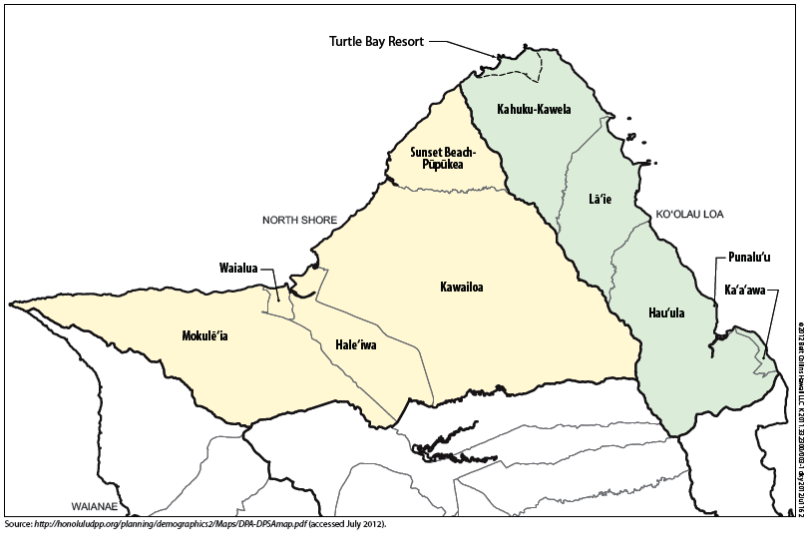
	Total Population			Civilian Employment		
	2010 est.	2025	2035	2010 est.	2025	2035
Kaʻaʻawa	1,399	1,393	1,379	147	80	89
Hauula/Punaluu	3,717	3,864	3,893	600	648	673
Lāʻie	5,902	6,394	6,557	3,147	3,318	3,359
Kahuku/Kawela	3,138	3,499	3,623	1,734	2,522	2,723
Sunset Beach/Pupukea	4,240	5,643	6,177	995	1,082	1,068
Kawailoa	3,779	3,732	3,674	227	238	239
Haleʻiwa	4,198	4,350	4,365	1,765	1,796	1,807
Waialua	3,249	3,157	3,085	384	390	391
Mokulēʻia	2,258	2,244	2,216	392	403	405
KNS Region	31,880	34,276	34,969	9,391	10,477	10,754
KNS 2010 Census	32,700			NA		
Increase over 2010 Census		1,576	2,269			

NOTE: The Census deals with employed residents; the projections deal with jobs in the region. In 2010, some 16,079 persons living in the KNS region were in the civilian labor force. Civilian employed residents of the region numbered about 1.6 times the number of jobs in the region.
SOURCE: City and County of Honolulu, Department of Planning and Permitting, posted at http://honoluludpp.org/planning/demographics2/Projections/2000-2035byDPSA.pdf

Recently, the State forecast has been updated. For the civilian population of the City and County as a whole, population growth now is projected as slightly slower.[23] While the projected total island population in 2025 and 2035 is higher in the new projection, the difference is due to the increase that has already occurred on Oʻahu, not to future growth.

[23] In the new projection, DBEDT expects the military and military dependent population on Oʻahu to shrink slightly (http://hawaii.gov/dbedt/info/economic/data_reports/2040-long-range-forecast).

Figure 3-3: Sub-Areas in the KNS Region



Source: *http://honoluludpp.org/planning/demographics2/Maps/DPA-DPSAmap.pdf* (accessed July 2012).

BELT COLLINS NORTH 0 1 2 3 SCALE IN MILES

Figure 3-3
KO'OLAU LOA-NORTH SHORE REGION SUBAREAS
Socio-Economic Impact Assessment, Turtle Bay Resort
July 2012

3.2.6 Community Issues and Concerns

Sources

For this analysis, Belt Collins Hawaii (BCH) has drawn on public records of those discussions and planning documents produced with community input, and on a series of interviews with key stakeholders. Most of the interviews were conducted in October through December 2011. Table 3-9 lists the interviewees who shared their views and those of others in their communities.

Throughout the interview process, BCH staff sought to learn stakeholders' ideas and concerns, not to convince them or to poll them on a single issue. The process did not yield quantitative findings that can be attributed to the regional population or even any stakeholder group. Instead, it served to identify the range of issues and concerns that shape attitudes towards the Proposed Action and Alternatives. Interviewees were asked whether they thought the various alternatives would have greater or lesser, or different, impacts than the Proposed Action. The aim was to learn more about anticipated impacts, not to find which alternatives had more support.

Table 3-9: Persons Interviewed for This Report

First	Last	Affiliation Notes
Kat	Adcox	Kuilima Estates resident Waimea Valley employee
Steve	Albert	Rainbow School
Eric	Beaver	President, Hawaii Reserves, Inc. Past Chairman, Kahuku Hospital
Tinker	Bloomfield	Pupukea resident; Waimea Valley employee
Clifton C.	Cassity	Managing Agent, Villa Management at Turtle Bay Resort
Mona	Chang-Vierra	Waimea Valley
Mitch	Costino	Kuilima Estates West Association - President
Tom	Cross	Turtle Bay Resort, Resort Manager
Joann	Dicion	Turtle Bay Resort employee
Kent	Fonoimoana	Ko'olauloa Neighborhood Board; Defend Oahu Coalition
Danna	Holck	Turtle Bay Resort, General Manager
Randal	Hoopai	Waimea Valley Facilities Manager; Waimea resident
Elaine	Hornal	Turtle Bay Resort employee
Patsy	Izumo	Waimea Valley
Choon	James	Marconi Road resident
Jeff	Johnston	Turtle Bay Resort employee

Continued on next page

Table 3-9, continued

First	Last	Affiliation Notes
Barbara	Kahana	Koʻolaulea Neighborhood Board
Kent	Kamiya	Kamiya Papaya Farm
Dee Ann	Kekahuna	Waimea Valley Human Resource Manager; Kahuku resident
Daniel	Kerwin	Unite Here! Local 5 Hawaii, Organizer
Bob	Leinau	North Shore Neighborhood Board
DeeDee	Letts	Koʻolauloa Neighborhood Board; Koʻolauloa North Shore Alliance; Specialty Courts Coordinator; Mutual Housing Board - President
Melvin	Matsuda	Kahuku Brand Farms
Susan	Matsushima	Alluvion Inc, CEO (North Shore)
Creighton	Mattoon	Koʻolauloa Neighborhood Board: Kahuku Medical Center Board of Directors, Vice President; Koʻolauloa North Shore Alliance; Punaluʻu Community Association; Koʻolauloa Hawaiian Civic Club; Keep the Country Country
Cathleen	Mattoon	Koʻolauloa Hawaiian Civic Club; Punaluʻu Community Association
Lt Tasman	McKee	Honolulu Police Department
Elena	Meehan	Turtle Bay Resort employee
Antya	Miller	North Shore Neighborhood Board; North Shore Chamber of Commerce; Haleiwa Main Street; Wailua Community Association
Bob	Nakata	Former State Representative; Former State Senator; Kahaluu United Methodist Church, Sr. Pastor; Kahalu'u resident
Josanda	Napeahi	Turtle Bay Resort employee
Jay	Oku	North Shore Disaster Preparedness Committee
Kathleen	Pahinui	North Shore Neighborhood Board; Wailua Community Association
Junior	Primacio	North Shore Strategy Planning Committee; Former Koolualoa NB, No 28; General Manager of former Kahuku Housing Corporation
Ben	Shafer	Kahana Valley resident
Captain D.	Tsuchida	Honolulu Police Department
Bernadette	Tyrell	Principal, Sunset Elementary School
Stephanie	Vaioleti	Administrative Director, Kahuku Medical Center; Board Member, Koolauloa Educational Alliance Corp
Jeff	Wallace	Honolulu Fire Department; Caretaker for Continental Properties on Marconi Road
Ronald	Weidenbach	Hawaii Fish Company
Sadia	Wilkins	Turtle Bay Resort employee
Harvey	Wong	Turtle Bay Resort employee
Anonymous (three persons)		Kuilima Estates residents

NOTE: Affiliations are given to suggest how particular stakeholders helped Belt Collins Hawaii understand issues and concerns in the region. When an organization or agency is mentioned, no claim is made here that it supports the Proposed Action, or that it has made any official response to the Turtle Bay Resort redevelopment. BCH interviewers sought to elicit interviewees' knowledge and perspectives, not their support or opposition to the Proposed Action.

Many of the stakeholders interviewed have already expressed strong views about the Proposed Action or earlier plans for expansion. Several are members of organizations that have challenged expansion plans in court and in community discussions. BCH sought to learn from a wide range of knowledgeable members of the KNS population, not just those with a particular stand on the Proposed Action.

Issues and Concerns Independent of Project

For this report, BCH reviewed the minutes of the two Neighborhood Boards in the region for 2010 through early 2012 to learn of current concerns. Recurring themes that arose in the discussions included:

- Congested roadways: On the North Shore, this issue largely involves tourist traffic and visitors parking near beach sites, especially Laniākea. In Koʻolau Loa, residents were concerned about roadways where resident parking obstructed traffic, and about possible future expansion of the highway that could affect abutting properties.

- Concern about proposed development and redevelopment: Many residents in both areas expressed opposition to new development projects, including Envision Lāʻie, the expansion of Turtle Bay Resort and the proposed Haleʻiwa hotel. The Kamehameha Schools' project to renovate commercial areas in Haleʻiwa was viewed critically as affecting existing businesses, while the proposed move of the Hauʻula fire station was seen as taking limited Commercially-zoned land out of private hands.

- Appreciation for developers who listen to local stakeholders: While community members expressed concern about wind farm development at Kahuku and Kawailoa, they also expressed appreciation for the involvement of First Wind, the developer of both the currently operating Kahuku wind farm and the Kawailoa wind farm, now under construction. Similarly, community stakeholders have welcomed the open attitude of TBR in introducing and sharing information about the Proposed Action and the SEIS process.

- Members of both boards support agriculture and preservation of land for agriculture.

- Outside agencies may make decisions that ignore local views and concerns. Discussion of the Koʻolau Loa Sustainable Communities Plan has recently focused on the fact that the Public Review Draft, issued by the City Department of Planning and Permitting (DPP), supports the Envision Lāʻie plans, while the earlier draft vetted by an advisory committee did not. The change was repeatedly attributed to meetings "behind closed doors." Similarly, the Department of Education has threatened to close Kaʻaʻawa Elementary School despite community opposition.

- Residents are concerned about the effects of limited government budgets on local facilities and resources. Schools, parks, and civil defense budgets may all be affected.

- Disaster planning has emerged as a local initiative throughout the region, with an emphasis on stockpiling supplies needed in the event of emergencies.

- Tensions clearly exist among community leaders. These were evident when a petition to dissolve Neighborhood Board No. 28 in Koʻolau Loa was discussed, and in accounts of various parties involved in housing redevelopment in Kahuku who failed to meet to develop shared goals and proposals. However, Neighborhood Board meetings appear to

have proceeded without disruption, unlike more contentious boards elsewhere on O‘ahu. (The North Shore Board convened a meeting on the Hale‘iwa Hotel proposal that was rowdy and quickly adjourned. In this case, members of the audience were disruptive.)

In the course of interviews, respondents emphasized their deep commitment to “country” lifestyles. They list difficulties for local residents ranging from the inconvenient – Sears delivery service only on Sundays – to traffic congestion that can make the highway impassible during surf season. Still, no interviewee went on to suggest that they or their friends would leave the region because of such problems.

Interviewees mentioned the cost of housing and the limited availability of housing for residents as significant problems for the region. Illegal vacation rentals were sometimes mentioned as part of the problem, both as disruptive in residential neighborhoods and as affecting housing supply and prices.

The ideas of sustainability and food security, much discussed in Hawai‘i recently, have taken local form in the KNS region. First, much of the opposition to development has been expressed in terms of preserving the North Shore as a shared resource, a unique area enjoyed by the whole island and tourists from around the world. Next, many stakeholders are interested in maintaining the region’s agricultural resources. Third, major landowners – notably Kamehameha Schools and Hawaii Reserves Inc. – have identified the need for their regional resources to be increasingly self-sustaining.

Concerns with Regard to the Project

Redevelopment at Turtle Bay has been discussed in the KNS region for decades. The Proposed Action is seen by residents in relation to earlier proposals and discussions. The original master plan for the Kuilima EIS was welcomed by some as assuring economic stability, continuing jobs in the region, and opposed by others as bringing too much development, too many tourists, and too much traffic to the North Shore. Since the 1980s, public debates over development vs. open space have arisen again, notably with regard to plans for Lihi Lani, a recreational community, just north of Pupukea, for a proposed eco-camping resort at Pua‘ena, and, more recently, for a proposed Hale‘iwa hotel. Smaller residential subdivisions have been developed along the North Shore coastline. Along the Ko‘olau Loa side of the region, major new development has been proposed only by Hawai‘i Reserves, Inc., as part of the Envision Lā‘ie process, and little has been put in place.

At Turtle Bay, the 2005 announcement that the resort would carry out the development proposed in the Kuilima EIS revived old arguments, and several stakeholders developed the legal challenge that resulted in the Hawai‘i Supreme Court ruling that set the Kuilima EIS aside. The draft of the *Ko‘olau Loa Sustainable Communities Plan* spells out the concerns expressed in response to the proposal for expansion to the extent allowed in the late 1980s: [24]

> … many residents of Ko‘olau Loa do not support the resort expansion due to concerns about traffic impacts on the two-lanes of Kamehameha Highway, the capacities of existing infrastructure systems and public services to accommodate the future projected demand (e.g., water, wastewater, electrical systems, police and fire protection, and emergency services) and the potential impacts to archaeological, cultural and natural resources. Labor force issues related to population growth, housing demand and transportation, as well as a desire to preserve the undeveloped shoreline and scenic view planes and maintain the region’s rural character are also concerns. Although there is general support for the existing hotel operations, community discussions about the future development of the resort continues [*sic*], pending completion of an updated EIS. Community concerns about the proposed resort expansion include:
>
> - Preserving the uninterrupted shoreline and scenic view plane, as well as the cultural and historic significance of the area for future generations;
> - Providing for appropriate recreational and other uses that are compatible with existing land uses;
> - Maintaining the viability of the existing Turtle Bay Resort, restaurants, condominiums and golf courses as an employment base for the region;
> - Minimizing the impacts of future development;
> - Developing design guidelines for any proposed additional structures to assure their compatibility with the rural character of the region;
> - Providing for appropriate agricultural and other compatible uses in the *mauka* area; and
> - Acknowledging existing land use designations and development approvals that have already been granted.

This entire discussion is included here both because it reflects input from local stakeholders on the Community Advisory Committee for the planning process and because it covers the range of concerns about the resort that arose in recent interviews. (We did not hear discussions of design

[24] City and County of Honolulu, Department of Planning and Permitting, *Ko‘olauloa Sustainable Communities Plan Five-Year Review: Public Review Draft.* Honolulu, HI: 2010. The language quoted here was crafted largely in response to proposals by Oaktree, which sought development as permitted with the UA. Some of the concerns raised in the quotation have also been mentioned regarding the more limited Proposed Action. The Sustainable Communities Plan now in force and the draft update are more supportive of resort expansion than the stakeholders whose views are described in the above quotation.

guidelines, but did learn of people's concern that the resort be in keeping with the region's rural character.) Interviewees emphasized traffic congestion as the leading problem for the region. Some went on to discuss the resort expansion in relation to the need for jobs and housing in the region, and to inadequate infrastructure and public facilities. Others saw it as bringing too many tourists to the area, and as not needed.

The quotation above downplays differences in views of regional residents that could be heard in the course of interviews:

- The draft texts from the Department of Planning and Permitting emphasize opposition to the resort expansion; in interviews with BCH, both support and opposition were expressed. Many residents continue to see job creation as needed to support local communities, and welcome resort expansion for that reason.

- While view planes at Turtle Bay are important to some residents, others' attention focuses above all on their own home communities. Most interviewees said little about the appearance of the resort.

Comments on the SEISPN and at public events have covered the points raised above. Issues of concern to many include traffic congestion and protection of marine life (turtles and monk seals). Demands for careful archaeological studies and cultural sensitivity have been made forcefully; the archaeological inventory and cultural impact assessment conducted for TBR are part of the resort's response.

BCH staff asked interviewees to comment on the various alternatives and on components of the Proposed Action and alternatives that caught their eye. No consensus emerged. Some preferred the Kawela Conservation plan to the Proposed Alternative because it would limit development at Kawela Bay. A few preferred the Resort Residential Alternative because it involves no new hotels – while others saw a resort residential community as likely to be less responsive to the surrounding community than the operators of a mixed hotel and residential resort. A few said the Proposed Action seemed an appropriate and viable revision of earlier plans.

Some interviewees raised questions about the impact of resort development, especially resort residential development, on property values nearby.

Interviewees were also asked what steps they thought would be appropriate to mitigate effects of the Proposed Action. Some responses dealt with mitigation of specific anticipated impacts; others simply identified ways in which the resort could be of greater benefit to stakeholders:

- **Community housing**: KNS residents largely see "affordable housing" built to government pricing guidelines as unaffordable. Many do not trust the government or any developer to build homes that meet the needs of the regional community.

- **Unionization:** Several resort workers viewed the Proposed Action narrowly in relation to ongoing contract talks with the major union representing workers at the resort. They accused the hotel operators of increasing workloads in order to set a low baseline for future expansion. They viewed expansion as likely to involve facilities that were not unionized, where wages, benefits and working conditions could be worse than at the current hotel.

- **Disaster planning:** Some residents suggested that the resort could help surrounding communities by providing an evacuation site upland or by supporting work to maintain resources that would help the community in case of disasters. A related concern was that additional visitors at the resort would make evacuation even more difficult for the region than it is already.

- **Control over parks**: Conversion of land at Kawela Bay and Kahuku Point to City and County parks would involve increased access for visitors as well as nearby residents. Some question whether the City and County would be able to maintain these parks well. One Kawela Bay resident has spoken publically of his desire for limited access to Kawela, and for policing of any park by the resort. Others may share his hope that new park areas would be kept clean and park usage would be monitored without aiming to limit local access.

- **Pedestrian and bicycle routes**: Some interviewees pointed to the Malaekahana bike path as a valuable addition to the community, and sought to see it extended from Kahuku past Turtle Bay toward Sunset Beach. They mentioned this as bringing together people from Kahuku and Lāʻie who enjoy it as a new pedestrian link between their communities.

These comments should be understood as pointing towards desired goals as much as an analysis of the merits of the Proposed Action or alternatives.

3.2.7 KNS Regional Economy

Local employers support at least some 6,200 jobs. (Many additional jobs exist in the region, but the employers – for example, the State Department of Education – are located elsewhere. In addition, agricultural jobs are not included in Table 3-10.) Figure 3-4 shows the Zip Code areas in the region.

The largest employers are found in the Lāʻie and Kahuku ZipCode tabulation areas. These include the Polynesian Cultural Center, BYUH, Kahuku Medical Center and Turtle Bay Resort. Kahuku, with the Turtle Bay Resort and the Medical Center, has the highest average wage. Haleʻiwa is home to mid-sized retail and food service establishments. Alluvion, which grows and ships plants from Kawailoa, is also in the Haleʻiwa ZipCode area. On the other hand, few businesses are located along the coastline from Kaʻaʻawa through Hauʻula, and their workforce amounts only to 208 persons.

Table 3-10: Employment Patterns by Zip Code of Establishment, 2009

Area	ZipCode	2009 Business Patterns Data					
		Business Establishments	Workforce	Average No. Workers per Establishment	Average Annual Wage	Number of Establishments 50 to 99 Workers	Number of Establishments 100 or more Workers
Kaaawa	96730	10	60	6.0	$27,833	-	-
Hauula	96717	30	148	4.9	$25,601	-	-
Laie	96762	41	2,904	70.8	$18,826	4	2
Kahuku	96731	46	1,251	27.2	$33,160	1	3
Haleiwa	96712	202	1,491	7.4	$25,452	6	-
Waialua	96791	68	349	5.1	$31,350	-	-

SOURCE: ZipCode Business Patterns, 2009, downloads from http://censtats.census.gov/cgi-bin/zbpnaic/zbpsect.pl.

Figure 3-4: Zip Code Tabulation Areas, O‘ahu

Source: US Census

Figure 3-4
ZIP CODE TABULATION AREAS
Socio-Economic Impact Assessment, Turtle Bay Resort
July 2012

Table 3-11 provides more information on the work done by residents of the KNS region. The share of the workforce in the construction industry is high, especially in the North Shore CTs. On the Ko‘olau Loa side of the region, workers in the accommodation/food service/arts and recreation sector are especially numerous. A large share of the jobs in Lā‘ie, with a private university as well as public schools, is in education. Throughout the region, few workers are in the financial and real estate sector. Data on class of workers indicates that self-employment is high in the region, especially in CT 101 (Waimea-Kahuku).

Table 3-11: Industry and Class of Worker, 2006–2010

	City and County of Honolulu	KNS Region	Census Tract 102.01 Hauula-Kaaawa	Census Tract 102.02 Laie	Census Tract 101 Waimea-Kahuku	Census Tract 100 Kawailoa	Census Tract 99.02 Haleiwa	Census Tract 99.04 Kaena Point
Employed Civilian Workers	439,691	14,960	2,394	3,254	3,584	881	1,872	2,975
Industry								
Agriculture	0.8%	2.1%	1.5%	0.4%	1.2%	0.0%	6.0%	3.7%
Construction	7.2%	12.4%	13.7%	7.3%	15.3%	8.7%	9.1%	16.6%
Manufacturing	3.5%	2.3%	3.3%	1.0%	2.5%	3.4%	2.3%	2.6%
Wholesale trade	2.9%	1.7%	2.3%	0.7%	1.3%	0.2%	1.8%	3.4%
Retail trade	11.1%	10.0%	7.8%	7.9%	12.6%	6.0%	14.2%	9.7%
Transportation, Warehousing, Utilities	6.0%	3.3%	2.9%	3.3%	2.2%	3.7%	4.3%	4.3%
Information	2.1%	1.7%	1.6%	1.2%	2.0%	0.9%	0.5%	3.1%
Finance, Insurance, Real estate	7.2%	4.0%	4.8%	3.7%	3.8%	0.0%	4.4%	4.7%
Professional, administrative services	10.2%	7.3%	7.4%	6.3%	2.8%	18.8%	10.6%	8.2%
Education and Health	21.7%	25.5%	28.8%	39.0%	23.2%	19.4%	17.6%	17.7%
Accommodation, Food Service, Arts, Recreation	13.6%	19.8%	14.5%	26.1%	23.3%	21.3%	17.3%	14.1%
Public Administration	9.5%	5.7%	8.8%	1.7%	4.5%	12.6%	8.6%	5.3%
Other services	4.3%	4.0%	2.7%	1.5%	5.3%	4.8%	3.2%	6.6%
Class of worler								
Private wage & salary	71.5%	70.9%	67.1%	80.7%	64.9%	67.1%	72.8%	70.3%
Government	21.9%	18.6%	23.1%	13.6%	18.1%	25.3%	17.7%	19.5%
Self-Employed	6.4%	10.5%	9.9%	5.5%	17.0%	7.6%	9.5%	9.9%
Unpaid family workers	0.2%	0.1%	0.0%	0.2%	0.1%	0.0%	0.0%	0.2%

NOTE: The ACS is based on a series of samples, not an enumeration of the whole population, and is less reliable for cells with small counts. The table refers to residents of the region, who may work in the region or elsewhere.
SOURCE: American Community Survey data, 2006-2010, downloaded from www.census.gov.

Some 80% of the employees of the Turtle Bay Resort live in the KNS region. A recent count of 500 employees' home ZipCodes (provided by TBR) shows 213 (43%) as living in Ko‘olau Loa and 189 (38%) in North Shore ZipCodes. The only other region with more than a few employees was Central O‘ahu, with 76 (15%). In sum, about 40% of employees travel to and from the resort from the Ko‘olau Loa side, and about 60% travel along the highway on the North Shore.

Major Industries

While agriculture was once the local mainstay, its role is smaller nowadays. In Waialua District, much of the land that once was used by Waialua Sugar is now planted in seed corn. Coffee

production, floriculture and vegetable farming have also developed. Cows and horses are still raised in the region, although the local dairy closed in the 1990s. On the Koʻolau Loa side of the region, the remaining farms are mostly small-scale operations. Aquaculture has been developed in the Kahuku region, focusing on shrimp, with mixed success. Lunch trucks offering shrimp plates have done well, and now are a common stop on circle-island tours.

The major industry in the local economy is tourism. The North Shore is renowned as the home of big-wave surfing, and is a destination for visitors' day trips. The PCC in Lāʻie and Waimea Falls Park also attract visitors on circle-island trips. The Turtle Bay Resort not only serves its overnight guests but attracts tourists staying elsewhere and local residents to its beaches, golf courses, and restaurants.

Retail and other commercial establishments are concentrated in Haleʻiwa. In Koʻolau Loa, only Lāʻie supports a retail center larger than a strip mall. The region had industrial centers at the sugar mills in Waialua and Kahuku. Nowadays, the Kahuku Sugar Mill houses a mix of commercial establishments and civic offices, while the Waialua Mill site is home to a mix of small businesses, including surfboard makers, a soap factory, and food vendors. Coffee, chocolate and soda are manufactured in Waialua.

In the KNS region, much of the upland area is used by the U.S. Army and the Marines for training. The training areas may be reached through roads from Central O`ahu not used by the general public, or by convoys on public highways, or by air, with helicopters traveling over the water most of the way from Marine Corps Base Hawaii Kaneohe Bay, then crossing the shoreline area near Kahuku Point or Kawailoa to reach training areas. Also, a military housing area is located at Helemano, just within the North Shore SCP area.

3.2.8 Economic Trends and Proposed Development

For the region's establishments, the average reported wage in 2009 was $24,263. The ACS employed civilian labor force of about 14,960 is more than twice as large as the job count in Table 3-10: most regional workers must travel outside the KNS region to find work. Reported commute times are longer than the island average (except in the Lāʻie and the Kawailoa CTs).

The two major developments that could affect the local economy and employment are the expansion of Turtle Bay Resort and Envision Lāʻie, a planning process sponsored by Hawaii Reserves, Inc., the landowner. Both would support job growth and provide housing. The Turtle Bay Resort expansion would provide new jobs for residents throughout the KNS region.

Job growth through Envision Lāʻie would be more narrowly targeted, since Lāʻie's job centers are closely tied to Mormon church and educational activities. If new housing is for workers in the Lāʻie job centers, it could address crowding in that community with only limited impact on problems of cost and crowding elsewhere in the region. Some 1,260 units have been proposed to

be built out over 25 years.[25] The proposal nearly doubles the Lāʻie housing stock. It could add far more housing to the regional stock than the Proposed Action.

The new inn at Lāʻie would have up to 224 rooms and limited amenities (e.g., a coffee shop rather than a full restaurant). It would not be a resort comparable to Turtle Bay. It would primarily serve PCC and BYUH visitors and visitors to Koʻolau Loa families.

Work has already been completed on projects within the existing footprints of BYUH and the PCC. The Honolulu City Council approved the Special Management Area permit for the new hotel in 2011. New land use approvals would be needed for the university expansion and for a new residential area towards Malaekahana, so the scope and timing of these is currently unknown.

The leading Haleʻiwa landowner, Kamehameha Schools, completed a Master Plan for its North Shore lands in 2008. It includes renovation and expansion of commercial areas in Haleʻiwa, along with limited new residential development. On Kamehameha Schools land, the Kawailoa Wind project is now beginning construction. It would generate approximately 70 MW of power, and be Hawaiʻi's largest wind power facility. The towers are to be located well inland, and would be far less visible than the facility now operating at Kahuku, which was also built by First Wind.

Other new major projects that have been proposed (and opposed) include:

- Relocation of the Hauʻula fire station to commercial land acquired from local owners;
- A second wind farm project in Kahuku, which has been opposed by local stakeholders because its proponents failed to consult the community but claimed to have done so;
- A 75,000-square foot commercial development near the Sunset Beach supermarket was proposed, but plans are on hold, and the developer, Honu Group Inc., does not mention this project on its website; and
- A small hotel to be located near the shore at Haleʻiwa: This would occupy part of the land that the City and County had bought for park expansion; the proposal has inspired intense discussion in the community.

The North Shore Sustainable Communities Plan, passed by the Honolulu City Council in 2011, incorporates plans for revitalization of Haleʻiwa and Waialua as country towns, with new housing allowed nearby. In Haleʻiwa, the landowner and stakeholders support continuing retail development and creation of a community gathering place. For Waialua, industrial redevelopment at the mill site is supported.

[25] This figure was included in revisions to the Draft Koʻolau Loa SCP supported by several Lāʻie and Kahuku members of the SCP advisory group in 2009 (posted at http://envisionlaie.com/wp-content/downloads/kscp_proposed_amendment.pdf). The developer has not recently provided a revised total for housing to be built at Malaekahana.

3.2.9 Infrastructure

As a two-lane roadway, Kamehameha Highway's size limits traffic flow throughout the KNS region. The Haleʻiwa Bypass (Joseph P. Leong Highway) provided a local response to congestion. At Waimea Bay, road improvements and cliff stabilization were needed after a major rock fall in 2000, but another fall in 2007 resulted in a brief closure.[26] The City and County's Parks and Recreation Department has plans for support parks, notably at Laniakea, which could reduce roadside parking and unmanaged pedestrian crossings.

A new pedestrian and bike path opened in 2011 in Malaekahana, linking Lāʻie and Kahuku, as part of the Envision Lāʻie initiative.

The City and County of Honolulu has been seeking a new municipal sanitary landfill site to replace Waimanalo Gulch. A citizen committee has recently identified criteria for preliminary ranking of potential sites before land owner, city, state and federal guidelines are evaluated. Based on their input, a site immediately upland from the Turtle Bay Resort has emerged as the preferred location for a new landfill.[27] The site is under the control of the federal government, and is part of the Army's Kahuku Training Area. The City and County of Honolulu does not have the authority to take Army land without federal consent. Apparently, no consultation with federal authorities had occurred at the time of the study because the analysis was limited to an evaluation of physical land characteristics and did not take into account land ownership.

3.2.10 Similarities and Differences of the Two SCP Areas

The two SCP areas share "country" lifestyles, but these are realized in different ways in different communities.

The racial data in Table 3-2 show the KNS region, as a whole, being distinctive on the island of Oʻahu for its lower share of Asian residents and its large proportion of White residents. Koʻolau Loa has a higher proportion of Native Hawaiʻian and Pacific Island residents than the island as a whole.

Koʻolau Loa and North Shore stakeholders, working with the City and County's planners, have developed similar long-term visions for their areas:

> … Koʻolau Loa seeks to preserve the region's rural character and its natural, cultural and scenic resources. The community envisions a safe and healthy environment based on strong family values, where residents have access to quality jobs, affordable housing, and ample recreational opportunities within the region. Koʻolau Loa will remain country, characterized by small towns and villages with distinctive identities that exist in harmony with the natural settings, defined by the mountain ridges and scenic open spaces which help to give the region its unique form of organization.[28]

[26] Park, G. "Waimea Bay Rocked Again." *Honolulu Star-Bulletin.* April 8, 2007. Posted at http://archives.starbulletin.com/2007/04/08/news/story01.html.

[27] *Pacific Business News*, April 25, 2012. http://www.bizjournals.com/pacific/news/2012/04/25/kahuku-sites-now-top-oahu-landfill.html.

> The North Shore in the year 2035 retains the unique qualities that have long defined its attractiveness to residents and visitors alike. Scenic open spaces are protected and maintained, coastal resources are enhanced, and the region's Native Hawaiian heritage, cultural diversity, and plantation past have been carried forward in the revitalization of its communities.[29]

The former vision emphasizes the continuing wellbeing of local communities rooted in existing towns; the latter emphasizes open space, and treats towns as sites to be "revitalized." This difference is not new, and it is not simply a difference between the two SCP Areas within the region.[30] Areas where many residents value their coastal strip and ocean as "country" include Kaʻaʻawa and Punaluʻu in Koʻolau Loa as well as most of the North Shore. Similarly, "community" orientation and the hope of continuity for families and neighborhoods, from the plantation past to an uncertain present and future, is found as much in Waialua as in Kahuku or Lāʻie.

Local stakeholders in Haleʻiwa and Waialua see their communities as distinct towns with economic hubs to be supported, i.e., Haleʻiwa's mix of tourist retail and other businesses, and Waialua's Sugar Mill redevelopment area. Much the same could be said of Kahuku and Hauʻula in Koʻolau Loa, but their commercial areas appear less successful. Lāʻie stands out because its major employers are closely interrelated. The PCC depends on BYUH for much of its workforce, while it provides financial support to the university. Its economic organization follows from its role as a church center.

The growth of surfing and the surf industry has brought a younger population and an orientation to the ocean, more than to land resources, to the North Shore. The high levels of unemployment in the Haleʻiwa and Kawailoa Census Tracts is understandable if many residents live on the North Shore to enjoy the ocean, and do not need to support families or are willing to accept marginal economic conditions so long as they can live there. Many on the North Shore see their environment as a resource for the island and the entire world, not just for their own community. Accordingly, they may be more concerned with environmental protection than with economic sustainability. However, residents of communities throughout the region support both of these values and assess new initiatives in light of them both.

[28] City and County of Honolulu, Department of Planning and Permitting, *Koʻolau Loa Sustainable Communities Plan Five-Year Review: Public Review Draft.* Honolulu, HI: 2010, p. 2-1.

[29] City and County of Honolulu, Department of Planning and Permitting, *North Shore Sustainable Communities Plan: Public Review Draft.* Honolulu, HI: 2010, p.2-2

[30] The Socio-Economic Impact Assessment for the Kuilima EIS made much the same point in 1984:

> "At a very general level, there is an apparent value difference between residents who are primarily concerned with preserving a 'country' feeling and those who are more concerned with preserving a current 'community' for existing family and friends. While most people would like both, they tend to lean to one or the other if forced to choose." (Community Resources, Inc. and A. Lono Lyman, Inc., Appendix J to the Kuilima EIS, page 4).

3.2.11 Comparison of Current Socio-Economic Trends with Trends Discussed in the 1985 Kuilima EIS

The SEIS Lands and the Resort

Before the Kuilima EIS was processed, parts of the site were under short-term agricultural or residential leases. The leases were not renewed, and beach cottages along the eastern half of Kawela Bay on the SEIS lands were demolished. A major difference between the current situation and that of the Kuilima EIS is that the Proposed Action does not involve displacement of private homes or activities.

In the early 1980s, the hotel had low occupancy levels, and development permits did not, in the view of the owners, allow for adequate growth to achieve a prosperous level of operations. After the 1985 EIS was accepted, the owners took steps towards expansion but soon found they could not implement their plans for macro-economic reasons. In the intervening years, the hotel has been refurbished, and has come to have higher occupancy levels. The Ocean Villas have expanded the resort's offerings. Turtle Bay is now a viable resort operation. It has development permits for expansion and the owners plan to implement a phased development plan.

Regional Economy

In the 1980s, the KNS region was characterized by lower incomes and employment than the rest of the City and County of Honolulu, and by a narrow economic base. The region stood out as the center for aquaculture in Hawai'i. Tourism was recognized as offering "the greatest promise for providing new employment and business opportunities" on O'ahu.[31] While the region included major visitor attractions (at PCC and Waimea Valley), the EIS treated residents as more dependent on agriculture and fishing than tourism. Since then, the surf and visitor industries of the region have expanded, and the North Shore's reputation has grown. Only 2.1% of the civilian workforce is in agriculture (as shown in Table 3-11).

Tourism is now the region's leading industry. Household incomes for most of the region approach or exceed the island median. However, regional unemployment remains above the island average. Commute times for most of the region are still longer than for other parts of O'ahu and are longer than reported in 1980.

Populations and Communities in the Region

Demographic changes include population growth and aging of the overall population (from medians in the region of about 25 years in 1980 to about 32 years of age in 2010). Changes in ethnic composition are not easily specified, since classification schemes for race and ethnicity have changed, but a marked increase in the share of the population identified as (at least in part) White has occurred. However, occupancy rates have changed little.

Housing Market

[31] Community Resources, Inc. and A. Lono Lyman, Inc. *op. cit.*, page 6.

Housing costs on O'ahu have increased greatly over the last thirty years, and the ratio of housing costs to incomes has increased as well. In parts of the KNS region, rentals to vacationers or surfers have tended to increase rents and limit the inventory available to residents. Elsewhere on O'ahu, single-family housing and condominiums have been built in large new subdivisions, but housing development in the KNS region has been far slower than in Central O'ahu and 'Ewa. Available housing within the KNS region is even more limited and costly than before.

Emerging Trends

The 1985 Kuilima EIS dealt at length with the demographics, economy and aspirations of the region. By that time, the closing of Kahuku Sugar had transformed the economy of Ko'olau Loa, and it was clear that Waialua Sugar would close in the near future. Tourism was recognized then as a critical source of new jobs for the region.

The SIA emphasized that the City and County *General Plan* guidelines called for slow population and housing growth – but that existing approvals already provided capacity for a population of approximately 30,400 by 2000. (The actual 2000 population, as shown in Table 3-1, was 108% of the estimated capacity.)

The traffic analysis conducted for the 1985 EIS incorporated assumptions of continuing growth of traffic in the region: traffic was seen as increasing faster than population or housing.

These facts can be read in two ways in relation to the current situation in the region. On the one hand, the problems of a limited economic base, inadequate housing supply, and traffic congestion remain. Expansion of the resort is a source of jobs for many and some homes affordable for KNS families. To the extent that the expanded resort will provide recreation and other activities for its visitors, it might not add much to, and might even reduce, the circle-island visitor traffic in the region. However, some observers emphasize traffic congestion and housing demand, and claim that the need for an alternative job base is no longer pressing. They value the existing resort as a regional amenity but question the need for expansion.

The data reviewed above indicate that local job sources fail to meet the employment needs of many KNS residents, limiting employment for some and forcing others to commute long distances or to leave the region to find work. Both local employment demand and traffic congestion indicate that the main themes of the regional socio-economic analysis provided in the Kuilima EIS are still valid.

4 Socio-Economic Effects of the Proposed Action

Major socio-economic effects of resort expansion can be discussed as emerging from economic changes (capital coming to Hawai‘i for resort construction and, later, as visitor spending) that propel population changes (increased numbers of visitors and resort residents, new housing for local workforce families, incomes that support local families and allow successive generations to stay in the region, rather than move to other areas), and fiscal impacts (new government revenues and the cost of meeting increased demand for public services). These effects may then lead to ones that involve interactions between visitors and residents.

As discussed in Section 1.2, the effects of new development can be counted as “impacts” only in relation to an allowed action future baseline. If the baseline – the existing situation and potential development permitted under current laws – involves development, then the “impact” is the difference between permitted and proposed development. At Turtle Bay, the permits now in force allow for development of the Full Build-Out Alternative. The Proposed Action scales down new development, and limits its footprint.

In this chapter, the effects of the Proposed Action are contrasted with those of the No Action Alternative. Effects of the Full Build-Out Alternative and other development alternatives are assessed later.

It is useful to deal first with quantifiable effects. Once these have been discussed, readers are better able to assess whether significant qualitative effects occur. For quantitative and qualitative effects alike, both the development of effects over time and the cumulative effects deserve study. This chapter deals with effects of the Proposed Action; effects of the alternatives are discussed in the next chapter.

The Proposed Action will bring more visitors and workers to the resort. Wages from resort and resort-related jobs will in turn support resident households in the region. For this reason, population and housing effects are discussed below after estimating the number of operations jobs created by visitor spending, both at the resort and elsewhere in the region.

This chapter provides a step-by-step account of the estimation of demographic, economic and fiscal impacts of the Proposed Action. Sources for the analyses are shown as notes to tables. Some are discussed in more detail in Appendix B. The costs and benefits of the Proposed Action are summarized in Chapter 7.

4.1 Employment and Wages

The Proposed Action will bring both short-term jobs during the construction period and continuing operations jobs. Construction will involve an estimated 3,263 direct jobs over 11 years. Construction workers on-site at the resort during that period will number about 237 on average. The number of new continuing operations positions at the resort will climb to about

753. Next, visitor spending will not be confined to the resort, so the attraction of additional visitors to Turtle Bay will support an estimated 443 additional jobs in Hawai‘i by 2025.

Wages from both construction and continuing jobs will support island households. By 2025, the regional increase in wages is expected to be more than $30 million annually (2011 dollars, based on $23.8 million in resort operations wages and $7.4 million in the KNS region for off-site tourism-related work).

Investment in new facilities creates short-term jobs during the construction period and continuing jobs in building and landscape maintenance, security and administration. Visitor spending supports operations jobs on a continuing basis. While both have effects throughout the island economy, construction and construction-related jobs do not have much effect on the regional population size, except by providing nearby, relatively reliable jobs for residents of the region who are already construction workers.

4.1.1 Construction Employment and Wages

Project construction would begin as soon as building permits are granted. Assuming that construction begins in 2014, the completion schedule in Table 4-1 is expected:[32] Construction-related jobs would last until build-out.[33] All construction jobs are estimated as full-time jobs for a given year. These fall into the following categories:

1. On-site construction jobs: workers at the resort. Their number is estimated on the basis of annual construction spending. The actual number of workers on a given day would vary according to the jobs to be done.

2. Other direct construction jobs: Firms responsible for construction have workers at their offices and base yards as well as on-site. As a rule of thumb, on-site workers account for 80% and off-site workers account for 20% of direct construction jobs.

3. Indirect jobs: These are jobs supported when construction firms buy materials and services locally.

4. Induced jobs: These jobs are supported by expenditure of wages of direct and indirect workers. These include, jobs in retail trade, or educational and health services.

The distinction among direct, indirect and induced employment comes from Input-Output analysis. The models developed and maintained by the State Department of Business, Economic Development and Tourism (DBEDT) provide multipliers for indirect and induced jobs by

[32] The construction timetables in this report follows from an analysis provided by TBR. It depicts a process of market absorption. It should be viewed as a best estimate of likely demand over several years, rather than a strict, year-by-year, prediction of what will be built and sold at the resort.
[33] This account does not include design and engineering jobs which are not closely tied to the schedule.

Table 4-1: Construction Timetable, Proposed Action

	Cumulative, through 2025	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
New hotel units, for occupancy in year		30	30	30	64	65	60	70	70	70	71	65
New residential units, for occupancy in year												
Resort Residential		131	74	75	47	48	49	49	38	37	27	15
Community Residential		44	25	19	19	19	13	13	8			
Hotel units built by end of year	625	30	60	90	154	219	279	349	419	489	560	625
Residential Units built by end of year												
Resort Residential	590	131	205	280	327	375	424	473	511	548	575	590
Community Residential	160	44	69	88	107	126	139	152	160	160	160	160
Share of infrastructure $$ spent by end of year	100%	35%	45%	46%	52%	59%	65%	94%	96%	97%	99%	100%

SOURCE: TBR.

industry. The specific multipliers used are identified in Appendix B. Table 4-2 shows construction spending and the associated workforce for the Proposed Action.

Construction work ends when a structure is built. The job counts for the entire period are person-years of employment, over the 11 years of construction. As shown in Table 4-2, the average on-site construction workforce would number approximately 237 over 11 years.

Table 4-2: Construction-Related Jobs and Wages

	TOTAL	Annual Data 2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Construction Spending (million, 2011 $s)												
Infrastructure	$148.5	$48.0	$14.4	$3.5	$8.9	$10.4	$9.2	$40.2	$4.3	$3.3	$3.4	$2.9
Buildings	$324.4	$46.5	$31.8	$30.4	$32.6	$26.4	$23.1	$29.7	$25.7	$26.0	$27.4	$24.9
Single Family	$297.0	$49.8	$26.4	$26.7	$26.4	$31.0	$32.0	$32.8	$25.3	$22.5	$18.3	$5.9
	$769.9	$144.3	$72.5	$60.6	$67.9	$67.8	$64.3	$102.7	$55.3	$51.9	$49.1	$33.6
Direct Construction Workforce												
Infrastructure	564	183	55	13	34	39	35	153	17	12	13	11
Buildings	1,363	195	133	128	137	111	97	125	108	109	115	104
Single Family	1,336	224	119	120	119	140	144	147	114	101	82	26
	3,263	602	307	261	290	290	276	425	238	223	210	142
On-site Const. workers	2,611	482	245	209	232	232	221	340	191	179	168	113
Construction period (yrs.)	11											
Average annual on-site FTE	237											
Indirect and Induced Jobs	5,482	1,011	515	439	486	487	463	714	400	375	353	238
Wages (million, 2011 $s)												
Direct	$225.3	$41.6	$21.2	$18.0	$20.0	$20.0	$19.0	$29.4	$16.4	$15.4	$14.5	$9.8
Indirect and Induced	$247.7	$45.7	$23.3	$19.8	$22.0	$22.0	$20.9	$32.3	$18.1	$16.9	$16.0	$10.7
Total Wage Impact	$473.0	$87.2	$44.4	$37.9	$42.0	$42.0	$40.0	$61.6	$34.5	$32.4	$30.5	$20.5

NOTES: Construction spending estimated by Belt Collins Hawaii, based on input from TBR. Workforce counts based on recent job counts per construction spending. On-site workforce estimated on assumption that 20% of direct workforce is at baseyards, offices or otherwise off-site. Indirect and induced jobs estimated from Hawaii State Input-Output Model. Wages estimated from data for the construction industry and for all covered employment, for City and County of Honolulu, in 2009, adjusted to 2011 wages in proportion to changes in the Consumer Price Index. The numbers shown are rounded, so totals may differ slightly from the sum of the individual numbers in the table.
SOURCES: DBEDT, 2012, 2011, 2009; DLIR, 2011.

4.1.2 Operations Employment and Wages

A resort development demands staffing not just for accommodations, but also in food services, landscaping, building services, security and real estate. With an increased visitor population, demand for recreation would create additional jobs as well. Some retail jobs would be on-site at the resort, in hotels, in the new Gathering Place or at the farmer's market.

Operations jobs are expected to continue so long as a resort attracts visitors and residents. Spending at the resort would generate indirect and induced jobs in turn. Table 4-3 shows both direct jobs and indirect and induced ones.

Resort visitors also spend money off-site, for transportation, services, food and goods. The number of jobs involved can be estimated on the basis of statewide data on the jobs supported in the state economy by visitor spending. These jobs are calculated by DBEDT as direct and indirect jobs. For the present analysis, total spending by resort visitors for items other than lodging is estimated, and the associated jobs are counted. Off-site jobs can be estimated by subtracting out the on-site jobs from the total jobs supported by visitor spending, as shown in Table 4-4:

Table 4-3: On-Site Operations Jobs and Related Jobs, Proposed Action

	2025 -- Full Absorption	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Operations Jobs												
Direct Workers												
Hotel	511	25	49	74	126	179	228	285	342	400	458	511
Food and Beverage	140	8	15	22	36	51	64	80	95	110	126	140
Retail	51	3	6	9	14	20	24	30	35	41	46	51
Recreation Services	7	0	1	1	2	2	3	4	4	5	6	7
Landscaping	13	2	3	4	5	6	7	9	10	11	12	13
Security	13	2	3	4	5	6	7	9	10	11	12	13
Realty/Management	19	2	3	5	6	8	10	12	14	16	18	19
Direct Total	753	41	79	117	194	272	344	428	511	593	677	753
Indirect + Induced Workers	785	42	81	120	201	282	357	444	531	618	706	785
Total	1,539	83	160	237	395	554	701	872	1,042	1,211	1,383	1,539
Annual Wages (Million 2011 $s)												
Direct Workers	$23.8	$1.3	$2.5	$3.7	$6.1	$8.6	$10.9	$13.5	$16.1	$18.7	$21.4	$23.8
Indirect and Induced Workers	$35.5	$1.9	$3.7	$5.4	$9.1	$12.7	$16.1	$20.1	$24.0	$27.9	$31.9	$35.5
Total	$59.2	$3.2	$6.1	$9.1	$15.2	$21.3	$27.0	$33.6	$40.1	$46.6	$53.2	$59.2

NOTES: Employment estimated by Belt Collins Hawaii, based on development timetable and employment at Turtle Bay and comparable resorts. Job counts are based on the number of units built or occupied, as described in Appendix B. Sources for indirect and induced jobs and for wage estimates by industry are the same as in the preceding table, using the multipliers for the industries shows in the table. (See Appendix B for multipliers.) The numbers shown are rounded, so totals may differ slightly from the sum of the individual numbers in the table.

SOURCES: DBEDT, 2012, 2011, 2009; DLIR, 2011.

Table 4-4: Off-Site Employment Supported by Visitor Spending

	2025 -- Full Absorption	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Visitors Staying Overnight in New Units												
Total	2,206	221	386	553	729	921	1,102	1,326	1,534	1,753	1,997	2,206
Adjusted total, spending	1,862	154	280	406	562	727	880	1,068	1,248	1,440	1,664	1,862
Spending, Non-lodging												
Per person per day	$104.73	$104.73	$104.73	$104.73	$104.73	$104.73	$104.73	$104.73	$104.73	$104.73	$104.73	$104.73
Annual (Million $s)	$71.2	$5.9	$10.7	$15.5	$21.5	$27.8	$33.7	$40.8	$47.7	$55.0	$63.8	$71.2
Jobs from Visitor Spending												
Total (Direct and Indirect)	765	63	115	167	231	299	362	439	513	592	686	765
minus On-site (DII)	322	24	42	61	95	127	158	192	226	259	293	322
Off-site (DI)	443	39	73	106	137	172	205	246	287	333	393	443
Regional Share	177	16	29	42	55	69	82	99	115	133	157	177
Wages, Off-site (Million $s)	$18.4	$1.6	$3.0	$4.4	$5.7	$7.1	$8.5	$10.2	$11.9	$13.8	$16.3	$18.4
Regional Share	$7.4	$0.7	$1.2	$1.8	$2.3	$2.9	$3.4	$4.1	$4.8	$5.5	$6.5	$7.4

NOTES: Visitor total is all visitors in new hotel and resort residential units. "Adjusted total, spending" counts only half of the visitors in residential units, since (a) some of these may stay for longer periods, and spend less per day, and (b) these seem more likely to patronize big box stores outside the KNS area. Off-site jobs estimated from average non-lodging visitor spending per-person per day in Hawai'i, 2010, and statewide ratio of jobs generated by visitor spending (including direct and indirect jobs) as modeled by DBEDT for 2010. Visitors in the Proposed Action are assumed to spend 110% of average visitors to Hawai'i. Direct jobs generated on-site (excluding accommodations jobs) plus associated indirect and induced jobs are subtracted from the total. For consistency, average wage for visitor spending direct and indirect jobs is also taken from the State model (Data Book Table 7.32) which shows $41.505.50 in household income associated with each visitor-related job (including indirect jobs) as of 2010. Regional share of off-site jobs estimated by Belt Collins Hawaii LLC as 40%, based on visitor spending patterns (by industry) analyzed by DBEDT. The numbers shown are rounded, so totals may differ slightly from the sum of the individual numbers in the table, and shares of totals may reflect unrounded numbers.

SOURCES: DBEDT, 2011a, 2011b.

4.2 Population Growth and Distribution

As of 2025, the Proposed Action is expected to increase the number of people staying overnight at the Turtle Bay Resort (including the hotel and Kuilima Estates) from about 1,267 visitors and residents to approximately 4,167 persons on average (an increase of 2,900). During the daytime, many of these people would go outside the resort, but employees and day visitors would come to the resort. The daytime population growth with the Proposed Action is estimated as from about 1,485 to about 4,401 (an increase of 2,916).

Population growth at Turtle Bay Resort has already been anticipated in government projections for slow increases in the region's resident population.

4.2.1 Population at the Resort

Three different sorts of population effects are discussed in this report. With new hotel units and housing, the number of persons staying overnight on-site increases. During the daytime, many residents and some of the visitors staying on-site will be elsewhere, but the on-site population includes operations workers, construction workers, and day visitors to the resort. Regional population effects are estimated as including (a) new visitors to the resort and resort residents, (b) residents of community housing who come from outside the region, (c) persons who come to the region to take jobs supported by visitor spending, whether jobs at the resort or elsewhere in the region. On-site totals are typically larger than regional totals because many residents living at the resort or, supported by resort-related jobs and living elsewhere in the region, are not new to the region.

Currently, approximately 1,485 persons are at the Turtle Bay Resort at any given time, not counting construction workers. The number of persons present may be greater, when major events such as concerts or the Fourth of July celebrations attract people from outside the resort. Table 4-5 shows the breakout of persons estimated as on-site on, say, a weekday that is also a state holiday, when many residents might remain on-site. Table 4-6 provides a similar account of population with the Proposed Action.

4.2.2 Population Effects throughout the KNS Region

Table 4-7 estimates the new regional resident population anticipated with the Proposed Action, taking into account both new on-site population at the resort and population supported by new jobs throughout the region. The Proposed Action would contribute about a third of resident population growth for the 2025 KNS region, as shown in Table 4-7. (This calculation involves allocating to the region a share of island-wide effects. The shares shown are selected to provide a high but realistic estimate of regional effects.)

Table 4-7 combines counts of resort visitors and new regional residents to estimate the regional de facto population increase associated with the Proposed Action. However, no regional de facto

count of residents and visitors either passing through or staying in the region has been published, so this population cannot be compared either to a current total or projected growth.

Table 4-5: Estimated On-Site Daytime Population, Existing Turtle Bay Resort

	Daily (1)	Around noon (2)
Hotel and Ocean Villas guests	850	638
Kuilima Estates		
FT Residents	223	167
PT residents, visitors	194	146
Day visitors	Varies	96
Operations workforce, by industry		
Accommodations	350	280
Food and Beverage	115	69
Retail	25	13
Recreation Services	25	23
Landscaping	28	25
Security	35	18
Realty/Management	12	12
Subtotal	590	439
Construction workers (3)	14	12
Total		1,497

NOTES: Estimated from data provided by TBR, other operators, traffic study survey, and 2010 U.S. Census data. Day visitors include a few golfers, riders, surfers, and visitors to restaurants, but their numbers can be much larger during conferences, contests or concerts. The numbers shown are rounded, so totals may differ slightly from the sum of the individual numbers in the table. FT = full-time; PT = part-time.

(1) Present at some time for an average day. Not all employees are likely present at the same time.

(2) On-site at the same time, during a typical day, e.g., at noon. Some 75% of guests and residents expected to be present.

(3) Some renovations may be ongoing at any time. The figure used here is a rough estimate of the possible average over time, based on recent traffic counts.

The new on-site population at the resort (in Table 4-6) is larger than the new regional population (in Table 4-7). That is because much of the population new to the resort would come from the region: the community housing would largely serve families from the region.

Table 4-7: Estimated Contribution of Proposed Action to Regional Population Increase

	2010	2025
Regional Population Estimates		
DPP Forecast (2009)	31,880	34,276
2010 Census + Adjusted Forecast (1)	34,452	37,041
Resident Population Groups Associated with Proposed Action		*Islandwide*
A. TBR Resort Recreation Residents		55
B. TBR Community Housing Residents		638
C. Direct Operations Workforce Households (2)		1,613
D. Indirect and Induced Operations Workforce Households (2)		896
E. Off-Site Workforce Households (2)		505
Total (assuming unduplicated counts)		3,707
Potential New Regional Resident Population (3)		*KNS Region*
A. 100% of group		55
B. 30% of group		192
C. 20% of group		323
D. 20% of group		179
E. 40% of group		202
Total		**951**
Share of Projected Regional Population Increase		36.7%
Regional New De Facto Population Change		951
New Regional Resident Population with Proposed Action		2,206
New TBR Visitor and Part-time Population		3,157
Total		

NOTES: See Tables 3-8, 4-3, 4-4, 4-6.

(1) Adjusted estimate applies DPP projected growth rates, but starts from the actual 2010 Census population.

(2) For this calculation, the ratio of workers to residents in KNS households in 2010 was used to estimate workforce household populations.

(3) Regional population growth can occur either when housing opens up for people to move into the region or when jobs open up, making it possible and attractive for workers to move (or move back) to the region. In the case of Community Housing, the estimate is of households whose place in existing housing units will be taken by in-migrants to the region who are not counted in C., D., or E.

Table 4-6: Estimated Turtle Bay Resort On-Site Daytime Population, based on Proposed Action

	Existing Resort	2025 -- Full Absorption	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
	New Daytime Population with Proposed Action												
Hotel , Ocean Villa guests	638	1,139	65	130	194	297	400	493	607	721	845	998	1,139
Resort Residential (including Kuilima Estates)													
FT Residents	167	41	9	14	20	23	26	30	33	36	39	40	41
PT residents, visitors	146	516	101	160	221	250	291	334	387	429	470	499	516
Community Residential		479	132	206	263	320	377	416	455	479	479	479	479
Day Visitors	96	180	62	84	86	108	130	151	165	169	172	176	180
Operations workers	439	561	30	59	87	145	202	256	319	380	442	504	561
Construction workers	-	-	245	209	232	232	221	340	191	179	168	113	-
Total	1,485	2,916	645	862	1,102	1,374	1,647	2,020	2,157	2,393	2,614	2,811	2,916

NOTE: Only construction workers involved in new construction (rather than renovation) are included. Day visitors are expected to increase as Kawela Bay and other areas open to the public and as resort amenities become available. Golfers from outside the resort would decrease with fewer holes available on the Fazio Course. The Proposed Action would increase the number of persons on-site to a total of 4,358 after build-out. The population associated with the existing resort accounts for 34% of that total. The numbers shown are rounded, so totals may differ slightly from the sum of the individual numbers in the table.

Table 4-7 includes the assumption that some 40% of jobs supported by off-site visitor spending would be held by regional residents. That assumption takes into account the facts that much visitor spending goes for transportation and other services that may be based outside the region, and that jobs supported by visitor spending include indirect jobs, e.g., the manufacture of food or clothing purchased by visitors. Most of those indirect jobs would be outside the immediate region.

4.3 Fiscal Effects

Fiscal impacts consist of revenues generated by new development offset by new costs to local government incurred in order to support the new development and associated populations. New revenues can be estimated from new capital brought to Hawai‘i by project development and through visitor spending. New costs can be estimated as a share of the government spending needed to support Hawai‘i’s visitor and resident populations.

The Proposed Action will result in a cumulative net benefit – i.e., total benefits minus total costs – for the period 2014 to 2025 estimated as $163.4 million for the State of Hawai‘i and as $45.6 million for the City and County of Honolulu (in 2011 dollars). After full occupancy has been reached, the annual net benefit for the State will amount to $14.6 million, while the net benefit for the City and County will be about $6.6 million yearly.

4.3.1 Revenues

New revenues for the State of Hawai‘i come from (a) construction spending and construction-related workers’ incomes and spending, (b) cash flows with purchase or rental of real estate, and (c) other visitor spending. These are estimated for the major taxes used to collect such revenues in Tables 4-8 and 4-9. Additional property taxes for the City and County of Honolulu are estimated separately in Table 4-10.

Annual state construction-related revenues amount to nearly $10 million by 2020. Operations-related revenues for the state already exceed $10 million as of that year, and grow as spending by resort visitors increases.

Property tax revenue increases occur as land is redeveloped and new improvements are built. As Table 4-11 indicates, property tax revenues on new resort and residential units would amount to some $4.7 million in 2020, and would continue to increase until, after full absorption, they stabilize at approximately $8.3 million per year. The cumulative collections through 2025 would amount to $50.3 million.

Currently, the City and County of Honolulu collects about $12.4 million in real property taxes annually from residential and resort properties in the KNS region.[34] As of 2025, real property

[34] Estimated taxes compiled by Belt Collins Hawaii from Hawaii Information Service data (derived from City and County of Honolulu Real Property data), June 2012.

taxes on residential and resort units within the Proposed Action would amount to about $8.3 million of additional revenue annually, a major increase in funds available to support municipal services.

The property tax analysis is based on a detailed timetable for development of hotel and residential structures. Estimates of the increase in value of land are based on the new value of land developed, minus an average of values for land subject to redevelopment over time. The analysis omits the value of all new commercial structures and amenities, and increased value of the land they occupy.

Table 4-8: Government Revenues Associated with Construction

All figures are Millions of 2011 $s	Cumulative, through 2024	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Construction cost (1)	$769.9	$144.3	$72.5	$60.6	$67.9	$67.8	$64.3	$102.7	$55.3	$51.9	$49.1	$33.6
Construction-related Wages (2)	$473.0	$87.2	$44.4	$37.9	$42.0	$42.0	$40.0	$61.6	$34.5	$32.4	$30.5	$20.5
Excise Taxes To State (3)												
On Construction	$31.2	$5.8	$2.9	$2.5	$2.8	$2.7	$2.6	$4.2	$2.2	$2.1	$2.0	$1.4
On Spending by Workforce (4)	$12.0	$2.2	$1.1	$1.0	$1.1	$1.1	$1.0	$1.6	$0.9	$0.8	$0.8	$0.5
Excise Taxes to City and County of												
On Construction	$3.5	$0.6	$0.3	$0.3	$0.3	$0.3	$0.3	$0.5	$0.2	$0.2	$0.2	$0.2
On Spending by Workforce (4)	$1.3	$0.2	$0.1	$0.1	$0.1	$0.1	$0.1	$0.2	$0.1	$0.1	$0.1	$0.1
Income Taxes												
Corporate (5)	$1.3	$0.2	$0.1	$0.1	$0.1	$0.1	$0.1	$0.2	$0.1	$0.1	$0.1	$0.1
Personal (6)	$28.8	$5.3	$2.7	$2.3	$2.6	$2.6	$2.4	$3.8	$2.1	$2.0	$1.9	$1.3
Total Revenues from Construction Spending												
State of Hawaii	$73.3	$13.6	$6.9	$5.8	$6.5	$6.5	$6.2	$9.7	$5.3	$5.0	$4.7	$3.2
City and County of Honolulu	$4.8	$0.9	$0.5	$0.4	$0.4	$0.4	$0.4	$0.6	$0.3	$0.3	$0.3	$0.2

NOTES: Since occupancy is expected to be achieved in 2025, Belt Collins has treated 2024 as the last year of construction. Values are rounded, so totals may be slightly different than the sum of the values in the table.

1 Estimated by Belt Collins Hawaii, in millions of mid-2011 dollars.

2 From Table 4-2.

3 The State collects General Excise Tax (4%) and, on O'ahu, an additional tax for transit (0.5%). Act 247 of 2005 directs the State to retain 10% of the County surcharge for administrative costs. Hence the State share of excise taxes is 4.05%, while the City and County share is 0.45%.

4 Excise tax is calculated on disposable income, estimated as 62.6% of wages (from historical spending rates).

5 Corporate income tax estimated (from historical rates) as 0.17% of revenues (data from 2000).

6 Personal income tax estimated as 6.1% of taxable income (from 2005 data).

SOURCES:

DBEDT 2011, 2005; Hawaii State Department of Taxation, 2001, 2008

Table 4-9: Government Revenues Associated with Real Estate Purchases and Visitor Spending

All figures are Millions of 2011 $s	Cumulative, through 2025	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Conveyance Taxes	$5.1	$0.8	$0.5	$0.5	$0.5	$0.5	$0.4	$0.5	$0.4	$0.4	$0.4	$0.3
Taxes on Visitor Accommodations												
Transient Accommodations Tax (Hotel Condominiums and Visitors in Resort Residential Units)	$32.9	$0.8	$1.3	$1.8	$2.2	$2.7	$3.1	$3.6	$4.0	$4.3	$4.5	$4.6
Transient Occupancy Tax (Time Shares)	$16.3	$0.1	$0.5	$0.7	$0.9	$1.1	$1.3	$1.6	$1.9	$2.2	$2.8	$3.2
Taxes on Cash Flows from Visitor Spending												
Excise Taxes												
On Lodging (Visitors only)	$16.0	$0.4	$0.6	$0.9	$1.1	$1.3	$1.5	$1.7	$1.9	$2.1	$2.2	$2.2
On Other Visitor Spending	$17.7	$0.3	$0.5	$0.7	$1.0	$1.3	$1.5	$1.8	$2.1	$2.5	$2.9	$3.2
On On- and Off-Site Workers' Spending	$11.7	$0.1	$0.3	$0.4	$0.6	$0.8	$1.0	$1.2	$1.5	$1.7	$2.0	$2.2
Excise Tax Total	$45.5	$0.8	$1.4	$1.9	$2.6	$3.4	$4.0	$4.8	$5.6	$6.3	$7.0	$7.6
State of Hawai'i Share	$40.9	$0.7	$1.2	$1.7	$2.4	$3.0	$3.6	$4.3	$5.0	$5.7	$6.3	$6.9
City and County of Honolulu Share	$4.5	$0.1	$0.1	$0.2	$0.3	$0.3	$0.4	$0.5	$0.6	$0.6	$0.7	$0.8
Income Taxes												
On- and Off-Site Workers	$25.3	$0.3	$0.6	$0.8	$1.3	$1.7	$2.2	$2.7	$3.2	$3.7	$4.2	$4.7
State of Hawai'i Total	$120.6	$2.7	$4.0	$5.5	$7.2	$9.0	$10.7	$12.7	$14.4	$16.3	$18.2	$19.7
City and County of Honolulu Total	$4.5	$0.1	$0.1	$0.2	$0.3	$0.3	$0.4	$0.5	$0.6	$0.6	$0.7	$0.8

NOTES: All taxes estimated from current rates (excise at 4.5%; TAT at 9.25%; TOT at 7.25% of half of maintenance fee for period of occupancy; conveyance taxes at escalating rates depending on cost and whether buyer is a Hawai'i resident) and historic ratios between earnings or revenues and taxes. Excise tax on workers' income estimated for taxable disposable income. Property sale values and maintenance fees estimated by Belt Collins Hawaii based on information from TBR and review of comparable projects. Values are rounded, so totals may be slightly different than the sum of the values in the table.

Table 4-10: Increased Property Tax Revenues for the City and County of Honolulu, with Proposed Action

	2025 -- Full Absorption	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Land Redeveloped (acres)												
Annual	11	40	23	22	22	21	20	19	13	14	17	11
Cumulative	221	40	62	84	106	127	147	166	179	193	210	221
Value of Redevelopment (Mill $s) (1)												
Residential Construction	$441.0	$84.2	$130.8	$176.3	$210.7	$243.0	$275.0	$320.1	$357.6	$392.3	$422.9	$441.0
Residential Land	$586.8	$118.8	$182.0	$245.9	$309.5	$369.3	$429.9	$481.2	$516.7	$549.1	$577.6	$586.8
Hotel Construction	$175.9	$11.6	$23.1	$34.7	$59.3	$84.3	$107.4	$120.9	$134.4	$148.2	$163.3	$175.9
Hotel Land	$202.7	$9.3	$18.7	$28.0	$41.8	$55.7	$68.1	$84.6	$101.2	$124.0	$165.9	$202.7
Property Taxes (Mill $s)												
Annual Collections (new development built to date)												
Residential	$3.6	$0.7	$1.1	$1.5	$1.8	$2.1	$2.5	$2.8	$3.1	$3.3	$3.5	$3.6
Hotel, Resort	$4.7	$0.3	$0.5	$0.8	$1.3	$1.7	$2.2	$2.5	$2.9	$3.4	$4.1	$4.7
Cumulative Collections	$50.3	$1.0	$2.6	$4.8	$7.9	$11.8	$16.4	$21.8	$27.8	$34.4	$42.0	$50.3

NOTES: Land "redeveloped" is land that changes from existing use as golf or open space to hotel and residential, under or around new structures. Value of new development is taken from est construction costs and review of land values for hotel and resort residential properties in KNS and KO 'Olina. Land values are net, i.e., the increase in land value, over average current value for properties at Turtle Bay Resort, with redevelopment. The analysis does not deal with commercial space and other amenities in the resort. It is a conservative estimate of new property values taxes, not a complete one. The numbers shown are rounded, so totals may differ slightly from the sum of the individual numbers in the table
(1) For particular years, the value is for development coming on market that year; for absorption, it is the value of the entire project.

4.3.2 Government Costs and Net Benefit

New development may increase costs to government by increasing demand for services, by relocating demand to areas where service delivery is difficult, or by creating demand for new facilities. For a resort, many of these costs can be estimated using average cost analysis. This analysis identifies on a per-person basis the amount that government agencies actually spend. Some costs are treated as for services only to residents; other costs benefit both residents and visitors. The per-person cost is derived by dividing the cost of services by the resident or de facto (residents and visitors actually in-state or on-island on an average day) population in the year the services are provided. This approach estimates new resort-related costs in terms of the number of new residents and visitors served.

The average cost approach does not address the question of whether a new development demands significant new facilities, i.e., situations in which the marginal cost of serving additional residents or visitors is much greater than the average cost. Input from public service agencies and the analysis in the remainder of this chapter suggest that new facilities would not be warranted to serve the new populations associated with the Proposed Action., i.e., that the average cost analysis provides a reasonable estimate of actual costs associated with the Proposed Action.

Table 4-11 provides an average cost analysis for the State of Hawai'i, and Table 4-12 covers the average cost of services by the City and County of Honolulu, based on recent expenditure reports.

Table 4-11: Average Cost Analysis, State of Hawai'i

	FY 2009 spending ($1,000s)	Spending for residents or all?	Resident share	Visitor share
General expenditure, by function:				
General government	$597,210	All	$431.47	$431.47
Education	$3,362,707	Residents	$2,610.22	--
Public welfare	$2,119,481	Residents	$1,645.20	--
Health	$798,026	All	$576.56	$576.56
Highways	$442,421	All	$319.64	$319.64
Public safety	$435,414	All	$314.58	$314.58
Natural resources	$120,693	All	$87.20	$87.20
Culture and recreation	$110,404	All	$79.76	$79.76
Urban redevelopment, housing	179,819	Residents	$139.58	--
Economic development and assistance	$149,075	Residents	$115.72	--
Debt service	$401,722	All	$290.24	$290.24
Other and unallocable	$3,084	All	$2.23	$2.23
Total	$8,220,571	***Total Per Person***	$6,612	$2,102
		Adjusted to 2011	**$6,830**	**$2,171**

NOTES: Average cost is the cost of services delivered over a year's time, calculated per person, for resident or de facto population, depending on function. Some functions, such as highway maintenance, benefit both residents and visitors; for these the per-person share is estimated based on the de facto population. (The de facto population is the number of persons present on an average day, i.e., the average visitor census plus the number of residents actually in-state or, for the City and County of Honolulu, on the islands.) Spending is for the most recent year for which expenditures reported by function in Data Book (Table 9.19). The per-person spending totals are then adjusted in line with changes in the Consumer Price Index (3.29% from 2009 to 2011).

State of Hawaii Population, mid-2009:

Residents	1,288,285
De Facto	1,384,124

SOURCE: DBEDT, *State of Hawaii Data Book 2010; Quarterly Statistical and Economic Report, First Quarter, 2012*

Table 4-12: Average Cost Analysis, City and County of Honolulu

	FY 2009 spending ($1,000s)	Spending for Residents or All?	Resident share	Visitor share
General expenditure, by function:				
General government	$149,994	All	$151.91	$151.91
Public safety	$371,627	All	$376.37	$376.37
Highways	$16,781	All	$17.00	$17.00
Mass transit	$3,863	Residents	$4.04	$0.00
Miscellaneous	$218,130	All	$220.91	$220.91
Sanitation	$3,863	All	$3.91	$3.91
Health and human resources	$71,606	Residents	$74.93	$0.00
Culture and recreation	$73,087	All	$74.02	$74.02
Utilities and other enterprises	$27,758	All	$28.11	$28.11
Capital outlay	$330,581	Residents	$345.93	$0.00
Debt service	$185,164	All	$187.53	$187.53
Total	$1,452,454	***Total per person***	**$1,485**	**$1,060**

NOTES: Average cost calculated for resident or de facto population, depending on function. Some functions, such as road maintenance and public safety, benefit residents and visitors alike. Other functions benefit residents, and may benefit future visitors, but most recent year with expenditures reported by function in City's Consolidated Annual Financial Report.

City and County of Honolulu Population, mid-2010:

Residents	955,636
De Facto	987,406

SOURCES: DBEDT, State of Hawaii Data Book 2010; City and County of Honolulu, Consolidated Annual Financial Report for Fiscal Year 2011. Personal communication, Jan Nakamoto, State Data Center, July 2011.

Revenues would exceed project-related costs for both the state and county. Visitor-related and new resident-related costs to the State of Hawai'i associated with the Proposed Action are estimated as totaling about $28 million through build-out – but revenues for the state would be more than $190 million over that time. Revenues would continue to exceed costs by a large margin in later years.

Similarly, the City and County of Honolulu would see revenues greater than costs throughout the project development period and afterwards. At build-out, the net new revenues would exceed $45 million. The Proposed Action would continue to generate additional revenues from property taxes.

After 2025, the State would continue to collect an estimated $19.7 million (2011 dollars) in taxes annually due to visitor spending at the resort, while the City and County would collect about $8.3 million annually from property taxes. (City and County excise tax revenues are dedicated to the mass transit project and are to be eliminated when project costs are covered.)

Table 4-13: Summary of Government Revenues and Costs, Proposed Action

	Cumulative, through 2025	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
State of Hawai'i													
Revenues (Mill. $s)	$193.9	$13.6	$9.6	$9.9	$12.0	$13.7	$15.2	$20.4	$18.0	$19.4	$21.0	$21.4	$19.7
Average cost, Visitors	$2,171												
Average Census, Visitors staying at Resort	12,729	-	221	386	553	729	921	1,102	1,326	1,534	1,753	1,997	2,206
Visitor-Related Costs (Mill. $s)	$27.6	$0.0	$0.5	$0.8	$1.2	$1.6	$2.0	$2.4	$2.9	$3.3	$3.8	$4.3	$4.8
Average cost, Residents	$6,830												
Full-time Resort Residents at Resort	416	-	12	19	26	31	35	40	44	48	51	54	55
Resident-Related Costs (Mill. $s)	$2.8	$0.0	$0.1	$0.1	$0.2	$0.2	$0.2	$0.3	$0.3	$0.3	$0.4	$0.4	$0.4
Total Costs	$30.5	$0.0	$0.6	$1.0	$1.4	$1.8	$2.2	$2.7	$3.2	$3.7	$4.2	$4.7	$5.2
Net Revenues > Costs	$163.4	$13.6	$9.0	$8.9	$10.6	$11.9	$13.0	$17.7	$14.8	$15.8	$16.8	$16.7	$14.6
City and County of Honolulu													
Revenues (Mill. $s)	$59.7	$0.9	$1.5	$2.1	$2.9	$3.8	$4.6	$5.7	$6.2	$6.9	$7.6	$8.5	$9.1
Average cost, Visitors	$1,060												
Average Census, Visitors staying at Resort	12,729	-	221	386	553	729	921	1,102	1,326	1,534	1,753	1,997	2,206
Visitor-Related Costs (Mill. $s)	$13.5	$0.0	$0.2	$0.4	$0.6	$0.8	$1.0	$1.2	$1.4	$1.6	$1.9	$2.1	$2.3
Average cost, Residents	$1,485												
Full-time Resort Residents at Resort	416		12	19	26	31	35	40	44	48	51	54	55
Resident-Related Costs (Mill. $s)	$0.6	$0.0	$0.0	$0.0	$0.0	$0.0	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1
Total Costs	$14.1	$0.0	$0.3	$0.4	$0.6	$0.8	$1.0	$1.2	$1.5	$1.7	$1.9	$2.2	$2.4
Net Revenues > Costs	$45.6	$0.9	$1.2	$1.7	$2.2	$2.9	$3.6	$4.5	$4.7	$5.2	$5.7	$6.3	$6.6

NOTES: See Tables 4-8 to 4-12. The values shown are rounded, so totals may differ slightly from the sum of the individual values in the table.

4.4 Social Impacts

4.4.1 Housing

The Proposed Action would address the regional housing problem in four ways:

- Affordable housing will be built for members of the local community to buy or lease;
- With more stable jobs in the region, more residents will want to, and be able to, set up their own households nearby; and
- Resort residential housing will supply mostly luxury market-price homes and condominiums that may appeal to upper income residents as well as visitors.
- Resort residential housing at Turtle Bay Resort could attract some of the visitors who would otherwise stay in illegal transient vacation rental units. By reducing demand from that group, the Proposed Action would tend to discourage illegal rentals, and hence encourage some of the region's landlords to make housing available for residents.

While community housing (and, to a lesser extent, resort housing) would respond to resident housing demand, new workforce incomes will tend to increase demand. Additional wages for operations-related workers would help them establish families and households of their own. Household formation occurs over time, as workers gain families and savings. It can be affected by economic conditions such as housing prices and mortgage rates.

Table 4-14 estimates the first two potential housing effects for the KNS region, as of project absorption. The regional estimate includes both on-site workers and a share of off-site workers whose jobs are supported by visitor spending. Based on surveys of resort workers in West Hawai'i conducted in the 1980s, new incomes appear sufficient, over time, to support new household formation for 15% to 30% of the regional resort workforce.[35]

The table suggests that the regional effect of the Proposed Action is limited and could be positive: new workforce housing creation within the project could be greater than new household formation. Also, the new community housing is expected to be built from the beginning of the construction period, while housing demand due to new operations jobs would grow over time, as working families save for new homes.

35 Research on population and housing effects of resort development has dealt mainly with the introduction of resorts in rural areas. The present case involves expansion, in an area where skilled resort workers are already present. There is no reason to expect resort expansion to draw a large body of workers from other areas, and to have large effects on housing when the new facilities open. (Also, the market study for the project calls for gradual development of facilities from year to year, not a one-time opening event.) The high estimates based on earlier research may consequently overestimate the extent to which resort expansion affects demand for housing.

The effect of increases in resort residential housing supply on regional housing demand and prices depends on many factors, and is not estimated here. It is expected to be positive, i.e., to increase local supply available to meet resident demand.

Table 4-14: Major Housing Effects Associated with Proposed Action, KNS Region

As of 2025	Proposed Action
New Operations-Related Jobs	
On-site	753
Other direct jobs, KNS region (1)	177
	930
Dependents supported by new KNS workforce (2)	965
Households supported by workforce	556
New household formation over time (3)	
Low estimate (15%)	83
High estimate (30%)	167
New community housing at TBR	160
Housing Impact (Demand for Units):	
Low Estimate	77
High Estimate	(7)

NOTES: On-site jobs estimated in Table 4-3; off-site jobs derived from Table 4-4.

(1) Other direct jobs estimated as 40% of direct and indirect workforce supported by off-resort spending.

(2) Dependency ratios from 2006-2010 Five-year estimates for KNS region:

Population in households	31,111
Workforce	15,275
Average household size	3.41

(3) New housing demand estimated as 15% to 30% of workforce households, based on studies of West Hawaii resorts.

SOURCE: American Community Survey. (www.census.gov)

4.4.2 Public Safety Services and Facilities

Future without Project (No Action Alternative)

For Fiscal Year 2011/2012, the City and County of Honolulu adopted budget allows for the following positions:

- Police: 1,484 patrol officers (about 1.56 per thousand persons in the island of O‘ahu); and
- Fire Protection: 1,018 fire operations positions (about 1.07 per thousand).

The ratio of positions to population provides a basis for estimating need for additional staffing as local populations rise.

Future with Proposed Action

The Proposed Action would account for regional population growth of about 3,157 persons (including both residents and visitors). To provide for that increase, some 4.9 police patrol officers and 3.4 fire operations positions could be needed (extrapolating from recent ratios).[36] That increase is within the growth that can reasonably be forecast given recent DPP expectations.

The population increase does not appear large enough to motivate construction of new public safety facilities.

Redevelopment of the resort would bring increased patrols by resort security. New roadways, park facilities and landscaping would remove large areas of brush from the TBR lands. New construction would be to current fire codes, reducing the risk of fire and increasing access to the entire resort. All of these factors would tend to reduce demand for public safety services due to new development.

4.4.3 Educational Facilities

Schools

The State Department of Education is expected to provide its own projections of demand for school services and facilities associated with the Proposed Action. The estimates in this section offer projections for the Proposed Action and the Development Alternatives based on Census data.

Future without Project (No Action Alternative)

The regional population is expected to grow slowly, so demand for schools would likely increase slightly over the next decades.

Proposed Action

The Proposed Action would affect several groups with school-age dependents. Some, but not all, would have an effect on schools:

[36] The cost of increased fire protection and police protection might be estimated from current expenditures for salaries, overhead and patrol equipment. It is not calculated here, because it has already been estimated using the average cost approach (in Table 4-13).

- **Resort Residents:** New resort housing generates very little or no new public school student enrollment. Most such resort housing is occupied by part-time occupants. Full-time resort housing occupants tend not to have school-age children. They are unlikely to enroll in public schools the few children who live in resort homes.

- **Community Housing Residents:** Community housing at Turtle Bay is intended to serve the needs of existing regional residents, not to attract a new population. Some of those residents would vacate existing housing that then could house other families. Many would move from multi-generational homes, where they would not be so quickly replaced. The total number of households in the region would accordingly increase due to the development of community housing, but the increase would likely be a small fraction of the number of new homes built. The increase in the number of new public school students would similarly be small.

- **Workers in New Resort Jobs:** As estimated in Tables 4-3 and 4-4, operations jobs and visitor spending could increase the regional resident population. Dependents of such new resident workers could attend local schools.

Table 4-15 provides estimates of total regional new enrollment, based on the analysis of regional housing growth over time in Table 4-14. BCH suggests that the likely effect could fall near the midpoint between the low and high estimates.

Table 4-15: Potential New Public School Enrollment, Proposed Action, to 2025

	Proposed Action
New Community Housing	160
New Households Formed by Workers	
Low Estimate	83
High Estimate	167
Potential New K-12 Enrollment	
Low Estimate	49
High Estimate	123

NOTES: Enrollment estimated based on the 2010 ratio of households to Department of Education K through 12 students on O'ahu (37.6 students per 100 households). The low enrollment estimate counts, as generating student enrollment, only 30% of the new community housing units plus the low estimate of new households formed by workers as a new source of students. The high enrollment estimate counts all of the new community housing plus workers' household formation as sources of new students, and assumes that no double counting is involved in combining the two. In both cases, Resort Residential housing is not treated as a source of DOE students. Readers should note that all or nearly all the occupants of community housing are expected to be KNS region residents: this estimate follows standard practice for school impact studies but not the full set of assumptions used in earlier tables.
SOURCES: US Census; Hawai'i State Department of Education enrollment data posted in 2010.

The effect estimated here is regional, not confined to the immediately adjacent schools. It would occur over many years, not immediately. An increase of about 100 students (as compared to the current regional DOE enrollment of 4,826) would amount to about 2% of total enrollment, an amount that would likely not raise problems of capacity for regional schools. Consequently, even the high estimate does not indicate a significant effect on DOE schools.

4.4.4 Preschools

The recent American Community Survey for 2006 to 2010 counted 561 children enrolled in preschool among KNS residents, or 6.14 per 100 households.

Future without Project (No Action Alternative)

The regional population is expected to grow slowly, so demand for preschools would likely increase slightly over the next decades. As noted earlier, demand for preschools has decreased in recent years due to reduced state funding and tight family budgets. Access to preschool education is a theme of the education initiatives supported by the current state administration, so state funding could increase.

Proposed Action

With more resort jobs available, some local workers can avoid long commutes. Some young parents may rejoin the labor force, seeking part- or full-time work near home if they can combine work with child-care that meets their needs and standards.

The same analysis used for school enrollments can be made for preschools. Table 4-16 shows the new preschool enrollment associated with the Proposed Action to be modest. This analysis does not address the question of whether new resort employees would seek child-care facilities near the resort; the UA specifies establishment of such a center on or near the resort.

Table 4-16: Potential New Preschool Enrollment, Proposed Action, to 2025

	Proposed Action
New Community Housing	160
New Households Formed by Workers	
Low Estimate	83
High Estimate	167
Potential New Preschool Enrollment	
Low Estimate	8
High Estimate	20

SOURCE: U.S. Census, American Community Survey, 2006 through 2010.

4.4.5 Health Care

Future without Project (No Action Alternative)

A study published in 2003 reviewed both long-term demand trends and changes in technology and operations affecting usage of hospital beds. While increased demand was expected by 2010 and 2025, the report was "cautiously optimistic" about Hawai'i's ability to meet the population's need for acute and long-term care beds.[37] From 2001 through 2007, O'ahu had approximately 2,513 civilian acute care hospital beds, which were occupied about 67% of the time.[38] That number of beds corresponds to 2.7 beds per thousand persons (in the de facto population). However, the recent closure of a two-hospital corporation serving Honolulu and Leeward O'ahu has aroused new concerns.[39]

The City and County of Honolulu Emergency Medical Service staff currently includes 283.75 positions, or about 0.30 per thousand persons on O'ahu.[40]

Proposed Action

The regional population increase associated with the Proposed Action by 2025 – 951 regional residents and 2,206 visitors – might justify the addition of nine more beds (at historic occupancy levels) to the island's acute care inventory. The population increase associated with the Proposed Action might create demand for an EMS staff position by 2025.[41]

4.4.6 Recreational Opportunities

Resort Recreation

Future without Project (No Action Alternative)

If no further development occurs at Turtle Bay, both golf courses might remain open as 18-hole courses. Tennis and equestrian activities could be unchanged.

Proposed Action

With the Proposed Action, a new clubhouse and a new equestrian center would be built. The Fazio golf course would be redeveloped as part of an integrated 27-hole facility. With the onsite

[37] Hawaii Health Information Corporation. "Forecasting Long-Term Care and Acute Care Bed Days in Hawaii: Projections to 2025." Posted at http://hawaii.gov/shpda/resources-publications/shtrend.pdf.
[38] DBEDT, *State of Hawai'i Data Book 2010,* Table 2.26.
[39] A bill to authorize revenue bonds (HB2345) to cover the debts of Hawaii Medical Center was considered in the 2012 State Legislature but was not passed by both chambers. Both island and Mainland corporations have expressed some interest in re-opening one or both of these hospitals.
[40] The estimate is based on the budget passed by the City Council for the current fiscal year.
[41] As noted before for public safety services, the cost of service to new populations due to the Proposed Action was estimated in the average cost analysis.

visitor and resort resident population increased by about 195%, demand for golf is likely to increase, and usage would increase. The increased demand could affect other courses as well. The Kahuku public course could attract a few more resort residents and visitors. With higher usage, and perhaps higher fees at Turtle Bay, golf tour operators serving the island as a whole would tend to send fewer golfers to Turtle Bay.

Beach and Ocean Activities

Future without Project (No Action Alternative)

With no further action, demand for beach and ocean access at the resort would likely not increase greatly. However, beach, ocean education and beach park maintenance would not be improved. An increase in usage of Kawela Bay is likely, since the site is gaining a reputation as a "secluded" beach where turtles can be seen. Access would not be improved, so most visitors would park along the edges of Kamehameha Highway and walk to the beach around the gate.

Proposed Action

The Proposed Action calls for establishment of parks at Kawela Bay, Turtle Bay, Kuilima Bay, and Kahuku Point, with a total of 12 public shoreline access points. These improvements would help residents and visitors spread along the coastline, rather than congregating near the hotel(s) because stalls at the new parks will reduce the need for beachgoers to park at the hotel. While beach usage would increase significantly with more hotel guests and resort residents, the easily accessible area for beachgoers would also increase. Higher and more consistent usage of these sites would occur. As City and County beach parks, the Kawela and Kuilima Point parks might be staffed by lifeguards, when City and County budgets permit. The resort's operators can be expected to help maintain these sites and the surrounding area, assuring they are kept clean and secure, and helping to lower risks of ocean safety incidents.[42]

Parks and other Recreation Sites

Future without Project (No Action Alternative)

In the future without project alternatives, resident and visitor usage of beach parks and other public recreation sites in the KNS region would probably increase slowly, in line with growth in the island resident and visitor populations. Park usage already creates problems for circulation, especially at times of high surf and surf competitions.

Proposed Action

With the development of new parks at Kawela Bay and the Kahuku Point coast open to the public, Turtle Bay Resort would draw off some of the visitor traffic now clogging the roadside

[42] No claim is made here that the resort would staff the parks with lifeguards or other full-time staff, only that the presence of beachgoers, surf school staff and/or resort staff, would lower the risk of accidents and harm in ocean sports and that resort operators would be interested in supplementing City and County maintenance activities.

near Laniākea Beach and North Shore surf sites. However, the reduction and how much it might affect the overall traffic and pedestrian congestion issue are difficult to forecast.

New parks and pathways, along with improved access to beach areas, will make walking, jogging and bicycling more appealing for both resort visitors and their neighbors. Much as the new bikeway between Lāʻie and Kahuku encourages walking and sociability for the residents of those towns, so new trails and resources at the resort can encourage outdoor recreation and social interaction for resort-goers and residents, especially if new trails extend the length of the resort.

4.4.7 Geographic Extent of Effects

On-Site Effects

Construction work would bring a new workforce to the resort by 2015. If, as anticipated, new hotel and residential construction proceeds incrementally in response to market demand, construction would continue through 2024, with an average daytime on-site construction workforce of approximately 237 persons. (After 2024, some work to maintain and repair facilities would likely occur. The timing and extent of such work would depend on design and construction choices still to be made, and are not analyzed herein.)

New operations jobs would be created by 2015 and increase in numbers along with the increase in hotel and resort residential units. After build-out, the new on-site workforce would be about 753 workers, in addition to the current Turtle Bay workforce. The total operations workforce for the resort (including existing jobs) would be about 1,343 workers.

As reported earlier, some resort workers are concerned that new properties at Turtle Bay Resort would be non-union, and that expansion would result in increased workloads for both current and future staff. They ask whether the new hotel properties would be "full-service." Several factors bear on this concern:

- Because the Proposed Action consists of a resort expansion over several years, not a whole new resort created all at once (as the Waikoloa Hilton was), workforce growth would occur regularly over about ten years.

- Time share properties are sometimes thought to demand fewer staff per room for housekeeping and other departments. This may have been true of time share properties in areas such as Waikīkī in the past. Time shares at Turtle Bay will be staffed to support a relaxing resort experience for guests. Also, time shares would support an early marketing staff as well as staff on-site attending to guests.[43]

[43] Time share marketing staff may be on-site, off-site or even out of state. Consequently, this employment effect is not included in the analysis.

- Turtle Bay is an isolated resort, so the operator and on-site subcontractors provide a wide range of services and amenities for guests. With more hotel units and housing on-site, demand for resort services would increase.

- Successful expansion would depend on maintaining and enhancing the resort's reputation. New hotel properties would likely be more upscale than the existing hotel, and stand-alone resort residential units could be comparable to the Ocean Villas and other properties in Kapalua and Wailea on Maui. The operators would need to maintain or improve customer service throughout the resort.

- TBR is considering fair employment rules that could bind future operators to provide jobs with wage scales commensurate with similar jobs in the area.

In light of these factors, it seems likely that the expansion would bring significant job growth and moderately high staffing levels. In 2010, Maui Island had 0.89 accommodations jobs per visitor unit.[44] For the Proposed Action, the accommodations staffing for the new properties is estimated as 0.82 accommodations jobs per hotel unit.[45] This is higher than the current ratio for the Turtle Bay Hotel and Ocean Villas (about 0.70 to 0.75 accommodations jobs per unit).

Both time share and condominium hotel properties are likely to achieve high occupancy levels, much like those currently experienced at Turtle Bay. Time share properties are especially likely to have continuously high occupancy. Time share buyers have already invested in their units, and operators can rent out unsold weeks. With high occupancies would come consistent employment – more full-time jobs, fewer on-call and perhaps fewer part-time jobs.

The Proposed Action (and the Conservation Partner Alternative) surround the existing hotel and residential areas with new properties designed to attract today's visitors and second-home buyers. The Proposed Action increases the population on-site and hence demand for recreational resources. It would refurbish those resources and greatly improve access to beachfront areas. The number of golf holes would actually decrease from 36 to 27. New restaurants and other amenities may attract new day visitors, but this group is not being targeted to increase greatly.

The Gathering Place, combining retail, food and cultural amenities, could draw new day visitors to the resort. Some would spend a short time at the resort; others could combine a visit to the Gathering Place with a half- or full-day trip to the resort beaches. Day visitors' numbers and time on the property could climb during special events. The Gathering Place has been conceived as serving resort guests and residents of the region, not as a new draw attracting visitors from outside the KNS region.

[44] Data available from series maintained on DLIR and DBEDT websites: (http://www.hiwi.org/gsipub/index.asp?docid=421; http://hawaii.gov/dbedt/info/visitor-stats/visitor-plant/2010VPI.pdf). Unit count includes visitor condominiums as well as hotels. Job count is for accommodations only, i.e., only part of the workforce at hotels.

[45] This estimate was based on occupancy and staffing at other hotels viewed as offering comparable experiences, not on the global comparison mentioned here. See Appendix B for further discussion.

Development of a park at Kawela Bay would affect usage of this resource. The bay is already well known to area residents. It is mentioned in Internet reviews as "secluded," so improved access would both allow more users to reach the beach easily and reduce its status as a mysterious find. However, the beauty of the site, calm waters, and wildlife would likely attract many more beachgoers and ocean users, so recreational use would increase significantly.

Effects on the existing properties, owners and residents at Turtle Bay depend first on the fact of new development and secondly on its extent.

First of all, construction would likely bring some traffic, noise, and dust effects. These would be highly controlled. Contractors would be subject to State and City and County regulations limiting these effects. Moreover, the owners of the resort would presumably seek to minimize construction effects on existing properties in the resort, assuring operating income through the construction period. Also, the proposed construction schedule, involving incremental development over several years, points to a process that could restrict construction to delimited areas at any one time.

Construction is expected to last over some 11 years for the Proposed Action, and much longer for the Full Build-Out Alternative. Hotel construction and ongoing operations (at Turtle Bay Hotel and new hotels in the resort) can be successfully combined. This has been evident at the Maui Marriott at Ka'anapali, where workers transformed the concrete and steel structure floor by floor over several years from a traditional hotel to a time share property. The hotel retained high occupancy levels despite construction impacts.

The Turtle Bay Hotel would become the central property of a larger destination resort. The owner would likely maintain and upgrade it as part of the process of attracting upscale clients to the resort as a whole. While new resort properties may be more exclusive in reputation and achieve higher returns, their success would depend on the entire resort. Again, new amenities and activities would serve Turtle Bay Hotel guests as well as new visitors.

The Kuilima Estates condominiums would be affected by additional factors. The overall effect is not entirely clear:

- With development of new hotels near the shoreline, persons in the condominium units facing the ocean would see more buildings and more resort landscaping. In the case of the Proposed Action, the change is likely to involve an increase of visible landscaping (as opposed to ironwoods and brush at the far side of the Fazio golf course) as much as an increase in visible structures. Current plans call for structures to be spread out within the areas designated for hotel development, and for extensive landscaping. (Kuilima Estates units now have golf course or interior views, not unobstructed ocean views.)

- The Fazio golf course is expected to be refurbished as a nine-hole course. The published concept plan for the Proposed Action shows the entire Fazio Course area as continuing to be a golf course (rather than part being a golf course, and part being used simply as open space). A less cluttered course with appropriate landscaping would result in an improved view amenity for many units with views on and over the golf course.

- Increased activity nearby and the convenience of shopping at the Gathering Place and Farmer's Market would appeal to many residents, owners and renters.

Some property owners are concerned that the Proposed Action could result in lower values for some or many units in Kuilima Estates. BCH expects that this would not occur, so long as (a) the resort developer takes steps to ensure that visual effects of new development bring attention to the landscaping and open space in the resort and (b) the condominium owners maintain their properties and common areas. The resort owners' enthusiasm for the "Tomorrow's Ahupua'a" concept and acceptance of the role of steward for the Turtle Bay lands suggest that the redevelopment would enhance, rather than lower, the value of private property within the bounds of the resort.

The resort's neighbors, both in Kuilima Estates and outside the TBR lands, could benefit from improved access to beaches, paths and landscaping with redevelopment. Residents of homes along Kawela Bay would see increased recreational use of the bay, and hence a loss of the feeling of seclusion in their neighborhood.

Regional Effects

Regional effects follow largely from changes in employment at the resort, in off-site employment supported by visitor spending, and in the resort's contribution to regional traffic congestion. The last issue is analyzed in a separate study for the SEIS. Employment-related issues must be considered in light of (a) the quantity and quality of new jobs, (b) whether the regional population is able to take new jobs on-site and nearby, and (c) implications for housing, public facilities and community life. The first two issues are discussed in this section, while the last is discussed in relation to particular facilities and communities.

Some 753 new operations jobs would be created at the resort as of build-out by 2025. Additional jobs in the region would be due to off-site visitor spending and to the indirect and induced effects of operations employment. The off-site total is estimated as approximately 443 new off-site jobs island-wide, with a regional total of 177 off-site jobs.

The new jobs would likely be in a range of industries supporting resort facilities and activities. Similar jobs at the resort have been described in interviews as the best available in the KNS area, since few employers offer salaries, benefits, and job security found at a unionized resort. Island-wide, the average annual wage for the combined industries is approximately $22,850[46]. Resort workers at Turtle Bay gain union wages and substantial benefits, and many receive tips, over and above their wages.

The region's workforce can supply workers for both on- and off-site jobs. In addition to the 1,120 persons estimated as unemployed, the local high schools average more than 300 students in their senior class. The local school-leaving population would be far larger than the number of new jobs created annually. Many of these young adults would seek further education and jobs

[46] Wages from "hotel" and "food and beverage" jobs combined, based on 2009 data adjusted to 2011 dollars. Source is State Department of Labor and Industrial Relations, *Employment and Payrolls in Hawaii, 2009*.

elsewhere. Still, an increase in jobs in the region would offer them the opportunity to stay near their homes – to choose among nearby jobs, long-distance commuting, and relocation to urban areas. In effect, by increasing local demand for workers, resort expansion would benefit the region as a whole.

The anticipated development schedule for the resort involves building and opening increments over time. This gradual approach would help to support local access to jobs. Sudden creation of a large number of jobs would be more likely to result in hires from outside the region and off-island.

Establishment of a farmers' market on-site and new demand for local foods in resort restaurants and kitchens would help support regional agriculture. It is not clear how large an effect is involved, and any growth in local production would also be due to landowners' efforts to support local farms and to the overall growth of the island market for fresh foods.

The new visitors and employees brought by the Proposed Action will contribute to regional traffic. See the Traffic Impact Assessment Report in the SEIS for further detail on the project's contribution to regional congestion and on traffic management strategies.

As indicated in Table 4-14, the contribution of the Proposed Action to the resident housing stock will be of immediate benefit, and will likely be larger than the new demand generated over time by households supported by project-related jobs.

Little or no impact on property taxes would occur for two reasons. First, Real Property assessors typically separate new developments from existing ones as separate "neighborhoods," and value them separately. Next, while increases in resident and resort housing stock could help to counter the trend towards increased prices (and hence taxes), price effects are felt throughout the island market, of which Turtle Bay and the KNS region are only a small part.

Island and Statewide Effects

For many decades, Hawai'i leaders have seen the visitor industry as the engine of the local economy, and visitor industry expansion as occurring mainly on the Neighbor Islands. The latter trend has been inflected by resort development at Ko 'Olina. Large new time share projects have succeeded there in recent years. New development at Turtle Bay Resort would similarly offer visitors a resort experience on O'ahu but away from Waikīkī. Continued tourism development is anticipated in both state and county planning projections.

The fiscal analysis shows that all the development alternatives generate new cash flows for the state and county. New revenues would far exceed average cost effects. Consequently, major government spending on infrastructure or public facilities for the region could be justified as funded by regional growth.

4.5 Quality of Life and Community Cohesion

KNS stakeholders interviewed for this study saw their region positively, despite serious traffic congestion and limited job opportunities. None spoke of the region as needing major social changes or community organizing.

Factors affecting quality of life throughout the region include:

- Employment and incomes for residents, both at the resort and in the surrounding region;
- Housing for members of the community;
- Changes in traffic patterns and congestion;
- Increased child care opportunities, aimed to meet the needs of resort workers;
- Reduced commuting, allowing residents more time for their families and for community involvement;
- New support for regional activities and causes from the residents and operators of the resort; and
- Resources and amenities at the resort including access to beach parks and new retail outlets.

If new job growth in the region were concentrated in Lā'ie, in facilities linked to the Church of Jesus Christ of Latter-Day Saints, there would be limited employment opportunities for the rest of the region and little pressure to maintain or increase wages other than the existing union contracts in force at Turtle Bay. Due to incremental regional population growth, long-distance commuting to other parts of O'ahu would likely increase in the absence of new jobs at Turtle Bay Resort.

Trends associated with the Proposed Action affecting local community life include regional employment growth (and hence presumably less commuting), new housing being developed for local residents, an increase in resort and parks resources, along with increases in both visitors and part-time residents, and the spending in the local economy that would accompany them.

The Proposed Action's impacts on traffic congestion are assessed in a separate technical study, and not considered further here.

With new jobs and income associated with the Proposed Action spread throughout the KNS region by 2025, the project would have beneficial economic impacts and could help local communities to draw on more of the time and energy of residents for community activities than would be possible in the No Action future. The proposed new community housing area would

increase workforce housing in the immediate area.[47] The impact on resident housing would be positive or absent: the Proposed Action includes much more resident housing than would likely be demanded as a result of job project-related job growth.

The new visitor and part-time resident populations based at the resort would contribute to the region's economy as well as its traffic. Development of the commercial areas and cultural attractions at the Gathering Place would tend to increase the amount of their time spent at the resort, not on the road.

Some full-time resort residents could become active members of the larger community. Their involvement would depend on many factors. Resort residents in other parts of Hawai'i include local benefactors for community institutions along with some notable opponents of new development. Others – probably the large majority of resort homeowners – have little to do with groups and issues outside the boundaries of their home resort. Their consumer behavior would help to support local retailers, encouraging them to stock more items for affluent residents, not just for day visitors.

TBR is developing a non-profit Turtle Bay Foundation to address needs of the community. Future operators and homeowners would, as participants in a master resort association, contribute to the foundation.

Turtle Bay already has an important role in the lives of members of the KNS regional community. With expansion, the resort would also offer a greater range of retail, service and cultural venues for regional residents. Plans for the Gathering Plans and Farmers' Market and for cultural activities are intended to address residents' needs, not just those of short-term visitors.

More resort guests would seek to use beach and ocean resources than now – but access to such resources would greatly improve. Also, many new visitors at Hawai'i resorts make little use of ocean resources. Some stay at the resort pool; others walk the beach, but do not venture far into the ocean. Consequently, much of the increase in resort visitor numbers with the Proposed Action would be far smaller at the beaches and in the ocean than within the hotels.

4.6 Secondary and Cumulative Impacts of the Proposed Action

In an environmental impact statement, it is important to cover both direct and secondary or cumulative impacts. Secondary and cumulative impacts arise from the interaction of changes due to a project with the existing and expected context. The socio-economic analysis covers all of these effects by considering the existing resort along with proposed new development, and by identifying effects in the regional, island and state contexts.

[47] This statement follows from (a) assurances by TBR that the community housing would be priced to meet the needs of local workers, not just to meet government pricing rules, and (b) the fact that jobs at TBR have stood out in the region as offering stable employment and, in most cases, excellent benefits.

A major question is whether new developments will have a cumulative impact that overshadows the impact of any one development. In the KNS region, the TBR and Envision Lā'ie expansions concentrate new development in a fairly small area. They seem more complementary than likely to have reinforcing impacts. The Lā'ie development would increase enrollments at BYUH and workforce housing for the Lā'ie community. Again, the hotel in the Lā'ie project would not be a resort but an amenity supporting BYUH and the PCC. It would have limited amenities and would likely serve a different market than the existing and proposed Turtle Bay Resort hotels.

These two projects should not have significant cumulative effects. They both would address residents' demand for housing – but the demand for housing at reasonable prices is great, and the two projects would encourage workers to live near their work sites, reducing highway commutes. When and if the Envision Lā'ie project's housing is approved and built out, it could reduce local demand for workforce housing appreciably. However, that project is designed to serve the Lā'ie community, not provide housing to attract others to the region or address the problems of Kahuku and the North Shore.

Lā'ie and Kahuku are currently the largest communities in the KNS region. Even with much new housing in the two communities, they would remain distinct both geographically and economically. The development of one or two community housing increments at Turtle Bay Resort would not change the "country" appearance of the region.

The Proposed Action may have an important secondary impact on the regional housing supply. With new resort housing available, many vacationers will be drawn to units at the resort, rather than to illegal transient vacation rentals. Demand for the illegal units will be reduced, and some of these will become available for rental at rates that residents can afford.

5 Socio-Economic Effects of ~~Development~~ Alternatives

For this report, the effects of the Proposed Action and each development alternative are quantified both over the period through 2025, and over the period leading to full occupancy for each alternative. (Full occupancy dates range from 2022 for the Conservation Partner alternative, to 2053 for the Full Build-Out alternative.) The No Action alternative is considered in this chapter, but not shown in tables where a No Action column would simply show no impacts.

The analysis in this chapter follows the same organization as in the last chapter. To compare operations and fiscal effects of the Development Alternatives, calculations are shown for development through 2025 – i.e., Full Absorption for the Proposed Action and the Resort Residential Alternative, and shortly after Full Absorption for the Community Partner Alternative -- and for the actual year of Full Absorption.

Table 5-1 compares the construction schedules for the four alternatives to 2025. It shows that, while the Full-Build Out alternative will over time involve far more hotel and resort residential units than the Proposed Action, fewer units would be built by 2025. (The No Action alternative involves no new construction, so it is not listed in Table 5-1.)

Table 5-1: Construction Plans, Development Alternatives

	Action and Alternatives			
	Proposed Action	Full Build-out	Resort Residential	Conservation Partner
Through 2025				
Hotel units	625	592	0	440
Residential Units				
Resort Residential	590	468	454	252
Community Residential	160	90	46	48
Build-out year	*2024*	*2052*	*2024*	*2021*

NOTE: When completed, the Full Build-Out Alternative would include 2,500 hotel units, 910 resort residential units, and 90 community residential units. Development schedule estimated by TBR.

5.1 Employment and Wages

5.1.1 Construction Employment and Wages

In Table 5-2, construction spending, employment and wages are shown for the entire construction period for each of the development alternatives. The annual average on-site construction workforce provides a point of comparison among the alternatives. While the Full Build-Out Alternative, when finished, involves far more construction than the other alternatives,

the Proposed Action brings the highest average annual construction workforce, simply because the larger project could only be built over a very long time.

Table 5-2: Construction-Related Employment and Wages, Proposed Action and Development Alternatives

	Proposed Action	Full Build-Out	Resort Residential	Conservation Partner
Construction Spending (million, 2011 $s)				
Infrastructure	$148.5	$215.1	$120.0	$87.8
Buildings	$324.4	$1,138.6	$4.5	$167.3
Single Family	$297.0	$16.2	$304.1	$115.1
Total	$769.9	$1,369.9	$428.5	$370.2
Direct Construction Workforce				
Infrastructure	564	636	456	334
Buildings	1,363	4,782	19	702
Single Family	1,336	73	1,368	518
Total	3,263	5,491	1,843	1,554
On-site Const. workers	2,611	4,393	1,474	1,243
Construction period (yrs.)	11	39	11	8
Average annual on-site FTE	237	113	134	155
Indirect and Induced Jobs	5,482	9,225	3,096	2,611
Wages (million, 2011 $s)				
Direct	$225.3	$379.1	$127.3	$107.3
Indirect and Induced	$247.7	$416.8	$267.2	$118.0
Total	$473.0	$795.9	$394.4	$225.3

NOTE: The values shown are rounded, so totals may differ slightly from the sum of the individual values in the table.
SOURCES: See Tables 4-2, 5-1.

5.1.2 Operations Employment and Wages

The next two tables compare the long-term workforces associated with the development alternatives. Both 2025 and full-occupancy estimates are provided. As of 2025, the Proposed Action would bring the largest operations workforce – but the Full Build-Out would involve far more workers, both on-site and off-, as its visitor numbers and spending grow. The Resort Residential Alternative stands out as generating only modest numbers of new jobs. Moreover, the Resort Residential Alternative would support very few off-site jobs through visitor spending.

Table 5-3: On-Site Employment and Wage Impacts, Proposed Action and Development Alternatives

	Proposed Action	Full Build-Out	Resort Residential	Conservation Partner
As of 2025				
Operations-Related Workers				
Direct Workers	753	530	48	469
Indirect + Induced Workers	785	559	43	494
Total	1,539	1,089	91	963
Wages (Million 2011 $s)				
Direct Workers	$23.8	$16.8	$1.6	$14.8
Indirect and Induced Workers	$35.5	$25.2	$1.9	$18.5
Total	$59.2	$42.1	$3.5	$33.3
After Full Absorption				
Estimated Absorption	*2025*	*2053*	*2025*	*2022*
Operations-Related Workers				
Direct Workers	753	2,240	48	469
Indirect + Induced Workers	785	2,359	43	494
Total	1,539	4,598	91	963
Wages (Million 2011 $s)				
Direct Workers	$23.8	$71.1	$1.6	$14.8
Indirect and Induced Workers	$35.5	$106.6	$1.9	$18.5
Total	$59.2	$177.6	$3.5	$33.3

NOTE: The values shown are rounded, so totals may differ slightly from the sum of the individual values in the table.
SOURCES: See Tables 4-3, 5-1.

Table 5-4: Off-Site Employment and Wage Impacts Associated with Visitor Spending, Proposed Action and Development Alternatives

	Off-site Employment from Visitor Spending			
	Proposed Action	Full Build-Out	Resort Residential	Conservation Partner
As of 2025				
Visitors Staying in New Units				
Total	2,206	2,202	483	1,477
Adjusted total, spending	1,862	1,793	242	1,376
Spending, Non-lodging				
Per person per day	$104.73	$89.92	$132.24	$119.01
Annual (Million $s)	$71.2	$49.7	$11.7	$59.8
Jobs from Visitor Spending				
Total (Direct and Indirect)	765	534	125	643
minus On-site (DII)	322	261	91	240
Off-site (DI)	443	273	34	402
Regional Share (40%)	177	109	14	161
	-			
Wages, Off-site (Million $s)	$18.4	$11.3	$1.4	$16.7
Regional Share (40%)	$7.4	$4.5	$0.6	$6.7
After Full Absorption	***2025***	***2053***	***2025***	***2022***
Visitors Staying in New Units				
Total	2,206	5,968	483	1,477
Adjusted total, spending	1,862	5,669	242	1,376
Spending, Non-lodging				
Per person per day	$104.73	$89.92	$132.24	$119.01
Annual (Million $s)	$71.2	$189.3	$11.7	$59.8
Jobs from Visitor Spending				
Total (Direct and Indirect)	765	2,035	125	643
minus On-site (DII)	322	1,103	91	240
Off-site (DI)	443	933	34	402
Regional Share (40%)	177	373	14	161
Wages, Off-site (Million $s)	$18.4	$38.7	$1.4	$16.7
Regional Share (40%)	$7.4	$15.5	$0.6	$6.7

NOTES: See Table 4-4 for approach. Non-lodging visitor spending estimated for the action and alternatives as follows:

	Action	*Full Build-out*	*Res.Res.*	*Cons. Part.*
Relation to average spending	99%	85%	125%	113%
Per-person per day, non-lodging spending	$104.73	$89.92	$132.24	$119.01

The regional share estimate was developed by Belt Collins Hawaii LLC on the basis of visitor spending patterns. The values shown are rounded, so totals may differ slightly from the sum of the individual values in the table.

5.2 Population Growth and Distribution

5.2.1 Population at the Resort

By 2025, the development alternatives would result in quite distinct on-site populations. At that time, the Full Build-Out Alternative would support a population much like that of the Proposed Action: the difference between the two emerges as Full Build-Out construction continues until 2052, as shown in Table 5-5. The Resort Residential Alternative would bring the smallest new population. With this alternative, the existing resort's population would account for two-thirds of the people on-site. Finally, the Conservation Partner Alternative would bring a smaller on-site population than the Proposed Action. However, that alternative concentrates the population in the central section of the property, so the density would be similar in that area.

5.2.2 Population Effects throughout the KNS Region

Table 5-6 applies to the development alternatives the assumptions developed to estimate the regional population for the Proposed Action. Again, the Resort Residential Alternative stands out as generating smaller visitor and employee populations.

The Full Build-Out Alternative regional population would continue to grow with further development until after 2050. While the regional population associated with that alternative after build-out can be calculated, its share of the regional population cannot, since no regional projections extend so far into the future.

Table 5-5: New On-Site Population, Proposed Action and Development Alternatives

	Existing Resort (No Action Alt.)	New Daytime Population with			
		Proposed Action	Full Build-out	Resort Residential	Conservation Partner
As of 2025					
Hotel, Ocean Villa guests	638	1,139	1,291	-	957
Resort Residential (including Kuilima Estates)					
FT Residents	167	41	52	43	24
PT residents, visitors	146	516	334	362	151
Community Residential		479	269	138	144
Day Visitors	96	180	190	161	173
Operations workforce	439	561	530	34	350
Construction workforce	-	-	127	-	-
Subtotal	1,485	2,916	2,795	737	1,798
Total at Resort (Combined)	1,485	4,401	4,280	2,223	3,284
Existing share of Combined Total	100%	34%	35%	67%	45%
After Absorption					
Year		*2025*	*2053*	*2025*	*2022*
Hotel, Ocean Villa guests	638	1,139	5,370	-	957
Resort Residential					
FT Residents	167	41	94	43	24
PT residents, visitors	146	516	599	362	151
Community Residential		479	269	138	144
Day Visitors	96	180	323	161	173
Operations workforce	439	561	2,240	34	350
Construction workforce	-	-	-	-	-
Subtotal	1,485	2,916	8,894	737	1,798
Total at Resort (Combined)	1,485	4,401	10,380	2,223	3,284
Existing share of Combined Total	100%	34%	14%	67%	45%

NOTES: Weekday state holiday midday population estimated. Only construction workers involved in new construction (rather than renovations) are included. The values shown are rounded, so totals may differ slightly from the sum of the individual values in the table.
SOURCES: See Table 4-6.

Table 5-6: Regional Population Associated with Proposed Action and Development Alternatives, 2025

all figures are persons, year 2025	*Action and Alternatives* Proposed Action	Full Build-out	Resort Residential	Conservation Partner
Resident Population Groups (Islandwide)				
A. TBR Resort Recreation Residents	55	70	43	24
B. TBR Community Housing Residents	638	359	138	144
C. Direct Operations Workforce Households	1,613	1,135	102	1,004
Indirect and Induced Operations				
D. Workforce Households (islandwide)	896	1,196	92	1,058
E. Off-Site Workforce Households	505	584	74	862
Total (assuming unduplicated counts)	3,707	3,344	448	3,090
Potential New Regional Resident Population				
A. 100% of group	55	70	43	24
B. 30% of group	192	108	41	43
C. 20% of group	323	227	20	201
D. 20% of group	179	239	18	212
E. 40% of group	202	234	30	345
Total	951	877	152	824
Share of Projected Regional Pop. Increase	36.7%	33.9%	5.9%	31.8%
Regional New De Facto Population Change				
Regional Resident Population	951	877	152	824
New TBR Visitor and Part-time Population	2,206	2,202	483	1,477
Total	3,157	3,079	635	2,301

NOTES: The values shown are rounded, so totals may differ slightly from the sum of the individual values in the table. On completion (as of 2053), the Full Build-Out Alternative would involve a Potential New Regional Resident Population of 3,000. The Regional De Facto Population Change associated with that alternative would climb to 8,968.
SOURCES: See Tables 4-7, 5-4.

5.3 Fiscal Effects

5.3.1 Revenues

Tables 5-7 through 5-9 estimate government revenues due to construction, sales and operations, and property values with development. They show significant revenue flows for both the State of Hawai‘i and the City and County of Honolulu with development. No change to revenues or costs has been projected for the No Action alternative future.

5.3.2 Costs

The average cost analysis used in the last chapter can be applied for all the development alternatives. Table 5-10 shows the net revenue (i.e., amount of revenues in excess of costs). The ratio of revenues to costs by 2025 is positive for all development alternatives. As of that point, the net revenues for the City and County of Honolulu are largest with the Proposed Action. Over time, the additional development in the Full Build-Out Alternative would make the return from that alternative the highest for both levels of government.

Table 5-7: Government Revenues Associated with Construction, Proposed Action and Development Alternatives

All figures are Millions of 2011 $s	*Cumulative, through Build-out* Proposed Action	Full Build-out	Resort Residential	Conservation Partner
Construction cost (1)	$769.9	$1,369.9	$428.5	$370.2
Construction-related Wages (2)	$473.0	$795.9	$394.4	$225.3
Excise Taxes To State (3)				
On Construction	$31.2	$53.5	$17.4	$15.0
On Spending by Workforce (4)	$12.0	$20.2	$10.0	$5.7
Excise Taxes to City and County				
On Construction	$3.5	$5.9	$1.9	$1.7
On Spending by Workforce (4)	$1.3	$2.2	$1.1	$0.6
Income Taxes				
Corporate (5)	$1.3	$2.2	$0.7	$0.6
Personal (6)	$28.8	$48.5	$24.0	$13.7
Total Revenues from Construction Spending				
State of Hawaii	$73.3	$124.5	$52.1	$35.1
City and County of Honolulu	$4.8	$8.2	$3.0	$2.3

NOTE: The values shown are rounded, so totals may differ slightly from the sum of the individual values in the table.
SOURCES: See Table 4-8.

Table 5-8: Government Revenues Associated with Visitor Spending, Proposed Action and Development Alternatives

All figures are Millions of 2011 $s	Cumulative Proposed Action	Cumulative Full Build-out	Cumulative Resort Residential	Cumulative Conservation Partner
Through 2025				
Conveyance Taxes	$5.1	$2.4	$9.7	$1.9
Taxes on Visitor Accommodations				
Transient Accommodations Tax (Hotel Condominiums and Visitors in Resort Residential Units)	$32.9	$18.1	$23.2	$26.3
Transient Occupancy Tax (Time Shares)	$16.3	$3.7	$0.0	$6.6
Taxes on Cash Flows from Visitor Spending				
Excise Taxes				
On Lodging (Visitors only)	$16.0	$8.8	$11.3	$12.8
On Other Visitor Spending	$17.7	$11.6	$6.0	$21.5
On On- and Off-Site Workers' Spending	$11.7	$7.3	$1.6	$11.9
Excise Tax Total	$45.5	$27.7	$19.0	$46.2
State of Hawai'i Share	*$40.9*	*$25.0*	*$17.1*	*$41.6*
City and County of Honolulu Share	*$4.5*	*$2.8*	*$1.1*	*$4.6*
Income Taxes				
On- and Off-Site Workers	$25.3	$15.9	$3.5	$25.7
State of Hawai'i Total	$120.6	$65.0	$56.1	$102.2
City and County of Honolulu Total	$4.5	$2.8	$1.1	$4.6
Through Full Absorption *Year:*	***2025***	***2053***	***2025***	***2022***
Conveyance Taxes	$5.1	$7.1	$9.7	$1.9
Taxes on Visitor Accommodations				
Transient Accommodations Tax (Hotel Condominiums and Visitors in Resort Residential Units)	$32.9	$193.3	$13.2	$17.3
Transient Occupancy Tax (Time Shares)	$16.3	$41.6	$0.0	$3.9
Taxes on Cash Flows from Visitor Spending				
Excise Taxes				
On Lodging (Visitors only)	$16.0	$94.0	$6.4	$8.4
On Other Visitor Spending	$17.7	$173.0	$3.4	$13.5
On On- and Off-Site Workers' Spending	$11.7	$121.8	$0.9	$7.4
Excise Tax Total	$45.5	$388.8	$10.7	$29.3
State of Hawai'i Share	*$40.9*	*$349.9*	*$9.7*	*$26.4*
City and County of Honolulu Share	*$4.5*	*$38.9*	*$1.1*	*$2.9*
Income Taxes				
On- and Off-Site Workers	$25.3	$263.2	$2.0	$16.1
State of Hawai'i Total	$120.6	$855.1	$34.5	$65.5
City and County of Honolulu Total	$4.5	$38.9	$1.1	$2.9

All figures are Millions of 2011 $s	Cumulative Proposed Action	Cumulative Full Build-out	Cumulative Resort Residential	Cumulative Conservation Partner
Through 2025				
Conveyance Taxes	$5.1	$2.4	$9.7	$1.9
Taxes on Visitor Accommodations				
Transient Accommodations Tax (Hotel Condominiums and Visitors in Resort Residential Units)	$32.9	$18.1	$23.2	$26.3
Transient Occupancy Tax (Time Shares)	$16.3	$3.7	$0.0	$6.6
Taxes on Cash Flows from Visitor Spending				
Excise Taxes				
On Lodging (Visitors only)	$16.0	$8.8	$11.3	$12.8
On Other Visitor Spending	$17.7	$11.6	$6.0	$21.5
On On- and Off-Site Workers' Spending	$11.7	$7.3	$1.6	$11.9
Excise Tax Total	$45.5	$27.7	$19.0	$46.2
State of Hawai'i Share	*$40.9*	*$25.0*	*$17.1*	*$41.6*
City and County of Honolulu Share	*$4.5*	*$2.8*	*$1.9*	*$4.6*
Income Taxes				
On- and Off-Site Workers	$25.3	$15.9	$3.5	$41.8
State of Hawai'i Total	$120.6	$65.0	$56.1	$164.6
City and County of Honolulu Total	$4.5	$2.8	$1.1	$7.5
Through Full Absorption *Year:*	***2025***	***2053***	***2025***	***2022***
Conveyance Taxes	$5.1	$7.1	$9.7	$1.9
Taxes on Visitor Accommodations				
Transient Accommodations Tax (Hotel Condominiums and Visitors in Resort Residential Units)	$32.9	$193.3	$13.2	$17.3
Transient Occupancy Tax (Time Shares)	$16.3	$41.6	$0.0	$3.9
Taxes on Cash Flows from Visitor Spending				
Excise Taxes				
On Lodging (Visitors only)	$16.0	$94.0	$6.4	$8.4
On Other Visitor Spending	$17.7	$173.0	$3.4	$13.5
On On- and Off-Site Workers' Spending	$11.7	$121.8	$0.9	$7.4
Excise Tax Total	$45.5	$388.8	$10.7	$29.3
State of Hawai'i Share	*$40.9*	*$349.9*	*$9.7*	*$26.4*
City and County of Honolulu Share	*$4.5*	*$38.9*	*$1.1*	*$2.9*
Income Taxes				
On- and Off-Site Workers	$25.3	$263.2	$2.0	$16.1
State of Hawai'i Total	$120.6	$855.1	$34.5	$65.5
City and County of Honolulu Total	$4.5	$38.9	$1.1	$2.9

NOTES: All taxes estimated from current rates (excise at 4.5%; TAT at 9.25%; TOT at 7.25% of half of maintenance fee for period of occupancy; conveyance taxes at escalating rates depending on cost and whether buyer is a Hawai'i resident) and historic ratios between earnings or revenues and taxes. Excise tax on workers' income estimated for taxable disposable income. Property sale values and maintenance fees estimated by Belt Collins Hawaii based on information from TBR and review of comparable projects. The values shown are rounded, so totals may differ slightly from the sum of the individual values in the table.

SOURCES: See Table 4-9.

Table 5-9: Increased Property Tax Revenues for the City and County of Honolulu, Proposed Action and Development Alternatives

All $ figures are Millions of 2011 $s	Proposed Action	Cumulative Full Build-out	Cumulative Resort Residential	Cumulative Conservation Partner
Through 2025				
Land Redeveloped (acres)				
Cumulative	221	74	217	123
Value of Redevelopment (Mill $s)				
Residential Construction	$441.0	$146.8	$304.1	$115.1
Residential Land	$586.8	$136.7	$918.7	$281.5
Hotel Construction	$175.9	207.2	$0.0	$162.8
Hotel/Resort Land	$202.7	$125.7	$0.0	$198.7
Total redevelopment counted	$1,406.4	$616.5	$1,222.7	$758.1
Cumulative Property Taxes				
Residential	$26.0	$7.6	$31.3	$12.7
Hotel, Resort	$24.3	$20.3	$0.0	$35.4
Total Collections	$50.3	$27.9	$31.3	$48.1
Through Full Absorption *Year:*	***2025***	***2053***	***2025***	***~~2023~~ 2022***
Land Redeveloped (acres)				
Cumulative	221	217	217	123
Value of Redevelopment (Mill $s)				
Residential Construction	$441.0	$291.5	$304.1	$115.1
Residential Land	$586.8	$291.0	$918.7	$281.5
Hotel Construction	$175.9	$863.3	$0.0	162.75
Hotel/Resort Land	$202.7	$547.5	$0.0	$198.7
Total redevelopment counted	$1,406.4	$1,993.3	$1,222.7	$758.1
Cumulative Property Taxes				
Residential	$26.0	$51.4	$31.3	$8.5
Hotel, Resort	$24.3	$359.9	$0.0	$22.0
Total Collections	$50.3	$411.3	$31.3	$30.5

NOTES: Land development totals take into account new hotel and residential parcels. Commercial development, changes from golf course use to open space, and increased commercial land values are not considered. The values shown are rounded, so totals may differ slightly from the sum of the individual values in the table.
SOURCES: See Table 4-10.

Table 5-10: Revenue-Cost Summary, Proposed Action and Development Alternatives, through 2025

All $ figures are Millions of 2011 $s	Proposed Action	Cumulative Full Build-out	Cumulative Resort Residential	Cumulative Conservation Partner
Through 2025				
State of Hawai 'i				
Revenues (Mill. $s)	$193.9	$108.3	$108.2	$137.2
Average cost, Visitors $2,171				
Cumulative Census, Visitor-years at Resort	12,729	13,517	3,989	6,664
Visitor-Related Costs (Mill. $s)	$27.6	$29.3	$8.7	$14.5
Average cost, Residents $6,830				
Full-time Resort Residents at Resort	416	557	372	210
Resident-Related Costs (Mill. $s)	$2.8	$3.8	$2.5	$1.4
Total Costs	$30.5	$33.1	$11.2	$15.9
Net Revenues > Costs	$163.4	$75.1	$97.0	$121.3
Revenue/Cost Ratio	6.4	3.3	9.7	8.6
City and County of Honolulu				
Revenues (Mill. $s)	$59.7	$33.5	$35.4	$37.4
Average cost, Visitors $1,060				
Cumulative Census, Visitor-years at Resort	12,729	13,517	9,352	6,664
Visitor-Related Costs (Mill. $s)	$13.5	$14.3	$9.9	$7.1
Average cost, Residents $1,485				
Full-time Resort Residents at Resort	416	557	372	210
Resident-Related Costs (Mill. $s)	$0.6	$0.8	$0.6	$0.3
Total Costs	$14.1	$15.2	$10.5	$7.4
Net Revenues > Costs	$45.6	$18.3	$24.9	$30.0
Revenue/Cost Ratio	4.2	2.2	3.4	5.1

All $ figures are Millions of 2011 $s	Cumulative Proposed Action	Full Build-out	Resort Residential	Conservation Partner
Through 2025				
State of Hawai'i				
Revenues (Mill. $s)	$193.9	$108.3	$108.2	$199.6
Average cost, Visitors $2,171				
Cumulative Census, Visitor-years at Resort	12,729	13,517	3,989	6,664
Visitor-Related Costs (Mill. $s)	$27.6	$29.3	$8.7	$14.5
Average cost, Residents $6,830				
Full-time Resort Residents at Resort	416	557	372	210
Resident-Related Costs (Mill. $s)	$2.8	$3.8	$2.5	$1.4
Total Costs	$30.5	$33.1	$11.2	$15.9
Net Revenues > Costs	$163.4	$75.1	$97.0	$183.7
Revenue/Cost Ratio	6.4	3.3	9.7	12.6
City and County of Honolulu				
Revenues (Mill. $s)	$59.7	$69.6	$35.4	$35.7
Average cost, Visitors $1,060				
Cumulative Census, Visitor-years at Resort	12,729	13,517	9,352	6,664
Visitor-Related Costs (Mill. $s)	$13.5	$14.3	$9.9	$7.1
Average cost, Residents $1,485				
Full-time Resort Residents at Resort	416	557	372	210
Resident-Related Costs (Mill. $s)	$0.6	$0.8	$0.6	$0.3
Total Costs	$14.1	$15.2	$10.5	$7.4
Net Revenues > Costs	$45.6	$54.4	$24.9	$28.3
Revenue/Cost Ratio	4.2	4.6	3.4	4.8

NOTE: See Tables 4-12 and 4-13 for average cost analyses. Revenue calculations bring together information from Tables 5-7 through 5-9. The values shown are rounded, so totals may differ slightly from the sum of the individual values in the table.

5.4 Social Impacts

5.4.1 Housing

Housing impacts differ among the alternatives because these involve fewer community housing units than the Proposed Action, and because the alternatives vary in the number of workers (and hence workers' households) they support in the region. Both the Proposed Action and the Resort Residential Alternative involve a larger increase in housing supply than in demand. The Full Build-Out Alternative might generate more demand than housing for residents (based on the high estimate in Table 5-11). The Conservation Partner Alternative would clearly involve more demand for resident housing than the supply of community housing provided.

When construction of the Full Build-Out Alternative is complete around 2053, demand for housing from operations-related workforce households is estimated as 234 to 469 additional units, resulting in a net excess of demand over the supply provided by the resort expansion of 144 to 379 housing units in the KNS region.

Table 5-11: Housing Impacts, Proposed Action and Development Alternatives

Based on development through 2025	*Action and Alternatives* Proposed Action	Full Build-out	Resort Residential	Conservation Partner
New Operations-Related Jobs				
On-site	753	530	48	469
Other direct jobs, KNS region (1)	177	109	14	161
	930	640	61	630
Dependents supported by new KNS workforce (2)	965	663	64	653
Households supported by workforce	556	382	37	377
New household formation over time (3)				
Low estimate (15%)	83	57	6	57
High estimate (30%)	167	115	11	113
New community housing at TBR	160	90	46	48
Housing Impact (Demand for Units):				
Low Estimate	77	33	40	(9)
High Estimate	(7)	(25)	35	(65)

NOTES: On-site jobs estimated in Table 4-3 and Table 5-3; off-site jobs derived from Table 4-4 and Table 5-4.
(1) Other direct jobs estimated as 40% of direct and indirect workforce supported by off-resort spending.
(2) Dependency ratios from 2006-2010 Five-year estimates for KNS region:
Population in households 31,111
Workforce 15,275
Average household size 3.41
(3) New housing demand estimated as 15% to 30% of workforce households.
SOURCE: American Community Survey. (www.census.gov)

5.4.2 Public Safety Services and Facilities

Following the ratios and projections used above, new public safety services demand associated with the Full Build-Out Alternative could come to about 4.8 police patrol positions and 3.3 fire control positions by 2025; the total public service demand would climb to 14.0 police positions and 9.6 fire positions at completion. The eventual new population with the Full Build-Out might well justify acquisition of new equipment such as an additional fire truck. It might justify construction of additional space for public safety operations, if perhaps not a new facility.

The Proposed Action and the other development alternatives could justify modest increases in public safety personnel and equipment, but not new facility construction. The Resort Residential Alternative could, based on current staffing ratios, justify 1.0 additional police patrol positions and 0.7 fire control positions. The Conservation Partner Alternative could justify an additional 3.6 police positions and 2.5 fire positions.

The cost of new fire control and police services has already been estimated through the average cost analysis (in Table 5-10).

As noted for the Proposed Action, redevelopment of the resort would bring increased patrols by resort security. New roadways, park facilities and landscaping would remove large areas of brush from the TBR lands. New construction would be to current fire codes, reducing the risk of fire and increasing access to the entire resort. All of these factors would tend to reduce the effects of development on public safety services.

5.4.3 Educational Facilities

The high estimate of potential new school enrollment associated with the other development alternatives is lower than with the Proposed Action, because the Proposed Action includes a larger commitment to Community Housing. Table 5-12 shows that the development alternatives would generate less demand for spaces in the public schools than the Proposed Action as of 2025.

For the Full Build-Out Alternative, construction and increases in operations jobs would continue until about 2053. By that time, total potential regional project-related new school enrollment would be in the range from 98 to 210 students. That range is much larger than those in Table 5-12. Based on the high estimate, project-related enrollments could reach up to 4.4% of the 2011 total regional DOE enrollment. If that enrollment increase occurred on a regional level within a year or two, the DOE might need to take steps to assure that all students can be housed and taught effectively. However, the increase projected here would occur over forty years. In that time, other changes in standards, practices, and demography would intervene, so it is simply not clear whether the eventual project-related growth with the Full Build-Out Alternative (i.e., the growth anticipated under existing permits) would present a small challenge to the regional DOE schools or a large one.

Table 5-12: Potential New Public School Enrollment, Proposed Action and Development Alternatives, to 2025

	Action and Alternatives			
	Proposed Action	Full Build-out	Resort Residential	Conservation Partner
New Community Housing	160	90	46	48
New Households Formed by Workers				
Low Estimate	83	57	6	57
High Estimate	167	115	11	113
Potential New K-12 Enrollment				
Low Estimate	49	32	7	27
High Estimate	123	77	21	61

NOTES: See Table 4-15 for multipliers used to estimate school impacts, and Table 5-11 for housing estimates. See text for discussion of potential enrollment after completion of the Full Build-Out Alternative.

Based on current enrollment levels, demand for new preschool places in the region would be modest by 2025. (See Table 5-13.) By full absorption of the Full Build-Out Alternative, regional demand could climb to about 16 to 34 places.

With more resort employment and renewed state support, enrollments could climb. As noted earlier, these calculations are based on current demand for preschools in the KNS region, and could underestimate demand in more prosperous conditions.

Table 5-13: Potential New Preschool Enrollment, Proposed Action and Development Alternatives, to 2025

	Action and Alternatives			
	Proposed Action	Full Build-out	Resort Residential	Conservation Partner
New Community Housing	160	90	46	48
New Households Formed by Workers				
Low Estimate	83	57	6	57
High Estimate	167	115	11	113
Potential New Preschool Enrollment				
Low Estimate	8	5	1	4
High Estimate	20	13	4	10

NOTES: See Table 4-16 for multipliers used to estimate preschool impacts, and Table 5-11 for housing estimates. See text for discussion of potential enrollment after completion of the Full Build-Out Alternative.

5.4.4 Health Care

The new population associated with the Full Build-Out Alternative by 2025 could create demand for as many as 8.3 acute care beds and 0.9 Emergency Medical staff positions. The demand for medical services and facilities would be smaller with the Resort Residential Alternative or the

Conservation Partner Alternative than with the Proposed Action. After construction of the Full Build-Out Alternative finishes by 2053, demand for health care services for the new population at the resort could climb to 24.2 beds and 2.7 Emergency Medical staff positions.

The eventual demand associated with the Full Build-Out would be large in a region with limited health care facilities. It could make expansion of local health care facilities necessary. However, that demand would be realized over a period of many decades, so the impact of that demand cannot be clearly assessed at this time.

5.4.5 Recreational Opportunities

Under the Full Build-Out Alternative, much the same recreation facilities would exist as with the Proposed Action. Resort visitor demand for golf tee times would be even greater. The potential effects on other courses noted for the Proposed Action would also arise, and would probably be even greater.

In order to reposition the resort as an exclusive, upscale site for the Resort Residential Alternative or the Conservation Partner Alternative, the golf course operator could limit rounds on one course or both, and could offer preferential access to residents of the new resort homes. Consequently, access by hotel guests, nearby residents and golf tours would be limited and could become more expensive.

Since the Conservation Partner Alternative reduces golf at Turtle Bay to the Palmer Course alone, golf access would be even more limited than under the other alternative scenarios.

The Full Build-Out and Resort Residential Alternatives both include a beach club on Kuilima Bay. This would provide a separate venue for resort residents to enjoy beach and ocean activities. With the beach club serving part-time residents, the higher onsite population of the Full Build-Out Alternative might not lead to resource conflicts among residents, resort residents and visitors.

The Conservation Partner Alternative could increase access to Kawela Bay and would likely increase public knowledge of the area, while minimizing adjacent development. The resort and the Partner agency would need to anticipate a major increase in usage of the bay and its park.

As with the Proposed Action, the new park development under the various Development Alternatives could help visitors to spread out along the North Shore. However, the Full Build-Out Alternative includes a much larger on-site visitor population. In this case the beneficial effect of park development for the region could be offset by increased visitor numbers.

Under the No Action alternative, the two golf courses would remain, so the supply of golf tee times would be greater than with the development alternatives. Beach access and facilities would remain as they are at present. However, Kawela Bay has become known as a "secluded" spot where marine life can be observed, so an increase in the number of visitors from off-site is likely.

5.4.6 Geographic Extent of Effects

On-Site and Near the Resort

The development alternatives would bring new visitors, residents and on-site employees to the resort. The increase would be small in the case of the Resort Residential Alternative, since both occupancy and on-site employment are low with resort residential development. Occupancy levels for hotels with the Full Build-Out Alternative are expected to be somewhat lower than for the other scenarios, but on-site population and employment would still be much higher in this case, due to the size of the Full Build-Out Alternative development. Also, construction workers would be on-site until 2052, under the Full Build-Out scenario, adding to the resort daytime population.

The Conservation Partner Alternative might bring a larger number of day visitors than the Proposed Action and the other alternatives. The unique qualities of Kawela Bay and the coastline could be emphasized by the partner (and likely advertised), and access to shoreline resources would be improved, while few on-site visitors using the resources would compete with day visitors.

For the existing properties, the development alternatives could have distinct effects:

- The Full Build-Out Alternative would involve a much larger resort expansion than the Proposed Action. In order to achieve acceptable levels of occupancy, operators may have to accept lower price points. The resort would then appeal to a larger, but less exclusive, market. The amenities proposed for this alternative would have higher usage with more visitors on-site. Hotel developers and operators might choose to position the hotels at Kawela Bay and towards Kahuku Point as more upscale than the central properties, just as end units in a townhome complex tend to have greater appeal than ones in the middle of a line of units. Consequently, the central area of the resort, including the Turtle Bay Hotel and Kuilima Estates, could benefit less from redevelopment than peripheral sites. Under these circumstances, the risk that redevelopment would emphasize the age and relatively modest architecture of the Kuilima Estates units would be greater than with the Proposed Action. (In this case, the Kuilima Estates owners might invest in improvements to common areas to enhance their properties, and thereby maintain value.)

- With the Resort Residential Alternative, the resort's reputation would rest above all on new, luxurious homes near the ocean and the Palmer course. The existing Kuilima Estates condominiums would be more likely to be seen as no longer in keeping with the rest of the resort, and could suffer from the contrast. (As noted above, the condominium owners could invest to maintain their property values.) Also, improvements in the resort's landscaping and beach access could make these properties more appealing.

  As the only hotel, the Turtle Bay Hotel can be expected to continue to support high occupancies. This alternative would increase demand for existing restaurants and other amenities slightly, but the on-site population increase would be small.

- The Conservation Partner Alternative's effect on existing properties would be much like that of the Proposed Action. However, the Fazio course could be entirely closed, and the open space between the condominiums and the newly developed areas would narrow slightly. Whether these changes would affect the appeal and value of the condominiums would depend on design choices that have not been spelled out yet. Much as with the Resort Residential Alternative, the success of this alternative would depend on positioning new residential properties as luxurious and ocean-oriented. Again, the existing condominiums could suffer from the contrast.

While the Kuilima Estates condominiums might not enjoy increased value and reputation from resort development under the Resort Residential and Conservation Partner Alternatives, they would not lose or gain value simply by being near more expensive homes. No clear impact on their property values appears likely.

The No Action alternative could lead to effects on Kawela Bay. Continuing growth in the number of visitors is likely. Under the No Action alternative, no new measures would be taken to monitor human activity in the bay or control shoreline littering.

Regional Effects

Both the Full Build-Out Alternative and the Conservation Partner Alternative would support many new jobs in the region (approximately 640 and 627 jobs respectively by 2025). New job creation would continue under the Full Build-Out Alternative, reaching a total of about 2,613 regional jobs by 2053. While new job creation demand could be met locally over time, the resort's share of local employment would rise, reaching perhaps 25% of jobs in the region. As noted in the preceding sections, this alternative could eventually increase demand for schools, public safety and health services to a point that additional facilities might be needed. If the State and the City and County responded in a timely manner, the result could involve minimal effects for the region.

In contrast, the Resort Residential Alternative is expected to generate very few off-site jobs through visitor expenditures in the region. It would do little to lower unemployment and would offer few employment choices to local youth.

Table 5-6 shows the estimated new regional populations associated with the Proposed Action and the Development Alternatives.

The No Action alternative is not expected to affect regional populations and communities.

Island and State Effects of the Development Alternatives

All the development alternatives would generate revenues for local government The Full Build-Out Alternative could eventually lead to demand for new public facilities in the region, i.e., to government costs beyond the average-cost figures discussed earlier. However, by the time the effects of this large alternative were felt, increased revenues associated with the resort would be

very large, as estimated in Table 5-10 -- and likely would be more than enough to cover the additional costs of facility expansion, given prudent planning by government agencies.

5.4.7 Quality of Life and Community Cohesion

The three development alternatives could have somewhat different effects on the surrounding communities:

- **Full Build-Out Alternative**: The longer development period and larger visitor population anticipated with the Full Build-Out would have distinctive effects. If major construction stretches over decades, local contractors and construction workers could find nearly continuous work close to home. However, the larger visitor population would mean that some resort and natural resources – golf tee times and enjoyment of offshore waters – would be much less available to local residents over time. The larger visitor population would patronize local shops and restaurants and could contribute to congestion along the streets and shores of the region.

- **Resort Residential Alternative:** In this scenario, the new visitor population would be fairly small and affluent. Resource competition is less of an issue, unless new homeowners attempt to limit local residents' access to beach and marine resources. (BCH expects that the UA, policies of the TBR developer, and community vigilance would guarantee residents' access.) Much as with the Proposed Action, some resort residents could become active members of the regional community.

- **Conservation Partner Alternative:** This scenario depends on an unknown factor, a conservation partner willing and able to invest in the land in order to limit development to the center of the SEIS lands. That partner could affect access to and use of ocean and park resources in ways that cannot be foreseen. The partner could welcome residents, resort residents, and visitors or it could seek to keep the Kawela and Kahuku Point areas little disturbed. To date, no such partner has emerged, despite the urgings of the State government and local stakeholders.

The new visitors and employees brought by the development alternatives will contribute to regional traffic. See the Traffic Impact Assessment Report in the SEIS for further detail on the project's contribution to regional congestion and on traffic management strategies.

5.4.8 Secondary and Cumulative Impacts

When the effects of the development alternatives on regional population, housing and public services are seen in combination with potential effects of the Envision Lāʻie initiative, need for new public facilities appears much more likely. That project could have a large effect on the local resident population, justifying school expansion, before development at Turtle Bay would do so. If the Full Build-Out Alternative and all the housing proposed for Malaekahana were developed, regional demand for school, health, and public safety facilities would increase significantly. On the other hand, if the resort, BYUH and PCC provided new jobs, while the

Malaekahana and Turtle Bay community residential areas housed the workers for all three job centers, the combined impact could be limited.

5.5 Comparisons of Likely Socio-Economic Effects of the Proposed Action and Alternatives

5.5.1 Comparison with the Impacts Discussed in the 1985 Kuilima Revised Final EIS

The development proposed in the Kuilima EIS and accepted when permits were issued was substantially larger than the Proposed Action. The Kuilima EIS dealt with a different social context than the current SEIS does. Resort development has also changed in emphasis and risk management. In this section, major changes are noted as broad trends.

Resort Development

In 1985, hotels and condominiums were viewed as separate facilities. In the current marketplace, resorts tend to offer visitors a range of ownership and rental options, from condominium ownership through fractional ownership to rental of overnight accommodations, and may do so in the same structure. Design of hotels as condominium or time-share properties reduces risk for the developer, since the sale of units or time shares can defray costs quickly, and for the operator, since owners of time shares and condos have a vested interest in using their units. Long-term occupancy is typically more secure than it is for stand-alone hotels. Contemporary hotel properties involve a mix of occupancy types, and are likely to have higher occupancy levels than stand-alone hotels.

In 1985, most hotel rooms were bedrooms with attached bathrooms and lanais, with a low percentage of larger suites. Nowadays, studio, one and two-bedroom units with kitchen facilities are common. Often the larger units can be occupied either as a single unit or as two separate rentals (two "keys").

The Kuilima EIS identified a complex mix of positive and adverse socio-economic impacts. The themes noted above help to specify how the effects of the Proposed Action and alternatives differ from the major socio-economic impacts noted in 1985. Table 5-14 compares indicators of the impacts of each scenario. It shows both continuity and change.

Table 5-14: Comparison of Development Impacts, Kuilima EIS, Proposed Action and Alternatives

		Kuilima EIS and UA	*Action and Alternatives -- in Comparison to the With-Project Future in the Kuilima EIS* Proposed Action	Full Build-Out *(2025)*	Full Build-Out *(2053)*	Resort Residential	Conservation Partner	No Action
New Resort Units	Units	3,410	1,215	1,060	3,410	454	692	-
	Keys (1)	Not listed	up to 1,590	NA	NA	NA	NA	-
Workforce / Community Residential Units		90 (2)	160	90	90	46	48	-
Employment	On-site Jobs	2,614	753	530	2,240	48	469	-
Change in the Regional Economy		Development of a tourism "base"	Increase in visitor economy	Increase in visitor economy	Major increase in visitor economy	Increase in visitor economy	Increase in visitor economy	-
Housing "pressures"		Regional problem exists, increased demand with project	Regional problem continues; project housing impact is likely positive	Regional problem continues; project housing impact is negative	Regional problem continues; project housing impact is negative	Regional problem continues; project housing impact is positive	Regional problem continues; project housing impact is negative	Regional problem continues
Increased Presence of Visitors	Visitors	4,783	2,206	2,202	5,968	483	1,477	-
Displacement of Residents	Persons	140	None	None	None	None	None	None
Displacement of Activities	Activities	UA commits resort to work for a Kawela Bay Marine Conservation Area	Resort would follow UA	Resort would follow UA	Resort would follow UA	Resort would follow UA	Resort would follow UA	None
New Recreational Opportunities		Parks, shoreline access	Parks, shoreline access	Parks, shoreline access	Parks, shoreline access (with many more visitors)	Parks, shoreline access	Parks, shoreline access	None

NOTES: NA = Not Available

(1) When a two- or three-bedroom unit is designed so its components can be rented separately, the various components are counted as "keys." Units that cannot be subdivided in this way are counted as single "keys." For this table, resort residential units are also counted as single "keys." TBR has committed to have no more than 1,000 keys for 625 hotel units in the Proposed Action. No similar analysis of hotel room counts has been made for Development Alternatives.

(2) The UA specifies that (a) at least 51% of resort units must be "full-service hotel" units and that (b) workforce housing must be developed, on-site or off-site. The number of workforce housing units must equal 10% of the resort non-hotel units. Workforce housing must be provided at rates affordable by families earning 80% of the County average median household income, under a program supervised by the City and County (now by DPP). The community housing proposed by TBR would at least meet, and probably go farther than, County rules to assure housing is available for local families.

On the one hand, the economic impact of changing the region's economy to a tourism base occurred long ago. On the other hand, housing remains tight and costly in the region. The Proposed Action and the Resort Residential Alternative would provide more new community housing units than resort-related workforce demand; the Full Build-Out Alternative and Community Partner Alternative would generate more demand than new community units.

Apart from the Full Build-Out Alternative, the Proposed Action and Development Alternatives would have smaller socio-economic impacts than those identified in the Kuilima EIS. The current Proposed Action and Development Alternatives no longer create the most obvious adverse impacts (dislocation, possible social consequences of economic transformation) because those impacts occurred some two decades ago.

Critics of the resort expansion have argued that the North Shore's appeal as a visitor destination has already brought far more visitors than were present in the 1980s, so any further resort growth would bring too many visitors. In part, this argument deals with traffic congestion. The traffic study for the SEIS speaks to this concern, separating the future effects of Turtle Bay Resort visitors from other island visitors and residents. In part, it deals with the prosperity and wellbeing of the region and its institutions. This criticism is overstated for several reasons:

- Many in the region view resort employment as valuable, and would welcome additional resort jobs for their children;
- Unemployment is slightly higher in the region than island-wide, and long-distance commuting is more common, so new jobs can help to address current traffic, commuting and quality of life problems;
- The Polynesian Cultural Center is planning to expand, and would presumably welcome more visitors in the region. Waimea Falls Park has barely survived as a viable destination with support from the Office of Hawai'ian Affairs. Once again, a larger regional visitor count could have welcome results for businesses in the area.
- Resort residents and visitors may well have different consumption patterns from day visitors staying in Waikīkī. Resort resident may be willing to spend more on clothes, furnishings, food and entertainment in the region than day visitors. Resort visitors may complement day visitors as customers for local retail outlets.
- Most significantly, recent Hawaii Tourism Authority surveys indicate that close to 75% of all Oahu visitors visit the North Shore independent of activities or development at Turtle Bay Resort. The addition of new resort amenities, legal transient accomodations and new transportation management operations could take traffic off Kamehameha Highway that would otherwise travel to and from and around the North Shore.

Of the various development alternatives, the Full Build-Out comes closest to bringing the future situation painted by the critics, since it would involve, as it builds out, many more visitors than the other alternatives, and a larger concentration of hotels. The Proposed Action and other alternatives combine smaller visitor populations with the development of beach parks. Hence

they would involve far less risk that visitors' presence would adversely affect the region's towns and shores.

5.5.2 Comparison with Regional Trends

Many stakeholders hope that the resort expansion will bring sustained prosperity to the KNS region but not erode the region's "country" atmosphere and public services. The Proposed Action supports those objectives.[48] Quantifiable socio-economic findings for the Proposed Action and alternatives are summarized in Table 5-15 in relation to the current situation or forecast regional trends.

Table 5-15 shows that, by 2025, the Proposed Action creates more jobs and housing than the other development alternatives. It would bring a resident population increase within the forecast growth for the KNS region. After 2025, the Full Build-out Alternative would bring more residents, visitors, jobs and housing demand. The public service demand associated with that alternative would come to be much greater than for the Proposed Action and other development alternatives, and could lead to need for new medical or public safety facilities.

[48] For estimates of the impacts of the resort expansion on regional traffic, see the SEIS appendix on traffic impacts.

Table 5-15: Development Impacts in Regional Context

		Proposed Action, 2025	Full Build-Out, 2025	Full Build- Out, 2053	Resort Residential, 2025	Conservation Partner, 2025	No Action
Employment							
Regional Jobs, 2009	6,203						
New Continuing Jobs at Resort		753	530	2,240	48	469	-
New Continuing Jobs in KNS Region		177	109	373	14	161	-
Total New Continuing Jobs		930	640	2,613	61	630	-
As share of 2009 regional jobs		**15%**	**10%**	**42%**	**1%**	**10%**	**0%**
As share of forecast regional job growth, 2010 to 2025	1,086	**86%**	**59%**	**NR**	**6%**	**58%**	**0%**
Wages (Million $s)							
Regional Wages, 2009	$116.3						
New Continuing Wages at Resort		$23.8	$16.8	$71.1	$1.6	$14.8	$0.0
New Continuing Wages in KNS Region		$7.4	$4.5	$15.5	$0.6	$6.7	$0.0
Total New Continuing Wages		$31.1	$21.4	$86.6	$2.2	$21.5	$0.0
As share of 2009 regional wages		**27%**	**18%**	**74%**	**2%**	**18%**	**0%**
Population							
Forecast Regional Population, 2025	34,969						
Forecast Resident Population increase, to 2025	1,576						
New Regional Residents due to Action or Alternative		951	877	3,000	152	824	-
As share of KNS Population, 2025		**3%**	**3%**	**9%**	**0%**	**2%**	**0%**
As share of forecast growth		**60%**	**56%**	**NR**	**10%**	**52%**	**0%**
Housing							
2010 Household size (popul. in hholds)	3.27						
Forecast Resident Population increase, to 2025	1,576						
New Households in Region (Forecast Regional Population Increase divided by 2010 Household Size	482						
Community Housing at Resort		160	90	90	46	48	0
As share of forecast household growth		**33%**	**19%**	**NR**	**10%**	**10%**	**0%**
Net Project-Related Regional Housing Supply							
Low Estimate		77	33	(144)	40	(9)	0
High Estimate		(7)	(25)	(379)	35	(65)	0
As share of forecast household growth							
Low Estimate		**16%**	**7%**	**NR**	**8%**	**-2%**	**0%**
High Estimate		**-1%**	**-5%**	**NR**	**7%**	**-13%**	**0%**

Continued on next page

Table 5-15 Cont.

		Proposed Action, 2025	Full Build-Out, 2025	Full Build- Out, 2053	Resort Residential, 2025	Conservation Partner, 2025	No Action
Public Schools							
2011 KNS region enrollment	4,826						
New Project-Related Enrollment, 2025							
Low Estimate		49	32	98	7	27	-
High Estimate		123	77	210	21	61	-
As share of 2011 Enrollment							
Low Estimate		**1%**	**1%**	**2%**	**0%**	**1%**	**0%**
High Estimate		**3%**	**2%**	**4%**	**0%**	**1%**	**0%**
Other Public Services							
Police: current number of officers/1,000 persons	1.56						
Fire: current number of officers/1,000 persons	1.07						
Emergency Medical Service: per 1,000	0.30						
Hospital Beds per 1,000 persons	2.70						
		2025	***2025***	***2053***	***2025***	***2025***	***2025***
New regional demand associated with Project (New residents and visitors)		3,157	3,079	8,968	635	2,301	-
Police		4.9	4.8	14.0	1.0	3.6	-
Fire		3.4	3.3	9.6	0.7	2.5	-
Emergency Medical Services		0.9	0.9	2.7	0.2	0.7	-
Hospital Beds		8.5	8.3	24.2	1.7	6.2	-

NOTES: See Tables 5-3, 5-4, 5-6, 5-11, 5-12, and Chapter 3 text on Public Services, for regional conditions and trends. Ratios comparing the 2053 absorption of the Full Build-Out Alternative to forecast 2025 trends are all marked NR, i.e., Not Relevant, since these impacts refer to a much longer time period. The values shown are rounded, so totals may differ slightly from the sum of the individual values in the table.

6 Summary of Benefits and Costs of the Proposed Action

The analysis in the last two chapters has covered a wide range of issues. This chapter reviews the beneficial and adverse effects of the Proposed Action under two main headings: regional social effects and fiscal effects.

6.1 Regional Social Life

The Ko‘olau Loa-North Shore region is famed for “country” atmosphere along with its beaches and surf spots. The Turtle Bay Resort currently fits into that atmosphere in many ways; its beaches and waters are enjoyed by residents as well as visitors. It provides amenities enjoyed by regional residents. It provides jobs on-site. With wages and benefits protected by union contracts, the resort establishes a high standard for local employment practices. Its guests contribute to visitor spending for goods and services throughout the region.

The analysis in earlier chapters has identified several effects of the Proposed Action that would generally be considered beneficial:

- **Job-creation**:
  - Some 3,263 person-years of direct construction employment over 11 years (plus indirect and induced jobs throughout the island), with a total direct payroll exceeding $225 million;
  - An operations workforce estimated as including 753 direct jobs at the resort, with an annual payroll of about $23.8 million (plus indirect and induced jobs), continuing for many years; and
  - Approximately 177 new jobs within the region supported by visitor spending outside the resort, including retail, service and other jobs.

- **Development of new amenities** which could be used by residents and tend to increase visitors’ time at the resort (vs. on the North Shore roadways):
  - New beach parks with parking and shoreline access, greatly improving access to both open coastline and an enclosed bay;
  - An inland park area next to the wildlife preserve;
  - A Gathering Place combining performance space, stores and other uses;
  - An on-site Farmers’ Market;
  - A new golf clubhouse and a new equestrian center;
  - Landscaping and new development set back from the beachfront; roads and trails throughout the resort’s grounds; and
  - Road improvements including two new entries that will take vehicles off Kamehameha Highway earlier.

- **New housing for community residents,** responding to a long-recognized regional need.

- **Attraction of upscale visitors** who value the North Shore as a place to stay, not just to visit for a few hours.

- **Attraction of resort residents and homeowners, a few of whom would likely contribute their support to community causes.** (Elsewhere in Hawai‘i, such contributions can range for funds for local hospitals to fervent support of environmental groups.)

All of these can contribute to a prosperous regional community. With shorter commutes, more residents have time to spend with family and neighbors, and to participate in community life.

Drawbacks of new development may include increased traffic and more visitors in regional communities. The traffic impact assessment for the SEIS estimates both existing traffic congestion and the impact of new resort development. It identifies traffic management strategies to reduce the project’s contribution to this regional problem.

6.2 Fiscal Effects

Revenues for both the state and county would significantly exceed project-related costs with the Proposed Action. Table 6-1 shows the net revenues associated with the Proposed Action.

State revenues would continue to exceed costs by more than $14 million annually in later years. Net project-related revenues for the City and County would continue at a level over $6 million annually from 2025 onward.

Table 6-1: Revenue-Cost Summary, Proposed Action

	Cumulative, through 2025 *Million $ (2011)*
State Revenues	
Excise Tax	$84.1
Income Tax	$55.5
Transient Accommodations Tax	$32.9
Transient Occupancy Tax	$16.3
Conveyance Tax	$5.1
	$193.9
Costs for State	
For Visitors	$27.6
For New Residents	$2.8
	$30.5
Net Benefit (Revenues > Costs)	$163.4
Ratio of Benefits to Costs	6.4
City and County Revenues	
Excise Tax	$9.3
Real Property Tax	$50.3
	$59.7
Costs for City and County	
For Visitors	$13.5
For New Residents	$0.6
	$14.1
Net Benefit (Revenues > Costs)	$45.6
Ratio of Benefits to Costs	4.2

SOURCES: Tables 4-9 to 4-13.

As noted earlier, a new development can stimulate new spending by government agencies on public facilities. The new demand associated with the Proposed Action is not large enough to make such spending necessary, so the average cost approach provides a realistic estimate of the actual costs to government associated with the action.

7 Mitigations

7.1 Mitigations Proposed in Kuilima EIS and UA

Several conditions proposed in the Kuilima UA address socio-economic impacts.[49] These are summarized here, and the ways in which the Proposed Action addresses those conditions are discussed. The owners of the TBR accept the UA as running with the land, and hence would implement these conditions unless the UA is amended by City ordinance.

- UA Condition 3: Development shall "generally be based on" the schedule provided by the developer, although changed economic conditions or other circumstances could affect timing.

  Comment: The original schedule involved a timetable that ended before the present. The Proposed Action provides a new timetable responsive to current and anticipated market conditions. The actual timing of development could change, in response to changing economic conditions.

- UA Condition 3: A minimum of 51% of the 4,000 resort units (including the existing Turtle Bay hotel) shall be operated as full service hotel units.

  Comment: When "units" are counted, 65% of resort units in the Proposed Action (counting the Turtle Bay Hotel) are in hotels. When possible "keys" are counted, the share is 71%. No general definition of "full service hotel units" exists. However, DPP accepts traditional hotels, condominium hotels and time share properties as covered by this term.

  In the Kuilima EIS, hotels are discussed as employing far more workers than condominiums, so the designation of hotels in the Proposed Action as condominium or time share properties raises the question of whether this condition is still being met. It is the overall level of service provided, along with on-site resort amenities, that separate visitor properties with more or less operational employment, not the arrangements for leasing units. The operations employment figures estimated in this report are somewhat lower than those found in the Kuilima EIS. Largely that is because of productivity gains throughout the Hawai'i hotel industry in recent decades. On-site employment is expected to be comparable to that in other resorts in Hawai'i (and higher than that found in many hotels).

[49] The UA also includes conditions dealing with setbacks, other design conditions, roadways and historic/cultural sites, not discussed in this list. Comments in this section express the findings and views of BCH. They may report on commitments of the developer, but they do not constitute such commitments.

- UA Condition 4: Workforce housing shall be provided for sale to residents of the region; the number of workforce housing units shall equal 10% percent of the non-hotel dwelling units in Turtle Bay Resort (not including Kuilima Estates) .

  Comment: The Proposed Action exceeds this requirement by 171% with 160 vs. 59 units (i.e., 10% of 590 resort residential units), both by providing more units and by providing them at prices based on cost and local budgets, not County-wide income levels.

- UA Condition 5: To offset potential loss of access with development, the developer committed to developing parks once the resort expansion was under way. Parks would be dedicated to the City and County; parking and shoreline access would be provided.

  Comment: The Proposed Action and Development Alternatives continue to include these parks, and in the case of the Proposed Action, exceed them by 27.3% providing additional park space and public shoreline accesses for a total of 69.5 acres, 14.9 acres in addition to those required.

  (Some residents who live nearby have expressed a wish that the resort, not the City and County, would be responsible for the parks' maintenance and security. TBR is committed to meeting the terms of the UA. It would be in the interest of hotel operators and resort residents to support the City and County Parks Department in maintaining these parks.)

- UA Condition 7: All major roadways shall be open to the public. The developer shall minimize vehicle usage by means of:
  - Shuttle services to the airport, Waikīkī and PCC; and
  - Employee transportation services for points from Haleʻiwa to Kaʻaʻawa to the resort, provided at a reasonable cost.

  Comment: These transportation services will need to be developed based on the traffic studies for the Proposed Action and consultation with employees.

- UA Condition 11: Developer shall establish a child-care center for employees of the resort; a half acre of land shall be dedicated (in or near the resort) to North Shore Career Training for this purpose.

  Comment: Since the time of the Kuilima EIS, child-care facilities in the region have increased. Meanwhile, the regional population is aging, so the number of current and new resort employees who need child-care may have decreased. Extensive studies were made of the need of employees and others for services (e.g., day care for infants and for toddlers, preschool education, after school care, sick child care, or evening care to help parents on evening shifts).[50] These would need to be updated. North Shore Career Training's operational core, Resort Training Inc., is still in operation.

[50] These studies were conducted for the Kuilima/North Shore Strategy Planning Committee with the support of the Turtle Bay developer. That group has resumed meetings in recent years.

- UA Condition 12: Developer shall establish an employment training program and provide at least $500,000 for this purpose. (The amount cited will be provided in four years from the time that zoning is granted.)

  Comment: The payments identified under this condition were made by the developer to Resort Training Inc. soon after the UA was issued.[51] Since that time, Resort Training Inc. has continued operations. It is currently housed at the Turtle Bay Resort on a complimentary basis. Like other social service providers, it has been affected by budget cuts in recent years, but it is involved in training contracts with local employers. With resort expansion, the operators of new hotels will likely sponsor additional training.

- UA Condition 13: Developer shall work with the Kuilima/North Shore Strategy Planning Committee (KNSSPC) throughout the development of the resort.

  Comment: TBR is working with advisory groups, including KNSSPC, in order to design programs that address regional residents' needs and concerns; TBR has organized over 170 meetings, workshops and open houses with community groups and concerned citizens since 2010.

- UA Condition 14: Developer shall use its best efforts to promote the creation of a Marine Life Conservation District at Kawela Bay.

  Comment: TBR will work to meet this condition. Because it is not clear if such a district would affect local ocean recreation and fishing activities, TBR is recommending the creation of a regional Advisory Council to help determine the best course of action to address this requirement. The developer would seek to explore ways to establish a conservation regime at Kawela Bay in dialogue with others who have a stake in the use and preservation of the bay and its shores.

7.2 Mitigation for Possible New or Intensified Impacts of the Proposed Action

Mitigation measures for socio-economic impacts involve two distinct types of solution. To the extent that the problem is a technical one, and experts are recognized as the source of technical solutions, mitigation measures may consist of technical solutions applied when expert models find appropriate. Many traffic impacts are of this type, since transportation agencies and experts work out solutions based on their experience in dealing with congestion, and the agencies have extensive power to mandate which measures count as appropriate mitigation measures.

More often, socio-economic impacts combine material impacts, perceptions, and interactions. Addressing those impacts demands not just technical solutions but a process of identifying how problems and solutions are perceived, what stakeholders see as an appropriate response, and who can or should participate in mitigating the impact. Effective mitigation measures involve consultation and shared assessment of what works.

[51] Personal communication, Robert Comeau, Executive Director, Resort Training Inc. May 2012.

The vision of the future enunciated in the SEIS combines a holistic view of the land and people, stewardship, and a commitment to consultation with elders, neighbors, and other stakeholders. It identifies relationships and discussions that seem well suited to mitigation as an ongoing process of sustaining the land and people of the area. In other words, the SEIS identifies a promising framework for effective mitigation. Within that framework, three issues stand out as productive ones for further work to craft responses that suit the needs of local stakeholders.

1. **Parks and Sustaining Shorelines and Near-shore Resources.** The Proposed Action would increase the number of visitors in the region, and especially along the shores from Kawela Bay to Kahuku Point. The UA directs the developer to deal with this impact through park dedication. Since City and County park budgets are limited, this action may have the unintended consequence of deeding shore lands to the party least able to patrol, maintain and sustain them as a valued resource. The resort operator, homeowners and residents would likely be interested in assuring peace, quiet and clean enjoyment of the parks. (So, presumably, would their neighbors along the western shore of Kawela Bay.) They would need to establish working agreements with each other and the City and County Department of Parks and Recreation to share both enjoyment of and responsibility for the park areas.

2. **Child Care.** The UA directs the establishment of a child care center. What sort of center is needed, what age children need to be served, and how the center can collaborate with existing preschools and programs in the region remain to be seen. (These questions were examined in discussions with the Kuilima North Shore Strategy Planning group and research done for that group by Community Resources, Inc., but the research is now dated.) The developer, employees who may need support from a child-care center, and local providers can all contribute to developing an effective mitigation strategy, not just fulfilling a legal condition.

3. **Employee and Visitor Shuttle Operations.** The specifics of these operations will be developed based on studies of the traffic situation and input from employees.

7.3 Mitigation for Possible Socio-Economic Impacts of the Alternatives

Because the UA follows the land, it is binding for all development alternatives. The timing of actions such as parks development would need to be revised in the case of the Resort Residential Alternative, since hotel development triggers some UA conditions, and the Resort Residential Alternative involves no new hotels. The developer would comply with all applicable requirements.

The comments in the last section on mitigation measures and process hold true for all the alternatives, although each presents distinct challenges and opportunities. The Full Build-Out Alternative most closely resembles the development plans in the Kuilima EIS, so the Kuilima UA mitigations align well with it. The Proposed Action and other Development Alternatives involve much less new development, and hence may need somewhat different approaches to mitigation.

Full Build-Out Alternative

The Full Build-Out Alternative would involve many more visitors at the resort, and larger and taller structures set closer to the shoreline than with the Proposed Action. Hence potential competition for shore and ocean resources would be greater. It may be appropriate for the resort to take the lead in maintenance of the shoreline and protection of near-shore waters – but questions would likely emerge as to whether the resort is turning a public resource into a private one. Continuing consultation and shared responsibility with other stakeholders would be important.

As noted above, the Full Build-Out Alternative involves greater resident housing demand and a smaller community housing contribution than the Proposed Action, so housing impacts would be greater with this alternative.

Resort Residential Alternative

The Resort Residential Alternative involves smaller impacts based on the numbers of visitors and jobs. Its impacts would instead have more to do with differences between new homeowners, on the one hand, and existing nearby residents (in Kuilima Estates and West Kawela), the hotel, and beachgoers. New owners in the high-end residential development may seek to keep their spaces as exclusive as possible similar to existing Kawela homeowners. Since their homes would be nearer the parks than the hotel is, community associations may take a major role in park management and security. The UA is clear on the need to maintain public access on all major roadways and shoreline access routes. However, homeowners would want assurance that their own property is secure, so the possibility of conflict involving community associations and their security personnel may be an issue. Involvement of the residential community associations in a wider resort operating group may be necessary to minimize or avoid such conflict. TBR expects to form a master resort association in the course of development under this or other alternatives.

Conservation Partner Alternative

The Conservation Partner Alternative would involve social differences and exclusionary tendencies similar to those described for the Resort Residential Alternative. Mitigation measures in this case would depend greatly on the policies and involvement of an unknown party, the Conservation Partner. If that partner emphasizes resource preservation, it may constrain public beachgoers and recreation activities (including surf schools) while assuring nearby residents of peace and quiet. If that partner emphasizes public access to and regulation over shared resources, the result could be a significant increase in the number of visitors at the shoreline parks, and development of new educational programs rather than recreational businesses. A resort operating group or association would no longer be the venue for collaboration among stakeholders. Instead, the agreement between the partner and the resort would set the terms for future decision-making.

No Action Alternative

Compared to the future allowed by existing permits, the No Action Alternative involves few impacts and none of the mitigations specified in the UA. Access to shoreline resources would continue to be limited.

Over the long term, resources such as the Fazio course and shore areas could be degraded by erosion or use without sufficient funding to maintain them. Visitors to Kawela Bay from outside the resort would probably increase in number, affecting the shoreline and bay. Under the No Action Alternative, the resort, its residents and homeowners might not be able to invest in sustaining and redeveloping ~~them~~ these resources.. Hence, while continuing operation of the resort is anticipated, its long-term viability and environmental sustainability could be less certain than with the Proposed Action.

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Appendix A: Regional Geography

Table A-1: Communities, Districts and Places in the KNS Region

Communities in the Ko'olauloa/North Shore Region, from West to East

	Mokulē'ia	Waialua	Hale'iwa	Kawailoa	Waimea Bay	Pupukea-Sunset Beach	Kawela	Kuilima	Kahuku	Lā'ie	Hau'ula	Punalu'u	Kahana	Ka'a'awa
U.S. Census														
1980	99.01		99.02	100	101					102.02	102.01			
1990	99.01		99.02	100	101					102.02	102.01			
2000	99.01		99.02	100	101					102.02	102.01			
2010	99.04		99.02	100	101					102.02	102.01			
2010 names	Kaena Point		Haleiwa	Kawailoa	Waimea-Kahuku					Laie	Hauula - Kaaawa			
CDPs	Mokuleia	Waialua	Haleiwa			Pupukea	Kawela		Kahuku //	Laie //	Hauulu	Punaluu		Kaaawa
State of Hawaii														
	Waialua (North Shore) District					Ko'olauloa District								
City and County of Honolulu														
	North Shore SCP						Ko'olau Loa SCP							
	North Shore Neighborhood Board, No. 27						Ko'olauloa Neighborhood Board, No. 28							

NOTES: "CDP" = Census Designated Place(s). Parts of the region are not included in any CDP. This is indicated above in two ways. First, some communities are simply not included in CDPs, and are outside the named boxes. Second, CDP boundaries may not be contiguous. In the table. "//" indicates where CDP boundaries of nearby named communities are not contiguous.
CDP boundaries may have changed slightly over time, due to changes in mapping procedures.
The Waialua District is often termed the North Shore District. Other names reflect spelling conventions used by the agencies named in the table.
The State judicial districts are also designated Census Divisions.
2010 Census Tract names are supplied by State Data Center, DBEDT.

Appendix B: Economic, Demographic and Fiscal Notes

B.1 Approach

The quantitative analysis is intended to provide realistic estimates of major socio-economic effects of development at Turtle Bay Resort as compared to the No Action Alternative. It depends on models that have been developed and refined to account for the Hawai‘i economy. It incorporates assumptions about the visitor industry that have been chosen as mid-range or conservative.

Development of the resort as proposed by TBR would occur over many years; development according to alternative scenarios would take more time, in the case of the Full Build-Out Alternative, or less time, for the Conservation Partner Alternatives.

For this analysis, resort development is understood above all as attracting capital from outside the Hawai‘i regional economy. That capital comes first in the form of funds for construction and later as visitors' expenditures in the course of their vacation experience.

B.1.1 Sources and Assumptions

The quantitative analysis begins with information and assumptions about:

- What will be built (supplied by TBR);
- When will it be built (by TBR);
- What will construction cost (by BCH, based on input from TBR and current cost data from other sources);
- What market will be served, and hence what are likely timeshare, condo and housing prices (by BCH, based on input from TBR, comparative data from other resorts, and analysis of data on resort unit sales and North Shore residential sales); and
- Activities and employment on-site (supplied by TBR and operators).

The account of effects on the Hawai‘i economy relies on sources and models that have been refined over many years in light of both local and global trends:

- The Hawai‘i Input-Output Model, providing estimates of the regional impact of the introduction of new capital to Hawai‘i. This has been developed and refined over decades. The current version incorporates 2007 economic census data as well as DBEDT findings and analysis. The key multipliers used from this model are for indirect and induced jobs associated with growth of jobs in various industries. The Type II multipliers

(i.e., the number of direct, indirect and induced jobs associated with each direct job) used are:

- Construction 2.68
- Retail 1.54
- Real Estate/leasing 2.68
- Accommodations 2.23
- Food service 1.55
- Other services 1.63

All Input-Output analyses deal with the circulation of capital in a regional economy. They may be expressed in terms of jobs, personal income and/or output. However, these are alternative measures of the same economic activity, not separate impacts. Consequently, the current analysis is rooted in estimates of job creation, for which wages can be forecast based on recent wages.

- Hawai‘i Long-Range Population and Economic Projections, also maintained by DBEDT and based on econometric models, providing forecasts of population, employment, visitor counts and visitor spending for the state and counties. DBEDT issued a revised series of projections in 2009 to account for the recession. (More recent Census data and DBEDT projections suggest that the trend analysis remains valid, although population growth from 2000 to 2010 was greater than had been anticipated.)

- The City and County of Honolulu Department of Planning and Permitting's allocation of the 2009 DBEDT projections to community planning areas and sub-areas, taking into account local development policies, along with developers' activity and plans.

- Data on employment and wages compiled by the State Department of Labor and Industrial Relations for the state and county economies. Average salaries per industry in 2009 were used, and adjusted to 2011 values in line with changes in the cost of living:

	2009	*2011*
Construction	$65,460	$69,046
Retail	$27,573	$29,084
Real Estate/leasing	$42,687	$45,026
Accommodations	$33,517	$35,354
Food service	$16,136	$17,020
Arts/Recreation	$24,179	$25,504
Other services	$29,713	$31,341
All covered employment	$42,838	$45,185

("All covered employment" is an average for the entire island economy, and is used for wages in indirect and induced jobs.)

Construction jobs were estimated from the ratio of construction spending in the state economy to full-time construction jobs. The average ratio was 4.4 jobs per million dollars spent (based on data in the *State Data Book* from the 2007 Economic Census). Based on

industry trends, this was adjusted to cover the various types of construction in the Proposed Action and development alternatives as follows:

- Infrastructure/heavy construction: 3.8 jobs per million $
- Buildings 4.2 jobs per million $
- Single-family 4.5 jobs per million $

- Data on relations between income and taxes for both individuals and corporations, maintained by the State Department of Taxation. These ratios are cited in the notes to Tables 4-8 and 4-9.

- Real property tax rates for the year 2011-2012 in the City and County of Honolulu:
  - $3.50 per $1,000 in land or improved value for Residential property, and
  - $12.40 per $1,000 in land or improved value for Hotel and Resort property.

- Information about the visitor industry that has been compiled over many years by the Hawai‘i Visitors Bureau, the State Department of Business, Economic Development and Tourism, and the Hawai‘i Tourism Authority.

- Census data, from the American Community Survey conducted annually since 2005 and from the 2010 Census.

Additional specific assumptions used in this study are identified in the notes to particular tables.

A question of general concern for community stakeholders is whether timeshare and condominium hotel guests would support employment comparable to that of “full service hotels.” The data are complex:

- Spending by hotel visitors can be higher, on a per person per day basis, than spending by condominium or time share visitors[52];

- Much of the difference lies in spending on lodging, spending which is not trip related in the case of condominium and time share-interval owners, and hence not counted in survey-based visitor spending analyses;

- Time shares have higher visitor occupancy rates in two senses: units are occupied more days of the year, and the number of persons per unit is higher in time shares than in hotels;

[52] Hospitality Advisors LLC. *County of Maui: Summary Analysis of Economic and Social Impacts on Maui County from Timeshare Conversions: Final Report.* Honolulu, HI, 2006; Hawai‘i Tourism Authority, *2010 Annual Visitor Research Report.* Honolulu, HI 2011, posted at http://hawaii.gov/dbedt/info/visitor-stats/visitor-research/. The Hospitality Advisors study is valuable for two key reasons. By focusing on Maui, it deals with non-urban resorts, more comparable to TBR than either O‘ahu or Statewide samples, in which Waikīkī data predominate. Next, the study separates out lodging and non-lodging expenditures.

- At Turtle Bay Resort, the operators would need to establish their new products in competition with other Hawai‘i resorts, notably the new time share operations at Ko ‘Olina and Ka‘anapali. To do so, they would need to offer rewarding visitor experiences. The resort already includes a wide range of amenities, which would be refurbished and expanded.

Taking these factors into account, direct employment due to the resort expansion is estimated in two ways. On-site employment is estimated for new occupied units and new amenities based on their likely market position. (The overall positioning can be averaged as Deluxe for the Proposed Action; a mix of Standard and Deluxe for the Full Build-Out Alternative; and Luxury for the Conservation Partner Alternative and (for residential rentals) the Resort Residential Alternative.)[53] Off-site jobs supported by visitor expenditures are estimated from total estimated expenditure-supported jobs minus on-site jobs. The total expenditure figures take into account both resort market position and a discount factor for spending by time share and condominium visitors. (These assumptions are intended as conservative; with a rebound in market demand, spending and hence employment could be higher.)

Specific ratios for operations employment derived from unit construction and occupancy. Occupancy estimates were developed by Belt Collins Hawaii based on experience with Hawaii hotels and resorts:

Occupancy of new units		Persons per unit	Share of this product	Occupancy
Time Share		3.2	100%	90%
Condo	Owners	2.5	15%	30%
	Visitor pool	3.2	85%	50%
Resort Residential				
FT		2.5	5%	75%
PT	Owners	2.5	20%	30%
	Visitor pool	3.5	75%	50%

NOTES: “Occupancy” here refers to the share of the time that units are occupied by residents or visitors. Condos and resort residential units may be bought and held by owners for their own use, or made available for visitor rental as well as the owner’s use.

Community housing units were assumed to be 95% occupied (to allow for time when units are empty before residents move in). Occupied units were assumed to have an average household size of 4.2 persons per unit, based on 2010 Kahuku Census figures.

Taking occupancy into account, and sorting jobs according to whether they are highly sensitive to occupancy levels, the following rates were used for the Proposed Action:

[53] See Hawai‘i Tourism Authority, *2011 Visitor Plant Inventory*. Honolulu, HI, 2012, page 88, posted at http://hawaii.gov/dbedt/info/visitor-stats/visitor-plant/2011VPI.pdf , for the classification of properties by rack rate. For this analysis, comparisons with several existing resort properties, rather than a classification scheme, were used.

	Jobs per Hotel unit	Jobs per Resort Residential unit
o Hotel	0.82	0.00
o Food and Beverage	0.21	0.01
o Retail	0.07	0.02
o Recreation Services	0.01	0.00
o Landscaping	0.01	0.015
o Security	0.01	0.015
o Realty/Management	0.02	0.03

As noted above, job ratios were adjusted on the basis of occupancy and spending assumptions for the different development alternatives.

B.1.2 Limitations of the Analysis

All monetary values used in the analysis are expressed in constant 2011 dollars, with earlier figures adjusted to 2011 dollars in proportion to changes in the Consumer Price Index for Honolulu. Consequently, the analysis excludes inflation. Information about phasing (and hence the costs and revenues associated with the project over time) is indicated for the Proposed Action by reporting annual development estimates; for the development alternatives, only full-occupancy and 2025 cumulative data are shown.

The timetables for construction follow from current estimates by TBR. For the Proposed Action and all development alternatives, the timing of construction would depend on market conditions affecting both capital markets and resort investment by individuals. The timetables for phasing used in this analysis should be seen as a general guide to future activity, not as binding on the developer.

The fiscal analysis depends on the assumptions that rates of taxation would not change, and that historic ratios of income to tax payments in Hawai‘i, for individuals and corporations, provide a guide to future taxes.

Real property values for land are estimated from the value of existing resort and residential property in the North Shore area. For buildings, value is estimated from approximate construction cost. Since real property assessment is based on market value, not replacement value, this could well underestimate taxable value and tax revenues.

Estimates of construction cost and sales have been averaged for all properties in each subdivision (such as “Resort Residential 1” in a particular development scenario) or hotel. Similarly, when land is developed, the change in land value for real property analysis is estimated on the basis of the new land value minus an average value for land in the resort that could be redeveloped, not on the recent valuation of the specific site within the resort. The accounts of real property values focus on development of new residential and hotel properties, since these involve the major construction costs and increases in land value.

Some possible cash flows have not been studied. They could involve additional construction costs and jobs, or additional tax revenues. They are largely excluded for lack of information about monetary values or timing. (For example, the resort could sell parcels to sub-developers who in turn would build and sell resort residential units. Such land sales are not included in the analysis. Again, many new hotel and resort residential properties would likely be resold during the period of the analysis, but such resales are not considered here.)

Estimates of on-site vs. off-site direct employment depend on assumptions about visitor spending and behavior. Information compiled and analyzed by state agencies provides information about average patterns of behavior and spending. On-site employment can be estimated from information and conservative assumptions about resort facilities and operations. The extent of off-site employment is identified as a residual. The location of off-site direct employment is not specified, although much of that employment could be in the region surrounding the resort.

On-site population estimates may deal with persons staying overnight (and hence count many residents, but few workers) or present at some time during the day (counting most workers, some residents). Estimates of average or future daytime populations take into account the draw of new facilities and the ability of existing resources (e.g., beaches and golf courses) to accommodate new demand, but they are not based on extensive surveys and counts.

This analysis was conducted to assess effects for the Turtle Bay Resort Supplemental Environmental Impact Statement in April 2012, and is not intended as an attestation of value for any other purpose.

While the alternatives vary greatly in size, and hence in the extent of their effects on employment, wages and revenues, they all result in positive net cash flows for the State of Hawai‘i and the City and County of Honolulu.

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APPENDIX I: (revised)

TRAFFIC IMPACT ANALYSIS REPORT

REVISED TRAFFIC IMPACT ANALYSIS REPORT

FOR THE PROPOSED

TURTLE BAY RESORT MASTER PLAN

KAHUKU, OAHU, HAWAII

PREPARED FOR

TURTLE BAY RESORT, LLC

PREPARED BY

THE TRAFFIC MANAGEMENT CONSULTANT

REVISED TRAFFIC IMPACT ANALYSIS REPORT

FOR THE PROPOSED

TURTLE BAY RESORT MASTER PLAN

KAHUKU, OAHU, HAWAII

PREPARED FOR

TURTLE BAY RESORT, LLC

~~NOVEMBER, 2012~~ MAY, 2013

RANDALL S. OKANEKU
LICENSED PROFESSIONAL ENGINEER
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THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

SIGNATURE

04/30/2014
EXPIRATION DATE OF LICENSE

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TRAFFIC IMPACT ANALYSIS REPORT
FOR THE PROPOSED
TURTLE BAY RESORT MASTER PLAN
KAHUKU, OAHU, HAWAII

I. Introduction

A. Retrospective on the Master Planning of the Turtle Bay Resort

The master planning of the expansion of the Turtle Bay Resort has spanned almost 30 years. The traffic impacts of the Turtle Bay Resort Master Plan have been documented in several studies, which are summarized as follows.

The 1985 Traffic Impact Report for the Proposed Turtle Bay Resort, dated June, 1985, was prepared by Austin, Tsutsumi & Associates, Inc., and was incorporated into the Revised Environmental Impact Statement for the Kuilima Resort Expansion, dated October, 1985 (1985 EIS).

An update of the 1985 EIS traffic study entitled, Traffic Impact Analysis Report for the Proposed Kuilima Resort Expansion, was prepared by The Traffic Management Consultant (TMC), dated July 25, 1991. The 1991 traffic study focused on the access to the Resort.

A subsequent update entitled, the Traffic Impact Analysis Report Update for the Proposed Turtle Bay Resort Master Plan (TIAR Update) was prepared by The Traffic Management Consultant, dated September 9, 2005. The purpose of the TIAR Update was to support the design of the proposed Turtle Bay Resort access intersections along Kamehameha Highway.

TMC prepared Addendum No. 1 to the 2005 TIAR Update, dated February 14, 2006, to analyze the channelization design of the intersection of Kamehameha Highway and Kaihalulu Drive (formerly known as Alpha Road and West Kuilima Drive).

At the request of the City and County of Honolulu Department of Planning and Permitting (DPP), TMC prepared Addendum No. 2 of the 2005 TIAR Update, dated April

21, 2006, to determine if and when Kaihalulu Drive should be widened from two lanes to four lanes.

TMC prepared Addendum No. 3 to the 2005 TIAR Update, dated August 25, 2006, to analyze a second phase of improvements on Kamehameha Highway at the Kaihalulu Drive intersection, and at the Kuilima Drive intersection.

TMC prepared Addendum No. 4 to the 2005 TIAR Update, dated June 27, 2007, to determine the first phase of development, where access would be provided by the improved intersection of Kamehameha Highway and Kuilima Drive.

The 2009 Revised Traffic Impact Analysis Report Update for the Proposed Turtle Bay Resort Master Plan (Revised TIAR Update) was prepared by The Traffic Management Consultant, dated April 16, 2009. The Revised TIAR Update was formally accepted by the State of Hawaii Department of Transportation (DOT) in their letter dated July 9, 2009.

The traffic studies from 1985 through 2009 were all based upon the same overall density for the Turtle Bay Resort Master Plan, i.e., a total of 3,500 new hotel rooms and resort residential units, as approved by Zoning Ordinance. The current Turtle Bay Resort Master Plan is the first effort to significantly reduce the Resort density to 1,375 new hotel rooms (which excludes the existing Turtle Bay Hotel and Ocean Villas), resort residential units (which excludes the existing Kuilima Estates), and community housing units.

In the preparation for this current Traffic Impact Analysis Report, Turtle Bay Resort, LLC and its consultants worked extensively with the State of Hawaii Department of Transportation staff to establish the scope, study area, methodology, and guidelines of this study.

B. Purpose and Scope

The purpose of this traffic study is to analyze the traffic impacts that may result from the development of the Turtle Bay Resort Master Plan, hereinafter referred to as the "Proposed Action" and three (3) Alternatives. This report presents the findings and recommendations of the study. The scope of this study includes:

1. The description of the Proposed Action and the three (3) Alternatives.
2. Traffic count surveys during the weekday and weekend on Kamehameha Highway in the study area, which extends from Turtle Bay Resort west to Haleiwa and east to Kahaluu.
3. An evaluation of the traffic count survey data to establish existing traffic conditions within the study area.
4. The development of the trip generation characteristics for the Proposed Action and the three (3) Alternatives for Turtle Bay Resort.

5. Identification and analysis of the traffic impactsresulting from the full build out and occupancy of the Proposed Action and the three (3) Alternatives.

6. The development and evaluation of traffic improvements, which would mitigate the traffic impacts identified in this study

C. Methodologies

1. Capacity Analysis Methodology

The highway capacity analysis, performed for this study, is based upon procedures presented in the Highway Capacity Manual (HCM), published by the Transportation Research Board, 2010. HCM defines Level of Service (LOS) as "a quality measure describing operational conditions within a traffic stream". Several factors are considered in determining LOS, such as: speed, travel time, freedom to maneuver, traffic interruptions, driver comfort, and convenience. LOS's "A", "B", and "C" are considered satisfactory Levels of Service. LOS "D" is generally considered a "desirable minimum" operating level of service. LOS "E" is an undesirable condition, and LOS "F" is an unacceptable condition.

The Level of Service for a two-lane highway are defined by HCM for three (3) classes of highway. The Class II highway applies to most of Kamehameha Highway in the study area. Class II highways are defined as scenic or recreational routes, where speeds are moderate. The Levels of Service for a Class II two-lane highway are based upon the Percent Time-Spent-Following (PTSF). PTSF is a measure of restricted traffic flows or "platoon" flows, i.e., groups of vehicles following slow-moving vehicles, combined with limited opportunities for passing. Passing opportunities are affected by sight distance limitations and the volume of opposing traffic. As a result, the lower LOS on a Class II two-lane highway can result from low traffic flow relative to the high PTSF.

Intersection LOS is based primarily on average vehicle delay, which is expressed in terms of seconds per vehicle (sec/veh). The LOS delays at a signalized intersection are generally higher than at a stop-controlled intersection due to user expectations. A motorist will tolerate longer delays at signalized intersections, which are generally located on high volume facilities. Stop-controlled intersections are located on lower volume roadways where delay is less predictable, which reduces the driver's tolerance for delay. Table 1 summarizes the LOS criteria.

Table 1. Level of Service Criteria (HCM)

LOS	Two-Lane Highway (Class II)	Intersection Delay	
	PTSF (%)	Signalized Control (sec/veh)	Stop-Control (sec/veh)
A	≤ 35	≤ 10	≤ 10
B	> 35 – 50	> 10 – 20	> 10 – 15
C	> 50 – 65	> 20 – 35	> 15 – 25
D	> 65 – 80	> 35 – 55	> 25 – 35
E	> 80	> 55 – 80	> 35 – 50
F	(volume exceeds capacity)	> 80	> 50

"Volume-to-capacity" (v/c) ratio is another measure of effectiveness, which indicates the relative traffic demand to the roadway's capacity. HCM defines capacity as "the maximum number of vehicles that can pass a given point during a specified period under prevailing roadway, traffic flow, and traffic control conditions." A v/c ratio of 0.50 indicates that the traffic demand is utilizing 50 percent of the roadway's capacity. A v/c ratio in excess of 1.00 indicates that the traffic demand exceeds the capacity of the highway facility. The v/c ratio may be more indicative of the facility utilization in the case of Kamehameha Highway, since it compares traffic demand with the highway capacity. While LOS represents the traffic operations of the two-lane highway, where slow-moving vehicles can increase the platooning effect and affect operating speeds. Worksheets for the capacity analysis, performed throughout this report, are presented in the Appendix.

2. Traffic Simulation

SimTraffic is a traffic simulation software, which is developed by Trafficware Corporation. Traffic simulation is a stochastic process, which can analyze the interactions of individual vehicles on a roadway network over time. SimTraffic was used to analyze the vehicle queuing and the overall operations of the arterial network. The recommended left-turn storage lengths were based upon the 95th percentile queue lengths, which were determined by averaging ten (10) SimTraffic simulations during the peak hour of traffic. Where HCM analysis yielded unrealistic results, SimTraffic was used to verify the traffic analysis.

3. Traffic Signal Warrant Analysis

Traffic signal warrant analyses were prepared for the intersection of Kamehameha Highway and Kuilima Drive. The Manual on Uniform Traffic Control Devices (MUTCD) provides guidelines to determine the necessity for the installation of traffic signals. The MUTCD recommends that, a "traffic control signal should not be installed unless one or more of the factors" are met. However, the MUTCD goes on to state that the "satisfaction of a traffic signal warrant or engineering analysis and judgment must be used to develop alternative traffic controls to improve operations and safety." Warrants 1 and 2 were analyzed for the intersection of Kamehameha Highway and Kuilima Drive. The traffic signal warrant analysis worksheets are attached in the Appendix.

a. Warrant 1, Eight-Hour Vehicular Volume

Warrant 1 is separated into Conditions A and B. Condition A – Minimum Vehicular Volume is considered when the volume of intersecting traffic over an eight-hour period is the principal reason to consider traffic signalization. The minimum volumes on the major and minor streets are required to meet Condition A. Condition A can be met under special conditions at the 80 percent and 70 percent levels of the minimum volumes on the major and minor streets.

Condition B – Interruption of Continuous Traffic is considered when the traffic volume on the major street is so heavy that traffic on the minor street would suffer excessive delays or conflicts entering or crossing the major street. The minimum volumes on the major and minor streets are required to meet Condition B. Condition B also can be met under special conditions at the 80 percent and 70 percent levels of the minimum volumes on the major and minor streets.

b. Warrant 2, Four-Hour Vehicular Volume

Warrant 2 is considered when the volume of intersecting traffic over a four-hour period is the principal reason to consider traffic signalization. The minimum volumes on the major and minor streets are required to meet Warrant 2 for any 4 hours of an average day.

D. Existing Development

The Turtle Bay Resort is located on the northernmost point of the island of Oahu. The 842-acre Resort property extends from Kawela Bay to Marconi Road. Figure 1 depicts the vicinity map. The existing Turtle Bay Resort includes the Turtle Bay Hotel and Ocean Villas, totaling 500 rooms, two 18-hole golf courses, and the 368-dwelling unit Kuilima Estates. Existing access to the Resort is provided via Kuilima Drive. The existing land uses are depicted on Figure 2.

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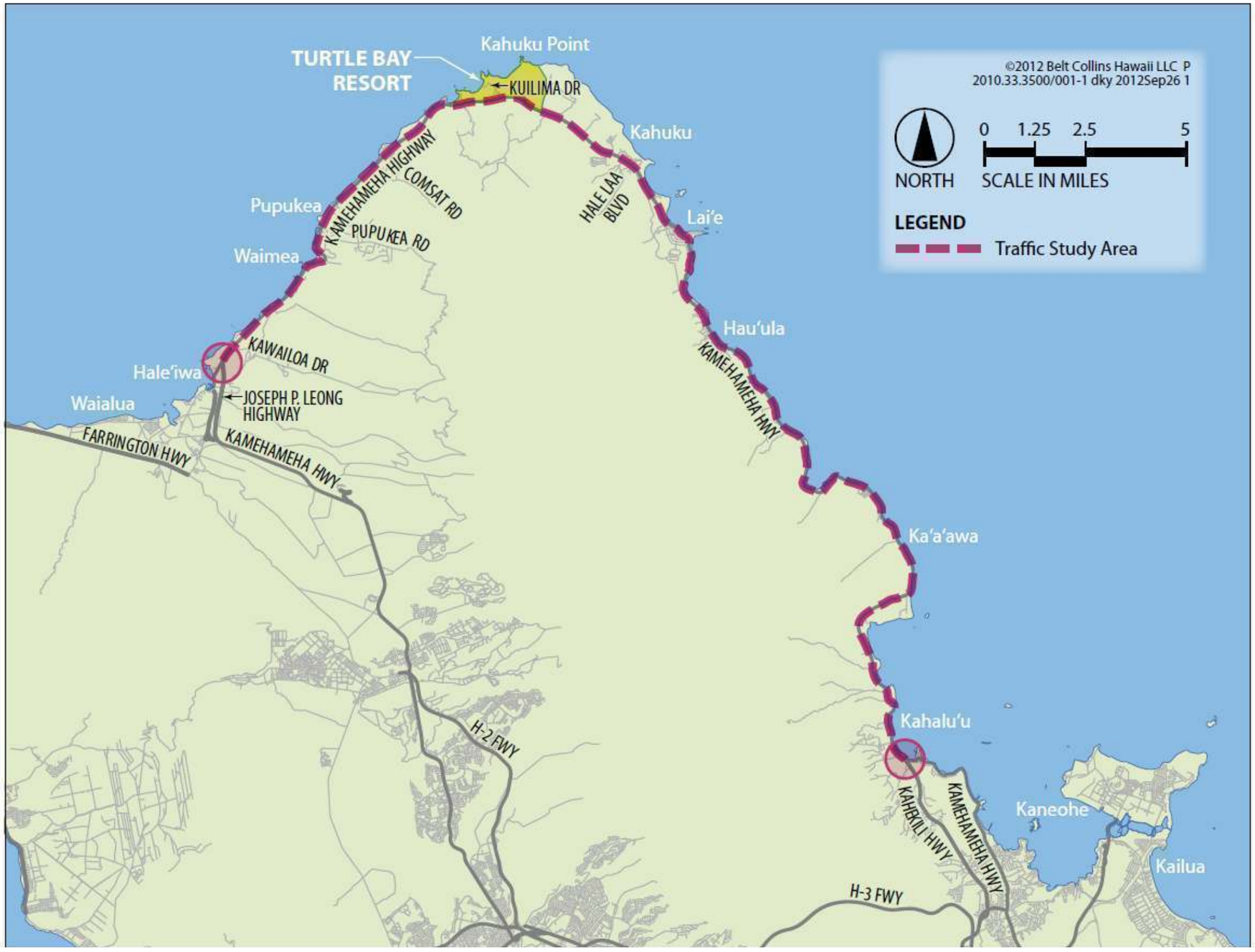


Figure 1. Study Area Map

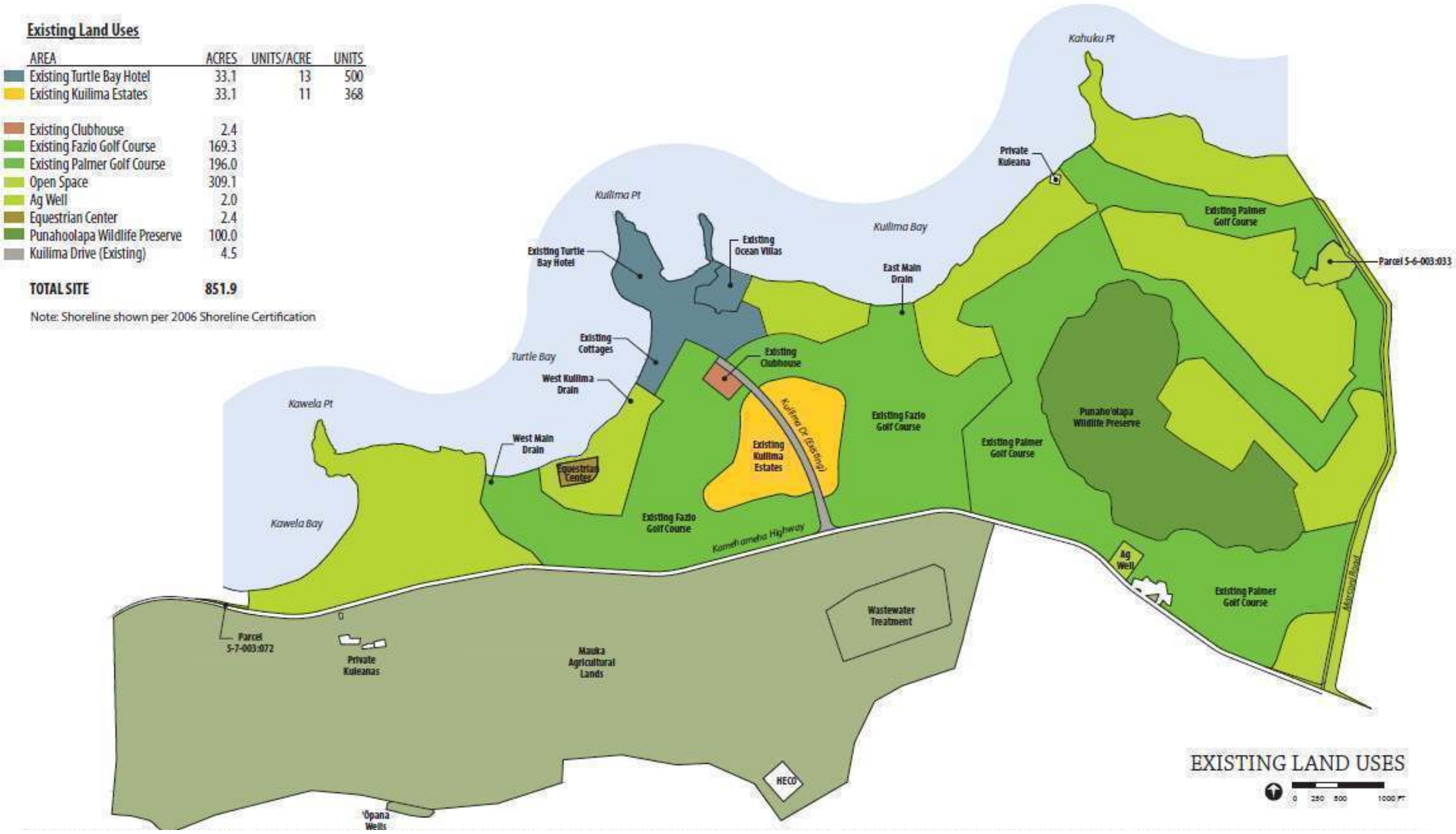


Figure 2. Existing Land Uses

Marconi Road abuts the east edge of Resort golf courses and provides access to properties (owned by others), which are located to the east of the Resort. Two service driveways, which are located on Kamehameha Highway between Kuilima Drive and Marconi Road, provide access to the Palmer Golf Course (G-2). One driveway provides access to the Palmer Golf Course maintenance facility for golf course employees only. The other driveway provides access for large vehicles, which service the golf courses. Both driveways will be maintained for service access under the Proposed Action and the three (3) Alternatives.

II. Proposed Action and Alternative Development Plans

This study analyzes the traffic impacts of the Proposed Action for the Turtle Bay Resort Master Plan at full build out and occupancy by the Year 2025. For the purpose of comparison, the traffic impacts of three (3) Alternatives also are analyzed within the same development time frame. The Proposed Action and the three (3) Alternatives are assumed to begin occupancy in the Year 2015, and reach full build out and occupancy in the Year 2025. Ultimately, market conditions will dictate the actual absorption rates of the various alternative densities. A shorter development time frame will result in a higher proportion of Turtle Bay Resort traffic relative to the background growth in traffic. The annual increase in traffic may be lower while spreading out over a longer time frame. However, the cumulative traffic will be higher as the background growth in traffic continues in the future, which may require more extensive traffic mitigation measures.

A small shopping village (also known as the Gathering Place) is common to the Proposed Action and the three (3) Alternatives. The shopping village will include 40,000 square feet of gross leasable floor area (SFGLFA) for local retails shops and restaurants. The Proposed Action and the three (3) Alternatives also include a farmers market or similar commercial shopping area on Kaihalulu Drive near Kamehameha Highway.

Also common to the Proposed Action and the three (3) Alternatives is a variety of recreational uses, which may include shoreline parks, a bird sanctuary and wildlife preserve, and an equestrian center. Table 2 summarizes the Proposed Action and the three (3) Alternatives analyzed in this traffic impact analysis report (excludes the existing Turtle Bay Hotel, Ocean Villas, and Kuilima Estates).

Table 2. Land Use Summaries – Proposed Action and Alternatives

Land Use	Proposed Action	Full Build Out	Resort Residential	Conservation Partner
Hotel	625 Rooms	2,500 Rooms	0 Rooms	440 Rooms
Resort Residential	590 Units	910 Units	454 Units	252 Units
Community Housing	160 Units	90 Units	46 Units	48 Units
Shopping Village	40,000 SFGLFA	40,000 SFGLFA	40,000 SFGLFA	40,000 SFGLFA
Farmers Market	7.5 Acres	3.4 Acres	3.4 Acres	6.6 Acres
Recreational Uses	182 Acres	160 Acres	171 Acres	166 Acres

A. Proposed Access

Pursuant to the Proposed Action, access to the Resort is proposed at two existing intersections and one new intersection on Kamehameha Highway. The existing intersection of Kamehameha Highway and Kuilima Drive will continue to provide access to Turtle Bay Hotel, Ocean Villas, and Kuilima Estates. The Kuilima Estates are gated at the four entrances on Kuilima Drive. The Turtle Bay Hotel is currently open to the public. The existing intersection of Marconi Road and Kamehameha Highway will provide access to the east side of the Resort, as well as to the properties east of the Resort.

Pursuant to the Proposed Action, access to the west side of the Resort is proposed via a new roadway (formerly known as Alpha Road and West Kuilima Drive), hereinafter referred to as Kaihalulu Drive. Kaihalulu Drive will intersect Kamehameha Highway at a channelized Tee-intersection. The location of the Kaihalulu Drive intersection at Kamehameha Highway varies between the Proposed Action and the three (3) Alternatives. Kaihalulu Drive will continue east through the Resort, crossing Kuilima Drive. With the exception of the Conservation Partner Alternative, Kaihalulu Drive will continue to the east and intersect Marconi Road. Under the Conservation Partner Alternative, Kaihalulu Drive will terminate at the new Golf Clubhouse. Kaihalulu Drive will be open to the public at its intersection at Kamehameha Highway.

Under the State Land Use Commission Decision and Order, the district boundary reclassification for the Turtle Bay Resort lands is subject to a condition that the Resort fund the design and construction of improvements to Kamehameha Highway. These

improvements were described as intersection improvements at Kuilima Drive, Kaihalulu Drive, and Marconi Road. In the Unilateral Agreement (UA) and Declaration for Conditional Zoning recorded by the Turtle Bay Resort, Condition 7 states that the following traffic improvements are to be made throughout the development of the entire project, at the Resort's cost:

- Channelization of the intersection of Kaihalulu Drive (formerly West Kuilima Drive) and Kamehameha Highway.
- Construction of left-turn storage and deceleration lanes on Kamehameha Highway at Kuilima Drive and Kaihalulu Drive.
- Construction of left-turn storage and deceleration lanes on Kamehameha Highway at Marconi Road (formerly Kahuku Airport Road).
- Signalizing Kamehameha Highway at Marconi Road and Kaihalulu Drive.
- Providing a total of six bus turnouts along the portion of Kamehameha Highway fronting the Resort, to be located near each of the entrances to the Resort on both sides of the highway.

The UA requires approval of the proposed roadway improvements by the City and County of Honolulu Departments of Land Utilization and Transportation Services, and the State Department of Transportation. The City approvals for roadway improvements have since be consolidated under the Department of Planning and Permitting. The entitlement conditions also required the reservation of right-of-way along the Resort highway frontage for the future transportation plan.

Under the Proposed Action and the three (3) Alternatives, Park P-1 lot will be located on Kawela Bay on the west end of the Resort, and will be dedicated to the City and County of Honolulu. Park P-1 lot will have legal access on Kamehameha Highway, about one quarter of a mile west of the Kaihalulu Drive intersection.

The Resort accesses on Kamehameha Highway at Kaihalulu Drive, Kuilima Drive, and Marconi Road are common to the Proposed Action and the three (3) Alternatives, analyzed in this traffic impact analysis report, except in the Conservation Partner Alternative, where the concentration of development around the central core of the existing Turtle Bay Hotel and the limited development on the east side of the Resort will not require the extension of Kaihalulu Drive to Marconi Road. Furthermore, the intersection of Kaihalulu Drive and Kamehameha Highway would be located further east under the Conservative Partner Alternative.

B. Proposed Action

The Proposed Action represents a reduction of over sixty percent (60%) from the previously planned density, which was analyzed in the 1985 EIS through the 2009 Revised TIAR Update. One thousand three hundred and seventy-five (1,375) additional units are planned as compared to the 3,500 units, which is allowed under existing land

use approvals ~~Four (4) new hotels~~ One new hotel totaling 625 rooms, 590 resort residential units, and 160 affordable community housing units are included in the Proposed Action. The Proposed Action concentrates the higher density development at the central core of the Resort near the existing Turtle Bay Hotel. Lower density resort-residential developments will be located to the east and west of the core of the Resort. Figure 3 depicts the Proposed Action development plan.

C. Full Build Out Alternative

The Full Build Out (FBO) Alternative represents maximization of the development permitted under current land use entitlements and approvals. Five new hotels, totaling 2,500 rooms, 910 new resort residential units, and 90 affordable community housing units are included under the FBO Alternative. The additional 3,500 units under the FBO Alternative is comparable to the density analyzed in the 1985 EIS through the 2009 Revised TIAR Update. The FBO Alternative development plan is depicted on Figure 4.

D. Resort Residential Alternative

The Resort Residential (RR) Alternative represents the development of an exclusive resort residential community, which excludes future hotel development in the Turtle Bay Resort. The Resort Residential Alternative represents the lowest density among the Proposed Action and the three (3) Alternatives with 454 new resort residential units and 46 affordable community housing units. Figure 5 depicts the Resort Residential Alternative development plan.

E. Conservation Partner Alternative

The Conservation Partner (CP) Alternative concentrates all future development in the core of the Resort, and maintains open space along the Resort's coastline at Kawela Bay and on the eastern half of the Resort where the existing golf courses are located. The Conservation Partner Alternative includes 440 new hotel rooms, 252 new resort residential units, and 48 affordable community housing units. The Conservation Partner Alternative development plan is depicted on Figure 6.

III. Existing Conditions

A. Roadways

Kamehameha Highway is the primary arterial highway in the North Shore area and Windward Oahu. Kamehameha Highway is a two-way, two-lane highway with posted speeds, which range from 25 miles per hour in the build-up towns along the North Shore and Windward coast to 45 mph along isolated segments of the Highway. In the vicinity of Kuilima Drive, the Kamehameha Highway speed limit is posted at 35 mph. According to DOT traffic data collected in 2011, Kamehameha Highway carried about 9,700 vehicles per day (vpd), total for both directions, west of Turtle Bay Resort. Further to the west, Kamehameha Highway carried about 16,000 vpd, north of the Joseph P. Leong Highway junction in Haleiwa. To the east, Kamehameha Highway carried approximately 19,000 vpd, north of the Kahekili Highway junction in Kahaluu.

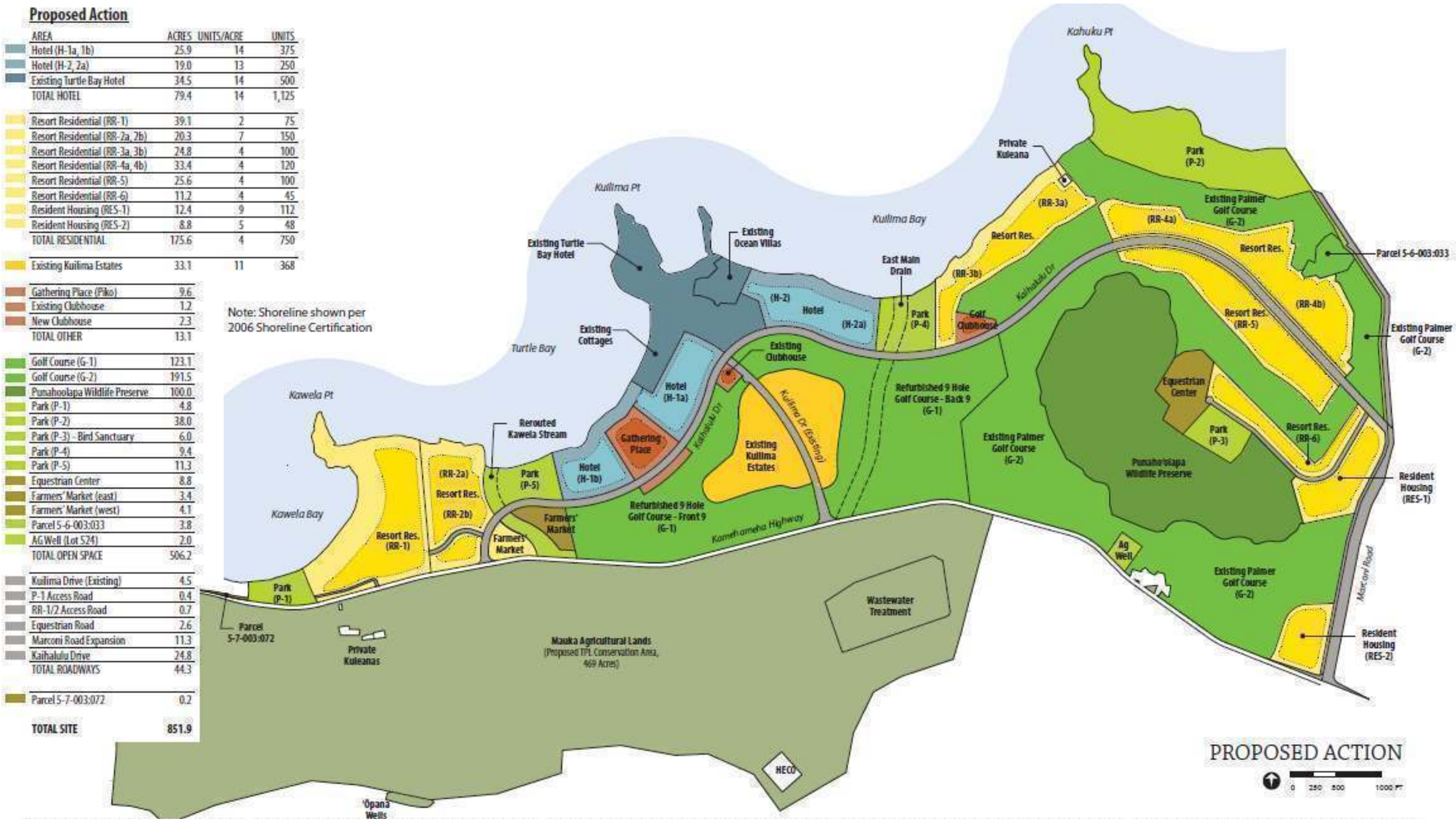


Figure 3. Turtle Bay Resort Master Plan – Proposed Action

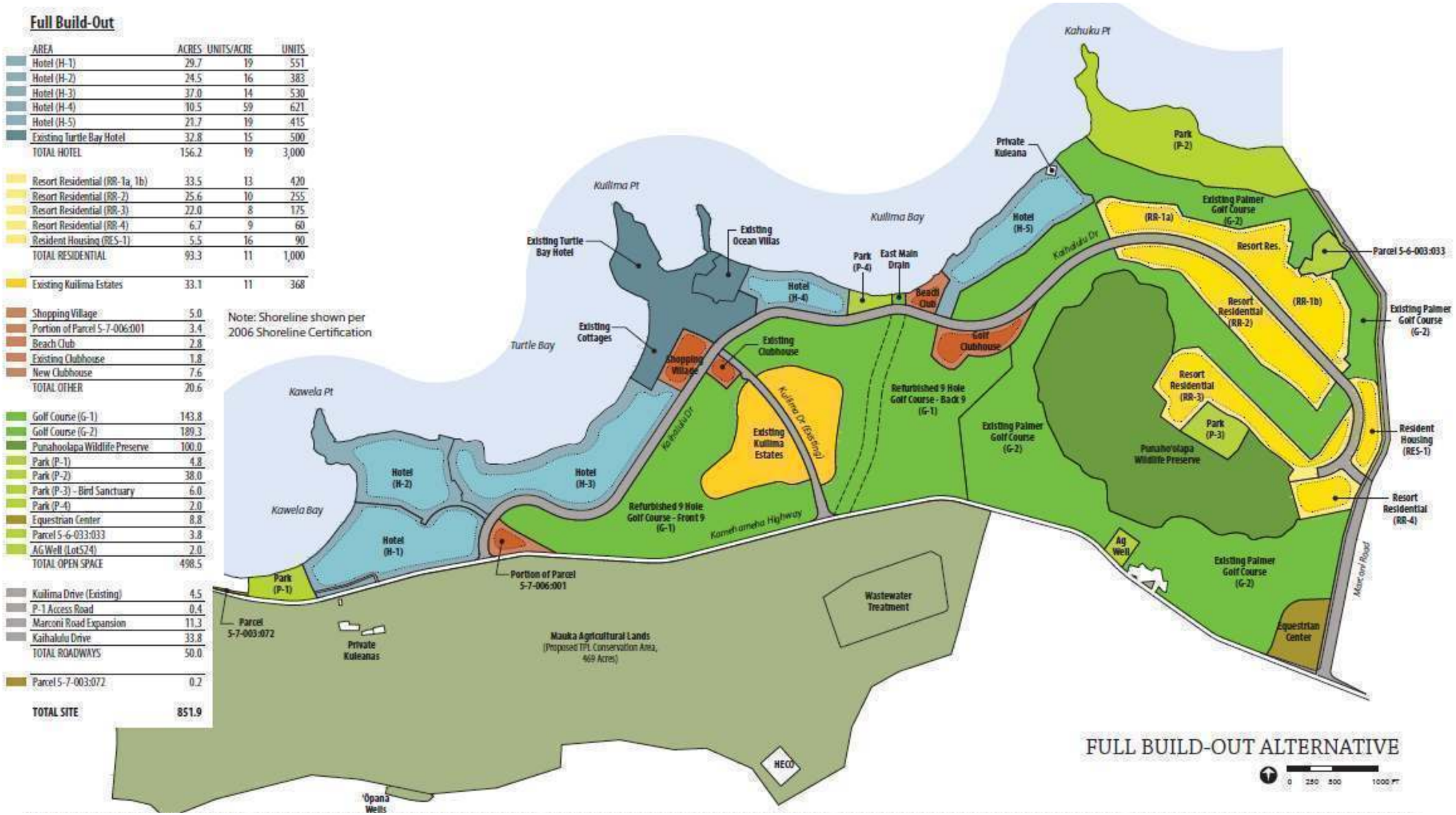


Figure 4. Turtle Bay Resort Master Plan – Full Build Out Alternative

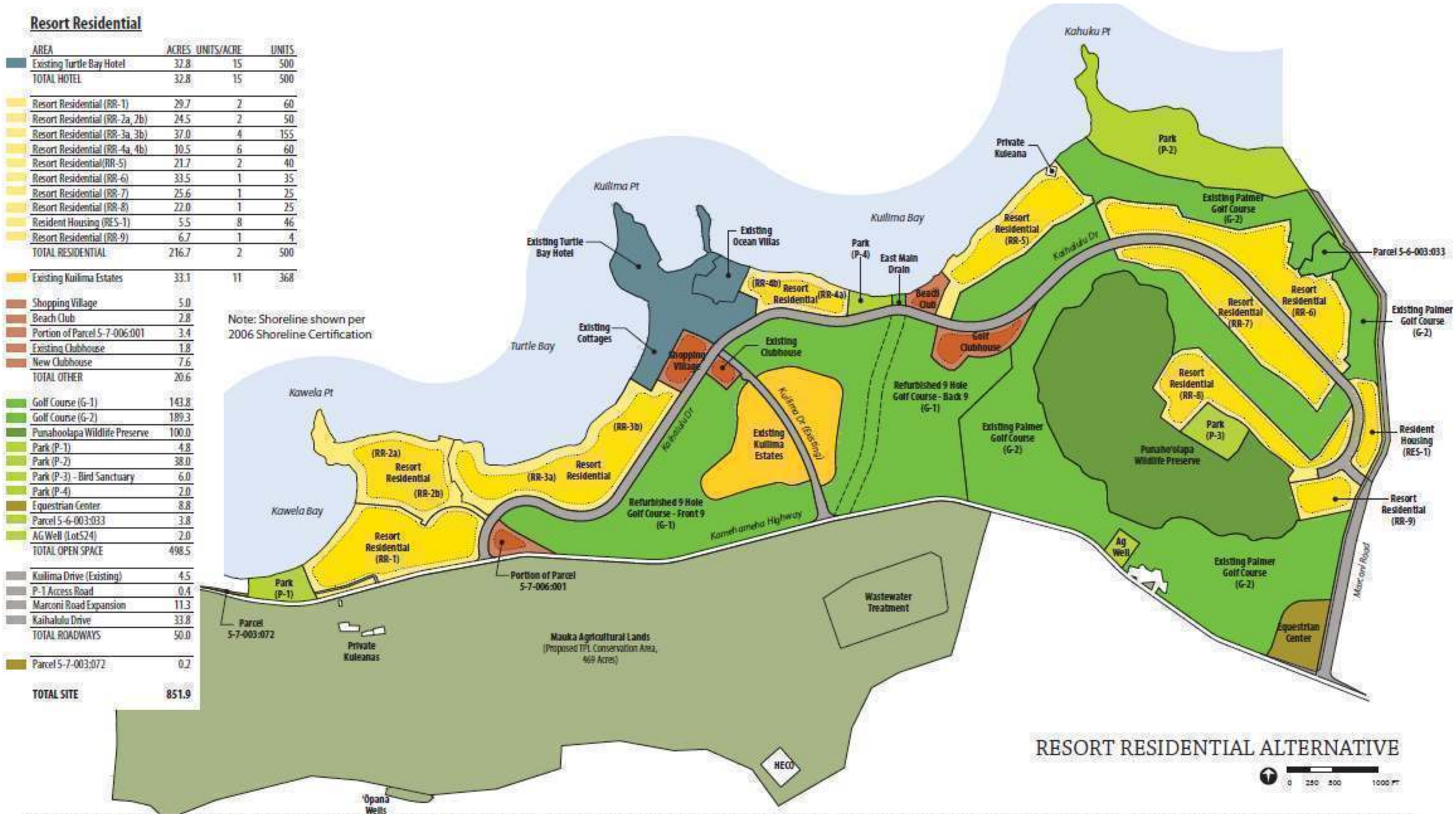


Figure 5. Turtle Bay Resort Master Plan – Resort Residential Alternative

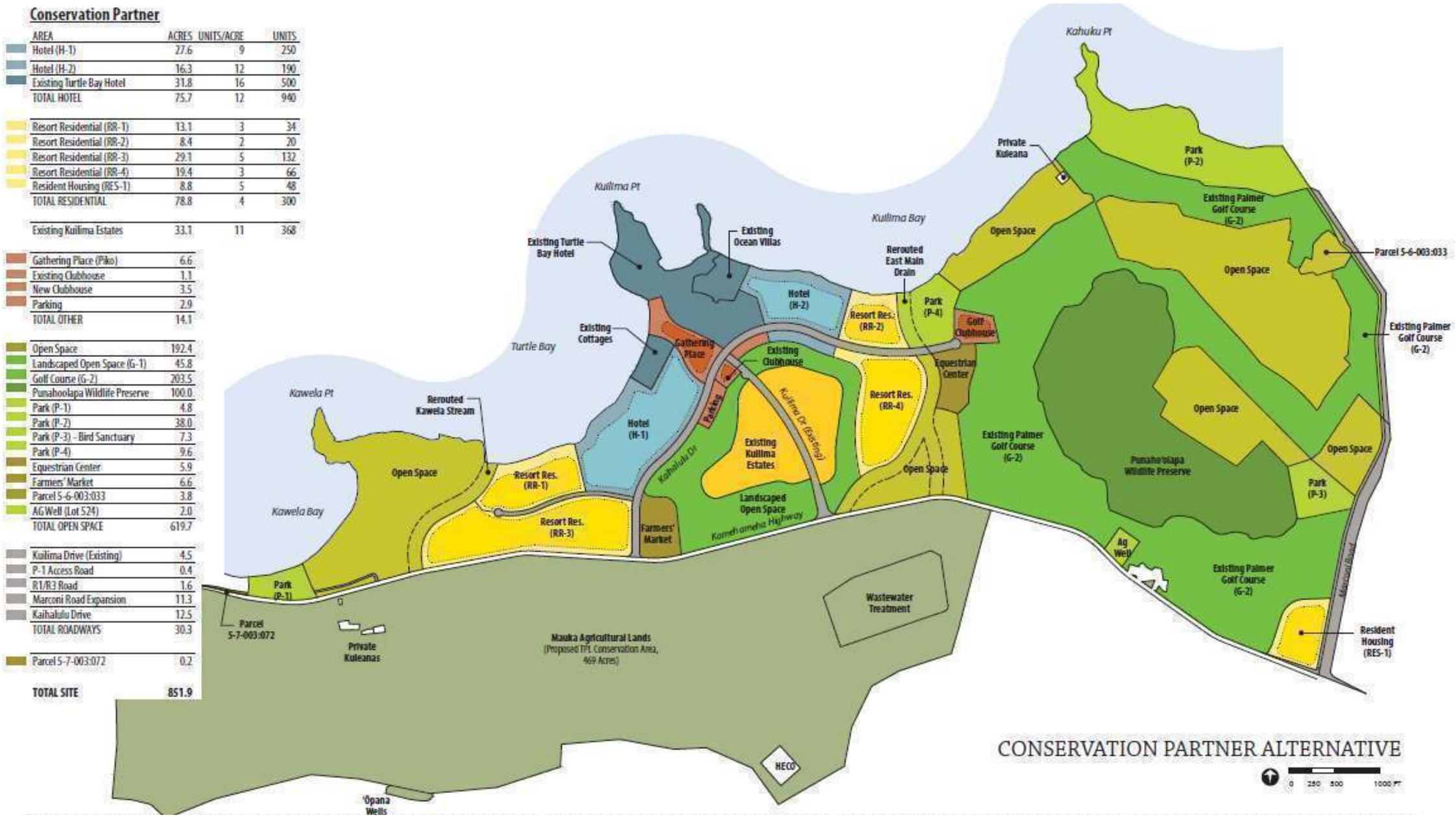


Figure 6. Turtle Bay Resort Master Plan – Conservation Partner Alternative

Kuilima Drive is a two- to four-lane, two-way roadway. Kuilima Drive intersects Kamehameha Highway at a stop-controlled Tee-intersection. Kamehameha Highway currently does not have provisions for exclusive turning lanes at Kuilima Drive. Kuilima Drive provides access to the existing Turtle Bay Resort Hotel and Golf Club and Kuilima Estates. Kuilima Drive carried an average of about 4,200 vpd, total for both directions during the 2011 field investigation for this study.

Marconi Road is a two-lane, two-way roadway, which intersects Kamehameha Highway at a stop-controlled Tee-intersection. Kamehameha Highway currently does not provide exclusive turning lanes at Marconi Road. Marconi Road is a low volume roadway, which provides access to existing residential dwelling units and the coastline.

Joseph P. Leong Highway is a two-way, two-lane high quality highway, which is a continuation of Kamehameha Highway that bypasses Haleiwa Town (also known as the Haleiwa Bypass Highway). At its north junction, the east leg of Kamehameha Highway intersects Kamehameha Highway/Joseph P. Leong Highway at a signalized Tee-intersection. The southbound approach of Kamehameha Highway includes an exclusive right-turn lane, and the northbound approach of Joseph P. Leong Highway includes an exclusive left-turn lane.

Kahekili Highway is a two-way, two-lane high quality highway, which is a continuation of Kamehameha Highway that bypasses Kaneohe Town. The east leg of Kamehameha Highway is stop-controlled at its Tee-intersection with Kamehameha Highway/Kahekili Highway. Southbound Kamehameha Highway does not have provisions for an exclusive left-turn lane to the eastbound Kamehameha Highway. Northbound Kahekili Highway has an exclusive right-turn lane to the eastbound Kamehameha Highway.

B. Existing Peak Hour Traffic Volumes and Operating Conditions

1. Field Investigation and Data Collection

Traffic count surveys were conducted at the Kamehameha Highway intersections at Kuilima Drive and at Marconi Road on November 3, 2011 (Thursday) and on November 5, 2011 (Saturday). The field investigation was conducted during the high surf season on the North Shore, but prior to the Vans Trip Crown of Surfing. Turning movement and vehicle classification traffic counts were taken at the intersection of Kamehameha Highway and Kuilima Drive from 6:00 AM to 6:00 PM during the weekday, and from 9:00 AM to 6:00 PM on Saturday. Turning movement traffic counts also were taken at the intersection of Kamehameha Highway and Marconi Road during the peak periods of traffic.

A week-long traffic count survey was conducted on Kuilima Drive at Kamehameha Highway and at the Turtle Bay Hotel entrance from Sunday, October 30, 2011 to Sunday, November 6, 2011. The purpose of the survey was to develop trip generation characteristics for the resort hotel and resort residential units at Turtle Bay Resort. The traffic count survey was coordinated with a travel interview survey, which was conducted by SMS Research & Marketing Services, Inc. (SMS) at Turtle

Bay Hotel and Kuilima Estates from November 1, 2011 through November 6, 2011. The purpose of the interview survey was to determine the origins and destinations of all traffic entering and exiting the Resort. The results of SMS survey provided the basis for the geographic trip distribution of the Turtle Bay Resort trips.

The limits of the study area were recommended by DOT, during pre-consultation meetings. The study area extends over 35 miles along the North Shore and Windward Oahu between the intersection of Kamehameha Highway and Joseph P. Leong Highway in Haleiwa, and the intersection of Kamehameha Highway and Kahekili Highway in Kahaluu. Peak period traffic count surveys were conducted at these intersections on October 29, 2011 (Saturday) and November 1, 2011 (Monday). The traffic survey data are presented in the Appendix.

While surfing on the North Shore is a major attraction on Oahu, the beach locations are spread out over seven (7) miles and affect traffic only during high surf conditions and surfing contests. In past several years Laniakea (Turtle Beach) has also become a popular attraction due to the daily presence of sea turtles that come ashore. The other major traffic generator in the study area is concentrated in La`ie, which includes the Polynesian Cultural Center (PCC) and Brigham Young University Hawaii (BYU-H). "Envision La`ie" is the long-range plan for PCC, BYU-H, and the surrounding lands, which are owned and managed by Hawaii Reserves, Inc. in affiliation The Church of Jesus Christ of Latter-Day Saints. The planning of Envision La`ie is still being developed at this writing, while Hawaii Reserves, Inc. seeks entitlement and zoning approvals. Without a detailed development proposal, a transportation plan cannot be developed and included in this cumulative traffic analysis. Therefore, Envision La`ie was excluded from this traffic impact analysis.

2. Existing AM Peak Hour of Weekday Traffic

Turtle Bay Resort is located at the northernmost point of the island of Oahu, while the Primary Urban Center of Oahu is located along the south shore of the island. The traditional AM peak period of commuter traffic, which generally occurs between 6:00 AM and 9:00 AM in urban areas, was virtually non-existent in the vicinity of Turtle Bay Resort. Kamehameha Highway peak period traffic was typical of a scenic/recreational route.

The AM peak hour of weekday traffic on Kamehameha Highway, in the vicinity of Turtle Bay Resort, occurred between 11:00 AM and 12:00 Noon. Kamehameha Highway carried about 500 vehicles per hour (vph), total for both directions, which continued to increase in the afternoon. Kamehameha Highway operated at LOS "E", with a v/c ratio of 0.18, west of Kuilima Drive.

The left-turn and right turn movements from Kuilima Drive at Kamehameha operated at LOS "C" and LOS "B", respectively during the AM peak hour of weekday traffic. Marconi Road operated at LOS "B" at Kamehameha Highway.

The typical AM peak hour of commuter traffic also was not evident at the western end of the study area in Haleiwa. The AM peak hour of weekday traffic occurred between 10:45 AM and 11:45 AM at the north junction of the intersection of Kamehameha Highway and Joseph P. Leong Highway. North of Joseph P Leong Highway, Kamehameha Highway carried about 1,100 vph, total for both directions. Kamehameha Highway operated at LOS "E" with a v/c ratio of 0.35 north of Haleiwa. The intersection of Kamehameha Highway and Joseph P. Leong Highway operated at an overall LOS "B" during the AM peak hour of weekday traffic. The individual traffic movements at the intersection operated at satisfactory Levels of Service, i.e. LOS "C" or better.

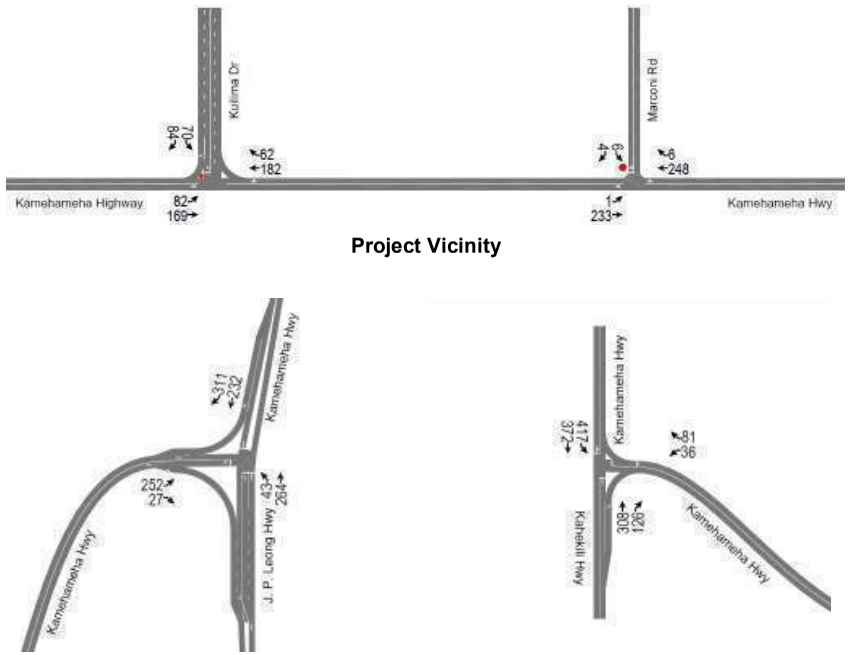
The AM peak hour of weekday traffic at the eastern end of the study area in Kahaluu occurred between 6:45 AM and 7:45 AM. North of Kahekili Highway, Kamehameha Highway carried about 1,200 vph, total for both directions, and operated at LOS "E" with a v/c ratio of 0.41. The predominant traffic movement was on southbound Kamehameha Highway with about 800 vph, which split between continuing onto Kahekili Highway and turning left into Kamehameha Highway. The left-turn movement from eastbound Kamehameha Highway operated at LOS "F" onto Kahekili Highway. However, the left-turn demand was relatively low at less than 40 vph, and the observed delays were much lower than calculated delays when courteous motorists on southbound Kamehameha Highway permitted the left-turn movement from westbound Kamehameha Highway. The other traffic movements at the intersection operated at satisfactory Levels of Service. The existing AM peak hour traffic volumes are depicted on Figure 7.

3. Existing PM Peak Hour Traffic

The typical PM peak hour of commuter traffic, which occurs between 3:00 PM and 6:00 PM in urban areas, also was not evident in the vicinity of Turtle Bay Resort. The PM peak hour of weekday traffic on Kamehameha Highway occurred between 2:00 PM and 3:00 PM. Kamehameha Highway carried about 700 vph, total for both directions in the vicinity of Turtle Bay Resort. West of Kuilima Drive, Kamehameha Highway operated at LOS "E", with a v/c ratio of 0.26.

The left-turn and right turn movements from Kuilima Drive at Kamehameha Highway operated at LOS "C" and LOS "B", respectively during the PM peak hour of weekday traffic. Marconi Road operated at LOS "B" at Kamehameha Highway.

The PM peak hour of weekday traffic in Haleiwa occurred between 2:45 PM and 3:45 PM. Kamehameha Highway carried over 1,400 vph, total for both directions. Kamehameha Highway operated at LOS "E" with a v/c ratio of 0.48 north of Haleiwa. The intersection of Kamehameha Highway and Joseph P. Leong Highway operated at an overall LOS "B" during the PM peak hour of weekday traffic. The individual traffic movements at the intersection operated at satisfactory Levels of Service.



Legend

Lane Controls

137→ **Traffic Movement Volume (vph)**

Figure 7. Existing AM Peak Hour Traffic

The PM peak hour of weekday traffic in Kahaluu occurred between 3:30 PM and 4:30 PM. Kamehameha Highway carried about 1,500 vph, total for both directions. North of the Kahekili Highway intersection, Kamehameha Highway operated at LOS "E" with a v/c ratio of 0.48. The traffic movements at the intersection of Kamehameha Highway and Kahekili Highway operated at satisfactory Levels of Service. Figure 8 depicts the existing PM peak hour traffic volumes.

4. Existing Peak Hour of Weekend Traffic

The weekend peak hour of traffic is represented by a single peak hour on Saturday or Sunday. The existing weekend traffic data in the study area indicated that Sunday traffic was lower than Saturday traffic. Lower Sunday traffic can be attributed, in part, to the fact that PCC does not operate on Sundays. In addition, the Saturday peak hour trip generation rates for hotels, which are developed by the Institute of Transportation Engineers (ITE), are higher than the Sunday peak hour trip rates. During the pre-consultation meetings with DOT, it was mutually agreed that the Saturday peak hour traffic would represent the weekend peak hour traffic in the study area.

The peak hour of weekend traffic in Kahuku occurred between 2:00 PM and 3:00 PM. Kamehameha Highway carried almost 900 vph, total for both directions. Kamehameha Highway operated at LOS "E", with a v/c ratio of 0.29. The left-turn and right turn movements from Kuilima Drive at Kamehameha Highway operated at LOS "D" and LOS "B", respectively during the peak hour of weekend traffic. Marconi Road operated at LOS "B" at Kamehameha Highway.

In Haleiwa, the peak hour of weekend traffic occurred between 11:45 AM and 12:45 PM. Kamehameha Highway carried almost 1,600 vph, total for both directions. Kamehameha Highway operated at LOS "E" with a v/c ratio of 0.54 north of Haleiwa. The queuing on northbound Kamehameha Highway was a result of traffic congestion at Laniakea Beach, where motorists are turning on and off the Highway and stopping for pedestrians cross the Highway. The intersection of Kamehameha Highway and Joseph P. Leong Highway operated at an overall LOS "B" during the peak hour of weekend traffic. The left-turn movement on northbound Joseph P. Leong Highway operated at LOS "D". The other traffic movements at the intersection operated at satisfactory Levels of Service.

The peak hour of weekend traffic in Kahaluu occurred between 2:15 PM and 3:15 PM. Kamehameha Highway carried about 1,500 vph, total for both directions. North of its intersection with Kahekili Highway, Kamehameha Highway operated at LOS "E" with a v/c ratio of 0.50. The traffic movements at the intersection of Kamehameha Highway and Kahekili Highway operated at satisfactory Levels of Service. Figure 9 depicts the existing weekend peak hour traffic volumes. Table 3 summarizes the intersection analysis for the existing peak hours of traffic. Table 4 summarizes the Kamehameha Highway two-lane traffic operations for the existing peak hours of traffic.

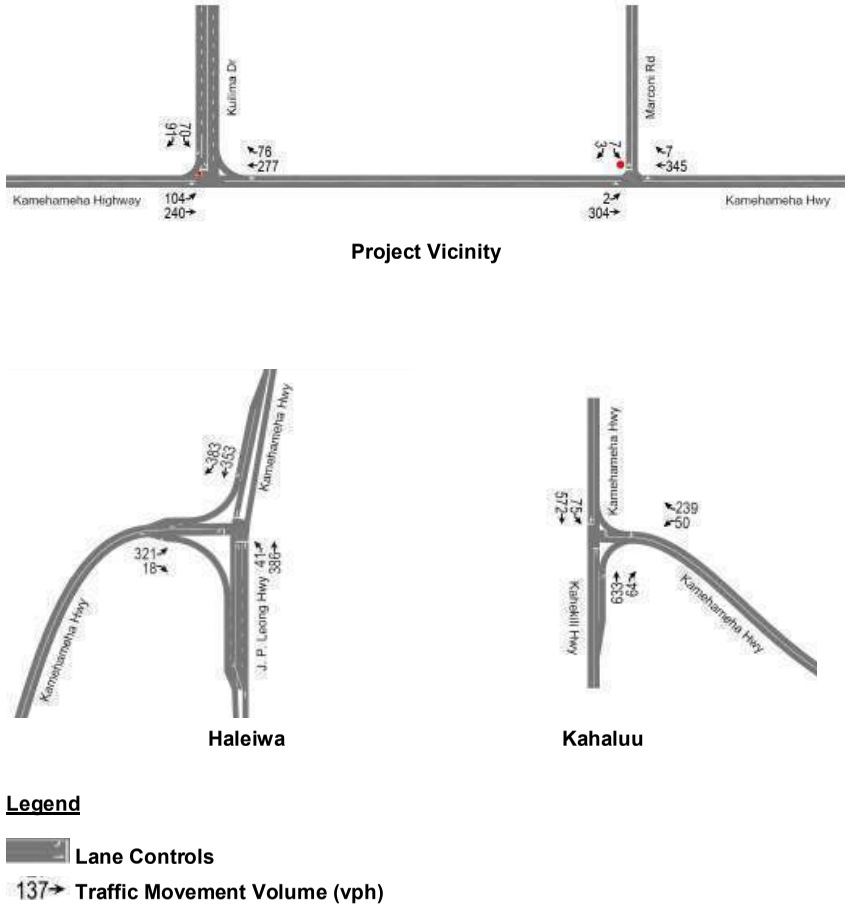
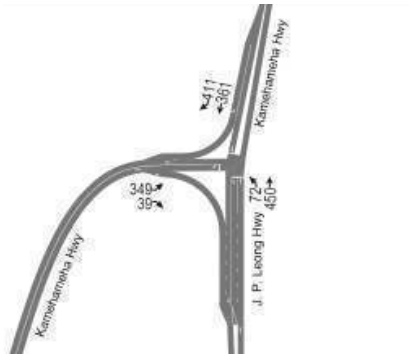


Figure 8. Existing PM Peak Hour Traffic

Project Vicinity



Haleiwa

Kahaluu

Legend

Lane Controls

137→ **Traffic Movement Volume (vph)**

Figure 9. Existing Weekend Peak Hour Traffic

Table 4. Intersection Traffic Analysis Summary - Existing Peak Hour Conditions

Scenario	Kamehameha Hwy Intersection	MOE	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Intersection
Existing AM Peak Hour of Weekday Traffic	Kuilima Drive	LOS	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	C	N/A	B	A
		Delay	8.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15.8	N/A	10.4	3.8
		v/c	0.07	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.18	N/A	0.11	N/A
	Marconi Rd	LOS	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	B			A
		Delay	7.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.5			0.2
		v/c	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.02			N/A
	Joseph P. Leong Hwy	LOS	C	N/A	A	N/A	N/A	N/A	C	A	N/A	N/A	B	A	B
		Delay	24.4	N/A	0.2	N/A	N/A	N/A	26.1	8.3	N/A	N/A	13.9	3.7	12.7
		v/c	0.65	N/A	0.05	N/A	N/A	N/A	0.31	0.31	N/A	N/A	0.30	0.39	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	F	N/A	N/A	N/A	N/A	N/A	B	N/A	N/A	F
		Delay	N/A	N/A	N/A	>300	N/A	N/A	N/A	N/A	N/A	12.2	N/A	N/A	78.0
		v/c	N/A	N/A	N/A	>1.2	N/A	N/A	N/A	N/A	N/A	0.55	N/A	N/A	N/A
Existing PM Peak Hour of Weekday Traffic	Kuilima Drive	LOS	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	C	N/A	B	A
		Delay	8.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.6	N/A	11.4	3.6
		v/c	0.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.26	N/A	0.15	N/A
	Marconi Rd	LOS	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	B			A
		Delay	8.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.3			0.3
		v/c	0.01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.03			N/A
	Joseph P. Leong Hwy	LOS	C	N/A	A	N/A	N/A	N/A	C	A	N/A	N/A	B	A	B
		Delay	25.6	N/A	0.2	N/A	N/A	N/A	32.2	9.3	N/A	N/A	15.8	3.7	13.6
		v/c	0.69	N/A	0.05	N/A	N/A	N/A	0.39	0.38	N/A	N/A	0.45	0.45	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	B	N/A	N/A	N/A	N/A	N/A	A	N/A	N/A	A
		Delay	N/A	N/A	N/A	13.4	N/A	N/A	N/A	N/A	N/A	9.6	N/A	N/A	2.8
		v/c	N/A	N/A	N/A	0.41	N/A	N/A	N/A	N/A	N/A	0.09	N/A	N/A	N/A
Existing Weekend Peak Hour of Traffic	Kuilima Drive	LOS	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	D	N/A	B	A
		Delay	8.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	32.6	N/A	12.1	4.3
		v/c	0.14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.37	N/A	0.17	N/A
	Marconi Rd	LOS	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	B			A
		Delay	8.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12.1			0.3
		v/c	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.03			N/A
	Joseph P. Leong Hwy	LOS	C	N/A	A	N/A	N/A	N/A	D	B	N/A	N/A	B	A	B
		Delay	25.1	N/A	0.4	N/A	N/A	N/A	42.6	12.3	N/A	N/A	17.7	4.2	15.1
		v/c	0.74	N/A	0.09	N/A	N/A	N/A	0.51	0.50	N/A	N/A	0.51	0.52	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	C	N/A	N/A	N/A	N/A	N/A	A	N/A	N/A	A
		Delay	N/A	N/A	N/A	16.6	N/A	N/A	N/A	N/A	N/A	9.7	N/A	N/A	2.9
		v/c	N/A	N/A	N/A	0.45	N/A	N/A	N/A	N/A	N/A	0.10	N/A	N/A	N/A

Table 4. Existing Peak Hour Two-Lane Operations on Kamehameha Highway			
Peak Hour	**Location**	**LOS**	**v/c**
Weekday AM	Haleiwa	E	0.35
	Kahuku	E	0.18
	Kahaluu	E	0.41
Weekday PM	Haleiwa	E	0.48
	Kahuku	E	0.26
	Kahaluu	E	0.48
Weekend	Haleiwa	E	0.54
	Kahuku	E	0.29
	Kahaluu	E	0.50

5. Traffic Signal Warrant Analysis

The existing weekday traffic conditions at the intersection of Kamehameha Highway and Kuilima Drive meet the 70 percent levels for Warrant 1, Conditions A and B, between the hours of 10:00 AM and 4:00 PM. According to the MUTCD, "if the intersection lies within the built-up area of an isolated community having a population of less that 10,000 or speeds on the major highway exceeds 40 mph, the traffic volumes in the 70 percent columns in Table 4C-1 of the MUTCD may be used." The population criterion applies to the Kahuku area. Therefore, Warrant 1, Conditions A and B of the MUTCD were met at the intersection of Kamehameha Highway and Kuilima Drive under existing conditions. The traffic signal warrant worksheet is attached in the Appendix.

IV. Future Traffic Conditions Without Proposed Action

A. Existing Turtle Bay Resort

During the trip generation survey, the reported occupancies for Turtle Bay Hotel ranged from 72 percent to 96 percent. The estimated occupancies for Kuilima Estates ranged from 45 percent to 63 percent. The existing Turtle Bay Hotel traffic, under future traffic conditions without the Proposed Action, was analyzed at occupancy rates of 90 percent and 95 percent during the weekday and weekend peak hours of traffic without the Proposed Action, respectively. Similarly, the existing Kuilima Estates were analyzed at 60 percent occupancies for both the weekday and weekend peak hours of traffic. The occupancy levels were based upon the assumptions, which were recommended by DOT during pre-consultation meetings.

B. Future Roadway Improvements

The Oahu Regional Transportation Plan 2035 (ORTP) mid-range projects through the Year 2020 include the construction of "safety improvements along Kamehameha Highway, from Haleiwa to Kahaluu. Safety improvements include turn lanes, guardrails, signage, crosswalks, etc., to improve safety." The ORTP goes on to state that the "Widening of Kamehameha Highway will only be in areas where needed for storage/turn lanes and safety improvements." Notwithstanding, DOT continues to request reservation or dedication of rights-of-way for future widening of Kamehameha Highway. However, DOT has deferred further planning for the widening in response to community opposition to a four-lane highway.

C. Kahuku Mauka Agricultural Lots

The Kahuku Mauka Agricultural Lots is located on south side of Kamehameha Highway to the east of Turtle Bay Resort. The agricultural subdivision is not part of the Proposed Action because the property is not owned by Turtle Bay Resort. The future access from Kamehameha Highway to the agricultural project will be constructed (by others) opposite Marconi Road, creating a four-legged intersection. Therefore, it is included as part of the cumulative traffic analysis both with and without the Proposed Action and with the three (3) Alternatives.

The traffic assessment of a proposed agricultural subdivision (TMK: 5-6-003: 010, 026, & 032) was prepared by Julian Ng, Incorporated, dated June 6, 2008. The Ng traffic study analyzed the traffic impacts of a 36-lot agricultural subdivision. The Ng study included the findings of another Ng study, Traffic Analysis Report, Kahuku Mauka Agricultural Lots, Phases I & II, dated August 2007.

The current status of the Kahuku Mauka Agricultural Lots was obtained from Bow Engineering & Development, Inc. The 36-lot subdivision plan has been consolidated into a 3-large lot subdivision. The construction of the Kahuku Agricultural Access Road, opposite Marconi Road, is being deferred until the development of the 36-lot subdivision plan resumes. For purpose of this analysis, it is assumed that the Kahuku Mauka Agricultural Lots would be fully developed by the Year 2025. The trip generation and traffic assignments from the Ng studies were incorporated into the future traffic analysis of the study area.

D. Regional Traffic Forecasts

Year 2025 traffic conditions without the Proposed Action are developed to establish the baseline conditions from which to evaluate the traffic impacts of the Proposed Action and the three (3) Alternatives. The Institute of Transportation Engineers (ITE) indicates that an area-wide transportation plan is "often used with large projects that will be developed over a long period of time" (Transportation Impact Analysis for Site Development). ITE goes on to suggest that regional travel forecasts can be more accurate than the straight-line growth projections, based upon historical trends, especially for large developments that occur over a long period of time.

The Oahu Regional Transportation Plan 2035 (ORTP), was prepared for the Oahu Metropolitan Planning Organization (OMPO) in April 2011. The Year 2035 weekday traffic forecasts on the North Shore and Windward Oahu were obtained from OMPO, through the assistance of DOT.

The Year 2025 traffic forecasts on Kamehameha Highway were derived by interpolating between the Year 2035 ORTP model forecasts and the Base Year 2011 DOT data for weekday traffic, assuming a straight-line growth pattern. (Weekend traffic was not analyzed in the ORTP). Three locations on Kamehameha Highway were selected for the regional traffic assessment: northeast of Joseph P. Leong Highway in Haleiwa, west of Kuilima Drive in Kahuku, and northwest of Kahekili Highway in Kahaluu. Table 5 compares the with DOT 2011 traffic data, the ORTP 2035 traffic forecasts, and the interpolated 2025 traffic forecasts used in this study.

Table 5. Existing and Future Weekday Traffic

Location	2011 Traffic (DOT)	2025 Traffic (Interpolated)	2035 Traffic (ORTP)	Average Annual Growth
	Totals	Totals	Totals	Totals
Haleiwa	16,101	16.759	17,229	0.29 %
Kahuku	9,666	11,329	12,516	1.23 %
Kahaluu	19,130	23,012	25,784	1.45 %

Over a 24-year period between the Years 2011 and 2035, the ORTP projected relatively low growth (7 percent) in Haleiwa, and more moderate growth (30-35 percent) in the Kahuku and Kahaluu areas. It should be noted that OMPO reported that the ORTP forecasts included a total of 1,184 resort units at Turtle Bay Resort, i.e., about 300 more resort units than the existing Turtle Bay Hotel, Ocean Villas, and Kuilima Estates. Therefore, use of the ORTP forecast to establish future traffic conditions with and without the Proposed Action can considered to be conservative, i.e., it overestimates the future traffic on the North Shore and Windward Oahu.

The average annual growth rates were applied uniformly to peak hour traffic in the respective areas to establish the Year 2025 peak hour traffic conditions without the Proposed Action. In the vicinity of Turtle Bay Resort, the average annual growth rate was applied only to through and pass-by traffic and not to Turtle Bay Resort traffic.

E. Year 2025 Peak Hour Traffic Analysis Without the Proposed Action

1. Year 2025 AM Peak Hour Traffic Without the Proposed Action

During the Year 2025 AM peak hour of traffic without the Proposed Action, the Kuilima Drive and Marconi Road intersections on Kamehameha Highway are expected to operate at satisfactory Levels of Service. The two-lane section of

Kamehameha Highway is expected to operate at LOS "E", with a v/c ratio of 0.22, in the project vicinity.

The intersection of Kamehameha Highway and Joseph P. Leong Highway in Haleiwa also is expected to operate at satisfactory Levels of Service, during the Year 2025 AM peak hour of traffic without the Proposed Action. North of Haleiwa, Kamehameha Highway is expected to operate at LOS "E", with a v/c ratio of 0.38, during the Year 2025 AM peak hour of traffic without the Proposed Action.

In Kahaluu, the westbound approach of Kamehameha Highway at Kamehameha Highway/Kahekili Highway is expected to operate at LOS "F", during the Year 2025 AM peak hour of traffic without the Proposed Action. Kamehameha Highway is expected to operate at LOS "E", with a v/c ratio of 0.51, in the Kahaluu area. Figure 10 depicts the Year 2025 AM peak hour traffic without the Proposed Action.

2. Year 2025 PM Peak Hour Traffic Without the Proposed Action

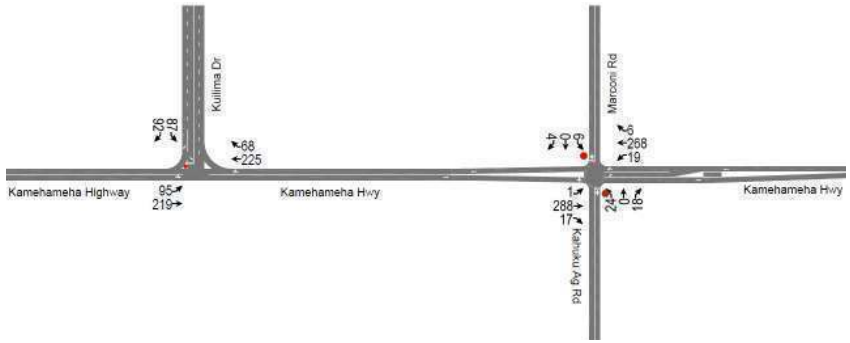
Kuilima Drive is expected to operate at LOS "E" at Kamehameha Highway, during the Year 2025 PM peak hour of traffic without the Proposed Action. The intersection of Kamehameha Highway and Marconi Road is expected to operate at satisfactory Levels of Service. West of Kuilima Drive, Kamehameha Highway is expected to operate at LOS "E", with a v/c ratio of 0.33, during the Year 2025 PM peak hour of traffic without the Proposed Action.

In Haleiwa, the intersection of Kamehameha Highway and Joseph P. Leong Highway also is expected to operate at satisfactory Levels of Service. Kamehameha Highway is expected to operate at LOS "E", with a v/c ratio of 0.52, north of Haleiwa.

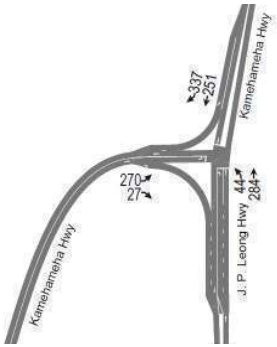
The westbound approach of Kamehameha Highway is expected to operate at LOS "F" at Kamehameha Highway/Kahekili Highway in Kahaluu. North of Kahekili Highway, Kamehameha Highway is expected to operate at LOS "E", with a v/c ratio of 0.60. The Year 2025 PM peak hour traffic without the Proposed Action is depicted on Figure 11.

3. Year 2025 Weekend Peak Hour Traffic Without the Proposed Action

During the Year 2025 weekend peak hour of traffic without the Proposed Action, the left-turn movement from Kuilima Drive onto Kamehameha Highway is expected to operate at LOS "F". Marconi Road and Kahuku Agricultural Road are expected to operate at satisfactory Levels of Service at Kamehameha Highway. Kamehameha Highway is expected to operate at LOS "E", with a v/c ratio of 0.35, in the project vicinity, during the Year 2025 weekend peak hour of traffic without the Proposed Action.



Project Vicinity



Haleiwa

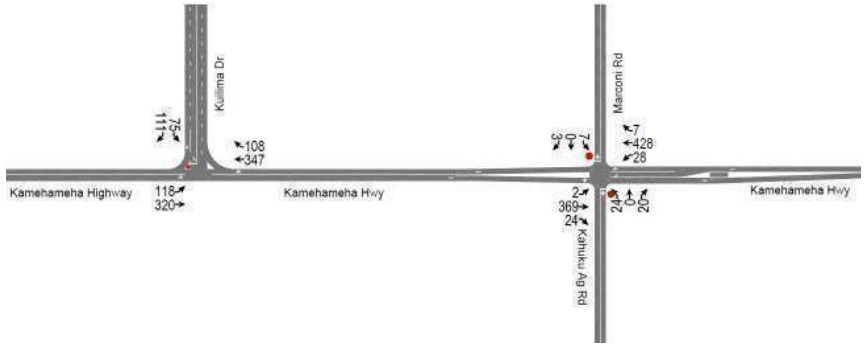
Kahaluu

Legend

Lane Controls

137→ **Traffic Movement Volume (vph)**

Figure 10. Year 2025 AM Peak Hour Traffic Without the Proposed Action



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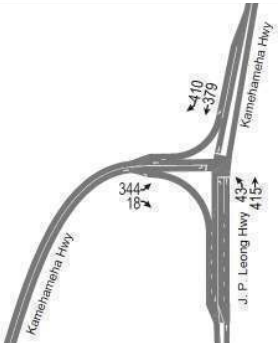


Haleiwa

Kahaluu

Legend

Lane Controls

137→ **Traffic Movement Volume (vph)**

Figure 11. Year 2025 PM Peak Hour Traffic Without the Proposed Action

The left-turn movement from northbound Joseph P. Leong Highway to westbound Kamehameha Highway in Haleiwa is expected to operate at LOS "D". The other traffic movements at the intersection of Kamehameha Highway and Joseph P. Leong Highway are expected to operate at satisfactory Levels of Service. North of Haleiwa, Kamehameha Highway is expected to operate at LOS "E", with a v/c ratio of 0.57, during the Year 2025 weekend peak hour of traffic without the Proposed Action.

The westbound approach of Kamehameha Highway is expected to operate at LOS "F" at Kahekili Highway/Kamehameha Highway in Kahaluu. Kamehameha Highway is expected to operate at LOS "E", with a v/c ratio of 0.61, in the Kahaluu area.

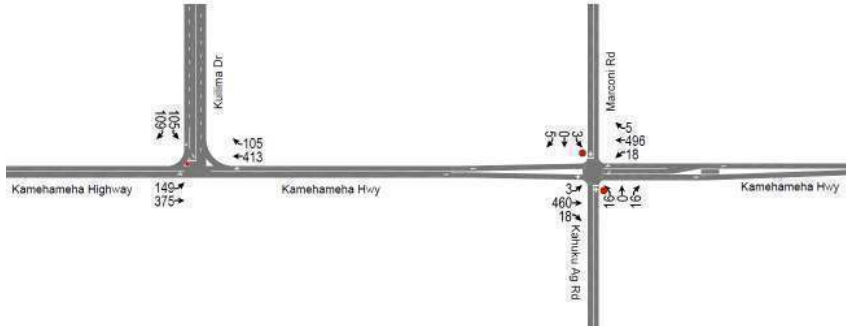
Table 6 summarizes the Kamehameha Highway two-lane traffic operations for the peak hours of traffic without the Proposed Action. Table 7 summarizes the intersection analysis for the peak hours of traffic without the Proposed Action. Figure 12 depicts the Year 2025 weekend peak hour traffic without the Proposed Action.

Table 6. Peak Hour Two-Lane Operations on Kamehameha Highway Without Proposed Action

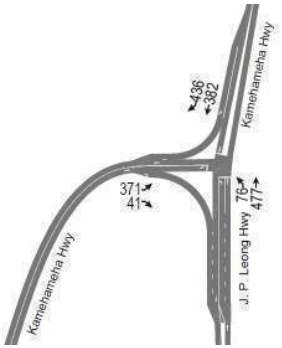
Peak Hour	Location	LOS	v/c
Weekday AM	Haleiwa	E	0.38
	Kahuku	E	0.22
	Kahaluu	E	0.51
Weekday PM	Haleiwa	E	0.52
	Kahuku	E	0.33
	Kahaluu	E	0.60
Weekend	Haleiwa	E	0.57
	Kahuku	E	0.35
	Kahaluu	E	0.61

Table 7. Intersection Traffic Analysis Summary - Peak Hour Conditions Without Proposed Action

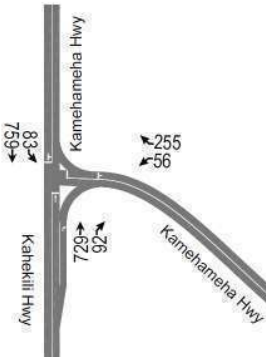
Scenario	Kamehameha Hwy Intersection	MOE	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Intersection
2025 AM Peak Hour of Weekday Traffic Without Proposed Action	Kuilima Drive	LOS	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	C	N/A	B	A
		Delay	8.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20.2	N/A	10.5	4.2
		v/c	0.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.27	N/A	0.13	N/A
	Marconi Rd	LOS	C	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	A			A
		Delay	16.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8.8			1.4
		v/c	0.12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.02			N/A
	Joseph P. Leong Hwy	LOS	C	N/A	A	N/A	N/A	N/A	C	A	N/A	N/A	B	A	B
		Delay	25.4	N/A	0.2	N/A	N/A	N/A	29.2	8.5	N/A	N/A	14.6	3.7	13.3
		v/c	0.67	N/A	0.05	N/A	N/A	N/A	0.35	0.30	N/A	N/A	0.32	0.42	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	E			N/A	N/A	N/A	B	N/A	N/A	F
		Delay	N/A	N/A	N/A	39.3			N/A	N/A	N/A	14.8	N/A	N/A	403.2
		v/c	N/A	N/A	N/A	N/A			N/A	N/A	N/A	0.65	N/A	N/A	N/A
2025 PM Peak Hour of Weekday Traffic Without Proposed Action	Kuilima Drive	LOS	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	E	N/A	B	A
		Delay	9.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	36.8	N/A	12.9	4.4
		v/c	0.12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.41	N/A	0.21	N/A
	Marconi Rd	LOS	C	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	A			A
		Delay	22.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.2			1.5
		v/c	0.19	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.03			N/A
	Joseph P. Leong Hwy	LOS	C	N/A	A	N/A	N/A	N/A	C	A	N/A	N/A	B	A	B
		Delay	26.6	N/A	0.1	N/A	N/A	N/A	31.2	9.4	N/A	N/A	14.7	3.3	13.3
		v/c	0.72	N/A	0.03	N/A	N/A	N/A	0.30	0.41	N/A	N/A	0.52	0.44	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	F			N/A	N/A	N/A	B	N/A	N/A	B
		Delay	N/A	N/A	N/A	60.5			N/A	N/A	N/A	10.4	N/A	N/A	11.1
		v/c	N/A	N/A	N/A	0.92			N/A	N/A	N/A	0.12	N/A	N/A	N/A
2025 Weekend Peak Hour of Traffic Without Proposed Action	Kuilima Drive	LOS	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	F	N/A	B	A
		Delay	9.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	70.8	N/A	13.2	9.4
		v/c	0.15	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.75	N/A	0.25	N/A
	Marconi Rd	LOS	C	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	A			A
		Delay	22.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.3			1.1
		v/c	0.15	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.02			N/A
	Joseph P. Leong Hwy	LOS	C	N/A	A	N/A	N/A	N/A	D	B	N/A	N/A	B	A	B
		Delay	28.7	N/A	0.7	N/A	N/A	N/A	47.1	12.7	N/A	N/A	19.8	4.5	16.7
		v/c	0.79	N/A	0.10	N/A	N/A	N/A	0.57	0.52	N/A	N/A	0.57	0.55	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	F			N/A	N/A	N/A	B	N/A	N/A	C
		Delay	N/A	N/A	N/A	103.9			N/A	N/A	N/A	10.6	N/A	N/A	15.5
		v/c	N/A	N/A	N/A	1.04			N/A	N/A	N/A	0.14	N/A	N/A	N/A



Project Vicinity



Haleiwa



Kahaluu

Legend

Lane Controls

137→ **Traffic Movement Volume (vph)**

Figure 12. Year 2025 Weekend Peak Hour Traffic Without the Proposed Action

V. Trip Generation Analysis

A. Trip Generation Methodology

The Institute of Transportation Engineers (ITE) has developed trip generation rates for various land use activities, which are published in Trip Generation, 8th Edition. The ITE trip generation methodology was developed from actual data from trip generation studies conducted at developed sites throughout the country and compiled into regression equations or weighted average rates.

While ITE has developed trip rates for a wide variety of land use activities, it cannot account for local characteristics that can have a significant effect on travel behavior, such proximity to employment and shopping opportunities, highway access, transit service, and demographics. The range of data that ITE analyzed reflects the wide variation in travel patterns from the same land use activity in different parts of the country. In lieu of more locally valid data, the ITE trip generation methodology is generally accepted by government agencies and widely used throughout the transportation engineering profession for traffic impact analysis of new developments.

When analyzing the traffic impacts an expansion of an existing development, site-specific trip generation data can be collected from the existing development and applied to the future expansion. Such is the case with the Turtle Bay Resort Master Plan, where the proposed land uses are essentially the same character as the existing Resort, and where most of the local characteristics that affect travel behavior will remain the same. In these cases, ITE recommends the use of local trip generation rates where available to estimate traffic from the new or expanded development. Accordingly, the study has developed trip generation rates, which are based upon locally-collected data from existing land uses and further discussed in the following sections. The ITE methodology was used where the local trip data were not available.

1. Resort Hotel

The existing Turtle Bay Hotel and future hotels in the Turtle Bay Resort Master Plan fall under the ITE category of resort hotel. ITE did not develop a weekday trip rate for a resort hotel. ITE Saturday trip data for a resort hotel were limited to one observation. During the pre-consultation meetings with DOT, it was agreed that the existing trip generation from the Turtle Bay Hotel would provide the most relevant source for estimating traffic volumes from new hotel rooms in the Proposed Action and the three (3) Alternatives.

2. Resort Residential Development

Kuilima Estates and the resort residential units in the Turtle Bay Resort Master Plan can be described under the ITE category of recreational homes. However, DOT has expressed concern over the use of the ITE recreational home trip rates to analyze the traffic impacts of resort residential units. It was agreed that travel characteristics

of the Kuilima Estates were uniquely suited to develop trip generation rates for the resort residential units in the Proposed Action and the three (3) Alternatives.

3. Timeshare Hotel

The Proposed Action, the Full Build Out Alternative, and the Conservation Partner Alternative includes timeshare hotel rooms, in addition to traditional and/or condo-hotel rooms. ITE describes timeshare as developments, where each unit may be purchased by multiple owners with rights of use for specific time periods each year. While the original timeshares were often developed as recreational condominiums or vacation homes, the timeshares for the Turtle Bay Resort Master Plan are planned to be developed as full service hotels, similar to the Aulani Disney Resort in Ko Olina, with vacation club (timeshare) units and traditional hotel rooms. Therefore, the ITE weekday trip rates for timeshares were used to analyze the timeshare hotels in the Proposed Action and the three (3) Alternatives. Since ITE did not provide Saturday trip rates for timeshares, the weekday trip rates for the timeshare hotels were adjusted by ratio between Saturday and the average weekday trip rates developed from the Turtle Bay Hotel trip generation study, as discussed in the following section. The average daily trip rates for the proposed timeshares were derived from the following ITE regression equations:

$Ln(T) = 1.06 \times Ln(X) + 2.09$ (Weekday Traffic)

$Ln(T) = 1.06 \times Ln(X) + 2.09 \times \frac{\text{Turtle Bay Hotel Saturday Rate}}{\text{Turtle Bay Hotel Weekday Rate}}$ (Saturday Traffic)

where, Ln = natural logarithm function

T = average vehicle trip ends

X = number of occupied rooms

4. Shopping Center

The average daily trip rates for the proposed shopping village or "gathering place" were derived from the following ITE regression equations:

$Ln(T) = 0.65 \times Ln(X) + 5.73$ (Weekday Traffic)

$Ln(T) = 0.63 \times Ln(X) + 6.23$ (Saturday Traffic)

where, Ln = natural logarithm function

T = average vehicle trip ends

X = 1,000 square feet of gross leasable floor area

ITE developed hourly variation of shopping center traffic for both the average weekday and Saturdays, which were expressed as percentages of 24-hour traffic for

each hour from 10 AM to 10 PM. The hourly variations were applied to the average weekday and Saturday traffic to determine the hourly traffic volumes.

The total trips generated by a shopping center can be defined as driveway trips, i.e., traffic entering and exiting the project site. A percentage of the peak hour trips generated by a shopping center are considered to be "pass-by" trips, i.e., traffic already on the road stopping at a "secondary" destination. The "new" or primary trips are trips where the primary destination is the shopping center. ITE compiled data from traffic studies that correlated pass-by trips with the gross leasable floor areas of the shopping centers. The results of the analysis were published in the Trip Generation Handbook, June 2004. The ITE average shopping centers pass-by trip percentages of 34 percent and 26 percent, during the weekday PM and Saturday peak periods of traffic, respectively, applied to the hourly traffic volumes generated by the shopping village. Since the shopping village will be planned to cater to Resort guests and residents, and will be located well within the Resort and not directly on Kamehameha Highway, it was assumed that the pass-by trips would be comprised of the Resort guests and residents and not from traffic passing on Kamehameha Highway.

5. Multi-Family (Community) Housing

The Proposed Action and the three (3) Alternatives are expected to include affordable multi-family (community) housing. The community housing is expected to be developed as rental apartment units and/or owner-occupied condominium units. For the purpose of this traffic impact analysis, the ITE trip generation rates for the apartment use were applied to the affordable housing units, since it is more conservative (higher) than the residential condominium use. The ITE peak hour of generator rates were used instead of the peak hour of adjacent street traffic rates, which applies to commuter peak hour traffic. The peak hour trip rates for the rental apartment were derived from the following regression equations:

$T = 0.54 \times X + 2.45$ (AM Peak Hour of Weekday Traffic)

$T = 0.60 \times X + 14.91$ (PM Peak Hour of Weekday Traffic)

$T = 0.41 \times X + 19.23$ (Saturday Peak Hour of Traffic)

where, T = average vehicle trip ends

X = number of dwelling units

6. Recreational Uses

The Proposed Action and the three (3) Alternatives are expected to maintain over 500 acres of open space in the form of the two existing golf courses, beach parks, a wildlife preserve and bird sanctuary, and an equestrian center. The trip generation for the existing golf courses is already included in the existing traffic count data. The average ITE trip rates for beach parks of 0.48 trip per acre, 0.60 trip per acre, and

1.18 trips per acre were used to analyze parks which front the ocean, during the AM, PM, and Weekend peak hours of traffic, respectively.

For lack of specific ITE trip rates for the wildlife preserve, the bird sanctuary, and the equestrian center, the ITE land use designation of County Park was used to represent these uses. The average ITE trip rates for county parks of 0.52 trip per acre, 0.59 trip per acre, and 2.24 trips per acre were used to analyze the various recreational uses, during the AM, PM, and Weekend peak hours of traffic, respectively.

B. Turtle Bay Resort Trip Generation Study

A trip generation study was conducted at the existing Turtle Bay Resort from October 30, 2011 through November 6, 2011, in accordance with ITE recommended practice published in the Trip Generation Handbook, Second Edition. The purpose of the study was to develop trip generation characteristics for "local" trip generation rates for resort hotels and resort residential development in the Turtle Bay Resort Master Plan.

Traffic count data were collected on Kuilima Drive at Kamehameha Highway and at the Turtle Bay Hotel entrance. The traffic count data were reduced to 5-minute intervals to account for internal trips. The differences between the traffic count data at Kamehameha Highway and at the entrance to the Hotel were assumed to be Kuilima Estates trips. Where differences were negative values, the trips were considered internal circulation between the Turtle Bay Hotel and Kuilima Estates, and were not included in the trip generation rates. The Turtle Bay Hotel and Kuilima Estates traffic were correlated with the daily occupancies, which were reported by the Hotel and a rental management company for Kuilima Estates, respectively.

The SMS travel survey discovered a very unique trip generation characteristic of the Turtle Bay Hotel, i.e., pass-by trips, which are normally associated with shopping centers. The Turtle Bay Hotel is located at the farthest point from Waikiki, the Honolulu International Airport, and the population centers of Oahu. It is situated between two of the most popular destinations on Oahu, the Polynesian Cultural Center to the east, and the world famous surfing beaches on the North Shore to the west. The Turtle Bay Hotel has become a well-known rest stop for both visitors and residents driving around island. The SMS survey indicated that over 17 percent of respondents identified themselves as Oahu residents visiting the Resort. The SMS data excluded the residents who were attending special events held at the Resort during the survey period. Tourists visiting the Resort (non-guests) made up an additional 13 percent of the total respondents for a total of 30 percent of the hotel trips. Taking a conservative approach, the visiting tourists were excluded from the pass-by trips, since the future Turtle Bay Resort Master Plan may become a primary destination for tourists driving around the island. The Oahu residents were classified as "Resort pass-by trips", i.e., trips bound for other primary destinations in the region, who take a rest stop at the Resort. Based upon the SMS travel survey, there were an estimated 500 pass-by trips per weekday that stopped or departed the Turtle Bay Hotel between the hours of 8:00 AM and 6:00 PM. During the weekend, the pass-by traffic increased to 920 vehicles per day.

The Oahu resident pass-by trips were deducted from the hotel trip rates and analyzed separately. It was more reasonable to assume that the pass-by trips were a function of the volume of traffic passing on Kamehameha Highway, rather than the number of occupied rooms at the Turtle Bay Hotel. Therefore, the increase in pass-by trips was based upon the regional growth in traffic on Kamehameha Highway. The ITE timeshare trip rates also were adjusted for the pass-by trip rates observed at the Turtle Bay Hotel.

To ensure a more conservative technical analysis and to account for potential deviation between the existing trip generation characteristics and future travel behavior, the Turtle Bay Hotel and Kuilima Estates trips rates were uniformly increased by 10 percent, per the recommendation of DOT staff. Tables 8 and 9 summarize the trip generation data for the Turtle Bay Hotel and the Kuilima Estates, respectively.

Table 8. Existing Turtle Bay Hotel Daily Trip Generation Rate Calculations

Day of the Week	Mon	Tue	Wed	Thu	Fri	Sat
Volume (trips/day)	3,038	3,058	3,122	3,464	3,916	3,936
Occupied Rooms	381	367	360	413	470	478
Occupancy	76 %	73 %	72 %	83 %	94 %	96 %
Daily Trips per Occupied Room	7.97	8.33	8.67	8.39	8.33	8.23
	Weighted Weekday Average = 8.34					8.23
Pass-By Trip Reduction	7.08					6.31
+10% Adjustment Factor	7.79					6.94

Table 9. Existing Kuilima Estates Daily Trip Generation Rate Calculations

Day of the Week	Mon	Tue	Wed	Thu	Fri	Sat
Volume (trips/day)	727	722	622	866	918	820
Occupied Units	165	206	203	230	227	206
Occupancy	45 %	56 %	55 %	63 %	62 %	56 %
Daily Trips per Occupied Unit	4.41	3.50	3.06	3.77	4.04	3.98
	Weighted Weekday Average = 3.74					3.98
+10% Adjustment Factor	4.11					4.38

Kamehameha Highway, in the vicinity of Turtle Bay Resort, carries the lowest traffic volumes in the study area. It is reasonable to assume that the peak hour traffic from the Resort will determine when the peak hours of traffic on Kamehameha Highway are expected to occur. The trip generation characteristics are expressed in terms of daily trips, which are distributed throughout the day on an hourly basis, based upon the trip

generation study. The hourly volumes are added to the future Kamehameha Highway traffic to determine when the peak hours of traffic will occur.

C. Farmers Market Trip Generation Study

A trip generation study was conducted at the Haleiwa Farmers Market at the intersection of Kamehameha Highway and Joseph P. Leong Highway (North Junction) on Sunday, June 10, 2012 between the hours of 9:00 AM and 3:00 PM. The Haleiwa Farmers Market generated almost 1,200 vehicle trips during the survey period. During the peak hour of traffic, the Haleiwa Farmers Market generated 275 vph. It should be noted that the trip generation study was conducted on the closing day of the Haleiwa Farmers Market at that location. The trip generation data can be considered to be conservative, i.e., higher than on normal days.

For the purpose of this traffic impact analysis, it was assumed that the Turtle Bay Resort Farmers Market would be comparable to the Haleiwa Farmers Market in terms of trip generation. To remain conservative, the trip generation data for the Farmers Market was applied to both the weekday and weekend operations. The average ITE shopping center pass-by trip rates of 34 percent during weekday peak periods of traffic and 26 percent during the Saturday peak period also was applied the trip rates to account for the Resort guests and residents shopping at the Turtle Bay Resort Farmers Market.

D. Trip Generation Characteristics

During the pre-consultation meetings with DOT, it was agreed that to remain conservative the trip generation for the hotels would be analyzed at 90 percent occupancy during the weekday and 95 percent occupancy on the weekend for the Proposed Action and the three (3) Alternatives, based upon recent occupancies at the Turtle Bay Hotel. It was further agreed that the trip generation for the resort residential development would analyzed at 60 percent occupancy for both the weekday and weekend, which are considered to be conservative based upon recent market data provided by HVS International Consulting and Evaluation.

The Full Build Out Alternative is expected to generate the highest volumes of traffic during the peak hours of traffic with a total of 3,500 new units. The 500-unit Resort Residential Alternative is expected to generate the least amount of peak hour traffic. The Conservation Partner Alternative has the second lowest trip generation estimate with a total of 740 new units. The Proposed Action is expected to generate the second highest peak hour traffic with a total of 1,375 new units. Table 10 summarizes the trip generation characteristics for the Proposed Action and the three (3) Alternatives.

Table 10. Trip Generation Characteristics

Alternative	Area	Land Use	Units/Area	AM Peak Hour				PM Peak Hour				Saturday Peak Hour			
				Enter (vph)	Exit (vph)	Total (vph)	% of Total	Enter (vph)	Exit (vph)	Total (vph)	% of Total	Enter (vph)	Exit (vph)	Total (vph)	% of Total
Proposed Action	H-1a, H-2	Timeshare Hotel	350	79	93	171	17%	130	130	259	25%	83	97	180	12%
	H-1b, H-2a	Hotel	275	56	65	121	12%	90	75	165	16%	63	71	134	9%
	RR-1, RR-2a, RR-2b, RR-3a, RR-3b, RR-4a, RR-4b, RR-5, RR-6	Resort Residences	590	38	43	81	8%	57	50	106	10%	46	66	112	8%
	RES-1, RES-2	Apartment	160	26	63	89	9%	68	43	111	11%	46	39	85	6%
	Gathering Place	Shopping Center	40,000 SFGLFA	94	104	198	20%	113	102	215	21%	184	176	360	24%
	Farmers Market	Farmers Market	7.5 Acres	98	83	181	18%	3	9	11	1%	80	90	170	12%
	P-1, P-2, P-4, P-5	Beach Park	~~47.6~~ 63.4 Acres	56	39	95	10%	29	57	86	8%	76	89	165	11%
	P-3, Wildlife Preserve, Equestrian Center	County Park	118.6 Acres	44	18	62	6%	24	45	70	7%	157	109	266	18%
	Proposed Action Total Traffic			**491**	**508**	**998**	**100%**	**514**	**511**	**1023**	**100%**	**735**	**737**	**1472**	**100%**
Full Build Out	H-1, H-4, H-5	Hotel	1,578	321	377	698	38%	530	446	976	43%	355	409	764	32%
	H-2, H-3	Timeshare Hotel	913	217	257	474	26%	354	342	696	31%	230	269	499	21%
	RR-1a, RR-1b, RR-2, RR-3, RR-4	Resort Residences	910	58	66	124	7%	97	70	167	7%	71	102	173	7%
	RES-1	Apartment	90	15	36	51	3%	42	27	69	3%	30	26	56	2%
	Gathering Place	Shopping Center	40,000 SFGLFA	94	104	198	11%	112	96	208	9%	184	176	360	15%
	TMK: 5-7-006: Por, 001	Farmers Market	3.4 Acres	98	83	181	10%	2	13	15	1%	80	90	170	7%
	P-1, P-2, P-4, Beach Club	Beach Park	44.8 Acres	39	27	66	4%	21	40	61	3%	54	63	117	5%
	P-3, Wildlife Preserve, Equestrian Center	County Park	114.8 Acres	42	17	60	3%	24	44	68	3%	152	105	257	11%
	Full Build Out Alternative Total Traffic			**884**	**967**	**1852**	**100%**	**1182**	**1078**	**2260**	**100%**	**1156**	**1240**	**2396**	**100%**
Resort Residential	RR-1, RR-2a, RR-2b, RR-3a, RR-3b, RR-4a, RR-4b, RR-5, RR-6, RR--7, RR-8, RR-9	Resort Residences	454	29	33	62	10%	29	34	63	13%	18	49	67	6%
	RES-1	Apartment	46	8	19	27	4%	26	17	43	9%	21	18	38	4%
	Shopping Village	Shopping Center	40,000 SFGLFA	94	104	198	32%	114	101	215	45%	184	176	360	35%
	TMK: 5-7-006: Por, 001	Farmers Market	3.4 Acres	98	83	181	30%	2	8	10	2%	69	97	166	16%
	P-1, P-2, P-4, Beach Club	Beach Park	56.1 Acres	49	34	84	14%	26	50	76	16%	67	79	146	14%
	P-3, Wildlife Preserve, Equestrian Center	County Park	114.8 Acres	42	17	60	10%	24	44	68	14%	152	105	257	25%
	Resort Residential Alternative Total Traffic			**320**	**290**	**612**	**100%**	**221**	**254**	**475**	**100%**	**511**	**524**	**1034**	**100%**
Conservation Partner	H-1	Timeshare Hotel	250	54	64	118	15%	92	83	175	23%	58	61	119	10%
	H-2	Hotel	190	40	45	85	11%	63	51	114	15%	44	46	90	7%
	RR-1, RR-2, RR-3, RR-4	Resort Residences	252	16	19	35	4%	25	21	46	6%	11	28	39	3%
	RES-1	Apartment	48	8	~~66~~ 20	28	4%	27	~~66~~ 17	44	6%	21	~~66~~ 18	39	3%
	Gathering Place	Shopping Center	40,000 SFGLFA	94	104	198	25%	114	101	215	29%	184	176	360	30%
	Farmers Market	Farmers Market	6.6 Acres	98	83	181	23%	2	8	10	1%	69	97	166	14%
	P-1, P-2, P-4	Beach Park	52.4 Acres	46	33	81	10%	25	49	74	10%	70	79	149	12%
	P-3, Wildlife Preserve, Equestrian Center	County Park	113.2 Acres	42	17	59	7%	23	43	67	9%	150	104	254	21%
	Conservation Partner Alternative Total Traffic			**398**	**431**	**785**	**100%**	**372**	**422**	**745**	**100%**	**607**	**657**	**1216**	**100%**

VI. Trip Distribution

A. Travel Survey

SMS conducted an extensive week-long travel survey at the Turtle Bay Resort from Monday, October 31, 2011 through Sunday, November 6, 2011. The travel survey consisted of personal interviews of about 4,800 motorists that entered and exited the Turtle Bay Hotel and Kuilima Estates. The purpose of the travel survey was to determine the origins and destinations of the trips arriving at and departing from the Resort. The trip distribution for this traffic impact analysis was determined from the findings of the travel survey. The methodology and results of the travel survey was documented by SMS in the Quantification of Turtle Bay Resort Traffic Patterns Report, dated December, 2011.

According to the SMS survey, about 43 percent of the Turtle Bay Resort traffic entered or exited the study area, i.e., with origins or destinations in Honolulu, Central Oahu, and Leeward Oahu. About 39 percent of the Turtle Bay Resort traffic remained within the limits of the field investigation, which extended from Haleiwa to Kahaluu. The remaining 18 percent were contained within the fringes of the study area in Haleiwa/Waialua and Windward Oahu.

B. Trip Distribution

The SMS travel survey data were further disaggregated by time period to determine the trip distribution during the peak hours of traffic. The trip distribution for Turtle Bay Hotel traffic was applied to the proposed hotels, and the trip distribution of Kuilima Estates traffic was applied to proposed resort residential developments. The trip distribution of traffic generated by other land uses in the Proposed Action and the three (3) Alternatives were based upon existing peak hour traffic patterns. Table 11 summarizes the trip distribution patterns for the Proposed Action and the three (3) Alternatives in terms of the percentages (%) of total site traffic on Kamehameha Highway along the project site frontage (local traffic) and at the limits of the study area in Haleiwa and Kahaluu.

Table 11. Trip Distribution Summary

Alternative	Local vs. Regional	Direction	AM Peak Hr		PM Peak Hr		Weekend Peak Hr	
			Enter	Exit	Enter	Exit	Enter	Exit
Proposed Action	Local Traffic	EB	59%	46%	53%	41%	57%	42%
		WB	41%	54%	47%	59%	43%	58%
	Regional Traffic	Haleiwa	23%	22%	25%	26%	24%	24%
		Kahaluu	13%	11%	13%	14%	13%	9%
Full Build Out	Local Traffic	EB	61%	45%	52%	38%	56%	42%
		WB	39%	55%	48%	62%	44%	58%
	Regional Traffic	Haleiwa	35%	32%	34%	36%	44%	35%
		Kahaluu	15%	11%	13%	15%	26%	15%
Resort Residential	Local Traffic	EB	57%	47%	54%	43%	57%	42%
		WB	43%	53%	46%	57%	43%	58%
	Regional Traffic	Haleiwa	17%	18%	18%	21%	22%	22%
		Kahaluu	12%	12%	13%	15%	9%	7%
Conservation Partner	Local Traffic	EB	59%	46%	54%	42%	57%	41%
		WB	41%	54%	46%	58%	43%	59%
	Regional Traffic	Haleiwa	22%	21%	25%	27%	25%	23%
		Kahaluu	13%	12%	13%	15%	12%	8%

VII. Traffic Impact Analysis

A. Traffic Improvements

Based upon the conditions in the Unilateral Agreement and Declaration for Conditional Zoning, the following traffic improvements are required at each of the proposed access intersections on Kamehameha Highway:

1. Widen westbound Kamehameha Highway to provide an exclusive right-turn lane.
2. Widen eastbound Kamehameha Highway to provide an exclusive left-turn lane.
3. Widen westbound Kamehameha Highway to provide a right-turn acceleration lane.
4. Construct separate left-turn and right-turn lanes on side street approaches at Kamehameha Highway.

5. Construct a shared left-turn/through lane and an exclusive right-turn lane on Marconi Road at Kamehameha Highway, if the future Kahuku Mauka Agricultural Road is constructed at the time of improvement.

6. Construct bus turnouts in both directions on Kamehameha Highway at each intersection.

7. Signalize the intersections at Kamehameha Highway, when warranted, with protected left-turn phases on Kamehameha Highway.

The intersection of Kuilima Drive and Kamehameha Highway meets traffic signals warrants under existing conditions. The Kuilima Drive intersection would be signalized along with the construction of the auxiliary turning lanes during the initial phase of the Proposed Action or one of the Alternative development plan.

The auxiliary lane improvements at the intersection of Kamehameha Highway and Kaihalulu Drive should be constructed when it is first open to the public. A median left-turn refuge lane should be constructed on the east leg of Kamehameha Highway to facilitate the left-turn movement from Kaihalulu Drive under unsignalized control.

The auxiliary lane improvements at the intersection of Kamehameha Highway and Marconi Road also should be constructed during the initial phase of development of the Proposed Action or the Alternative development plan. If the Kahuku Mauka Agricultural Road is not constructed opposite of Marconi Road, the intersection should remain unsignalized, and a median left-turn refuge lane should be constructed on the east leg of Kamehameha Highway to facilitate the left-turn movement from Marconi Road.

B. Traffic Impact Analysis of the Alternative Development Plans

1. Alternative Development Plan Phasing

In general, the traffic impact analysis of development plans over five (5) years are analyzed in phases to coordinate the traffic improvements with the proposed development schedule. During the pre-consultation meeting with DOT, it was agreed that the Alternatives will not require phased traffic impact analyses unless one of the Alternatives becomes the preferred plan. At that time, this traffic impact analysis will be updated to reflect the phasing of the new preferred plan.

2. Full Build Out Alternative

The Full Build Out Alternative will require the construction of double left-turn lanes on eastbound Kamehameha Highway at Kaihalulu Drive and at Kuilima Drive. Kaihalulu Drive will require four lanes, two lanes in each direction for the Full Build Out Alternative. The Turtle Bay Resort access road intersections at Kamehameha Highway are expected to operate at overall LOS "C" or better, during the peak hours of traffic with the Full Build Out Alternative. The intersection of Kamehameha Highway and Joseph P. Leong Highway in Haleiwa also is expected to operate at LOS "C" or better, during the peak hours of traffic. In Kahaluu, the left-turn

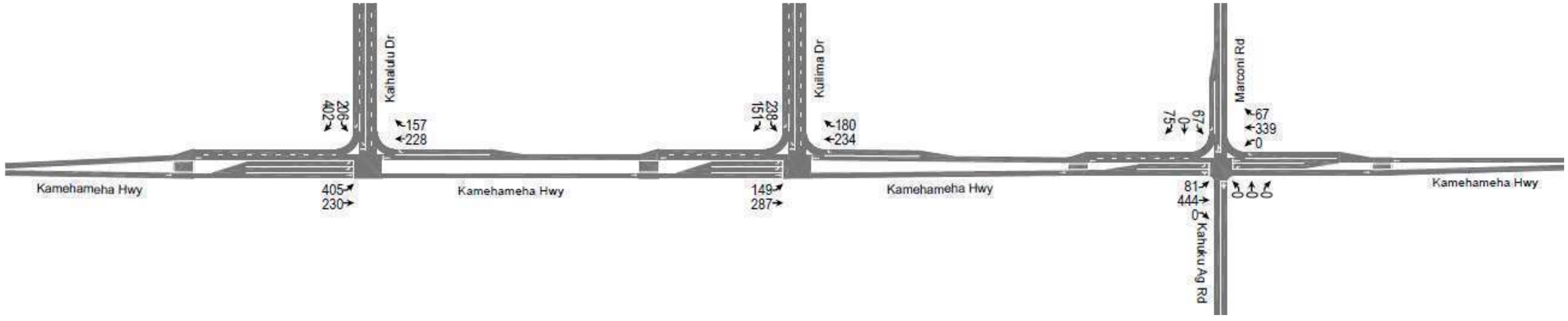
movement from westbound Kamehameha Highway to southbound Kahekili Highway is expected to continue to operate at LOS "F", during the peak hours of traffic. Table 12 summarizes the two-lane traffic analysis of Kamehameha Highway with the Full Build Out Alternative. Table 13 summarizes the intersection analysis for the peak hours of traffic with the Full Build Out Alternative. The AM, PM, and Weekend peak hour assignments of site traffic are depicted on Figures 13, 14, and 15, respectively. Figures 16, 17, and 18 depict the cumulative AM, PM, and Weekend peak hour traffic volumes, respectively, with the Full Build Out Alternative.

Table 12. Peak Hour Two-Lane Operations on Kamehameha Highway With FBO Alternative

Peak Hour	Location	LOS	v/c
Weekday AM	Haleiwa	E	0.62
	Kahuku	E	0.59
	Kahaluu	E	0.61
Weekday PM	Haleiwa	E	0.78
	Kahuku	E	0.73
	Kahaluu	E	0.72
Weekend	Haleiwa	E	0.90
	Kahuku	E	0.79
	Kahaluu	E	0.79

Table 13. Intersection Traffic Analysis Summary - Peak Hour Conditions With FBO Alternative

Scenario	Kamehameha Hwy Intersection	MOE	EBLT	EBTH	EBRT	WBLT	WBTH	WBRT	NBLT	NBTH	NBRT	SBLT	SBTH	SBRT	Intersection
2025 AM Peak Hour of Weekday Traffic With Full Build Out Alternative	Kaihalulu Drive	LOS	C	A	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	C
		Delay	33.9	9.3	N/A	N/A	34.0	4.1	N/A	N/A	N/A	30.3	N/A	7.3	20.9
		v/c	0.68	0.48	N/A	N/A	0.83	0.27	N/A	N/A	N/A	0.52	N/A	0.62	N/A
	Kuilima Drive	LOS	C	B	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	B
		Delay	30.3	11.4	N/A	N/A	22.0	3.4	N/A	N/A	N/A	26.6	N/A	6.0	16.8
		v/c	0.40	0.60	N/A	N/A	0.73	0.28	N/A	N/A	N/A	0.60	N/A	0.33	N/A
	Marconi Rd	LOS	C	B		C	B	A	A			C		A	B
		Delay	32.1	14.7		32.8	18.7	1.6	1.6			25.7		5.6	16.3
		v/c	0.39	0.73		0.21	0.73	0.10	0.18			0.33		0.23	N/A
	Joseph P. Leong Hwy	LOS	C	N/A	A	N/A	N/A	N/A	C	B	N/A	N/A	C	A	B
		Delay	30.6	N/A	0.1	N/A	N/A	N/A	33.7	15.2	N/A	N/A	22.4	5.3	18.1
		v/c	0.83	N/A	0.04	N/A	N/A	N/A	0.41	0.60	N/A	N/A	0.61	0.61	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	F			N/A	N/A	N/A	C	N/A	N/A	F
		Delay	N/A	N/A	N/A	>300			N/A	N/A	N/A	19.3	N/A	N/A	50.8
		v/c	N/A	N/A	N/A	>1.2			N/A	N/A	N/A	0.75	N/A	N/A	N/A
2025 PM Peak Hour of Weekday Traffic With Full Build Out Alternative	Kaihalulu Drive	LOS	D	A	N/A	N/A	C	A	N/A	N/A	N/A	D	N/A	C	C
		Delay	47.2	8.3	N/A	N/A	34.5	3.0	N/A	N/A	N/A	38.5	N/A	24.1	26.1
		v/c	0.82	0.51	N/A	N/A	0.87	0.34	N/A	N/A	N/A	0.56	N/A	0.85	N/A
	Kuilima Drive	LOS	D	A	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	C
		Delay	49.9	9.1	N/A	N/A	30.6	2.9	N/A	N/A	N/A	34.7	N/A	7.2	20.7
		v/c	0.74	0.55	N/A	N/A	0.89	0.42	N/A	N/A	N/A	0.68	N/A	0.44	N/A
	Marconi Rd	LOS	D	B		D	C	A	A			D		B	C
		Delay	54.0	14.6		52.0	26.7	2.0	7.0			50.3		11.6	22.9
		v/c	0.55	0.69		0.31	0.89	0.10	0.25			0.54		0.35	N/A
	Joseph P. Leong Hwy	LOS	D	N/A	A	N/A	N/A	N/A	D	B	N/A	N/A	C	A	C
		Delay	47.1	N/A	0.1	N/A	N/A	N/A	49.4	19.3	N/A	N/A	34.2	5.1	25.8
		v/c	0.92	N/A	0.04	N/A	N/A	N/A	0.51	0.70	N/A	N/A	0.83	0.66	0.83
	Kahekili Hwy	LOS	N/A	N/A	N/A	F			N/A	N/A	N/A	B	N/A	N/A	F
		Delay	N/A	N/A	N/A	>300			N/A	N/A	N/A	11.1	N/A	N/A	59.7
		v/c	N/A	N/A	N/A	>1.2			N/A	N/A	N/A	0.15	N/A	N/A	N/A
2025 Weekend Peak Hour of Traffic With Full Build Out Alternative	Kaihalulu Drive	LOS	D	A	N/A	N/A	D	A	N/A	N/A	N/A	D	N/A	C	C
		Delay	49.1	8.5	N/A	N/A	42.0	2.7	N/A	N/A	N/A	46.3	N/A	24.6	29.2
		v/c	0.80	0.56	N/A	N/A	0.94	0.24	N/A	N/A	N/A	0.65	N/A	0.84	N/A
	Kuilima Drive	LOS	D	B	N/A	N/A	C	A	N/A	N/A	N/A	D	N/A	A	C
		Delay	44.8	10.9	N/A	N/A	33.7	2.6	N/A	N/A	N/A	46.8	N/A	7.0	23.6
		v/c	0.64	0.62	N/A	N/A	0.90	0.34	N/A	N/A	N/A	0.81	N/A	0.44	N/A
	Marconi Rd	LOS	D	B		D	D	A	A			D		A	C
		Delay	53.9	16.7		54.1	39.9	2.6	1.0			51.9		9.5	28.6
		v/c	0.71	0.75		0.29	0.94	0.17	0.13			0.67		0.45	N/A
	Joseph P. Leong Hwy	LOS	D	N/A	A	N/A	N/A	N/A	D	C	N/A	N/A	D	A	C
		Delay	48.8	N/A	5.1	N/A	N/A	N/A	53.1	30.9	N/A	N/A	37.6	4.4	29.9
		v/c	0.93	N/A	0.14	N/A	N/A	N/A	0.42	0.88	N/A	N/A	0.88	0.62	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	F			N/A	N/A	N/A	B	N/A	N/A	F
		Delay	N/A	N/A	N/A	>300			N/A	N/A	N/A	13.2	N/A	N/A	218.6
		v/c	N/A	N/A	N/A	>1.2			N/A	N/A	N/A	0.23	N/A	N/A	N/A

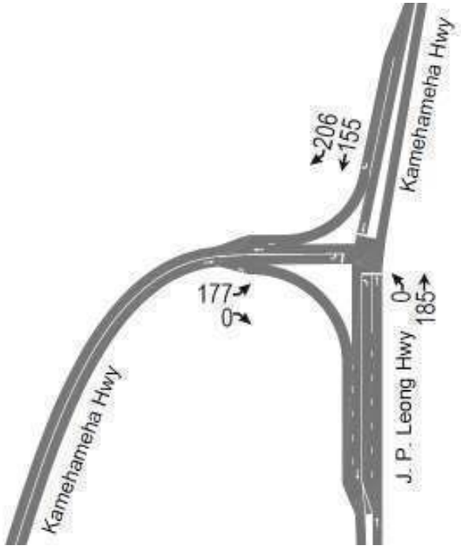


Project Vicinity

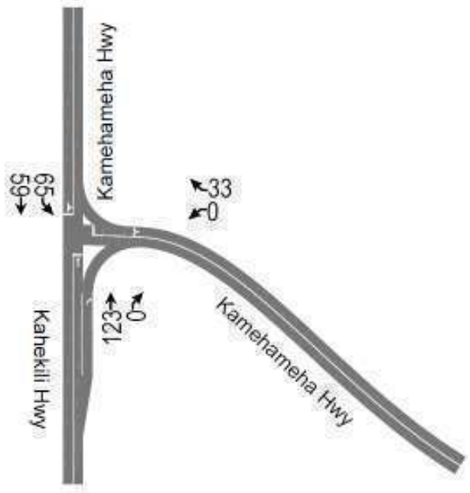
Legend

Lane Controls

137→ **Traffic Movement Volume (vph)**

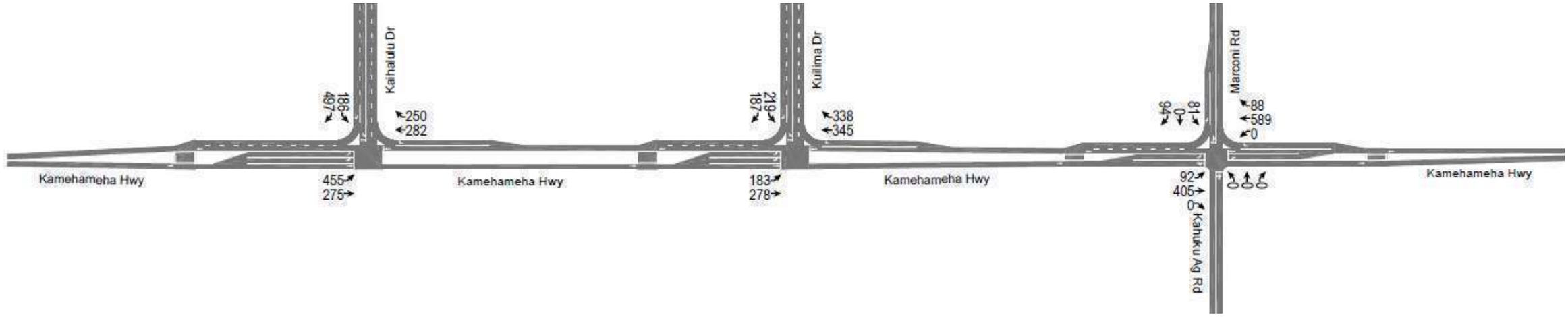


Haleiwa



Kahaluu

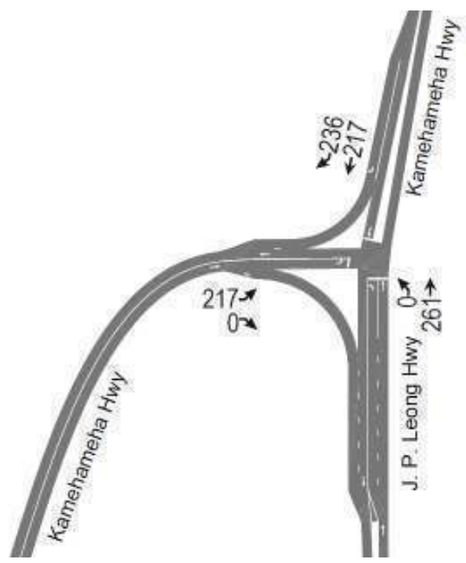
Figure 13. AM Peak Hour Site Traffic Assignment – FBO Alternative



Project Vicinity

Legend

Lane Controls
137→ **Traffic Movement Volume (vph)**



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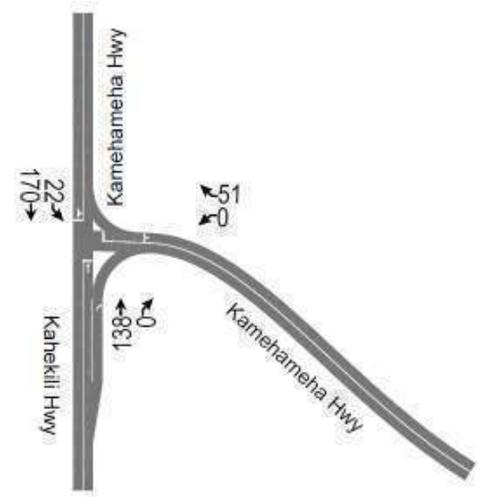
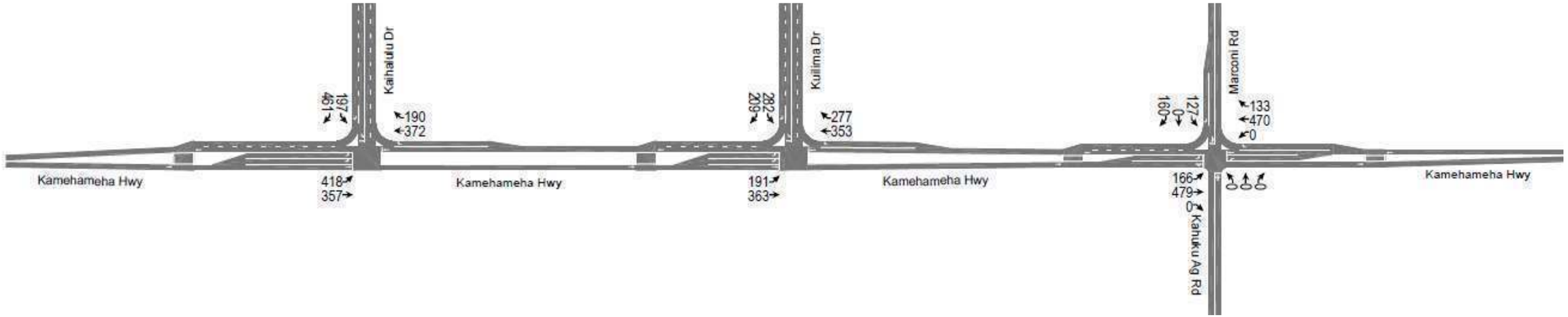


Kahaluu

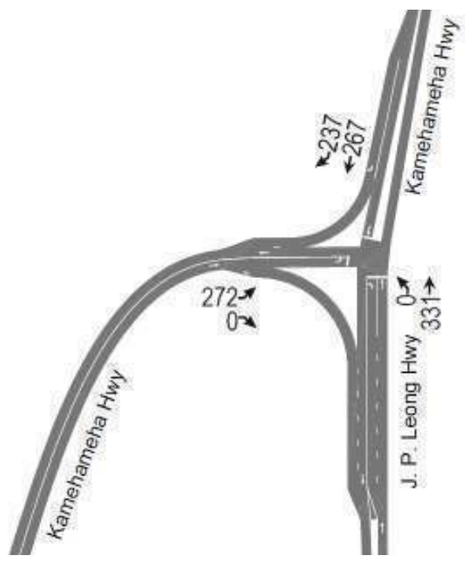
Figure 14. PM Peak Hour Site Traffic Assignment – Full Build Out Alternative



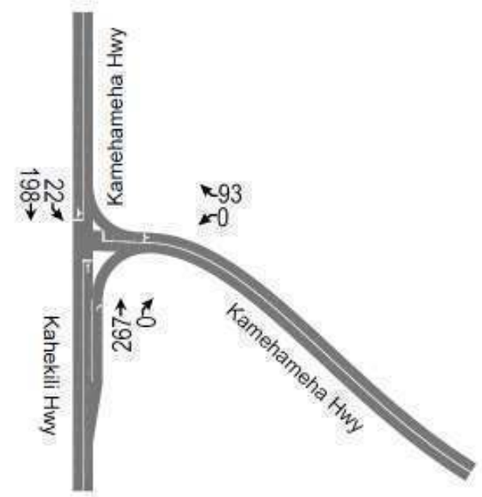
Legend

Lane Controls
137→ **Traffic Movement Volume (vph)**

Project Vicinity

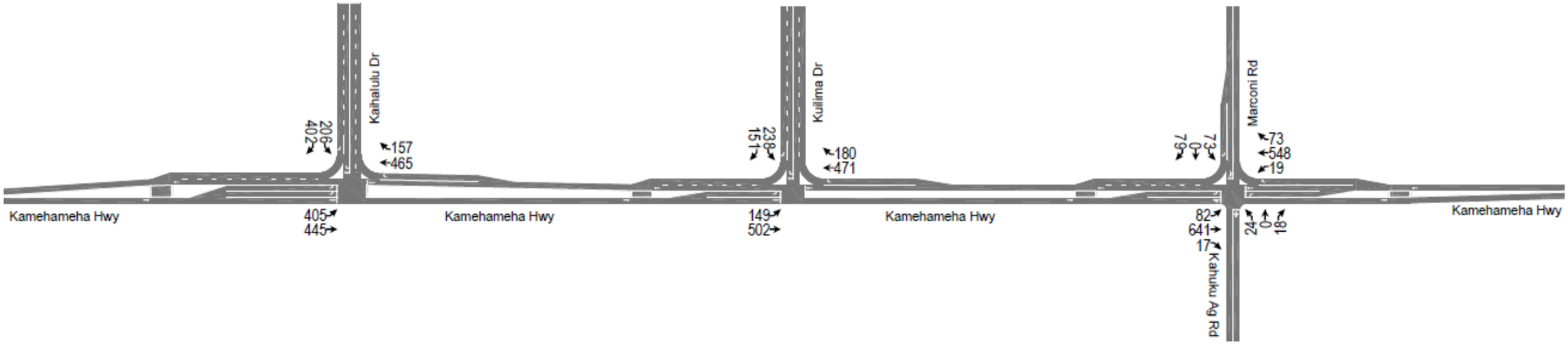


Haleiwa



Kahaluu

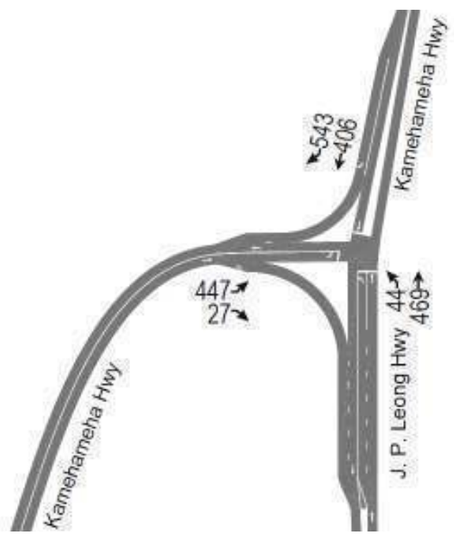
Figure 15. Weekend Peak Hour Site Traffic Assignment – Full Build Out Alternative



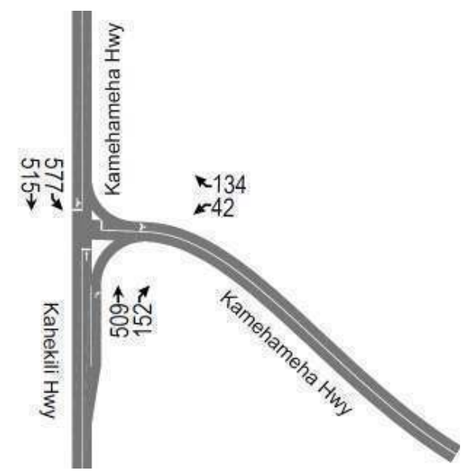
Project Vicinity

Legend

Lane Controls
137→ **Traffic Movement Volume (vph)**

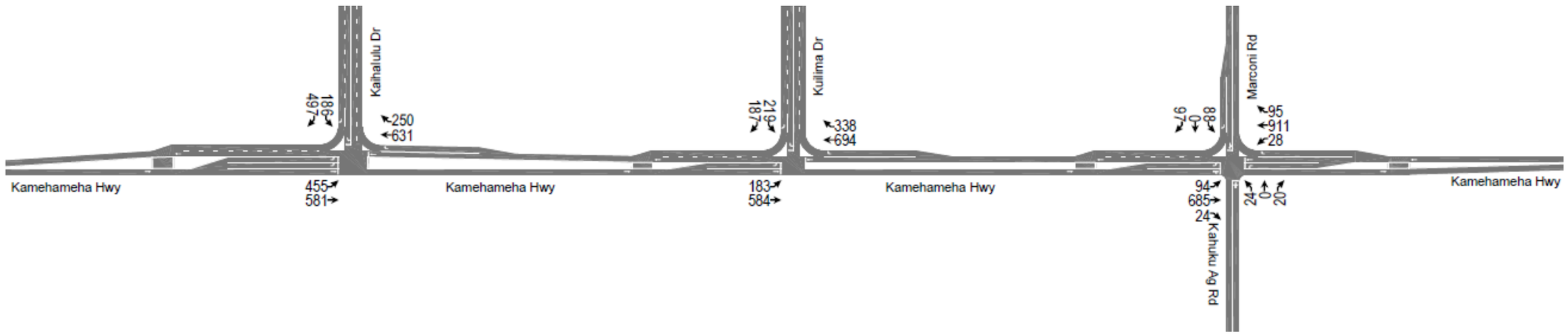


Haleiwa



Kahaluu

Figure 16. Cumulative AM Peak Hour Traffic FBO Alternative



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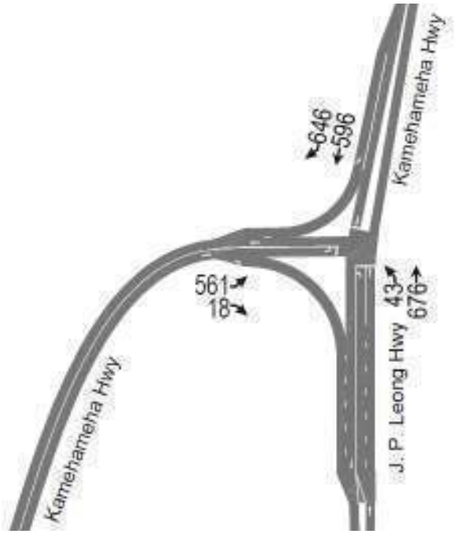
Lane Controls
137→ **Traffic Movement Volume (vph)**

Project Vicinity



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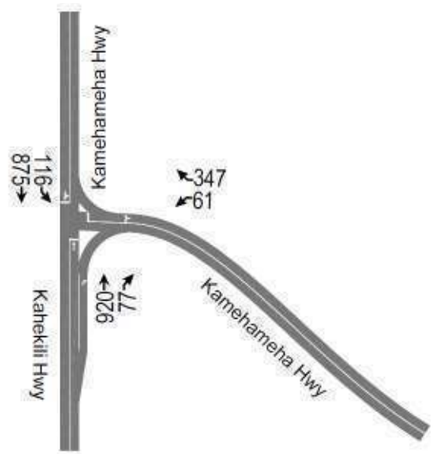
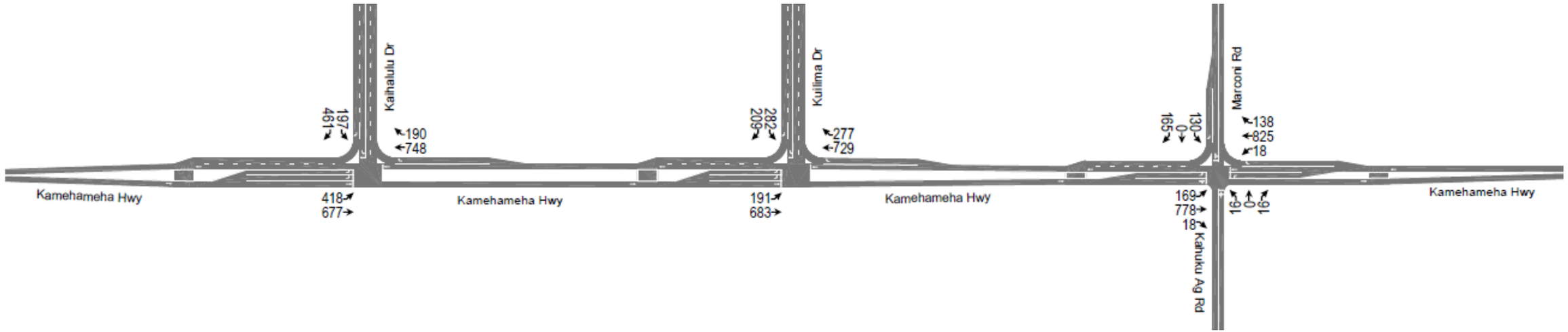


Kahaluu

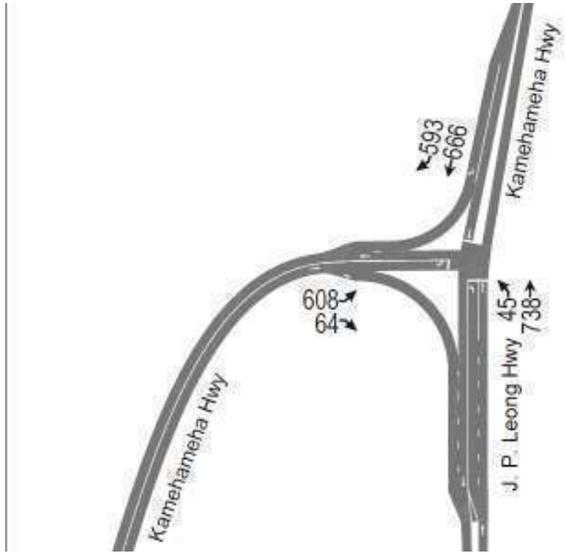
Figure 17. Cumulative PM Peak Hour Traffic FBO Alternative



Legend

Lane Controls
137→ **Traffic Movement Volume (vph)**

Project Vicinity



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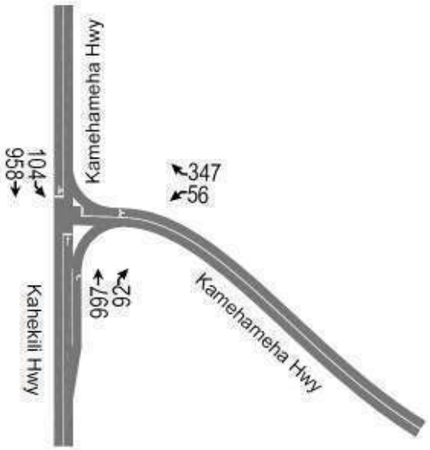

Kahaluu

Figure 18. Cumulative Weekend Peak Hour Traffic With FBO Alternative

3. Resort Residential Alternative

The Kaihalulu Drive, Kuilima Drive and Marconi Road intersections at Kamehameha Highway are expected to operate at overall LOS "B", during the peak hours of traffic with the Resort Residential (RR) Alternative. In Haleiwa, the intersection of Kamehameha Highway and Joseph P. Leong Highway also is expected to operate at LOS "B", during the peak hours of traffic. The left-turn movement from westbound Kamehameha Highway to southbound Kahekili Highway in Kahaluu is expected to continue to operate at LOS "F" during the peak hours of traffic with the Resort Residential Alternative. Figures 19, 20, and 21 depict the AM, PM, and Weekend assignment of site generated traffic for the Resort Residential Alternative. The cumulative AM, PM, and Weekend peak hour traffic volumes with the Resort Residential Alternative are depicted on Figures 22, 23, and 24, respectively.

The two-lane traffic analysis of Kamehameha Highway with the Resort Residential Alternative is summarized on Table 14. Table 15 summarizes the intersection analysis for the peak hours of traffic with the Resort Residential Alternative.

Table 14. Peak Hour Two-Lane Operations on Kamehameha Highway With RR Alternative

Peak Hour	Location	LOS	v/c
Weekday AM	Haleiwa	E	0.43
	Kahuku	E	0.34
	Kahaluu	E	0.55
Weekday PM	Haleiwa	E	0.57
	Kahuku	E	0.40
	Kahaluu	E	0.64
Weekend	Haleiwa	E	0.67
	Kahuku	E	0.54
	Kahaluu	E	0.69

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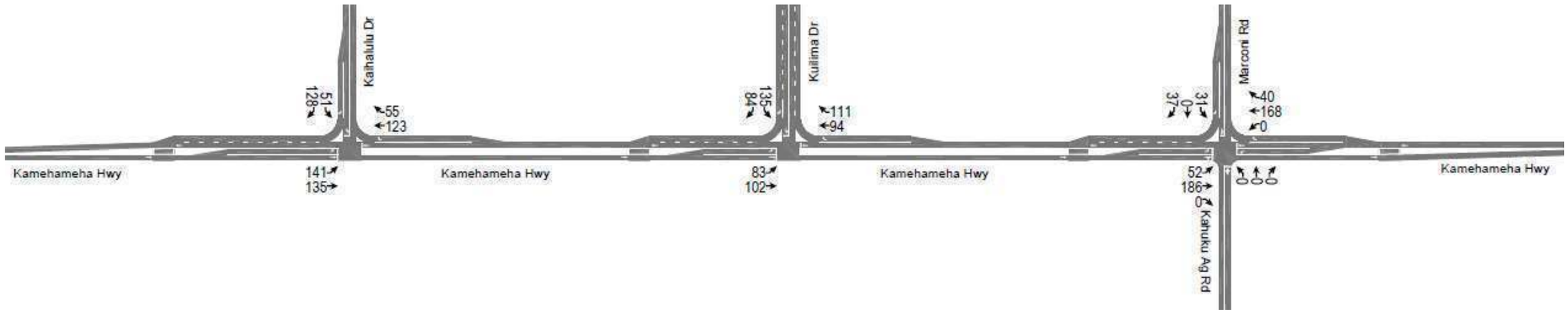
Table 15. Intersection Traffic Analysis Summary - 2025 Peak Hour Conditions With Resort Residential Alternative

Scenario	Kamehameha Hwy Intersection	MOE	EBLT	EBTH	EBRT	WBLT	WBTH	WBRT	NBLT	NBTH	NBRT	SBLT	SBTH	SBRT	Intersection
2025 AM Peak Hour of Weekday Traffic With Resort Residential Alternative	Kaihalulu Drive	LOS	C	B	N/A	N/A	C	A	N/A	N/A	N/A	B	N/A	A	B
		Delay	33.7	11.3	N/A	N/A	30.7	0.9	N/A	N/A	N/A	15.8	N/A	4.8	19.6
		v/c	0.57	0.48	N/A	N/A	0.77	0.12	N/A	N/A	N/A	0.10	N/A	0.23	N/A
	Kuilima Drive	LOS	C	A	N/A	N/A	B	A	N/A	N/A	N/A	B	N/A	A	B
		Delay	22.0	7.8	N/A	N/A	17.6	4.0	N/A	N/A	N/A	19.5	N/A	3.5	12.7
		v/c	0.28	0.42	N/A	N/A	0.59	0.21	N/A	N/A	N/A	0.37	N/A	0.20	N/A
	Marconi Rd	LOS	B	B		C	B	A	A			B		A	B
		Delay	19.3	10.7		22.8	12.9	0.2	1.1			17.7		0.5	11.2
		v/c	0.18	0.57		0.14	0.57	0.07	0.16			0.14		0.11	N/A
	Joseph P. Leong Hwy	LOS	C	N/A	A	N/A	N/A	N/A	C	B	N/A	N/A	B	A	B
		Delay	24.1	N/A	0.1	N/A	N/A	N/A	28.5	10.1	N/A	N/A	16.7	4.3	13.8
		v/c	0.69	N/A	0.05	N/A	N/A	N/A	0.33	0.37	N/A	N/A	0.39	0.47	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	F			N/A	N/A	N/A	C	N/A	N/A	F
		Delay	N/A	N/A	N/A	>300			N/A	N/A	N/A	15.0	N/A	N/A	>300
		v/c	N/A	N/A	N/A	>1.2			N/A	N/A	N/A	0.65	N/A	N/A	N/A
2025 PM Peak Hour of Weekday Traffic With Resort Residential Alternative	Kaihalulu Drive	LOS	C	A	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	B
		Delay	33.7	9.0	N/A	N/A	26.2	0.1	N/A	N/A	N/A	23.9	N/A	7.4	18.2
		v/c	0.43	0.49	N/A	N/A	0.78	0.03	N/A	N/A	N/A	0.04	N/A	0.22	N/A
	Kuilima Drive	LOS	C	A	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	B
		Delay	26.7	7.0	N/A	N/A	20.9	3.8	N/A	N/A	N/A	21.6	N/A	4.8	14.0
		v/c	0.41	0.41	N/A	N/A	0.71	0.27	N/A	N/A	N/A	0.38	N/A	0.25	N/A
	Marconi Rd	LOS	C	B		C	B	A	A			B		A	B
		Delay	24.2	13.8		23.4	14.2	0.1	1.2			18.8		1.9	13.3
		v/c	0.24	0.64		0.18	0.67	0.06	0.16			0.21		0.15	N/A
	Joseph P. Leong Hwy	LOS	C	N/A	A	N/A	N/A	N/A	C	B	N/A	N/A	B	A	B
		Delay	29.0	N/A	0.1	N/A	N/A	N/A	31.5	12.0	N/A	N/A	16.8	3.5	14.9
		v/c	0.76	N/A	0.03	N/A	N/A	N/A	0.31	0.58	N/A	N/A	0.60	0.48	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	F			N/A	N/A	N/A	B	N/A	N/A	B
		Delay	N/A	N/A	N/A	60.2			N/A	N/A	N/A	10.4	N/A	N/A	11.1
		v/c	N/A	N/A	N/A	0.92			N/A	N/A	N/A	0.12	N/A	N/A	N/A
2025 Weekend Peak Hour of Traffic With Resort Residential Alternative	Kaihalulu Drive	LOS	D	A	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	C
		Delay	44.0	8.5	N/A	N/A	33.4	0.7	N/A	N/A	N/A	33.4	N/A	8.2	22.2
		v/c	0.63	0.53	N/A	N/A	0.86	0.05	N/A	N/A	N/A	0.21	N/A	0.40	N/A
	Kuilima Drive	LOS	C	A	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	B
		Delay	34.8	9.2	N/A	N/A	25.9	3.4	N/A	N/A	N/A	28.3	N/A	6.8	17.8
		v/c	0.50	0.55	N/A	N/A	0.79	0.26	N/A	N/A	N/A	0.54	N/A	0.29	N/A
	Marconi Rd	LOS	C	B		C	C	A	A			C		A	B
		Delay	33.6	11.0		33.9	22.8	3.1	1.0			27.4		7.8	17.0
		v/c	0.49	0.62		0.20	0.79	0.15	0.13			0.37		0.31	N/A
	Joseph P. Leong Hwy	LOS	C	N/A	A	N/A	N/A	N/A	D	B	N/A	N/A	C	A	B
		Delay	31.9	N/A	0.7	N/A	N/A	N/A	48.2	16.3	N/A	N/A	26.5	5.3	19.8
		v/c	0.84	N/A	0.09	N/A	N/A	N/A	0.58	0.66	N/A	N/A	0.72	0.63	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	F			N/A	N/A	N/A	B	N/A	N/A	C
		Delay	N/A	N/A	N/A	128.3			N/A	N/A	N/A	10.6	N/A	N/A	19.0
		v/c	N/A	N/A	N/A	1.11			N/A	N/A	N/A	0.14	N/A	N/A	N/A



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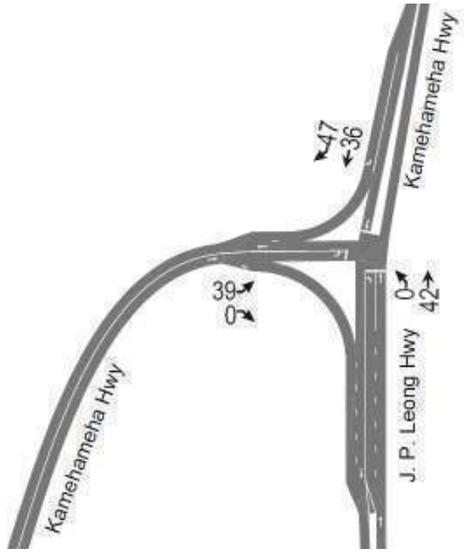
Lane Controls
137→ **Traffic Movement Volume (vph)**

Project Vicinity



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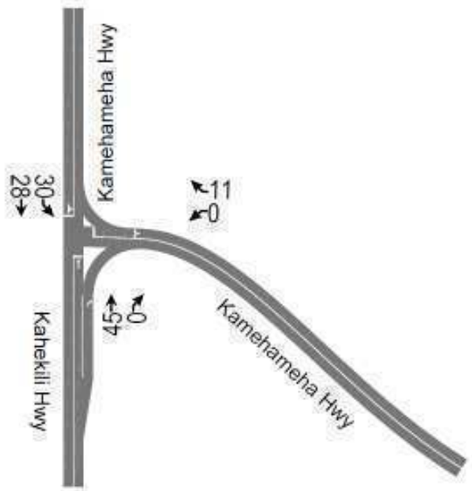
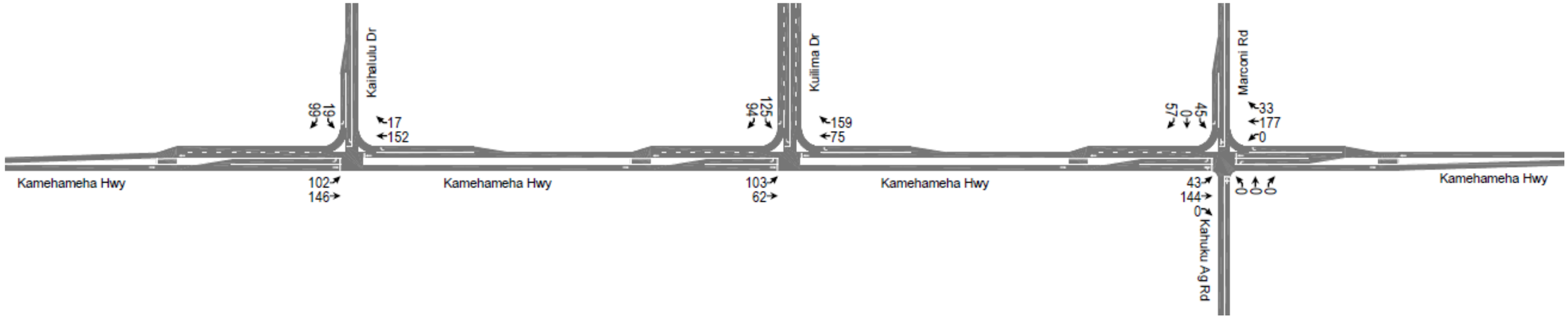


Kahaluu

Figure 19. AM Peak Hour Site Traffic Assignment – Resort Residential Alternative



Project Vicinity

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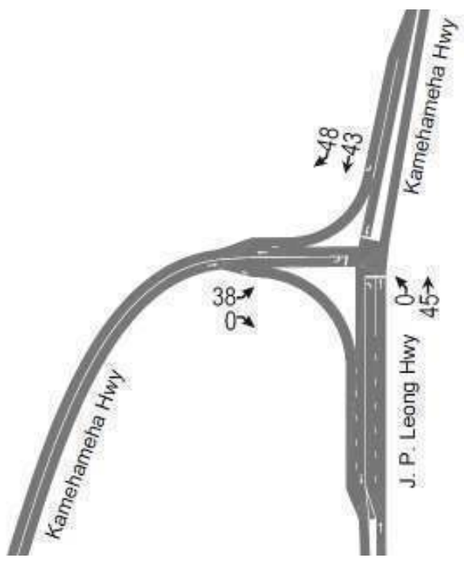
Lane Controls

137 **Traffic Movement Volume (vph)**



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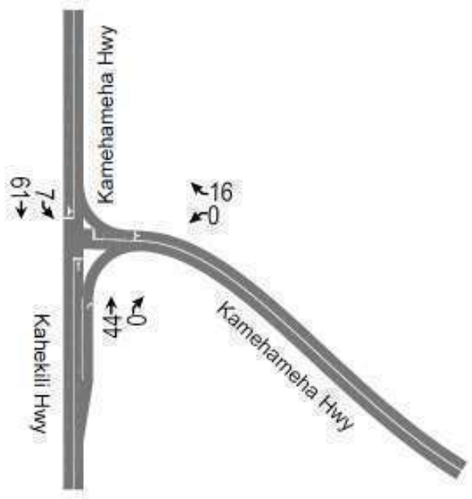
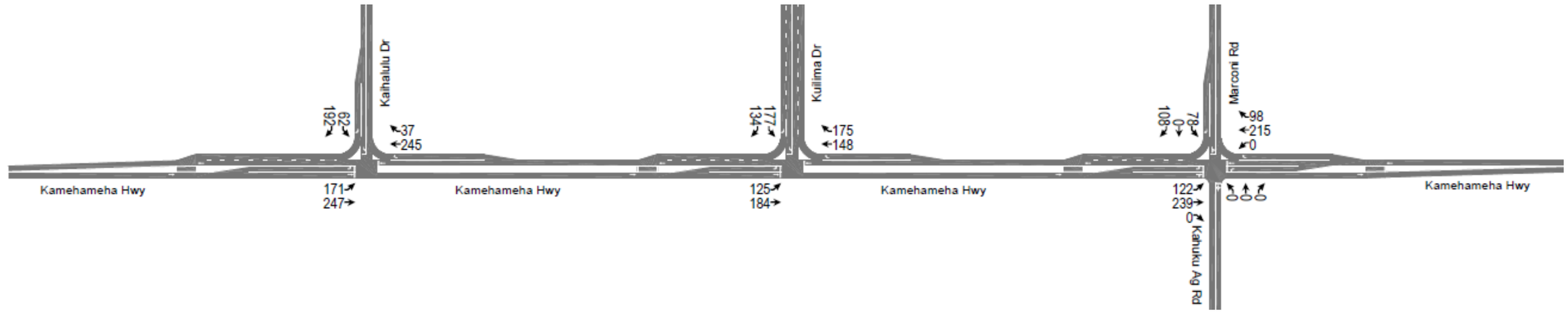


Kahaluu

Figure 20. PM Peak Hour Site Traffic Assignment – Resort Residential Alternative



Project Vicinity

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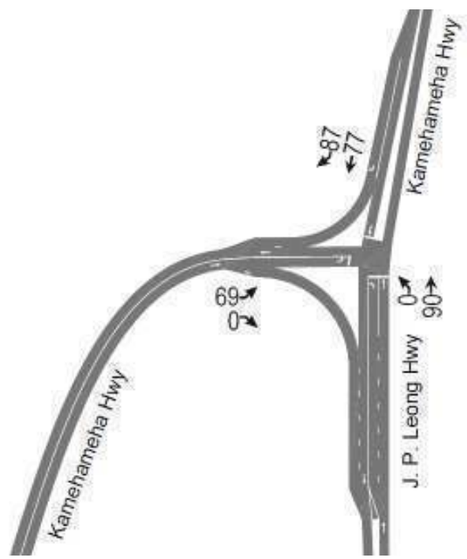
Lane Controls

137→ **Traffic Movement Volume (vph)**



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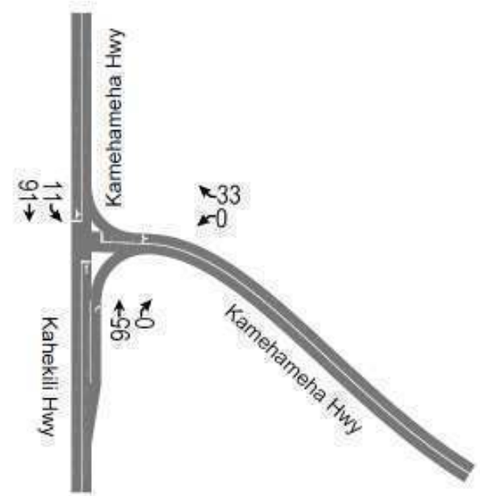

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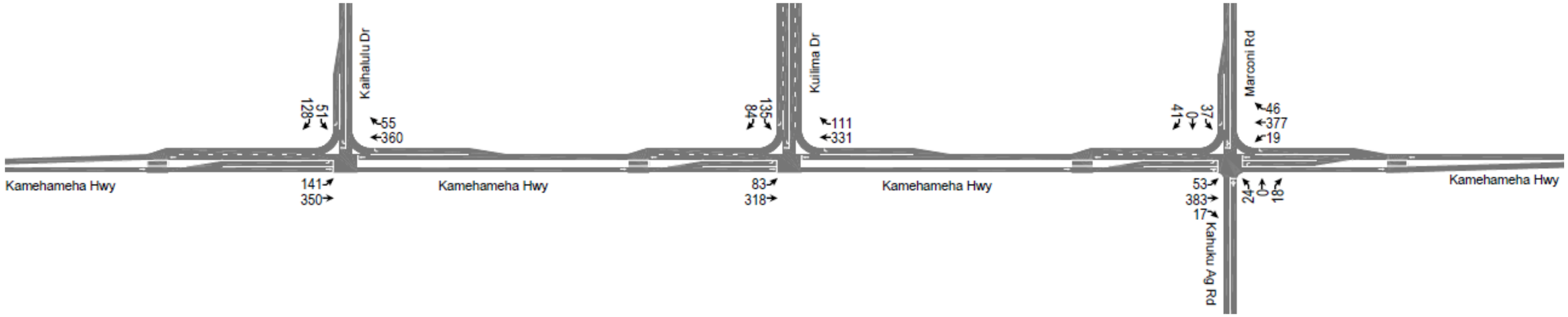
Figure 21. Weekend Peak Hour Site Traffic Assignment – Resort Residential Alternative



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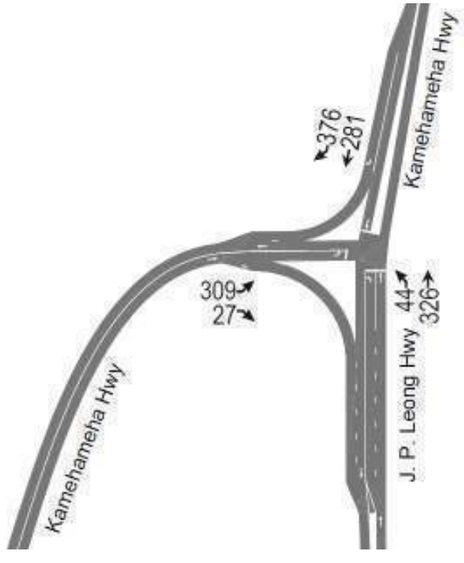
Lane Controls
137 **Traffic Movement Volume (vph)**

Project Vicinity



Haleiwa

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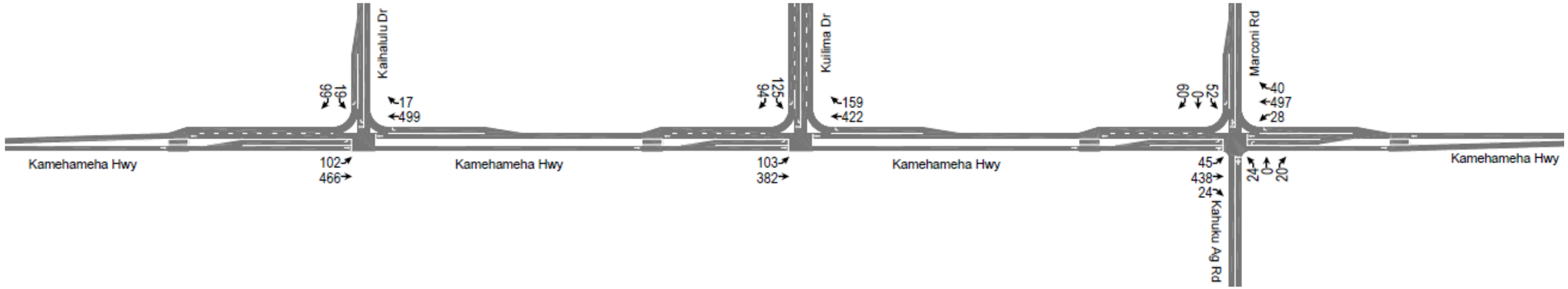
Figure 22. Cumulative AM Peak Hour Traffic – Resort Residential Alternative

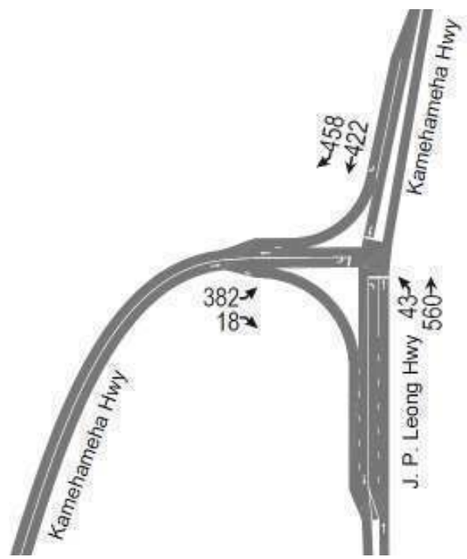


Project Vicinity

Legend

Lane Controls

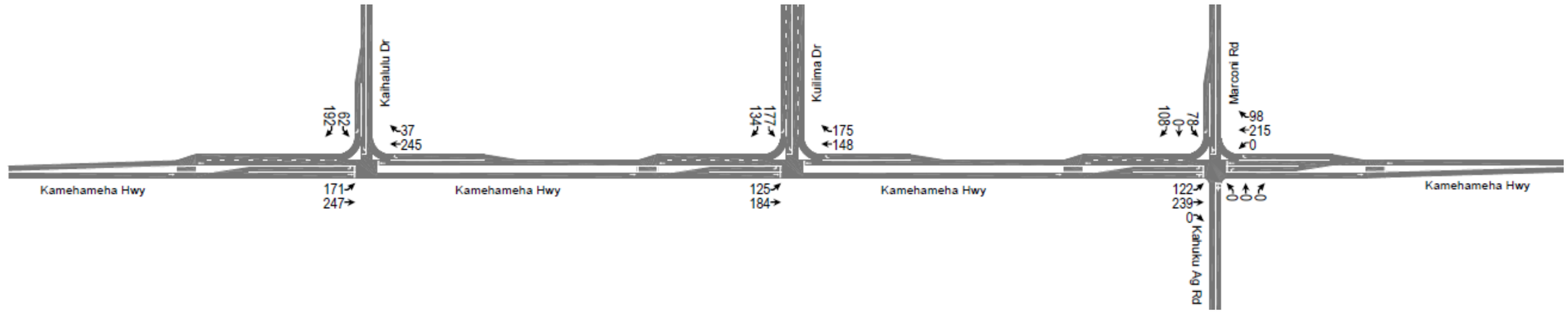
137→ **Traffic Movement Volume (vph)**



Haleiwa

Kahaluu

Figure 23. Cumulative PM Peak Hour Traffic – Resort Residential Alternative

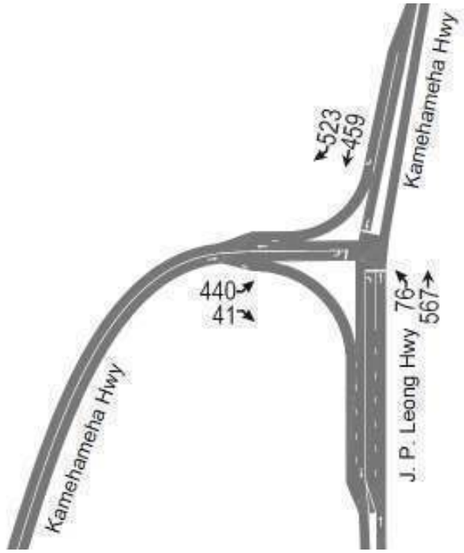


Project Vicinity

Legend

Lane Controls

137→ **Traffic Movement Volume (vph)**



Haleiwa

Kahaluu

Figure 24. Cumulative Weekend Peak Hour Traffic – Resort Residential Alternative

4. Conservation Partner Alternative

The Kamehameha Highway intersections at Kaihalulu Drive, Kuilima Drive, and Marconi Road are expected to operate at overall LOS "C" or better, during the peak hours of traffic with the Conservation Partner (CP) Alternative. The intersection of Kamehameha Highway and Joseph P. Leong Highway is expected to operate at LOS "C" or better, during the peak hours of traffic. The left-turn movement from westbound Kamehameha Highway to southbound Kahekili Highway is expected to operate at LOS "F" during the peak hours of traffic.

Table 16 summarizes the two-lane traffic analysis of Kamehameha Highway with the Conservation Partner Alternative. Table 17 summarizes the intersection analysis for the peak hours of traffic with the Conservation Partner Alternative. The AM, PM, and Weekend peak hour assignment of site traffic with the Conservation Alternative are depicted on Figures 25, 26, and 27, respectively. Figures 28, 29, and 30 depict the cumulative AM, PM, and Weekend peak hour traffic volumes, respectively, with the Conservation Partner Alternative.

Table 16. Peak Hour Two-Lane Operations on Kamehameha Highway With CP Alternative

Peak Hour	Location	LOS	v/c
Weekday AM	Haleiwa	E	0.46
	Kahuku	E	0.37
	Kahaluu	E	0.56
Weekday PM	Haleiwa	E	0.60
	Kahuku	E	0.44
	Kahaluu	E	0.65
Weekend	Haleiwa	E	0.70
	Kahuku	E	0.57
	Kahaluu	E	0.70

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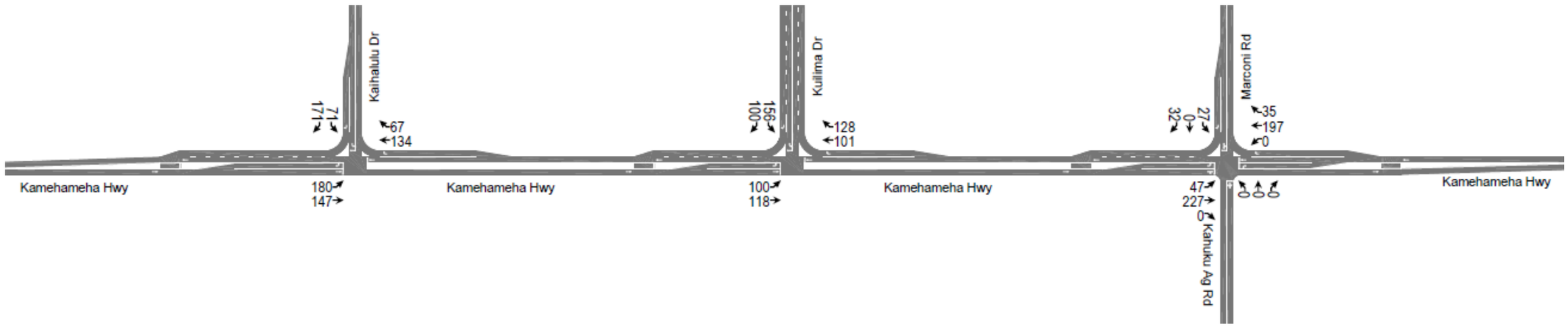
Table 17. Intersection Traffic Analysis Summary - 2025 Peak Hour Conditions With Conservation Partner Alternative

Scenario	Kamehameha Hwy Intersection	MOE	EBLT	EBTH	EBRT	WBLT	WBTH	WBRT	NBLT	NBTH	NBRT	SBLT	SBTH	SBRT	Intersection
2025 AM Peak Hour of Weekday Traffic With Conservation Partner Alternative	Kaihalulu Drive	LOS	C	A	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	B
		Delay	33.9	9.0	N/A	N/A	30.2	2.4	N/A	N/A	N/A	21.1	N/A	5.9	19.0
		v/c	0.62	0.42	N/A	N/A	0.76	0.14	N/A	N/A	N/A	0.17	N/A	0.34	N/A
	Kuilima Drive	LOS	C	A	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	B
		Delay	24.7	7.8	N/A	N/A	20.5	4.4	N/A	N/A	N/A	21.1	N/A	4.9	14.1
		v/c	0.37	0.41	N/A	N/A	0.64	0.25	N/A	N/A	N/A	0.43	N/A	0.25	N/A
	Marconi Rd	LOS	C	B		C	B	A	A			B		A	B
		Delay	20.4	10.3		22.7	12.6	0.2	1.2			17.7		0.4	11.0
		v/c	0.19	0.57		0.14	0.59	0.06	0.16			0.13		0.09	N/A
	Joseph P. Leong Hwy	LOS	C	N/A	A	N/A	N/A	N/A	C	B	N/A	N/A	B	A	B
		Delay	23.5	N/A	0.1	N/A	N/A	N/A	28.2	11.1	N/A	N/A	18.0	4.7	14.3
		v/c	0.70	N/A	0.05	N/A	N/A	N/A	0.33	0.42	N/A	N/A	0.44	0.51	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	F			N/A	N/A	N/A	C	N/A	N/A	F
		Delay	N/A	N/A	N/A	>300			N/A	N/A	N/A	15.5	N/A	N/A	<300
		v/c	N/A	N/A	N/A	>1.2			N/A	N/A	N/A	0.66	N/A	N/A	N/A
2025 PM Peak Hour of Weekday Traffic With Conservation Partner Alternative	Kaihalulu Drive	LOS	D	A	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	C
		Delay	40.1	8.5	N/A	N/A	31.4	1.8	N/A	N/A	N/A	27.1	N/A	7.3	20.9
		v/c	0.61	0.45	N/A	N/A	0.82	0.09	N/A	N/A	N/A	0.11	N/A	0.34	N/A
	Kuilima Drive	LOS	C	A	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	B
		Delay	31.1	7.4	N/A	N/A	23.1	3.8	N/A	N/A	N/A	22.5	N/A	6.2	15.4
		v/c	0.49	0.42	N/A	N/A	0.74	0.31	N/A	N/A	N/A	0.44	N/A	0.29	N/A
	Marconi Rd	LOS	C	B		C	B	A	A			B		A	B
		Delay	24.1	13.1		26.1	15.9	0.1	1.3			19.2		1.5	13.9
		v/c	0.22	0.65		0.23	0.73	0.05	0.17			0.19		0.15	N/A
	Joseph P. Leong Hwy	LOS	C	N/A	A	N/A	N/A	N/A	C	B	N/A	N/A	B	A	B
		Delay	30.2	N/A	0.1	N/A	N/A	N/A	31.8	11.2	N/A	N/A	18.5	3.6	15.5
		v/c	0.78	N/A	0.03	N/A	N/A	N/A	0.31	0.51	N/A	N/A	0.65	0.51	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	F			N/A	N/A	N/A	B	N/A	N/A	B
		Delay	N/A	N/A	N/A	71.7			N/A	N/A	N/A	10.5	N/A	N/A	13.1
		v/c	N/A	N/A	N/A	0.97			N/A	N/A	N/A	0.12	N/A	N/A	N/A
2025 Weekend Peak Hour of Traffic With Conservation Partner Alternative	Kaihalulu Drive	LOS	D	A	N/A	N/A	C	A	N/A	N/A	N/A	D	N/A	A	C
		Delay	50.4	8.1	N/A	N/A	34.9	2.9	N/A	N/A	N/A	35.4	N/A	8.4	23.4
		v/c	0.73	0.52	N/A	N/A	0.88	0.09	N/A	N/A	N/A	0.23	N/A	0.48	N/A
	Kuilima Drive	LOS	D	B	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	C
		Delay	46.3	10.0	N/A	N/A	32.9	3.4	N/A	N/A	N/A	26.5	N/A	6.0	20.7
		v/c	0.68	0.53	N/A	N/A	0.86	0.30	N/A	N/A	N/A	0.48	N/A	0.32	N/A
	Marconi Rd	LOS	C	B		C	C	A	A			C		A	B
		Delay	33.4	10.5		31.7	23.7	2.9	1.1			28.0		8.3	17.2
		v/c	0.48	0.61		0.16	0.81	0.14	0.13			0.34		0.31	N/A
	Joseph P. Leong Hwy	LOS	C	N/A	A	N/A	N/A	N/A	D	B	N/A	N/A	C	A	C
		Delay	34.4	N/A	0.7	N/A	N/A	N/A	49.1	17.7	N/A	N/A	28.8	5.5	21.3
		v/c	0.87	N/A	0.09	N/A	N/A	N/A	0.58	0.70	N/A	N/A	0.77	0.65	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	F			N/A	N/A	N/A	B	N/A	N/A	F
		Delay	N/A	N/A	N/A	>300			N/A	N/A	N/A	11.8	N/A	N/A	89.7
		v/c	N/A	N/A	N/A	>1.2			N/A	N/A	N/A	0.19	N/A	N/A	N/A

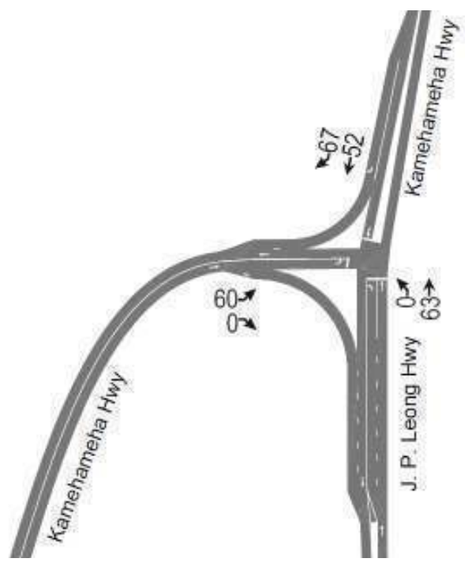


Project Vicinity

Legend

Lane Controls

137 **Traffic Movement Volume (vph)**



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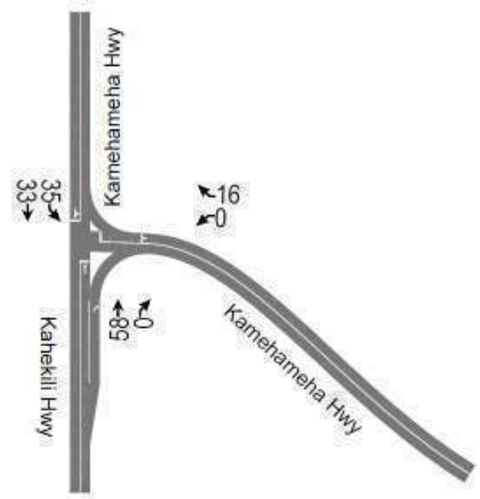
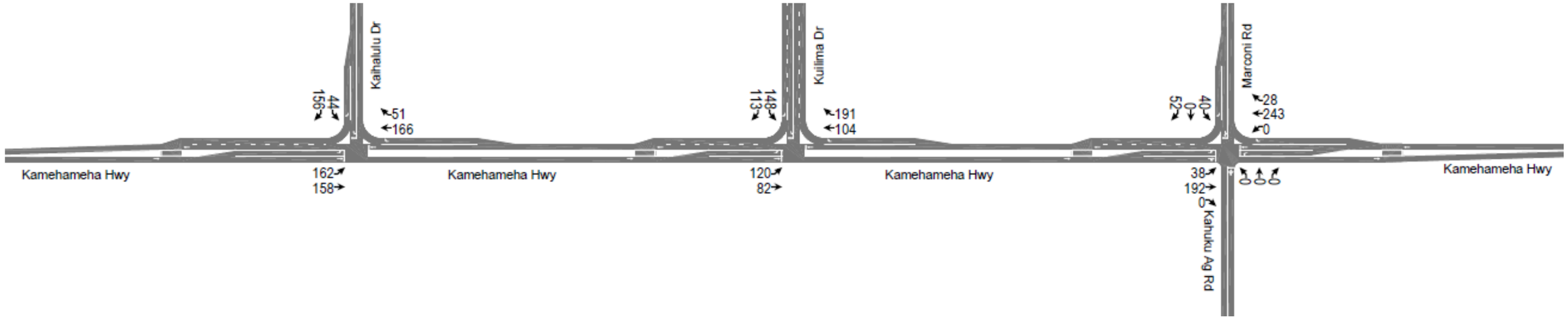


Kahaluu

Figure 25. AM Peak Hour Site Traffic Assignment – Conservation Partner Alternative

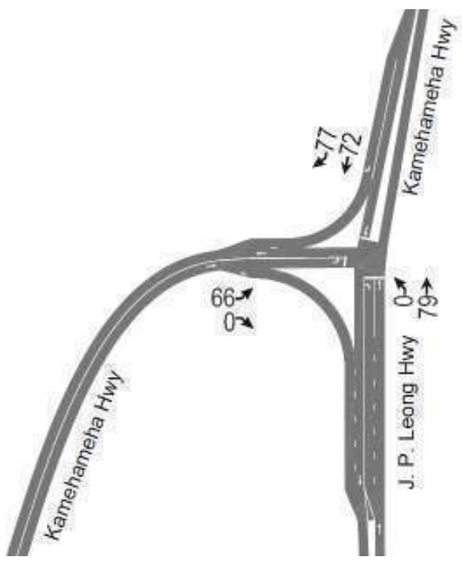


Project Vicinity

Legend

Lane Controls

137 **Traffic Movement Volume (vph)**



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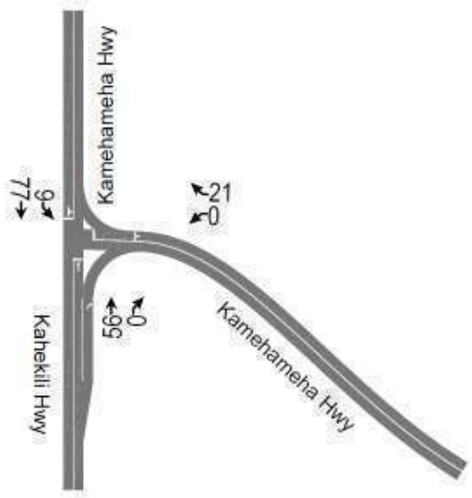
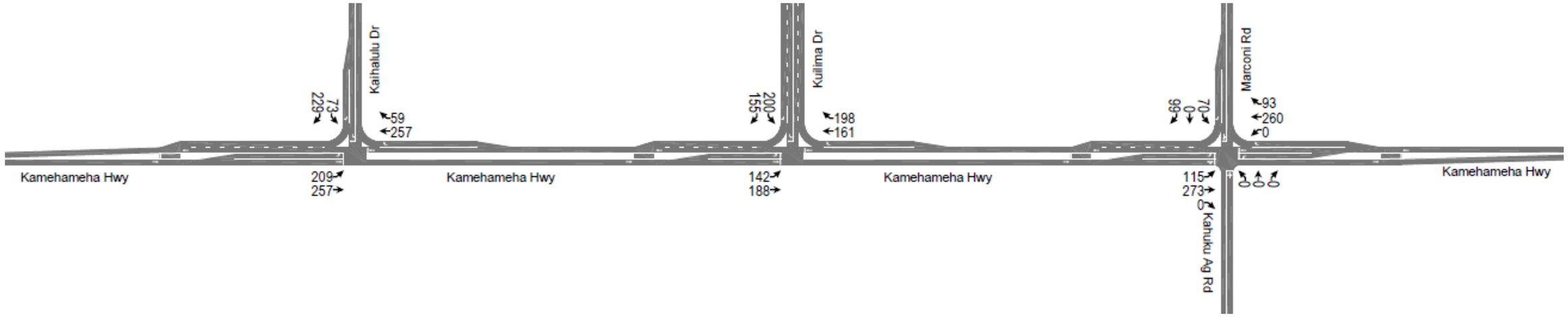


Kahaluu

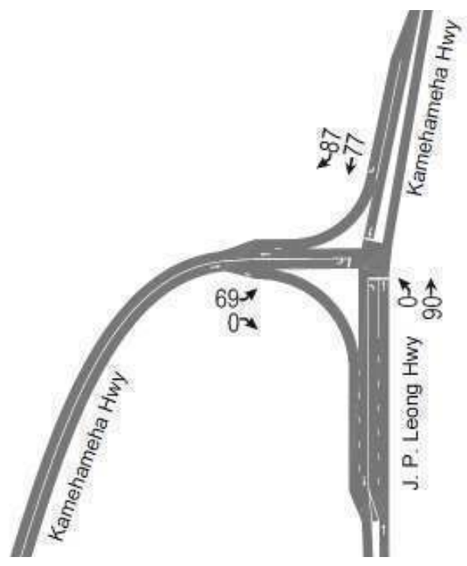
Figure 26. PM Peak Hour Site Traffic Assignment – Conservation Partner Alternative



Legend

Lane Controls
137→ **Traffic Movement Volume (vph)**

Project Vicinity



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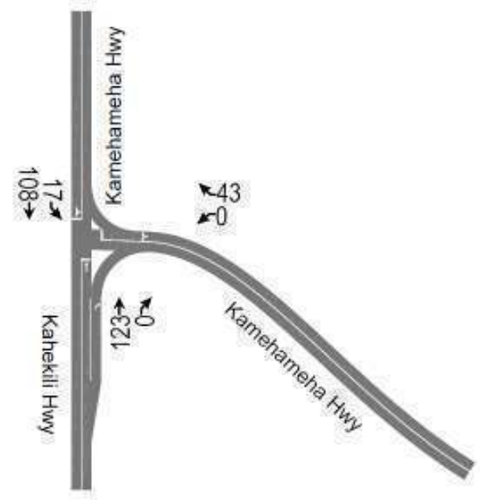

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Figure 27. Weekend Peak Hour Site Traffic Assignment – Conservation Partner Alternative

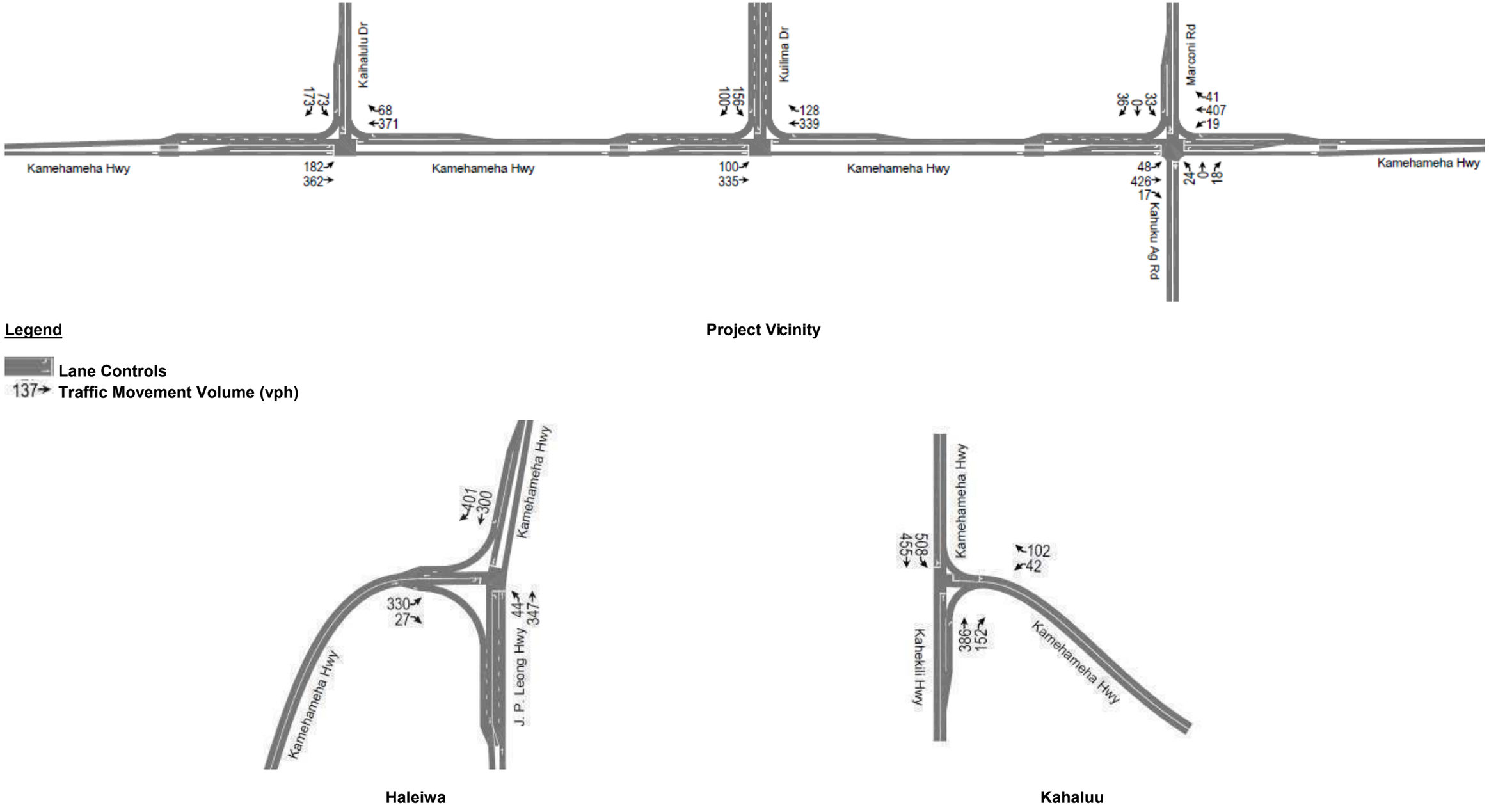
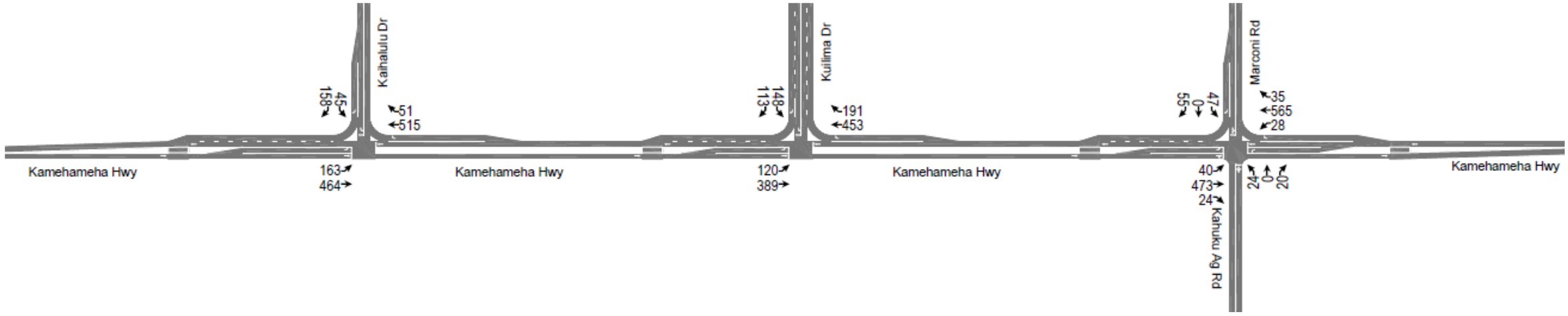


Figure 28. Cumulative AM Peak Hour Traffic – Conservation Partner Alternative



Legend

Lane Controls
137 **Traffic Movement Volume (vph)**

Project Vicinity

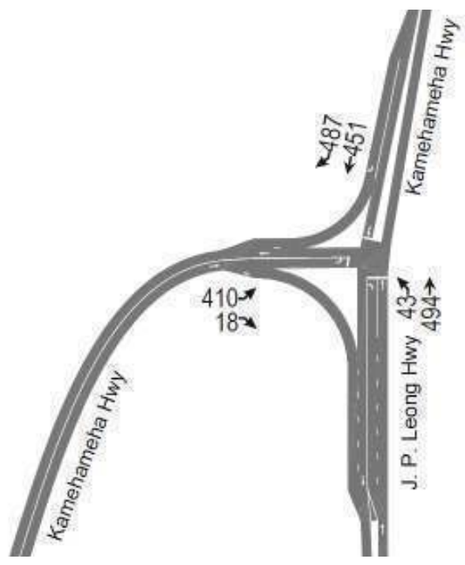


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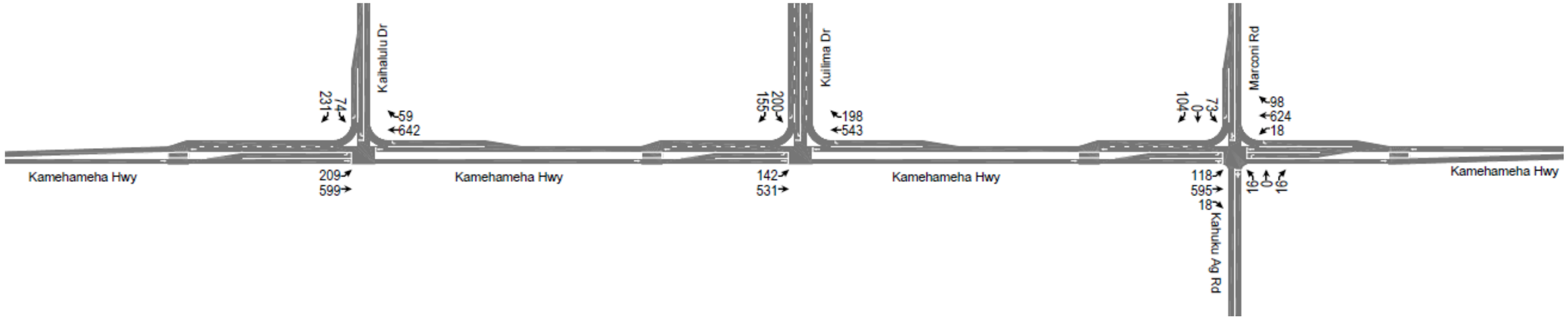
Figure 29. Cumulative PM Peak Hour Traffic – Conservation Partner Alternative



Legend

Lane Controls

137→ **Traffic Movement Volume (vph)**

Project Vicinity

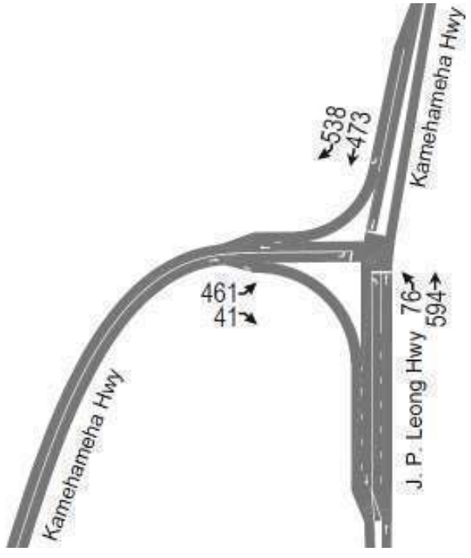


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Figure 30. Cumulative Weekend Peak Hour Traffic – Conservation Partner Alternative

C. Traffic Impact Analysis of the Proposed Action

1. Proposed Action Phasing

The purpose of analyzing the phasing of a long term development is to coordinate the proposed traffic improvements with the development schedule of the project. The development of the Proposed Action is expected to span eleven (11) years, from the Year 2015 through the Year 2025, which was based upon a market analysis prepared by HVS International Consulting and Evaluation.

In the first year of development, units on Parcels RR-1, RR-2a, RR-2b, H-1a, RR-5, RR-6, RES-1, and RES-2 are expected to begin occupancy. The first occupancy of Parcels RR-1, RR-2a, and RR-2b will require access on Kamehameha Highway at Kaihalulu Drive and the channelization improvements at the intersection. The initial development of Parcel H-1a will require the channelization improvements at the intersection of Kuilima Drive and Kamehameha Highway. Traffic signalization also will be necessary during the initial phase of development, since the intersection meets the MUTCD Warrant under existing conditions. When the first units are developed and become occupied, Parcels RR-5, RR-6, RES-1, and RES-2 will require the channelization improvements at the intersection of Marconi Road and Kamehameha Highway.

Because the Proposed Action is expected to start development on various Parcels across the entire Resort during the first year of occupancy, the previously discussed Kamehameha Highway channelization improvements at Kaihalulu Drive, Kuilima Drive, and Marconi Road are expected to be constructed in the first year of occupancy. Furthermore, Kaihalulu Drive also is expected to be constructed between Kamehameha Highway and Marconi Road during the first year of occupancy. This internal roadway would provide traffic circulation within the Resort, and minimize the Resort traffic demands on Kamehameha Highway.

The signalization of Kaihalulu Drive at Kamehameha Highway is <u>not</u> expected to be warranted until the final year of development. The traffic signals at Marconi Road and Kamehameha Highway are expected to become warranted when access to the Kahuku Mauka Agricultural Lots is constructed (by others) from Kamehameha Highway, opposite Marconi Road. As previously discussed, the Kahuku Mauka Agricultural Lots project is currently on hold. Since the traffic improvements for the Proposed Action are expected to be required only during the first year and the final year of development, the traffic impacts of the Proposed Action were analyzed at its completion.

The actual phasing of the development of the Proposed Action will be subject to future market and economic conditions. This traffic impact analysis report will be updated, as necessary, to coordinate the traffic improvements with any changes to the project schedule to the satisfaction of DOT and the City and County of Honolulu.

2. Year 2025 AM Peak Hour Traffic Analysis With the Proposed Action

The Kaihalulu Drive, Kuilima Drive, and Marconi Road intersections at Kamehameha Highway are expected to operate at LOS "B", during the Year 2025 AM peak hour of traffic with the Proposed Action. The individual traffic movements at all three intersections are expected to operate at LOS "C" or better. The AM peak hour site-generated traffic assignment for the Proposed Action is depicted on Figure 31. Figure 32 depicts the cumulative AM peak hour traffic with the Proposed Action.

3. Year 2025 PM Peak Hour Traffic Analysis With the Proposed Action

During the Year 2025 PM peak hour of traffic with the Proposed Action, the intersection of Kamehameha Highway and Kaihalulu Drive is expected to operate at LOS "C". The left-turn movement from eastbound Kamehameha Highway is expected to operate at LOS "D". The other traffic movements at the Kaihalulu Drive intersection are expected to operate at satisfactory Levels of Service.

The Kuilima Drive and Marconi Road intersections are expected to operate at overall LOS "B" at Kamehameha Highway, during the Year 2025 PM peak hour of traffic with the Proposed Action. The individual traffic movements at both intersections are expected to operate at satisfactory Levels of Service. Figure 33 depicts the PM peak hour site-generated traffic assignment for the Proposed Action. The cumulative PM peak hour traffic with the Proposed Action is depicted on Figure 34.

4. Year 2025 Weekend Peak Hour Traffic Analysis With the Proposed Action

The intersection of Kaihalulu Drive and Kamehameha Highway is expected to operate at an intersection LOS "C". The eastbound left-turn movement, westbound through movement, and the southbound left-turn movement are expected to operate at LOS "D".

During the Year 2025 Weekend peak hour of traffic with the Proposed Action, the Kuilima Drive and Marconi Road intersections are expected to operate at an overall LOS "C" at Kamehameha Highway. The left-turn movements from Kamehameha Highway are expected to operate LOS "D". The other traffic movements at the intersections are expected to operate at satisfactory Levels of Service. Figure 35 depicts the Weekend peak hour site-generated traffic assignment for the Proposed Action. The cumulative Weekend peak hour traffic with the Proposed Action is depicted on Figure 36. Table 18 summarizes the intersection analysis for the peak hours of traffic with the Proposed Action.

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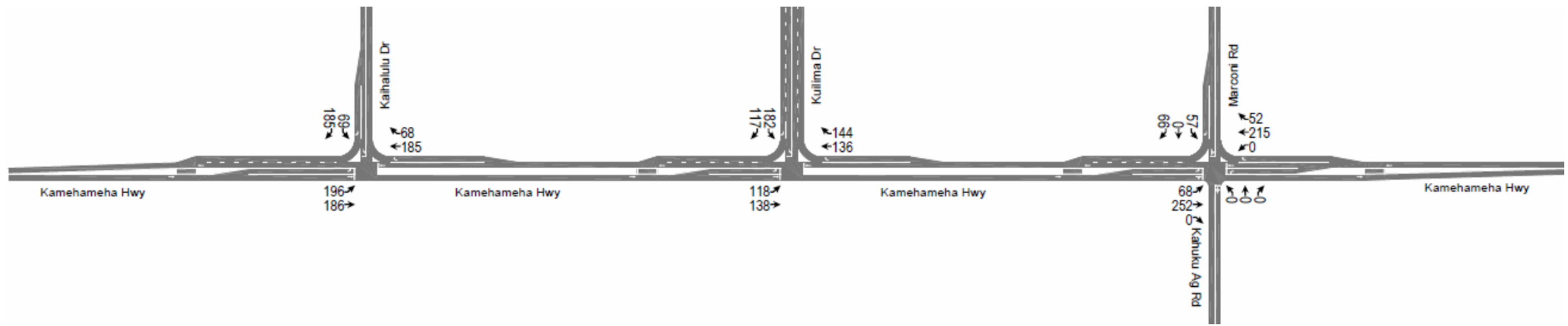

Legend

Lane Controls
137 **Traffic Movement Volume (vph)**

Project Vicinity

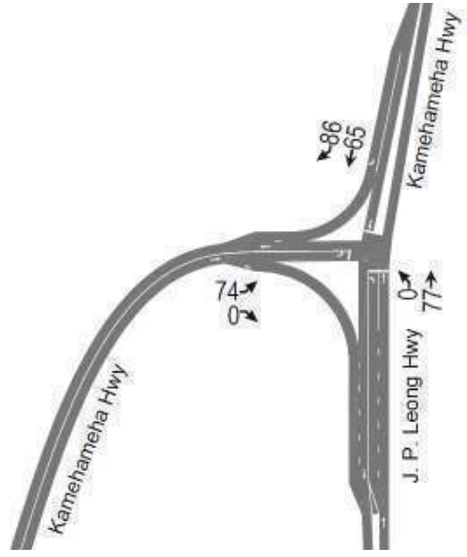

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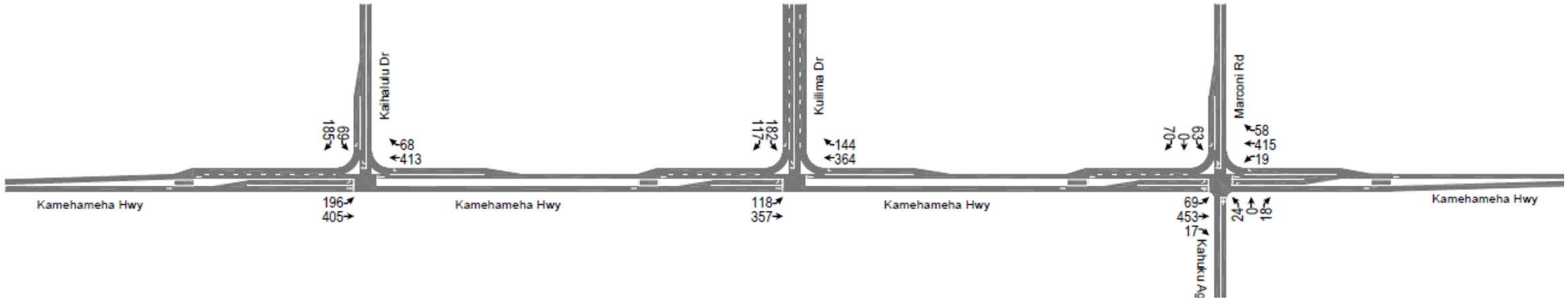
Figure 31. AM Peak Hour Site Traffic Assignment – Proposed Action



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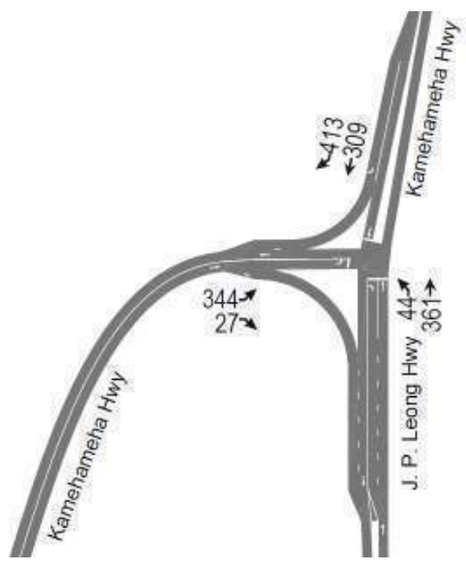
Lane Controls
137→ **Traffic Movement Volume (vph)**

Project Vicinity



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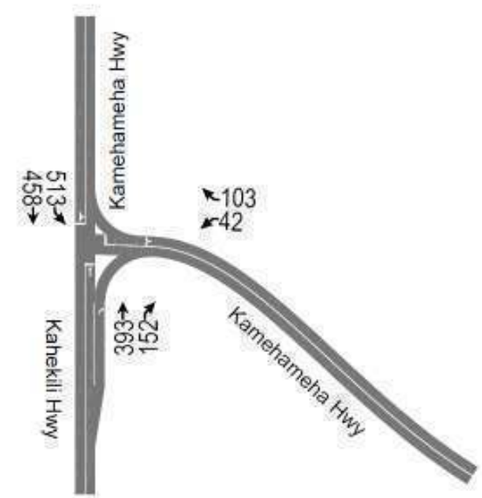

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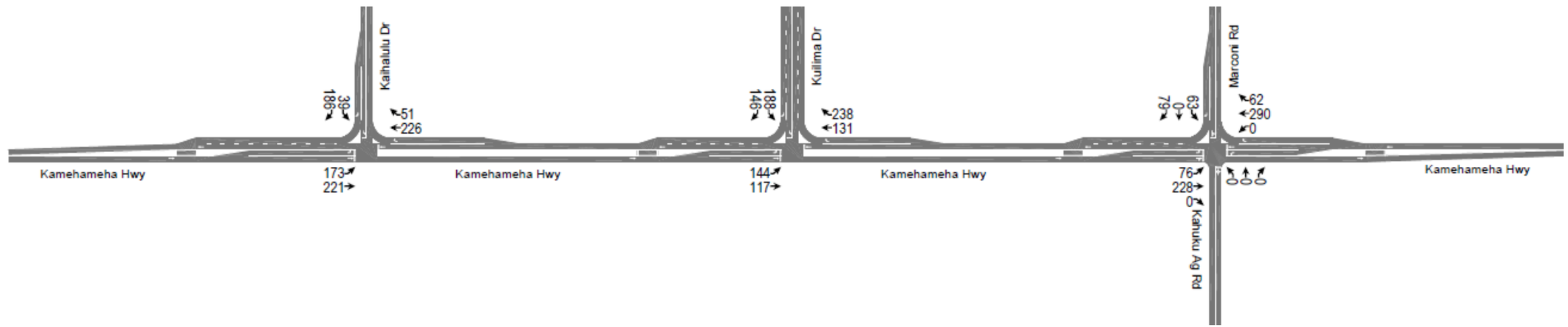
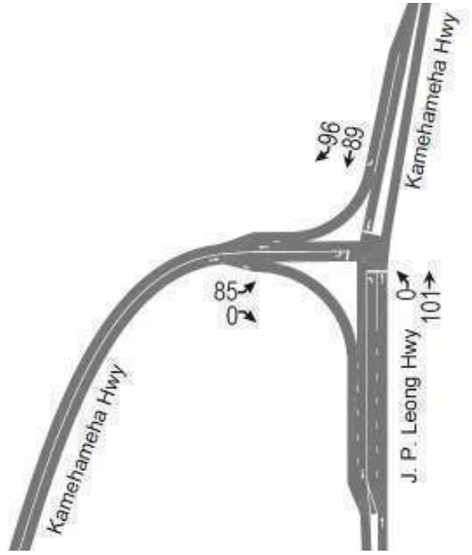
Figure 32. Cumulative AM Peak Hour Traffic – Proposed Action



Legend

Lane Controls
137 **Traffic Movement Volume (vph)**

Project Vicinity



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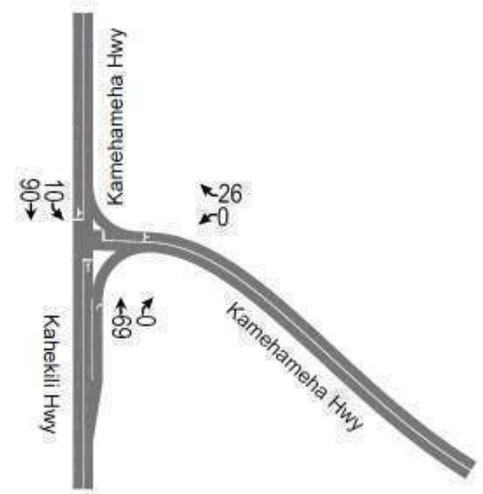

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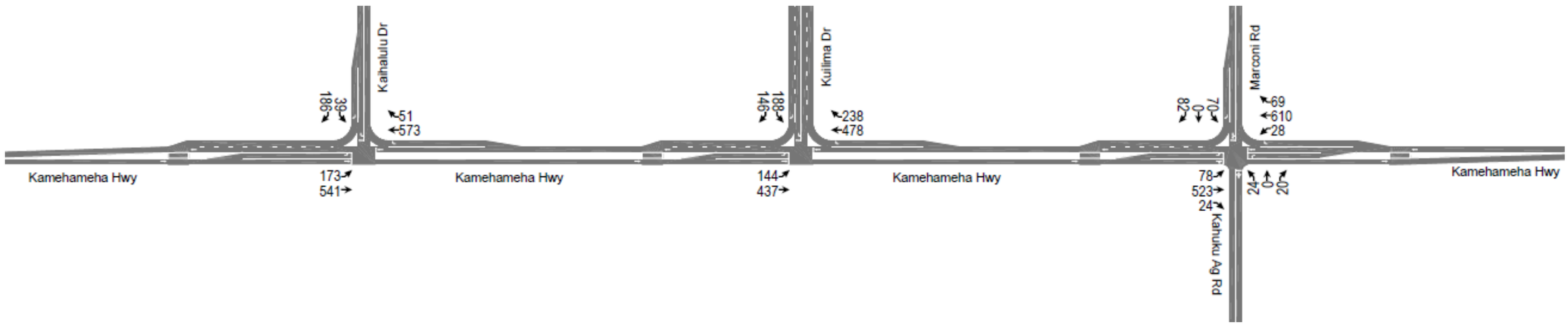
Figure 33. PM Peak Hour Site Traffic Assignment – Proposed Action



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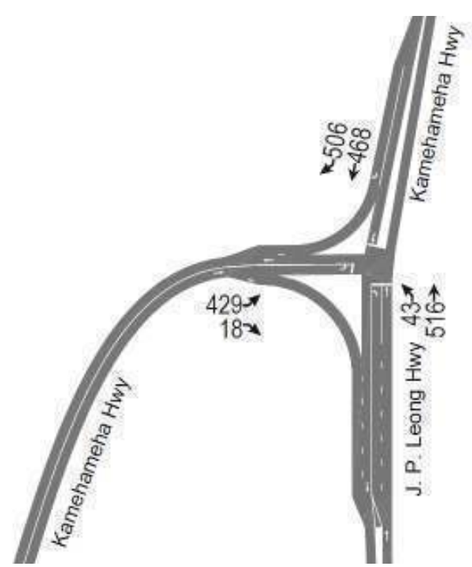
Lane Controls

137→ **Traffic Movement Volume (vph)**

Project Vicinity



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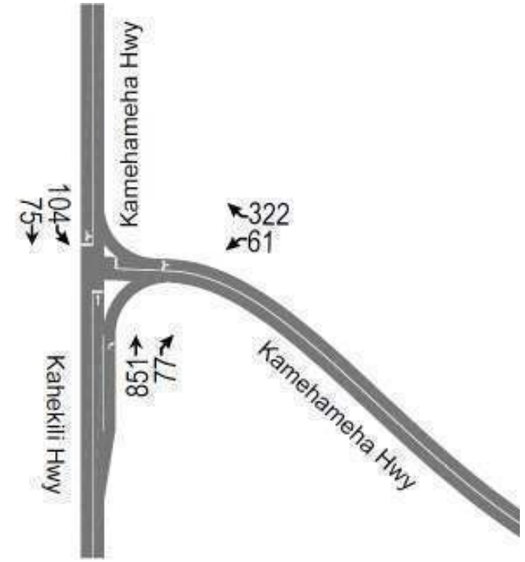

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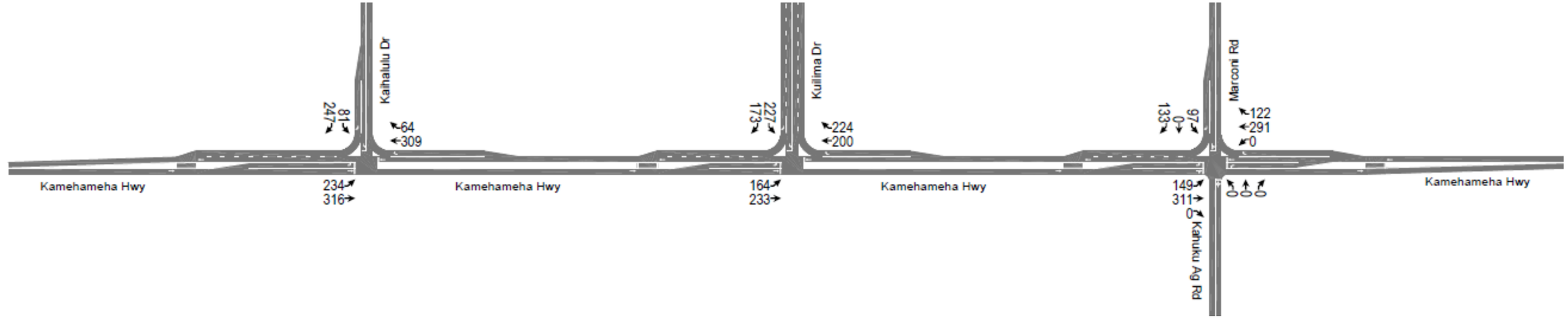
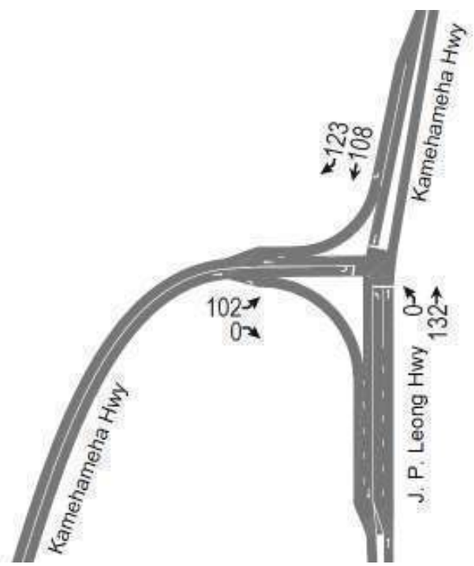
Figure 34. Cumulative PM Peak Hour Traffic – Proposed Action



Legend

Lane Controls
137 **Traffic Movement Volume (vph)**

Project Vicinity



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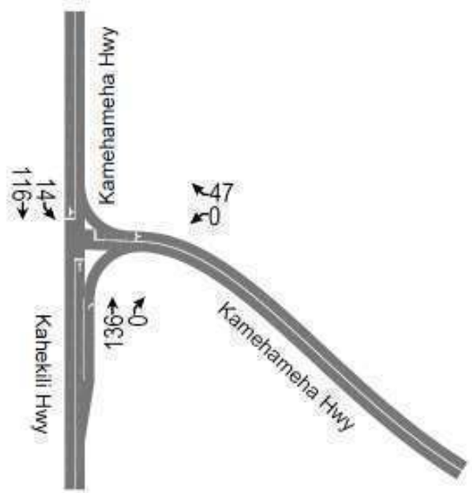

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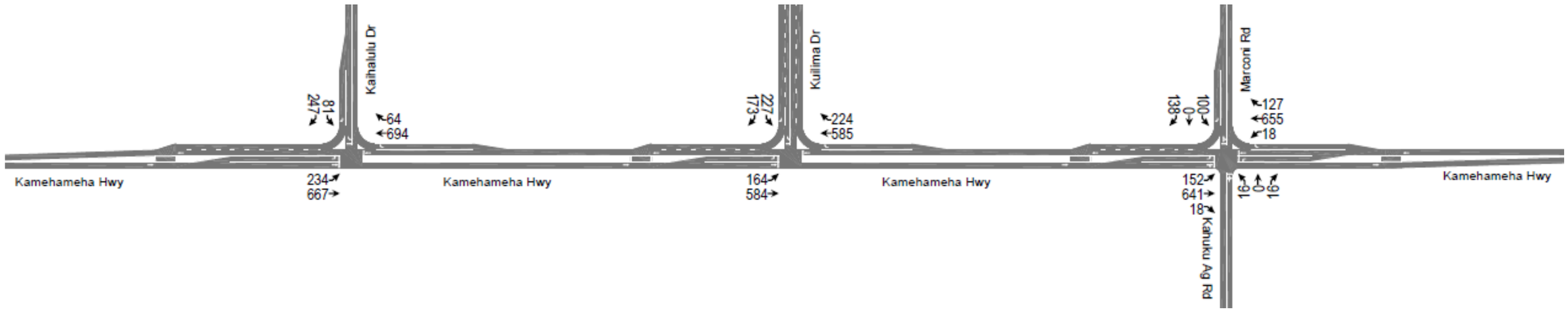
Figure 35. Weekend Peak Hour Site Traffic Assignment – Proposed Action



Legend

Lane Controls
137→ **Traffic Movement Volume (vph)**

Project Vicinity

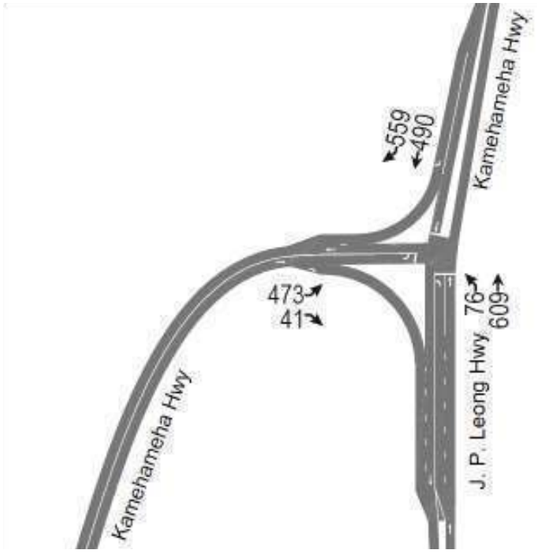


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Figure 36. Cumulative Weekend Peak Hour Traffic – Proposed Action

Table 18. Intersection Traffic Analysis Summary - 2025 Peak Hour Conditions With Proposed Action

Scenario	Kamehameha Hwy Intersection	MOE	EBLT	EBTH	EBRT	WBLT	WBTH	WBRT	NBLT	NBTH	NBRT	SBLT	SBTH	SBRT	Intersection
2025 AM Peak Hour of Weekday Traffic With Proposed Action	Kaihalulu Drive	LOS	C	A	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	B
		Delay	33.9	8.2	N/A	N/A	31.4	3.3	N/A	N/A	N/A	25.2	N/A	7.0	19.7
		v/c	0.62	0.43	N/A	N/A	0.79	0.13	N/A	N/A	N/A	0.18	N/A	0.39	N/A
	Kuilima Drive	LOS	C	A	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	B
		Delay	27.8	8.5	N/A	N/A	22.6	4.4	N/A	N/A	N/A	22.0	N/A	5.9	15.6
		v/c	0.44	0.44	N/A	N/A	0.69	0.27	N/A	N/A	N/A	0.48	N/A	0.28	N/A
	Marconi Rd	LOS	C	B		C	B	A	A			B		A	B
		Delay	24.4	11.8		25.3	15.5	0.7	1.2			19.5		2.7	13.0
		v/c	0.30	0.62		0.16	0.64	0.09	0.16			0.25		0.18	N/A
	Joseph P. Leong Hwy	LOS	C	N/A	A	N/A	N/A	N/A	C	B	N/A	N/A	B	A	B
		Delay	24.3	N/A	0.1	N/A	N/A	N/A	32.1	11.4	N/A	N/A	17.6	4.5	14.6
		v/c	0.72	N/A	0.05	N/A	N/A	N/A	0.39	0.43	N/A	N/A	0.44	0.51	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	F			N/A	N/A	N/A	C	N/A	N/A	F
		Delay	N/A	N/A	N/A	>300			N/A	N/A	N/A	16.0	N/A	N/A	>300
		v/c	N/A	N/A	N/A	>1.2			N/A	N/A	N/A	0.68	N/A	N/A	N/A
2025 PM Peak Hour of Weekday Traffic With Proposed Action	Kaihalulu Drive	LOS	D	A	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	C
		Delay	44.8	9.0	N/A	N/A	32.9	1.7	N/A	N/A	N/A	28.4	N/A	7.4	21.8
		v/c	0.66	0.51	N/A	N/A	0.85	0.08	N/A	N/A	N/A	0.10	N/A	0.39	N/A
	Kuilima Drive	LOS	C	A	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	B
		Delay	34.0	7.9	N/A	N/A	24.1	3.7	N/A	N/A	N/A	28.0	N/A	6.9	16.6
		v/c	0.53	0.45	N/A	N/A	0.74	0.36	N/A	N/A	N/A	0.54	N/A	0.35	N/A
	Marconi Rd	LOS	C	B		C	C	A	A			C		A	B
		Delay	31.7	11.9		32.5	21.3	1.9	3.3			29.7		8.4	16.9
		v/c	0.33	0.59		0.20	0.79	0.10	0.20			0.33		0.26	N/A
	Joseph P. Leong Hwy	LOS	C	N/A	A	N/A	N/A	N/A	C	B	N/A	N/A	B	A	B
		Delay	31.2	N/A	0.1	N/A	N/A	N/A	32.0	11.8	N/A	N/A	19.6	3.7	16.3
		v/c	0.80	N/A	0.03	N/A	N/A	N/A	0.31	0.54	N/A	N/A	0.67	0.52	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	F			N/A	N/A	N/A	B	N/A	N/A	C
		Delay	N/A	N/A	N/A	87.4			N/A	N/A	N/A	10.6	N/A	N/A	15.7
		v/c	N/A	N/A	N/A	1.02			N/A	N/A	N/A	0.13	N/A	N/A	N/A
2025 Weekend Peak Hour of Traffic With Proposed Action	Kaihalulu Drive	LOS	D	A	N/A	N/A	D	A	N/A	N/A	N/A	D	N/A	A	C
		Delay	53.5	7.9	N/A	N/A	38.1	3.9	N/A	N/A	N/A	41.3	N/A	9.4	25.2
		v/c	0.76	0.55	N/A	N/A	0.89	0.09	N/A	N/A	N/A	0.28	N/A	0.52	N/A
	Kuilima Drive	LOS	D	A	N/A	N/A	C	A	N/A	N/A	N/A	C	N/A	A	C
		Delay	48.7	9.4	N/A	N/A	33.1	3.4	N/A	N/A	N/A	32.7	N/A	6.7	21.5
		v/c	0.73	0.55	N/A	N/A	0.87	0.32	N/A	N/A	N/A	0.65	N/A	0.39	N/A
	Marconi Rd	LOS	D	B		D	C	A	A			C		A	C
		Delay	44.4	10.6		41.6	29.0	2.9	1.2			33.1		8.3	20.4
		v/c	0.66	0.60		0.26	0.87	0.17	0.14			0.48		0.38	N/A
	Joseph P. Leong Hwy	LOS	C	N/A	A	N/A	N/A	N/A	D	B	N/A	N/A	C	A	C
		Delay	33.5	N/A	1.2	N/A	N/A	N/A	47.0	13.2	N/A	N/A	32.0	5.7	21.6
		v/c	0.86	N/A	0.09	N/A	N/A	N/A	0.53	0.36	N/A	N/A	0.78	0.66	N/A
	Kahekili Hwy	LOS	N/A	N/A	N/A	F			N/A	N/A	N/A	B	N/A	N/A	F
		Delay	N/A	N/A	N/A	>300			N/A	N/A	N/A	11.9	N/A	N/A	95.3
		v/c	N/A	N/A	N/A	>1.2			N/A	N/A	N/A	0.19	N/A	N/A	N/A

5. Year 2025 Regional Traffic Analysis With the Proposed Action

Table 19 summarizes the regional traffic analysis of Kamehameha Highway with the Proposed Action.

Table 19. 2025 Peak Hour Two-Lane Operations on Kamehameha Highway With the Proposed Action

Peak Hour	Location	LOS	v/c
Weekday AM	Haleiwa	E	0.48
	Kahuku	E	0.41
	Kahaluu	E	0.57
Weekday PM	Haleiwa	E	0.63
	Kahuku	E	0.50
	Kahaluu	E	0.66
Weekend	Haleiwa	E	0.72
	Kahuku	E	0.63
	Kahaluu	E	0.71

VIII. Recommendations and Conclusions

A. Recommendations for the Proposed Action

1. Intersection Improvements

The following roadway improvements are recommended at each of the Kamehameha Highway intersections at Kaihalulu Drive, Kuilima Drive, and Marconi Road to accommodate the estimated increases in peak hour traffic with the development of the Proposed Action. The following access improvements are expected to mitigate the anticipated traffic impacts resulting from the implementation of the Proposed Action.

a. Westbound Kamehameha Highway should be widened to provide exclusive right-turn lanes at Kaihalulu Drive, Kuilima Drive, and Marconi Road.

b. Eastbound Kamehameha Highway should be widened to provide exclusive left-turn lanes at Kaihalulu Drive, Kuilima Drive, and Marconi Road.

c. Westbound Kamehameha Highway should be widened to provide right-turn acceleration lanes at Kaihalulu Drive, Kuilima Drive, and Marconi Road.

d. Each Resort access road should be widened/constructed to provide separate left-turn and right-turn lanes at Kamehameha Highway.

e. The Kamehameha Highway intersection at Kuilima Drive should be signalized, when improved to a channelized intersection.

f. The Kamehameha Highway intersection at Kaihalulu Drive should be signalized, when warranted.

g. The Kamehameha Highway intersection at Marconi Road should be signalized, when warranted.

2. Turning Lane Lengths

The left-turn storage lengths were based upon a protected left-turn signal phase at each of the Resort access intersections on Kamehameha Highway. The left-turn storage requirements were based upon the average of the 95th percentile queue lengths of ten (10) simulations, using SimTraffic. The acceleration and deceleration lengths are based upon AASHTO's A Policy on Geometric Design of Highways and Streets, (Exhibits 10-70 and 10-73) for the Kamehameha Highway design speed of 50 mph, as designated by DOT. The right-turn acceleration lane lengths are based upon an entrance curve design speed of 15 mph. The deceleration lane lengths are based upon a stop condition. Table 20 summarizes the turning lane requirements.

Table 20. Kamehameha Highway – Turning Lane Lengths (Feet)

Intersection	Lane Type	Lane No.	Storage Lane Length	Decel/ Accel Lane Length	Total	Design Lane Length
Kaihalulu Drive	EB LT	1	227	435	662	665
	WB RT Decel.	1	0	435	435	435
	WB RT Accel.	1	0	660	660	660
Kuilima Drive	EB LT	1	138	435	573	575
	WB RT Decel.	1	0	435	435	435
	WB RT Accel.	1	0	660	660	660
Marconi Road	EB LT	1	152	435	587	590
	WB RT Decel.	1	0	435	435	440
	WB RT Accel.	1	0	660	660	660
	WB LT	1	58	435	493	500

EB = eastbound WB = westbound LT = left-turn RT = right-turn
Decel = Deceleration Accel = Acceleration

3. Resort Roadways

As previously discussed, the development of the Proposed Action is expected to commence at various locations throughout the Resort area. Traffic improvements at each of the three access points on Kamehameha Highway should be constructed in the initial phase of development. Kaihalulu Drive also should be constructed in the first phase of development between Kamehameha Highway and Marconi Road. The two-lane internal road will facilitate traffic circulation within the Resort and reduce the traffic demand on Kamehameha Highway.

4. Traffic Demand Management

Turtle Bay Resort currently requires the implementation of an informal traffic demand management (TDM) plan by the promoters of special events held at the Resort. A TDM plan consists of a variety of mitigation measures, which are intended to reduce traffic generation. TDM measures are discussed in a memorandum titled "Turtle Bay Resort Transportation Demand Management (TDM) – Overview and Potential Strategies.", which was prepared by Fehr & Peers. TDM is a working document that will provide the Resort operator(s) a "toolbox", which will contain a variety of transportation strategies that can be implemented during special events as well as on a day-to-day basis. The effectiveness of each strategy will be measured during the implementation, which can be expected to reduce peak hour traffic from 5 percent to 15 percent. Since TDM measures cannot be accurately quantified at this writing, they were not taken into account in this traffic impact analysis.

5. Regional Traffic Improvements

The regional traffic improvements in the study area include the construction of turn lanes, guardrails, signage, and crosswalks to improve safety, as recommended in the ORTP. Kamehameha Highway is expected to remain a two-lane highway in response to community preference.

The intersection of Kamehameha Highway and Kahekili Highway in Kahaluu is an existing problem where the left-turn movement from westbound Kamehameha Highway to southbound Kahekili Highway is expected to continue to operate at LOS "F". The left-turn volumes on westbound Kamehameha Highway are below the minimum threshold volumes that are required to meet the warrants for the installation of traffic signals. The heavy left-turn demands on southbound Kamehameha Highway only occur during the existing 2-hour AM peak period, which would not meet traffic signal warrants. A modern roundabout intersection also has been considered by DOT. However, a multi-lane roundabout would be required to meet the traffic demands at the intersection. Currently, DOT restricts roundabout intersections on its highways to a single lane on the circular roadway. Finally, a left-turn refuge lane on Kahekili Highway would facilitate the left-turn movement from westbound Kamehameha Highway. However LOS "F" conditions would still persist during the existing AM peak hour of traffic.

B. Conclusions

The Proposed Action of the Turtle Bay Resort Master Plan is the first effort since the 1985 EIS to reduce the overall density of the Resort expansion. The owner/developer Turtle Bay Resort, LLC has reached out to the community and decision makers to craft a viable plan for the Turtle Bay Resort that addresses the concerns of the community. The Proposed Action represents a reduction of over 60 percent in the number of units that was originally proposed in the 1985 EIS through the 2009 Revised TIAR Update. Up to 40 percent of the weekend traffic is expected to be generated by resources that will be dedicated to the public, such as the beach parks, the farmers market, and the bird sanctuary and wildlife refuge.

This traffic study has consistently taken a conservative approach when establishing the assumptions upon which the traffic impact analysis is based. The ORTP travel forecast included an additional 300 resort units, which have not been credited in this study's forecast with the Proposed Action. The trip generation analysis has not taken into account the "critical mass" effect of a 2,243-unit resort, where trips are contained within the site by activities and opportunities of a destination resort.

The two-lane capacity of Kamehameha Highway is expected to accommodate the increase in traffic generated by the Proposed Action of the Turtle Bay Resort Master Plan. The LOS "E" conditions during the existing peak hours of traffic persist throughout the study area, and are expected to continue with or without the Proposed Action. The existing and future LOS "E" conditions, with or without the Proposed Action, are results of traffic flowing in platoons with few opportunities to pass slow-moving vehicles, resulting in restricted speeds, during the day and early evenings. The v/c ratios are less than 1.00 on Kamehameha Highway for all scenarios, which indicate available capacity on the two-lane highway.

Traffic congestion on the North Shore is a result of the uniqueness of the region, which attracts both visitors and residents alike. The "bottleneck" conditions on Kamehameha Highway at popular beach parks along the North Shore are results of motorists turning on and off Kamehameha Highway or parking on the Highway shoulders, and pedestrians walking across the Highway, thereby creating stop-and-go traffic flows. The land area for additional parking is limited on the makai side of Kamehameha Highway. The construction of parking lots on the mauka side of Kamehameha Highway will increase the pedestrian traffic across the Highway. A mauka bypass highway can increase the shoreline area to provide for more parking. However, a bypass highway would require the acquisition of additional rights-of-way. Additional parking will ultimately attract more traffic to the area. The current situation is further exacerbated by the world famous big wave surfing competitions during the winter months and the popular sightings of turtles sunning at Laniakea Beach, all of which contribute to the attractions on the North Shore of Oahu.

In Windward Oahu, traffic congestion occurs in the small towns along the coastline. The slow-moving traffic is typical of scenic routes as local traffic mixes with visitors touring the windward coast of Oahu. Left-turn storage lanes and refuge lanes will reduce delays at intersections. Bus bays also can reduce delays to through traffic. The existing congestion at the intersection of Kamehameha Highway and Kahekili Highway occur on the relatively low-volume left-turn movement from westbound Kamehameha Highway to Honolulu-bound Kahekili Highway. The existing conditions are somewhat mitigated by courteous drivers, who permit the left-turn movement onto Kahekili Highway, and the overall slow-moving traffic at the intersection. Several traffic mitigation measures have been considered. The construction of a left-turn storage lane and refuge lane can reduce delays, but not enough the improve the Level of Service. A single-lane roundabout intersection limits the capacity of the intersection. A multi-lane roundabout is currently not permitted on State highways. The existing traffic demands do not meet the volume warrants for the installation of traffic signals.

Up to 40 percent of the weekend traffic from the Proposed Action will be generated by benefits, which will be provided to the community by Turtle Bay Resort, such as, the beach parks, wildlife preserve, and the farmers market. While the farmers market traffic is not expected to extend beyond the study area, the beach parks and wildlife preserve could become regional attractions.

As the Turtle Bay Resort expands, Transportation Demand Management (TDM) measures are expected to be formalized into a plan which will be implemented by the Resort management. The remote location of the Resort, with only two routes to and from the Resort, present several opportunities for TDM measures, which can be implemented to promote alternative modes of transportation and reduce the Resort's contribution to traffic in the region.

Turtle Bay Resort LLC, and its consultants have worked extensively with the transportation agencies of the State of Hawaii and the City and County of Honolulu in the preparation of this traffic impact analysis. The traffic improvements, recommended herein, are expected to improve the capacity of Kamehameha Highway at the Turtle Bay Resort's access intersections, and mitigate the traffic impacts resulting from the development of the Proposed Action for the Turtle Bay Resort Master Plan.

TRAFFIC IMPACT ANALYSIS REPORT

FOR THE PROPOSED

TURTLE BAY RESORT MASTER PLAN

KAHUKU, OAHU, HAWAII

APPENDIX A

TRAFFIC COUNT DATA

Weekday Turning Movement Count Data
Study Name: Kam Hwy Kuilima Drive Wkday
Start Date: 11/03/2011

Vehicular Traffic

		Eastbound Kamehameha Hwy		Westbound Kamehameha Hwy		Southbound Kuilima Drive			
Start Time	End Time	Left-Turn	Through	Through	Right-Turn	Left-Turn	Right-Turn	Total	Hrly Total
6:00 AM	6:15 AM	7	20	21	10	12	5	75	
6:15 AM	6:30 AM	7	22	25	6	3	8	71	
6:30 AM	6:45 AM	10	40	26	7	4	5	92	
6:45 AM	7:00 AM	12	31	32	13	8	14	110	348
7:00 AM	7:15 AM	6	34	36	7	11	11	105	378
7:15 AM	7:30 AM	13	65	28	7	15	14	142	449
7:30 AM	7:45 AM	21	84	40	20	12	15	192	549
7:45 AM	8:00 AM	20	45	38	14	11	9	137	576
8:00 AM	8:15 AM	10	37	48	11	13	8	127	**598**
8:15 AM	8:30 AM	14	26	33	3	9	13	98	554
8:30 AM	8:45 AM	15	28	32	13	10	8	106	468
8:45 AM	9:00 AM	16	34	23	10	9	17	109	440
9:00 AM	9:15 AM	11	31	18	7	15	18	100	413
9:15 AM	9:30 AM	13	32	22	13	7	15	102	417
9:30 AM	9:45 AM	18	31	29	9	16	21	124	435
9:45 AM	10:00 AM	21	32	34	13	11	21	132	458
10:00 AM	10:15 AM	25	42	28	21	14	19	149	507
10:15 AM	10:30 AM	20	42	32	12	7	20	133	538
10:30 AM	10:45 AM	26	25	40	15	20	24	150	564
10:45 AM	11:00 AM	17	48	40	9	11	17	142	574
11:00 AM	11:15 AM	17	29	41	16	19	20	142	567
11:15 AM	11:30 AM	17	55	34	17	18	27	168	602
11:30 AM	11:45 AM	22	41	59	14	18	16	170	622
11:45 AM	12:00 PM	26	44	48	15	15	21	169	649
12:00 PM	12:15 PM	12	46	50	24	17	19	168	675
12:15 PM	12:30 PM	21	46	40	12	26	22	167	674
12:30 PM	12:45 PM	31	62	42	12	14	14	175	679
12:45 PM	1:00 PM	30	55	54	17	18	13	187	697
1:00 PM	1:15 PM	23	60	69	17	19	17	205	734
1:15 PM	1:30 PM	21	66	58	25	15	22	207	774
1:30 PM	1:45 PM	18	43	83	15	18	22	199	798
1:45 PM	2:00 PM	17	55	70	17	10	19	188	799
2:00 PM	2:15 PM	22	59	64	24	17	28	214	808
2:15 PM	2:30 PM	19	52	61	17	23	16	188	789
2:30 PM	2:45 PM	24	79	81	20	14	25	**243**	833
2:45 PM	3:00 PM	39	50	71	15	16	22	213	**858**
3:00 PM	3:15 PM	22	71	62	15	14	20	204	848
3:15 PM	3:30 PM	26	51	64	16	18	21	196	856
3:30 PM	3:45 PM	23	46	70	22	33	18	212	825
3:45 PM	4:00 PM	19	52	59	22	23	32	207	819
4:00 PM	4:15 PM	21	72	69	19	15	31	227	842
4:15 PM	4:30 PM	25	71	56	12	14	27	205	851
4:30 PM	4:45 PM	22	58	53	23	12	20	188	827
4:45 PM	5:00 PM	23	77	45	19	13	16	193	813
5:00 PM	5:15 PM	18	54	57	9	20	15	173	759
5:15 PM	5:30 PM	17	40	53	9	16	19	154	708
5:30 PM	5:45 PM	30	35	46	14	21	17	163	683
5:45 PM	6:00 PM	26	38	53	13	12	13	155	645

AM Peak Hour								
11:00 AM	12:00 PM	82	169	182	62	70	84	649
Peak Hour Factor		0.93	1.03	0.77	1.11	0.97	1.31	0.95
Heavy Vehicles (%)		3.7%	13.0%	5.5%	6.5%	5.7%	6.0%	7.4%

PM Peak Hour								
2:00 PM	3:00 PM	104	240	277	76	70	91	858
Peak Hour Factor		1.08	0.76	0.85	0.95	1.25	0.91	0.88
Heavy Vehicles (%)		1.9%	2.5%	5.4%	7.9%	4.3%	6.6%	4.4%

Saturday Turning Movement Count Data
Study Name Kam Hwy Kuilima Dr
Survey Date 11/5/2011 Saturday

Vehicular Traffic

		Eastbound Kamehameha Hwy		Westbound Kamehameha Hwy		Southbound Kuilima Drive			
Start Time	End Time	Left-Turn	Through	Through	Right-Turn	Left-Turn	Right-Turn	Total	Hrly Total
9:15 AM	9:30 AM	20	34	50	4	8	14	130	
9:30 AM	9:45 AM	18	35	40	11	16	27	147	
9:45 AM	10:00 AM	14	33	41	10	3	28	129	
10:00 AM	10:15 AM	23	32	42	9	9	17	132	538
10:15 AM	10:30 AM	26	36	72	18	16	31	199	607
10:30 AM	10:45 AM	18	32	52	12	17	35	166	626
10:45 AM	11:00 AM	19	43	64	23	13	21	183	680
11:00 AM	11:15 AM	23	49	75	12	15	36	210	758
11:15 AM	11:30 AM	22	60	68	18	22	26	216	775
11:30 AM	11:45 AM	18	51	60	13	14	24	180	789
11:45 AM	12:00 PM	19	63	88	19	18	21	228	834
12:00 PM	12:15 PM	27	81	68	18	10	21	225	849
12:15 PM	12:30 PM	28	62	81	18	21	27	237	870
12:30 PM	12:45 PM	32	78	78	14	18	31	251	941
12:45 PM	1:00 PM	33	49	77	23	27	26	235	948
1:00 PM	1:15 PM	35	69	72	21	22	31	250	973
1:15 PM	1:30 PM	21	81	89	16	16	30	253	989
1:30 PM	1:45 PM	24	70	77	20	16	22	229	967
1:45 PM	2:00 PM	25	79	68	22	17	26	237	969
2:00 PM	2:15 PM	24	95	76	27	14	26	262	981
2:15 PM	2:30 PM	26	78	87	21	28	32	272	1000
2:30 PM	2:45 PM	30	78	61	21	16	27	233	1004
2:45 PM	3:00 PM	37	77	98	26	16	19	**273**	**1040**
3:00 PM	3:15 PM	24	73	91	25	20	29	262	1040
3:15 PM	3:30 PM	32	67	70	15	26	18	228	996
3:30 PM	3:45 PM	30	83	58	16	17	30	234	997
3:45 PM	4:00 PM	25	71	63	16	17	36	228	952
4:00 PM	4:15 PM	20	65	59	18	23	43	228	918
4:15 PM	4:30 PM	24	77	51	13	25	35	225	915
4:30 PM	4:45 PM	30	62	56	22	13	26	209	890
4:45 PM	5:00 PM	28	75	78	16	16	15	228	890
5:00 PM	5:15 PM	20	75	48	11	15	27	196	858
5:15 PM	5:30 PM	28	60	52	16	14	28	198	831
5:30 PM	5:45 PM	24	66	46	8	17	17	178	800
5:45 PM	6:00 PM	23	49	49	18	16	28	183	755

Saturday Peak Hour Traffic								
2:00 PM	3:00 PM	117	328	322	95	74	104	1040
Peak Hour Factor		0.79	1.06	0.82	0.91	1.16	1.37	0.95
Heavy Vehicles (%)		2.6%	1.5%	4.7%	4.2%	2.7%	1.9%	3.0%

Sunday Turning Movement Count Data
Study Name Kamehameha Hwy Kuilima Dr Sunday
Start Date 2/26/2012

Vehicular Traffic

		Eastbound Kamehameha Hwy		Westbound Kamehameha Hwy		Southbound Kuilima Drive			
Start Time	End Time	Left-Turn	Through	Through	Right-Turn	Left-Turn	Right-Turn	Total	Hrly Total
10:00 AM	10:15 AM	18	31	34	5	11	26	125	
10:15 AM	10:30 AM	15	44	37	3	7	31	137	
10:30 AM	10:45 AM	26	36	61	13	14	19	169	
10:45 AM	11:00 AM	39	57	62	21	12	40	231	662
11:00 AM	11:15 AM	31	58	49	12	8	22	180	717
11:15 AM	11:30 AM	16	47	58	14	20	34	189	769
11:30 AM	11:45 AM	27	55	82	11	11	29	215	815
11:45 AM	12:00 PM	20	35	57	15	22	25	174	758
12:00 PM	12:15 PM	23	76	73	16	12	30	230	808
12:15 PM	12:30 PM	25	69	61	22	12	30	219	838
12:30 PM	12:45 PM	16	64	64	18	10	22	194	817
12:45 PM	1:00 PM	20	69	88	6	9	21	213	856
1:00 PM	1:15 PM	21	56	98	13	14	31	233	859
1:15 PM	1:30 PM	22	73	80	29	11	27	242	882
1:30 PM	1:45 PM	35	79	103	18	19	20	**274**	962
1:45 PM	2:00 PM	29	88	81	20	13	27	258	1007
2:00 PM	2:15 PM	29	70	92	16	18	36	261	1035
2:15 PM	2:30 PM	20	73	91	19	17	23	243	**1036**
2:30 PM	2:45 PM	32	60	83	21	25	28	249	1011
2:45 PM	3:00 PM	33	77	83	16	15	36	260	1013
3:00 PM	3:15 PM	26	63	71	10	29	42	241	993
3:15 PM	3:30 PM	22	77	58	18	14	33	222	972
3:30 PM	3:45 PM	26	85	61	14	22	32	240	963
3:45 PM	4:00 PM	25	54	72	14	12	19	196	899
4:00 PM	4:15 PM	24	67	74	16	24	24	229	887
4:15 PM	4:30 PM	38	73	62	17	13	24	227	892
4:30 PM	4:45 PM	31	86	43	13	11	28	212	864
4:45 PM	5:00 PM	24	59	63	16	13	19	194	862
5:00 PM	5:15 PM	32	67	57	17	13	32	218	851
5:15 PM	5:30 PM	15	56	50	19	15	27	182	806
5:30 PM	5:45 PM	29	60	32	12	15	28	176	770
5:45 PM	6:00 PM	27	45	42	17	14	27	172	748

Sunday Peak Hour								
1:30 PM	2:30 PM	113	310	367	73	67	106	1036
Peak Hour Factor		0.81	0.98	0.89	1.01	0.88	1.33	0.95
Heavy Vehicles (%)		1.8%	0.0%	0.0%	8.2%	3.0%	2.8%	0.2%

Weekday Turning Movement Count Data
Study Name Kam Hwy Marconi Rd Wkdy 0700-0830 1030-1630
Start Date 11/3/2011

Vehicular Traffic

		Eastbound Kamehameha Hwy		Westbound Kamehameha Hwy		Southbound Kuilima Drive			
Start Time	End Time	Left-Turn	Through	Through	Right-Turn	Left-Turn	Right-Turn	Total	Hrly Total
7:00 AM	7:15 AM	1	45	38	0	3	1	88	
7:15 AM	7:30 AM	1	74	37	1	1	0	114	
7:30 AM	7:45 AM	0	100	61	1	1	0	163	
7:45 AM	8:00 AM	2	56	57	2	2	0	119	484
8:00 AM	8:15 AM	1	52	55	1	0	0	109	505
8:15 AM	8:30 AM	0	34	33	2	1	0	70	461
10:30 AM	10:45 AM	1	48	51	1	0	2	103	
10:45 AM	11:00 AM	0	64	52	1	0	0	117	
11:00 AM	11:15 AM	0	40	51	3	1	1	96	
11:15 AM	11:30 AM	0	66	58	1	2	0	127	443
11:30 AM	11:45 AM	0	71	71	1	1	1	145	485
11:45 AM	12:00 PM	1	56	68	1	2	2	130	498
12:00 PM	12:15 PM	0	63	67	2	1	0	133	535
12:15 PM	12:30 PM	0	62	49	1	1	0	113	521
12:30 PM	12:45 PM	3	75	55	0	1	0	134	510
12:45 PM	1:00 PM	0	76	75	4	0	1	156	536
1:00 PM	1:15 PM	1	74	87	2	1	0	165	568
1:15 PM	1:30 PM	1	81	79	0	2	1	164	619
1:30 PM	1:45 PM	3	61	92	0	0	1	157	642
1:45 PM	2:00 PM	1	64	81	0	0	1	147	633
2:00 PM	2:15 PM	0	78	94	2	1	0	175	643
2:15 PM	2:30 PM	0	70	77	1	3	1	152	631
2:30 PM	2:45 PM	2	88	96	0	0	1	187	661
2:45 PM	3:00 PM	0	68	78	4	3	1	154	668
3:00 PM	3:15 PM	0	88	83	1	1	1	174	667
3:15 PM	3:30 PM	1	69	78	4	2	2	156	671
3:30 PM	3:45 PM	1	76	90	0	0	2	169	653
3:45 PM	4:00 PM	0	78	76	0	0	0	154	653
4:00 PM	4:15 PM	1	83	88	3	0	0	175	654
4:15 PM	4:30 PM	4	77	66	3	1	0	151	649

AM Peak Hour								
11:00 AM	12:00 PM	1	233	248	6	6	4	498
	PHF	N/A	0.82	0.87	1.50	1.50	1.00	0.86
PM Peak Hour								
2:00 PM	3:00 PM	2	304	345	7	7	3	668
	PHF	0.25	0.86	0.90	N/A	N/A	0.75	0.89

Saturday Turning Movement Count Data

Study Name Kam Hwy Marconi Rd Sat 1230-1530
Survey Date 11/5/2011

Vehicular Traffic

		Eastbound		Westbound		Southbound			
		Kamehameha Hwy		Kamehameha Hwy		Kuilima Drive			
Start Time	End Time	Left-Turn	Through	Through	Right-Turn	Left-Turn	Right-Turn	Total	Hrly Total
12:30 PM	12:45 PM	0	86	100	4	2	1	193	
12:45 PM	1:00 PM	0	75	90	3	2	1	171	
1:00 PM	1:15 PM	1	94	101	1	1	1	199	
1:15 PM	1:30 PM	0	91	103	2	1	1	198	761
1:30 PM	1:45 PM	0	83	82	0	0	0	165	733
1:45 PM	2:00 PM	1	97	98	6	0	2	204	766
2:00 PM	2:15 PM	1	103	105	1	1	3	**214**	781
2:15 PM	2:30 PM	2	109	94	1	2	1	209	792
2:30 PM	2:45 PM	0	94	87	1	0	0	182	809
2:45 PM	3:00 PM	0	85	124	2	0	1	212	**817**
3:00 PM	3:15 PM	0	96	87	1	0	0	184	787
3:15 PM	3:30 PM	1	89	80	1	0	1	172	750

Saturday Peak Hour Traffic

2:00 PM	3:00 PM	3	391	410	5	3	5	817
Peak Hour Factor		0.75	0.95	0.98	1.25	0.75	0.42	0.95
Heavy Vehicles (%)		0.0%	2.0%	4.4%	0.0%	0.0%	0.0%	3.2%

Study Name Kamehameha Hwy Marconi Rd Sun 1300-1500
Survey Date 2/26/2012

Vehicular Traffic

		Eastbound		Westbound		Southbound			
		Kamehameha Hwy		Kamehameha Hwy		Marconi Road			
Start Time	End Time	Left-Turn	Through	Through	Right-Turn	Left-Turn	Right-Turn	Total	Hrly Total
1:00 PM	1:15 PM	1	80	109	1	1	0	192	
1:15 PM	1:30 PM	0	79	98	2	1	0	180	
1:30 PM	1:45 PM	1	99	122	5	1	1	229	
1:45 PM	2:00 PM	2	95	112	1	2	1	213	814
2:00 PM	2:15 PM	0	82	91	2	0	0	175	797
2:15 PM	2:30 PM	0	94	113	2	1	1	211	828
2:30 PM	2:45 PM	0	86	107	1	1	0	195	794
2:45 PM	3:00 PM	1	86	89	2	0	0	178	759

Sunday Peak Hour

1:30 PM	2:30 PM	3	370	438	10	4	3	828
Peak Hour Factor		0.75	0.93	0.90	0.50	1.00	0.75	0.90

24-Hour Traffic Count Data on Kuilima Drive at Kamehameha Highway-Inbound
Site: [Kuilima Drive North] Kuilima Drive Hotel Entrance

* Sunday, October 30, 2011=928 (Incomplete) , 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Hrly	-	-	-	-	-	-	-	-	-	-	-	-	-	149	177	159	147	122	100	65	52	38	36	19
:00	-	-	-	-	-	-	-	-	-	-	-	-	-	39	43	41	35	33	34	21	17	11	11	6
:15	-	-	-	-	-	-	-	-	-	-	-	-	-	32	43	32	36	37	24	20	11	9	8	3
:30	-	-	-	-	-	-	-	-	-	-	-	-	-	38	47	42	42	27	20	11	11	10	10	5
:45	-	-	-	-	-	-	-	-	-	-	-	-	-	41	45	44	34	25	22	13	13	8	7	5

PM Peak Gen 14:45 to 15:45 Vol= 160 PHF= 0.89

* Monday, October 31, 2011=1665, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	9	3	3	6	29	42	54	114	93	108	103	129	151	116	159	142	144	117	110	75	76	82	40	16	1921
:00	3	0	1	0	2	7	9	18	24	30	26	34	41	25	35	52	31	29	24	21	23	15	9	4	
:15	1	2	2	1	5	11	13	28	22	19	19	44	28	18	41	27	37	31	21	20	11	35	12	5	
:30	1	0	0	2	5	10	14	36	25	30	27	26	50	33	43	30	43	23	39	20	27	10	11	5	
:45	4	2	0	3	17	15	18	33	23	30	32	26	33	40	40	34	34	34	26	15	15	23	8	2	

AM Peak Gen 10:45 to 11:45 Vol= 136 PHF= 0.77
PM Peak Gen 14:15 to 15:15 Vol= 176 PHF= 0.85

* Tuesday, November 01, 2011=1637, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	4	3	6	8	23	44	60	121	109	90	97	137	148	139	151	142	168	134	109	79	47	50	44	22	1935
:00	3	0	1	2	0	6	15	23	27	20	25	37	35	33	33	37	31	27	23	25	20	13	12	9	
:15	0	3	3	1	5	10	11	17	27	24	30	32	33	38	33	34	44	31	30	17	9	15	6	3	
:30	1	0	2	1	7	11	7	40	31	19	23	32	41	37	44	30	43	43	26	14	8	15	16	6	
:45	0	0	0	4	11	17	28	41	24	27	20	36	39	31	41	41	50	33	28	24	11	8	8	4	

AM Peak Gen 11:00 to 12:00 Vol= 137 PHF= 0.93
PM Peak Gen 16:00 to 17:00 Vol= 168 PHF= 0.84

* Wednesday, November 02, 2011=1661, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	8	3	2	5	27	45	65	104	112	94	113	108	131	162	160	133	160	116	96	78	63	70	39	14	1908
:00	2	2	0	0	4	8	14	14	26	23	27	23	24	45	35	29	49	24	26	24	11	10	10	0	
:15	4	1	1	1	1	9	15	21	34	20	26	27	32	44	41	33	16	40	30	19	23	20	11	4	
:30	2	0	1	1	8	9	9	34	22	22	31	33	33	31	38	34	40	20	19	14	16	28	13	6	
:45	0	0	0	3	14	19	27	35	31	29	29	26	42	43	46	38	53	32	22	21	11	12	5	4	

AM Peak Gen 10:00 to 11:00 Vol= 113 PHF= 0.91
PM Peak Gen 14:00 to 15:00 Vol= 160 PHF= 0.87

* Thursday, November 03, 2011=1952, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	3	5	5	6	25	46	74	107	98	117	150	158	166	157	186	169	163	137	135	100	88	73	46	22	2236
:00	1	2	1	1	1	7	18	13	21	20	45	40	33	43	48	37	38	23	34	25	30	13	8	13	
:15	0	1	1	2	3	12	12	19	19	32	37	34	41	42	37	42	38	31	45	32	22	32	11	4	
:30	1	0	2	1	4	12	15	39	30	30	39	39	45	39	45	46	42	44	23	24	22	19	18	2	
:45	1	2	1	2	17	15	29	36	28	35	29	45	47	34	57	44	46	40	34	19	14	9	10	3	

AM Peak Gen 11:00 to 12:00 Vol= 158 PHF= 0.88
PM Peak Gen 14:00 to 15:00 Vol= 186 PHF= 0.82

* Friday, November 04, 2011=2234, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	7	8	7	6	28	48	97	124	168	127	203	158	159	150	190	190	199	170	119	118	77	48	67	26	2494
:00	3	3	1	1	2	8	17	16	47	25	46	49	46	34	46	36	57	42	38	33	25	12	14	8	
:15	3	4	3	2	6	15	27	29	44	43	52	48	38	41	31	43	45	45	30	27	17	15	22	7	
:30	1	1	3	2	3	7	24	33	44	26	54	27	41	43	62	58	52	42	26	40	20	10	17	5	
:45	0	0	0	1	17	19	30	47	33	33	52	36	36	33	51	53	45	41	26	19	15	11	14	6	

AM Peak Gen 10:15 to 11:15 Vol= 207 PHF= 0.96
PM Peak Gen 15:30 to 16:30 Vol= 213 PHF= 0.92

* Saturday, November 05, 2011=2214, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	23	9	5	7	20	23	61	145	114	116	148	146	195	187	222	193	173	153	133	103	84	56	55	29	2400
:00	5	3	4	1	1	2	10	25	20	34	31	34	48	52	54	54	37	34	43	30	18	10	11	11	
:15	8	1	0	3	5	5	14	31	26	25	43	43	46	42	48	49	37	42	36	31	33	19	7	5	
:30	8	4	0	2	7	6	15	43	23	31	32	32	43	40	57	49	56	37	34	26	14	18	21	9	
:45	2	1	1	1	7	10	22	46	46	27	43	37	58	53	64	42	43	42	21	16	19	9	16	4	

AM Peak Gen 11:00 to 12:00 Vol= 146 PHF= 0.85
PM Peak Gen 14:15 to 15:15 Vol= 223 PHF= 0.87

* Sunday, November 06, 2011=1386, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Hrly	3	9	6	7	22	32	53	110	132	142	121	169	187	215	222	-	-	-	-	-	-	-	-	-
:00	0	5	1	1	1	2	4	18	41	29	24	30	50	53	57	-	-	-	-	-	-	-	-	-
:15	1	1	3	2	3	8	11	27	33	31	28	51	44	48	46	-	-	-	-	-	-	-	-	-
:30	1	1	0	2	12	9	19	30	30	39	37	48	49	59	62	-	-	-	-	-	-	-	-	-
:45	1	2	2	2	6	13	19	36	28	44	33	40	44	55	57	-	-	-	-	-	-	-	-	-

AM Peak Gen 11:00 to 12:00 Vol= 169 PHF= 0.83

24-Hour Traffic Count Data on Kuilima Drive at Kamehameha Highway-Outbound
Site: Kuilima Drive at Kamehameha Hwy Entrance

* Sunday, October 30, 2011=928 (Incomplete) , 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Hrly	-	-	-	-	-	-	-	-	-	-	-	-	-	150	142	166	155	129	122	71	47	38	51	30
:00	-	-	-	-	-	-	-	-	-	-	-	-	-	33	41	51	48	36	32	23	15	15	21	18
:15	-	-	-	-	-	-	-	-	-	-	-	-	-	39	29	42	47	33	34	14	11	6	14	4
:30	-	-	-	-	-	-	-	-	-	-	-	-	-	40	35	46	34	40	31	20	10	7	11	4
:45	-	-	-	-	-	-	-	-	-	-	-	-	-	38	38	27	27	20	25	14	11	10	5	4

PM Peak Gen 14:45 to 15:45 Vol= 177 PHF= 0.87

* Monday, October 31, 2011=1665, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	10	4	1	3	14	23	59	105	94	130	137	119	149	125	149	144	155	134	107	58	39	55	35	26	1875
:00	7	2	0	0	1	7	11	27	27	28	31	37	43	27	45	37	48	45	41	22	9	10	8	6	
:15	0	1	1	0	4	2	18	30	24	30	28	32	47	28	37	35	40	29	22	18	15	18	12	8	
:30	1	0	0	1	5	3	14	26	17	34	32	28	30	41	33	37	32	26	29	10	10	17	9	6	
:45	2	1	0	2	4	11	17	23	26	38	47	23	30	29	35	35	35	34	15	8	5	10	6	6	

AM Peak Gen 10:45 to 11:45 Vol= 144 PHF= 0.77
PM Peak Gen 14:15 to 15:15 Vol= 142 PHF= 0.96

* Tuesday, November 01, 2011=1637, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	8	2	1	4	15	27	52	90	101	117	108	124	131	153	155	148	155	138	128	66	37	44	40	31	1875
:00	4	2	0	2	5	7	8	14	30	24	25	33	23	40	41	44	44	38	36	23	14	13	17	16	
:15	1	0	0	2	4	3	16	27	28	31	22	29	32	32	34	26	50	43	40	20	5	10	7	7	
:30	2	0	0	0	2	4	10	28	22	31	29	33	36	44	52	44	28	33	30	15	6	9	9	3	
:45	1	0	1	0	4	13	18	21	23	32	32	30	40	37	28	34	33	24	22	8	12	12	7	5	

AM Peak Gen 11:00 to 12:00 Vol= 124 PHF= 0.94
PM Peak Gen 16:00 to 17:00 Vol= 155 PHF= 0.78

* Wednesday, November 02, 2011=1661, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	11	2	1	1	14	34	54	110	80	89	136	134	122	145	151	145	161	123	114	62	59	57	31	30	1866
:00	4	1	0	0	4	11	13	17	18	23	35	34	33	27	33	37	58	25	34	14	19	13	14	17	
:15	3	1	1	0	2	7	14	29	18	17	26	36	37	35	35	31	36	37	37	21	11	16	6	4	
:30	2	0	0	0	3	5	10	38	24	25	35	35	25	41	42	39	35	33	23	12	21	15	10	6	
:45	2	0	0	1	5	11	17	26	20	24	41	29	29	42	41	38	32	28	20	15	8	13	1	3	

AM Peak Gen 10:00 to 11:00 Vol= 136 PHF= 0.83
PM Peak Gen 14:00 to 15:00 Vol= 151 PHF= 0.90

* Thursday, November 03, 2011=1952, 15 minute drops 1652

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	12	1	2	4	13	31	58	98	91	131	135	170	141	143	161	176	148	133	113	95	81	82	56	47	2122
:00	7	0	0	1	1	8	16	22	22	33	33	39	36	36	45	33	47	35	35	31	17	33	16	19	
:15	3	1	0	2	3	4	11	29	23	27	27	53	44	38	40	40	40	35	32	24	21	25	12	12	
:30	0	0	1	0	3	10	9	27	20	40	45	41	29	42	38	49	32	38	22	20	20	13	18	9	
:45	2	0	1	1	6	9	22	20	27	32	30	37	32	28	38	54	29	25	24	20	23	11	10	7	

AM Peak Gen 11:00 to 12:00 Vol= 170 PHF= 0.80
PM Peak Gen 14:00 to 15:00 Vol= 161 PHF= 0.89

* Friday, November 04, 2011=2234, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	19	6	5	3	14	21	56	93	108	125	143	149	162	153	153	168	171	166	165	95	92	96	95	115	2373
:00	10	1	1	0	0	7	16	26	36	30	33	33	32	26	45	38	47	49	54	33	24	30	10	57	
:15	4	4	3	1	3	3	11	19	21	30	42	44	36	40	33	37	58	43	48	23	20	26	24	24	
:30	2	1	1	0	6	5	14	24	26	35	32	34	52	51	35	48	35	41	30	21	25	21	22	23	
:45	3	0	0	2	5	6	15	24	25	30	36	38	42	36	40	45	31	33	33	18	23	19	39	11	

AM Peak Gen 10:15 to 11:15 Vol= 143 PHF= 0.85
PM Peak Gen 15:30 to 16:30 Vol= 198 PHF= 0.85

* Saturday, November 05, 2011=2214, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	25	10	2	5	13	14	40	76	118	139	161	179	182	182	179	196	196	162	160	67	64	62	107	49	2388
:00	11	5	1	2	2	4	6	19	34	40	28	53	31	53	40	49	66	42	46	16	26	22	22	23	
:15	7	2	0	0	4	1	7	16	28	24	47	48	47	47	61	46	59	41	29	17	19	18	30	12	
:30	1	1	0	2	5	3	13	25	27	45	53	40	50	38	43	48	39	35	44	16	9	11	34	9	
:45	6	2	1	1	2	6	15	16	29	31	33	39	54	44	35	53	32	44	41	18	10	11	21	5	

AM Peak Gen 11:00 to 12:00 Vol= 179 PHF= 0.84
PM Peak Gen 14:15 to 15:15 Vol= 188 PHF= 0.77

* Sunday, November 06, 2011=1386, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Hrly	15	12	5	2	5	17	38	83	119	139	153	152	121	176	159	-	-	-	-	-	-	-	-	-
:00	8	6	1	0	3	1	5	15	23	35	28	46	31	36	31	-	-	-	-	-	-	-	-	-
:15	4	3	2	1	0	3	7	19	28	36	39	24	31	41	37	-	-	-	-	-	-	-	-	-
:30	1	0	1	1	2	5	10	24	34	31	49	36	27	57	46	-	-	-	-	-	-	-	-	-
:45	2	3	1	0	0	8	16	25	34	37	37	46	32	42	45	-	-	-	-	-	-	-	-	-

AM Peak Gen 11:00 to 12:00 Vol= 152 PHF= 0.83

24-Hour Traffic Count Data on Kuilima Drive at Kamehameha Highway
Site: Kuilima Drive at Kamehameha Hwy (Total for Both Directions)

* Sunday, October 30, 2011, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Hrly	-	-	-	-	-	-	-	-	-	-	-	-	-	300	321	325	303	251	222	136	99	76	87	49
:00	-	-	-	-	-	-	-	-	-	-	-	-	-	72	84	**92**	83	69	66	44	32	26	32	24
:15	-	-	-	-	-	-	-	-	-	-	-	-	-	71	72	**74**	83	70	58	34	22	15	22	7
:30	-	-	-	-	-	-	-	-	-	-	-	-	-	78	82	**88**	76	67	51	31	21	17	21	9
:45	-	-	-	-	-	-	-	-	-	-	-	-	-	79	**83**	71	61	45	47	27	24	18	12	9

PM Peak Gen 14:45 to 15:45 Vol= 337

* Monday, October 31, 2011, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	19	8	4	9	43	66	114	221	188	239	242	250	302	241	309	287	300	251	217	134	115	138	75	42	3814
:00	10	2	1	0	3	14	20	45	51	58	57	**71**	84	52	80	**89**	79	74	65	43	32	25	17	10	
:15	1	3	3	1	9	13	31	58	46	49	47	**76**	75	46	**78**	62	77	60	43	38	26	53	24	13	
:30	2	0	0	3	10	13	28	62	42	64	59	**54**	80	74	**76**	67	75	49	68	30	37	27	20	11	
:45	6	3	0	5	21	26	35	56	49	68	**79**	49	63	69	**75**	69	69	68	41	23	20	33	14	8	

AM Peak Gen 10:45 to 11:45 Vol= 280
PM Peak Gen 14:15 to 15:15 Vol= 318

* Tuesday, November 01, 2011, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	12	5	7	12	38	71	113	211	210	208	206	262	279	292	306	290	323	272	237	146	85	95	84	53	3817
:00	7	2	1	4	5	13	23	37	57	44	50	**70**	58	73	74	81	**75**	65	59	48	34	26	29	25	
:15	1	3	3	3	9	13	27	44	53	55	52	**61**	65	70	67	60	**94**	74	70	37	14	25	13	10	
:30	3	0	2	1	9	15	17	68	53	50	52	**65**	77	81	96	74	**71**	76	58	29	14	24	27	9	
:45	1	0	1	4	15	30	46	62	47	59	52	**66**	79	68	69	75	**83**	57	50	32	23	20	15	9	

AM Peak Gen 11:00 to 12:00 Vol= 262
PM Peak Gen 16:00 to 17:00 Vol= 323

* Wednesday, November 02, 2011, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	19	5	3	6	41	79	119	214	193	183	250	243	255	308	311	279	321	239	211	140	122	127	70	**44**	3782
:00	6	3	0	0	8	19	27	31	44	46	**62**	57	57	72	**68**	66	107	49	60	38	30	23	24	17	
:15	7	2	2	1	3	16	29	50	52	37	**52**	63	69	79	**76**	64	54	77	67	40	34	36	17	8	
:30	4	0	1	1	11	14	19	72	46	47	**66**	68	58	72	**80**	73	75	53	42	26	39	43	23	12	
:45	2	0	0	4	19	30	44	61	51	53	**70**	55	71	85	**87**	76	85	60	42	36	19	25	6	7	

AM Peak Gen 10:00 to 11:00 Vol= 250
PM Peak Gen 14:00 to 15:00 Vol= 311

* Thursday, November 03, 2011, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	15	6	7	10	38	77	132	205	190	249	285	328	307	302	348	345	312	271	249	195	169	155	103	69	4367
:00	8	2	1	2	2	15	34	35	43	53	78	**79**	69	79	**93**	70	85	58	69	56	47	46	24	32	
:15	3	2	1	4	6	16	23	48	42	59	64	**87**	85	80	**77**	82	78	66	77	56	43	57	23	16	
:30	1	0	3	1	7	22	24	66	50	70	84	**80**	74	81	**83**	95	74	82	45	44	42	32	36	11	
:45	3	2	2	3	23	24	51	56	55	67	59	**82**	79	62	**95**	98	75	65	58	39	37	20	20	10	

AM Peak Gen 11:00 to 12:00 Vol= 328
PM Peak Gen 14:00 to 15:00 Vol= 348

* Friday, November 04, 2011, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	26	14	12	9	42	70	154	218	276	252	347	308	322	304	343	358	370	336	285	214	169	144	162	141	4876
:00	13	4	2	1	2	15	33	42	83	55	**79**	82	78	60	91	74	104	91	92	66	49	42	24	65	
:15	7	8	6	3	9	18	38	48	65	73	**94**	92	74	81	64	80	103	88	78	50	37	41	46	31	
:30	3	2	4	2	9	12	38	57	70	61	**86**	61	93	94	97	106	87	83	56	61	45	31	39	28	
:45	3	0	0	3	22	25	45	71	58	63	**88**	73	77	69	91	98	76	74	59	37	38	30	53	17	

AM Peak Gen 10:15 to 11:15 Vol= 350
PM Peak Gen 15:30 to 16:30 Vol= 411

* Saturday, November 05, 2011, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	48	19	7	12	33	37	102	221	233	257	310	326	377	369	402	390	369	317	294	170	148	118	162	78	4799
:00	16	8	5	3	3	6	16	44	54	74	59	**87**	79	105	94	103	103	76	89	46	44	32	33	34	
:15	15	3	0	3	9	6	21	47	54	49	90	**91**	93	89	109	95	96	83	65	48	52	37	37	17	
:30	9	5	0	4	12	9	28	68	50	76	85	**72**	93	78	100	97	95	72	78	42	23	29	55	18	
:45	8	3	2	2	9	16	37	62	75	58	76	**76**	112	97	99	95	75	86	62	34	29	20	37	9	

AM Peak Gen 11:00 to 12:00 Vol= 326
PM Peak Gen 14:15 to 15:15 Vol= 411

* Sunday, November 06, 2011, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Hrly	18	21	11	9	27	49	91	194	251	282	275	321	308	391	381	-	-	-	-	-	-	-	-	-
:00	8	11	2	1	4	3	9	33	64	64	52	76	81	89	88	-	-	-	-	-	-	-	-	-
:15	5	4	5	3	3	11	18	46	61	67	67	75	75	89	83	-	-	-	-	-	-	-	-	-
:30	2	1	1	3	14	14	29	54	64	70	86	84	76	116	108	-	-	-	-	-	-	-	-	-
:45	3	5	3	2	6	21	35	61	62	81	70	86	76	97	102	-	-	-	-	-	-	-	-	-

AM Peak Gen 11:00 to 12:00 Vol= 321

24-Hour Traffic Count Data on Kuilima Drive at Kamehameha Highway-Inbound
Site: Kuilima Drive Hotel Entrance

* Sunday, October 30, 2011=928 (Incomplete) , 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Hrly	-	-	-	-	-	-	-	-	-	-	-	-	96	133	155	132	124	89	66	44	41	20	26	6
:00	-	-	-	-	-	-	-	-	-	-	-	-	2	29	38	35	27	25	25	16	16	9	12	1
:15	-	-	-	-	-	-	-	-	-	-	-	-	26	34	33	27	30	26	16	13	7	2	3	0
:30	-	-	-	-	-	-	-	-	-	-	-	-	37	36	42	33	40	19	16	10	9	6	6	2
:45	-	-	-	-	-	-	-	-	-	-	-	-	31	35	42	37	28	19	10	5	9	4	5	3

PM Peak 1400 - 1500 (155), PM PHF=0.92

* Monday, October 31, 2011=1665, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	4	2	2	6	32	40	52	112	102	114	108	136	140	119	130	127	100	83	57	51	51	66	26	11	1671
:00	0	0	1	0	1	8	9	17	26	35	30	31	35	30	27	46	20	19	11	15	15	4	7	4	
:15	1	0	1	0	4	11	14	25	20	19	24	44	28	17	35	27	29	16	15	15	8	35	7	4	
:30	0	0	0	3	6	8	12	38	26	35	24	36	38	34	35	24	27	20	18	10	16	9	7	1	
:45	3	2	0	3	21	14	18	33	31	26	30	25	40	38	34	30	25	29	13	12	12	18	6	2	

AM Peak 1045 - 1145 (140), AM PHF=0.80 PM Peak 1415 - 1515 (149), PM PHF=0.81

* Tuesday, November 01, 2011=1637, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	2	0	2	8	22	42	58	127	105	79	91	118	139	126	120	124	133	111	66	50	31	42	32	14	1642
:00	2	0	1	2	0	8	12	19	25	21	20	31	35	27	33	31	24	24	17	9	17	7	10	4	
:15	0	0	1	1	5	11	11	21	25	20	33	30	35	38	22	29	28	28	20	11	6	13	3	2	
:30	0	0	0	2	5	10	8	44	30	16	23	26	29	33	33	30	32	34	15	11	4	12	12	4	
:45	0	0	0	3	12	13	28	44	26	23	16	32	40	29	33	35	50	27	15	19	5	10	8	4	

AM Peak 0730 - 0830 (137), AM PHF=0.78 PM Peak 1200 - 1300 (139), PM PHF=0.87

* Wednesday, November 02, 2011=1661, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	9	1	1	5	29	44	61	101	105	91	118	101	115	144	149	125	124	95	69	53	37	46	34	9	1666
:00	0	1	0	0	4	9	9	10	24	22	29	19	24	40	27	22	41	25	13	16	8	4	9	0	
:15	3	0	1	1	2	8	16	26	32	21	32	20	27	38	41	35	15	31	26	14	12	18	10	3	
:30	6	0	0	2	9	10	10	30	24	20	30	38	27	27	38	32	28	13	13	10	10	16	8	4	
:45	0	0	0	3	15	17	26	36	26	28	28	24	38	39	44	36	41	26	18	14	8	8	8	2	

AM Peak 0730 - 0830 (121), AM PHF=0.85 PM Peak 1400 - 1500 (149), PM PHF=0.86

* Thursday, November 03, 2011=1952, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	3	2	5	5	27	48	71	114	93	112	138	147	144	134	167	155	135	107	103	80	68	53	33	13	1957
:00	2	2	0	0	1	6	13	14	21	21	44	46	26	40	36	32	34	18	24	21	22	12	9	6	
:15	0	0	1	2	4	12	11	21	21	28	36	31	38	37	31	40	29	26	36	21	19	21	4	3	
:30	1	0	0	1	4	12	16	41	22	27	31	34	43	27	41	41	39	37	21	22	19	16	13	1	
:45	0	0	4	2	19	18	32	38	29	36	27	37	38	30	59	42	34	27	22	17	9	5	8	3	

AM Peak 1100 - 1200 (147), AM PHF=0.80 PM Peak 1430 - 1530 (172), PM PHF=0.73

* Friday, November 04, 2011=2234, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	3	5	9	8	30	50	98	129	168	136	210	145	150	132	152	165	161	140	97	98	53	39	46	15	2239
:00	2	1	0	1	3	9	15	18	45	27	54	48	46	25	31	35	41	32	35	26	18	15	15	5	
:15	0	2	5	2	5	16	28	28	42	44	55	42	36	35	24	41	40	44	22	26	9	10	11	5	
:30	1	2	4	4	3	7	22	39	39	24	51	26	34	34	47	48	34	31	24	31	17	6	7	3	
:45	0	0	0	1	19	19	34	45	42	41	50	30	34	39	51	42	47	34	17	15	9	8	13	2	

AM Peak 1000 - 1100 (210), AM PHF=0.95 PM Peak 1445 - 1545 (174), PM PHF=0.86

* Saturday, November 05, 2011=2214, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	20	3	3	5	21	25	66	160	115	119	138	130	173	193	207	177	165	134	117	90	57	47	40	15	2220
:00	5	0	3	2	2	1	11	26	22	34	32	34	38	51	48	42	36	28	37	25	17	7	8	3	
:15	7	0	0	2	4	7	16	33	25	28	44	33	40	49	38	46	39	37	30	27	21	13	6	3	
:30	4	3	0	0	7	6	17	48	26	30	27	32	38	44	57	44	48	33	26	26	9	20	17	6	
:45	5	0	0	1	8	11	23	53	43	27	36	32	58	49	64	46	43	37	25	12	11	7	9	3	

AM Peak 0700 - 0800 (160), AM PHF=0.76 PM Peak 1430 - 1530 (208), PM PHF=0.81

* Sunday, November 06, 2011=1386, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Hrly	4	4	4	5	21	29	56	119	131	133	111	152	175	209	223	-	-	-	-	-	-	-	-	-
:00	0	2	1	0	2	3	6	23	39	29	21	34	48	55	57	-	-	-	-	-	-	-	-	-
:15	1	1	0	1	3	8	11	26	31	26	22	46	42	44	49	-	-	-	-	-	-	-	-	-
:30	2	0	0	2	10	6	20	34	33	30	36	42	40	57	58	-	-	-	-	-	-	-	-	-
:45	1	1	3	2	7	12	19	38	29	49	33	31	45	53	60	-	-	-	-	-	-	-	-	-

AM Peak 1115 - 1215 (167), AM PHF=0.87 PM Peak 1400 - 1500 (223), PM PHF=0.93

24-Hour Traffic Count Data on Kuilima Drive at Kamehameha Highway-Outbound
Site: Kuilima Drive Hotel Entrance

* Sunday, October 30, 2011=1148 (Incomplete) , 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Hrly	-	-	-	-	-	-	-	-	-	-	-	-	-	141	133	157	144	123	114	67	43	37	49	26
:00	-	-	-	-	-	-	-	-	-	-	-	-	-	33	39	52	47	42	29	22	14	14	21	15
:15	-	-	-	-	-	-	-	-	-	-	-	-	-	32	27	47	40	33	33	12	8	7	13	4
:30	-	-	-	-	-	-	-	-	-	-	-	-	-	40	32	36	30	31	31	19	13	6	9	3
:45	-	-	-	-	-	-	-	-	-	-	-	-	-	36	36	22	28	18	21	14	9	11	6	4

PM Peak 1445 - 1545 (171), PM PHF=0.82

* Monday, October 31, 2011=1710, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	10	6	0	4	9	17	31	67	74	131	125	124	151	120	126	146	153	121	94	51	34	62	34	25	1715
:00	8	2	0	0	0	6	5	20	26	31	30	33	43	30	44	33	48	42	36	17	5	12	8	8	
:15	1	2	0	0	2	1	11	18	10	30	28	34	43	25	30	39	36	25	21	15	14	20	11	9	
:30	0	0	0	2	4	1	8	11	12	37	25	29	36	40	26	38	31	26	28	14	11	20	10	4	
:45	1	2	0	2	3	9	8	19	26	33	43	29	30	26	27	37	39	28	10	6	5	10	6	5	

AM Peak 1145 - 1245 (149), AM PHF=0.88 PM Peak 1515 - 1615 (161), PM PHF=0.85

* Tuesday, November 01, 2011=1715, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	9	1	2	3	15	16	27	58	90	105	94	126	121	140	151	144	142	134	125	73	34	46	37	28	1721
:00	4	1	0	2	5	5	3	14	26	26	21	29	20	26	43	43	49	42	38	28	11	10	18	15	
:15	2	0	0	1	5	2	6	13	23	23	23	31	30	29	36	27	44	38	41	17	5	13	4	7	
:30	2	0	0	0	3	0	5	16	22	29	27	36	43	45	44	40	27	27	30	20	4	9	5	4	
:45	1	0	2	0	2	9	13	16	21	28	24	30	29	41	29	35	23	27	16	9	15	15	10	2	

AM Peak 1100 - 1200 (126), AM PHF=0.87 PM Peak 1530 - 1630 (167), PM PHF=0.86

* Wednesday, November 02, 2011=2196, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	12	1	0	0	12	23	34	69	70	77	131	124	108	156	155	145	170	204	231	118	111	118	62	70	2201
:00	5	0	0	0	4	10	7	13	16	21	34	37	26	27	39	34	62	46	83	25	38	19	28	43	
:15	3	1	0	0	3	5	8	22	16	14	28	33	28	35	38	31	35	70	67	39	20	30	13	13	
:30	4	0	0	0	4	2	8	18	20	23	37	28	28	48	34	41	30	49	42	20	44	40	17	11	
:45	1	0	0	0	2	7	11	16	18	20	32	27	27	47	45	40	44	40	39	35	10	29	4	4	

AM Peak 1030 - 1130 (139), AM PHF=0.94 PM Peak 1715 - 1815 (241), PM PHF=0.73

* Thursday, November 03, 2011=1828, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	25	3	7	6	20	47	46	65	75	90	97	127	118	121	134	151	136	119	97	92	75	84	54	45	1834
:00	17	0	0	4	0	16	16	16	21	23	27	31	29	31	43	26	46	37	30	30	15	35	16	19	
:15	5	3	0	2	4	13	6	18	18	15	21	42	38	28	29	31	41	30	29	25	20	24	11	9	
:30	0	0	5	0	7	4	8	15	16	27	28	28	26	39	31	47	25	31	21	17	18	15	18	9	
:45	4	0	2	0	10	14	16	16	20	26	21	27	25	24	32	47	25	22	18	21	23	11	9	8	

AM Peak 1100 - 1200 (127), AM PHF=0.77 PM Peak 1530 - 1630 (181), PM PHF=0.96

* Friday, November 04, 2011=2026, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	20	3	9	1	12	13	32	59	71	108	103	117	135	133	125	144	149	149	155	88	95	93	103	113	2030
:00	10	0	1	0	0	5	7	16	25	26	21	26	29	22	39	31	41	47	48	29	21	30	13	59	
:15	4	2	5	1	2	3	10	13	18	29	28	31	31	31	30	35	49	37	48	20	22	25	24	19	
:30	2	1	3	0	6	1	7	13	13	29	24	26	45	48	28	41	26	34	30	20	26	19	19	25	
:45	4	0	0	0	4	4	9	18	15	26	31	35	31	32	29	37	34	32	29	19	26	19	47	10	

AM Peak 1145 - 1245 (139), AM PHF=0.78 PM Peak 1530 - 1630 (167), PM PHF=0.86

* Saturday, November 05, 2011=2026, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	24	6	3	4	12	9	26	53	73	105	121	155	156	161	158	164	183	125	142	68	66	70	102	45	2031
:00	10	2	1	2	4	3	2	14	23	31	18	46	29	47	40	40	61	33	44	18	28	22	20	22	
:15	5	1	0	0	2	0	6	10	15	18	42	39	41	42	54	39	56	30	29	17	19	18	30	11	
:30	1	0	1	0	2	4	2	6	22	17	33	39	31	37	28	31	36	37	25	40	13	9	14	35	8
:45	8	2	2	0	2	4	12	7	19	23	23	39	49	44	34	50	30	37	31	20	11	16	17	5	

AM Peak 1100 - 1200 (155), AM PHF=0.85 PM Peak 1545 - 1645 (203), PM PHF=0.84

* Sunday, November 06, 2011=981, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Hrly	15	10	5	3	3	10	21	57	89	97	121	134	106	160	132	-	-	-	-	-	-	-	-	-
:00	7	5	0	0	2	2	2	15	21	24	22	40	26	34	27	-	-	-	-	-	-	-	-	-
:15	4	2	1	0	0	1	2	13	24	28	35	21	30	39	33	-	-	-	-	-	-	-	-	-
:30	1	0	1	1	1	1	6	15	24	18	41	32	26	50	41	-	-	-	-	-	-	-	-	-
:45	3	3	3	2	0	6	11	14	21	28	24	42	25	37	32	-	-	-	-	-	-	-	-	-

AM Peak 1015 - 1115 (139), AM PHF=0.85 PM Peak 1300 - 1400 (160), PM PHF=0.81

24-Hour Traffic Count Data on Kuilima Drive at Kamehameha Highway-Total for Both Directions
Site: Kuilima [Kuilima Drive North] Kuilima Drive Hotel Entrance

* Sunday, October 30, 2011=928 (Incomplete) , 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Hrly	-	-	-	-	-	-	-	-	-	-	-	-	-	275	289	289	270	213	181	111	85	59	75	32
:00	-	-	-	-	-	-	-	-	-	-	-	-	-	62	77	87	74	67	54	38	30	23	33	16
:15	-	-	-	-	-	-	-	-	-	-	-	-	-	66	60	74	70	59	49	25	15	9	16	4
:30	-	-	-	-	-	-	-	-	-	-	-	-	-	76	74	69	70	50	47	29	22	12	15	5
:45	-	-	-	-	-	-	-	-	-	-	-	-	-	71	78	59	56	37	31	19	18	15	11	7

PM Peak Gen 14:30 to 15:30 Vol= 313

* Monday, October 31, 2011=1665, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	14	8	2	10	41	58	85	181	177	246	234	261	293	240	258	274	255	205	152	104	86	128	62	37	3411
:00	8	2	1	0	1	14	14	37	52	66	60	64	78	60	71	79	68	61	47	32	20	16	15	12	
:15	2	2	1	0	6	12	25	43	30	49	52	78	71	42	65	66	65	41	36	30	22	55	18	13	
:30	0	0	0	5	10	9	20	49	38	72	49	65	74	74	61	62	58	46	46	24	27	29	17	5	
:45	4	4	0	5	24	23	26	52	57	59	73	54	70	64	61	67	64	57	23	18	17	28	12	7	

AM Peak Gen 10:45 to 11:45 Vol= 280
PM Peak Gen 15:00 to 16:00 Vol= 274

* Tuesday, November 01, 2011=1637, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	11	1	4	11	37	58	86	187	198	186	187	245	261	268	273	270	277	247	192	124	67	89	70	42	3391
:00	6	1	1	4	5	13	15	33	51	47	41	60	55	53	76	74	73	66	55	37	28	17	28	19	
:15	2	0	1	2	10	13	17	34	48	43	56	61	65	67	58	56	72	66	61	28	11	26	7	9	
:30	2	0	0	2	8	10	13	60	52	45	50	62	72	78	77	70	59	61	45	31	8	21	17	8	
:45	1	0	2	3	14	22	41	60	47	51	40	62	69	70	62	70	73	54	31	28	20	25	18	6	

AM Peak Gen 10:45 to 11:45 Vol= 223
PM Peak Gen 15:00 to 16:00 Vol= 270

* Wednesday, November 02, 2011=1661, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	22	2	1	6	43	68	97	171	176	169	250	226	225	301	306	271	296	300	301	173	150	164	97	80	3895
:00	5	1	0	0	8	19	16	23	40	43	63	56	50	67	66	56	103	71	96	41	46	23	37	43	
:15	6	1	1	1	5	13	24	48	48	35	60	53	55	73	79	66	50	101	93	53	32	48	23	16	
:30	10	0	0	2	13	12	18	48	44	43	67	66	55	75	72	73	58	62	55	30	54	56	25	15	
:45	1	0	0	3	17	24	39	52	44	48	60	51	65	86	89	76	85	66	57	49	18	37	12	6	

AM Peak Gen 10:00 to 11:00 Vol= 250
PM Peak Gen 15:15 to 16:15 Vol= 318

* Thursday, November 03, 2011=1952, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	29	5	12	11	49	95	118	179	168	203	235	276	263	256	302	306	273	228	201	174	145	139	88	58	3813
:00	19	2	0	4	1	22	29	30	42	44	71	77	55	71	79	58	80	55	54	51	37	47	25	25	
:15	5	3	1	4	8	25	17	39	39	43	57	73	76	65	60	71	70	56	65	46	39	45	15	12	
:30	1	0	5	1	11	16	24	56	38	54	59	62	69	66	72	88	64	68	42	39	37	31	31	10	
:45	4	0	6	2	29	32	48	54	49	62	48	64	63	54	91	89	59	49	40	38	32	16	17	11	

AM Peak Gen 11:00 to 12:00 Vol= 276
PM Peak Gen 14:45 to 15:45 Vol= 308

* Friday, November 04, 2011=2234, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	23	8	18	9	42	64	132	190	239	246	314	264	286	266	279	310	312	291	253	186	148	132	149	128	4289
:00	12	1	1	1	3	14	22	34	70	53	75	74	75	47	70	66	82	79	83	55	39	45	28	64	
:15	4	4	10	3	7	19	38	41	60	73	83	73	67	66	54	76	89	81	70	46	31	35	35	24	
:30	3	3	7	4	9	8	29	52	52	53	75	52	79	82	75	89	60	65	54	51	43	25	26	28	
:45	4	0	0	1	23	23	43	63	57	67	81	65	65	71	80	79	81	66	46	34	35	27	60	12	

AM Peak Gen 10:00 to 11:00 Vol= 314
PM Peak Gen 16:00 to 17:00 Vol= 312

* Saturday, November 05, 2011=2214, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24-Hr
Hrly	45	9	6	9	33	34	93	213	190	224	261	286	330	354	366	343	350	260	262	158	125	117	142	61	4271
:00	15	2	4	4	6	4	13	40	45	65	50	80	87	98	88	82	97	61	81	43	45	29	28	25	
:15	12	1	0	2	6	7	22	43	40	46	86	72	81	91	92	85	95	67	59	44	40	31	36	14	
:30	5	4	0	2	11	8	23	70	43	63	66	63	75	72	88	80	85	58	66	39	18	34	52	14	
:45	13	2	2	1	10	15	35	60	62	50	59	71	107	93	98	96	73	74	56	32	22	23	26	8	

AM Peak Gen 11:00 to 12:00 Vol= 286
PM Peak Gen 12:30 to 13:30 Vol= 371

* Sunday, November 06, 2011=1386, 15 minute drops

	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Hrly	19	14	9	8	25	39	77	178	222	232	234	288	282	369	357	-	-	-	-	-	-	-	-	-
:00	7	7	1	0	4	5	8	38	60	53	43	74	74	89	84	-	-	-	-	-	-	-	-	-
:15	5	3	1	1	3	9	13	39	55	54	57	67	72	83	82	-	-	-	-	-	-	-	-	-
:30	3	0	1	3	11	7	26	49	57	48	77	74	66	107	99	-	-	-	-	-	-	-	-	-
:45	4	4	6	4	7	18	30	52	50	77	57	73	70	90	92	-	-	-	-	-	-	-	-	-

AM Peak Gen 11:00 to 12:00 Vol= 288

Weekday Turning Movement Count Data
Study Name: Kamehameha Hwy Joseph P Leong Hwy Wkdy
Start Date: 11/01/2011

Vehicular Traffic

		Eastbound Kamehameha Hwy		Northbound Joseph P Leong Hwy		Southbound Kamehameha Hwy			
Start Time	End Time	Left-Turn	Right-Turn	Left-Turn	Through	Through	Right-Turn	Total	Hrly Total
6:30 AM	6:45 AM	18	2	1	45	56	14	136	
6:45 AM	7:00 AM	30	1	1	64	84	16	196	
7:00 AM	7:15 AM	27	0	2	53	75	29	186	
7:15 AM	7:30 AM	27	2	3	63	96	36	227	745
7:30 AM	7:45 AM	34	3	3	60	97	30	227	836
7:45 AM	8:00 AM	21	0	4	62	84	55	226	866
8:00 AM	8:15 AM	41	4	2	70	78	53	248	928
8:15 AM	8:30 AM	36	4	2	52	65	47	206	907
8:30 AM	8:45 AM	35	4	4	47	68	50	208	888
8:45 AM	9:00 AM	45	2	4	50	70	48	219	881
9:00 AM	9:15 AM	36	4	4	59	67	59	229	862
9:15 AM	9:30 AM	42	1	6	57	79	46	231	887
9:30 AM	9:45 AM	42	3	5	49	62	58	219	898
9:45 AM	10:00 AM	48	4	3	74	54	57	240	919
10:00 AM	10:15 AM	61	2	7	66	61	68	265	955
10:15 AM	10:30 AM	55	7	6	64	68	66	266	990
10:30 AM	10:45 AM	63	2	8	57	66	60	256	1027
10:45 AM	11:00 AM	72	4	17	68	57	84	**302**	1089
11:00 AM	11:15 AM	56	10	11	53	55	81	266	1090
11:15 AM	11:30 AM	71	11	7	71	66	75	301	1125
11:30 AM	11:45 AM	53	2	8	72	54	71	260	**1129**
11:45 AM	12:00 PM	66	4	11	63	49	58	251	1078
12:00 PM	12:15 PM	82	3	9	65	55	72	286	1098
12:15 PM	12:30 PM	71	6	17	72	65	84	315	1112
12:30 PM	12:45 PM	86	10	11	71	70	81	329	1181
12:45 PM	1:00 PM	93	7	7	72	47	93	319	1249
1:00 PM	1:15 PM	76	4	15	94	68	82	339	1302
1:15 PM	1:30 PM	96	5	12	82	65	83	343	1330
1:30 PM	1:45 PM	83	13	5	72	64	76	313	1314
1:45 PM	2:00 PM	67	7	9	97	73	75	328	1323
2:00 PM	2:15 PM	83	16	12	76	74	78	339	1323
2:15 PM	2:30 PM	94	7	11	90	44	93	339	1319
2:30 PM	2:45 PM	75	6	10	62	73	76	302	1308
2:45 PM	3:00 PM	81	6	6	92	81	98	364	1344
3:00 PM	3:15 PM	76	2	13	105	87	85	368	1373
3:15 PM	3:30 PM	82	7	17	93	81	101	381	1415
3:30 PM	3:45 PM	82	3	5	96	104	99	**389**	**1502**
3:45 PM	4:00 PM	91	4	11	83	62	68	319	1457
4:00 PM	4:15 PM	84	4	5	97	68	75	333	1422
4:15 PM	4:30 PM	71	9	5	107	70	76	338	1379
AM Peak Hour									
10:45 AM	11:45 AM	252	27	43	264	232	311	1129	
Peak Hour Factor		0.88	1.69	0.63	0.97	1.02	0.93	0.93	
Heavy Vehicles %		5.2%	0.0%	0.0%	5.7%	3.4%	3.2%	4.1%	
PM Peak Hour									
2:45 PM	3:45 PM	321	18	41	386	353	383	1502	
Peak Hour Factor		0.98	1.50	2.05	1.01	0.85	0.97	0.97	
Heavy Vehicles %		0.6%	0.0%	0.0%	0.3%	4.8%	1.6%	1.7%	

Saturday Turning Movement Count Data
Study Name: Kamehameha Hwy Haleiwa Bypass Sat 1130-1530
Start Date: 10/29/2011 Saturday

Vehicular Traffic

		Eastbound		Northbound		Southbound			
		Kamehameha Hwy		Joseph P Leong Hwy		Kamehameha Hwy			
Start Time	End Time	Left-Turn	Right-Turn	Left-Turn	Through	Through	Right-Turn	Total	Hrly Total
10:30 AM	10:45 AM	76	17	15	100	76	79	363	
10:45 AM	11:00 AM	85	10	15	92	59	81	342	
11:00 AM	11:15 AM	98	9	15	100	59	79	360	
11:15 AM	11:30 AM	98	12	13	90	70	73	356	1421
11:30 AM	11:45 AM	85	9	14	96	77	89	370	1428
11:45 AM	12:00 PM	89	3	24	128	80	86	410	1496
12:00 PM	12:15 PM	83	9	14	106	84	113	409	1545
12:15 PM	12:30 PM	105	14	15	109	95	118	**456**	1645
12:30 PM	12:45 PM	72	13	19	107	102	94	407	**1682**
12:45 PM	1:00 PM	79	5	17	98	70	80	349	1621
1:00 PM	1:15 PM	102	7	14	89	72	99	383	1595
1:15 PM	1:30 PM	94	14	12	91	80	96	387	1526
1:30 PM	1:45 PM	84	9	19	96	86	80	374	1493
1:45 PM	2:00 PM	90	14	11	92	79	99	385	1529
2:00 PM	2:15 PM	73	6	10	99	88	102	378	1524
2:15 PM	2:30 PM	97	11	13	87	84	77	369	1506
2:30 PM	2:45 PM	62	17	8	105	92	88	372	1504
2:45 PM	3:00 PM	85	12	12	85	90	74	358	1477
3:00 PM	3:15 PM	79	22	11	114	117	103	446	1545
3:15 PM	3:30 PM	67	8	12	83	112	72	354	1530
3:30 PM	3:45 PM	83	15	12	93	102	111	416	1574
3:45 PM	4:00 PM	57	10	11	97	85	97	357	1573
4:00 PM	4:15 PM	68	11	8	76	89	77	329	1456
4:15 PM	4:30 PM	77	8	11	97	96	75	364	1466

Saturday Peak Hour

11:45 AM	12:45 PM	349	39	72	450	361	411	1682
Peak Hour Factor		0.83	0.70	1.20	1.03	0.95	0.87	0.92
Heavy Vehicles		1.1%	0.0%	0.0%	2.9%	0.6%	1.7%	1.5%

Sunday Turning Movement Count Data
Study Name Kamehameha Hwy Haleiwa Bypass Sun 1100-1400
Start Date 3/4/2012

Vehicular Traffic

		Eastbound		Northbound		Southbound			
		Kamehameha Hwy		Joseph P Leong Hwy		Kamehameha Hwy			
Start Time	End Time	Left-Turn	Right-Turn	Left-Turn	Through	Through	Right-Turn	Total	Hrly Total
11:00 AM	11:15 AM	94	9	20	55	68	118	364	
11:15 AM	11:30 AM	94	10	29	82	65	115	395	
11:30 AM	11:45 AM	93	21	30	80	65	94	383	
11:45 AM	12:00 PM	116	21	30	59	68	97	391	1533
12:00 PM	12:15 PM	95	10	21	71	66	102	365	1534
12:15 PM	12:30 PM	88	23	24	70	51	106	362	1501
12:30 PM	12:45 PM	91	16	34	63	82	120	406	1524
12:45 PM	1:00 PM	94	16	28	72	68	110	388	1521
1:00 PM	1:15 PM	93	18	16	67	66	113	373	1529
1:15 PM	1:30 PM	116	21	29	84	77	111	**438**	**1605**
1:30 PM	1:45 PM	112	20	11	78	85	89	395	1594
1:45 PM	2:00 PM	105	28	18	69	71	71	362	1568

Sunday Peak Hour

12:30 PM	1:30 PM	394	71	107	286	293	454	1605
Peak Hour Factor		0.85	0.85	0.92	0.85	0.95	1.02	0.92

Weekday Turning Movement Count Data
Study Name: Kamehameha Hwy Kahekili Hwy Weekday
Start Date: 11/01/2011

Vehicular Traffic

		Westbound Kamehameha Hwy		Northbound Kahekili Hwy		Southbound Kamehameha Hwy			
Start Time	End Time	Left-Turn	Right-Turn	Through	Right-Turn	Left-Turn	Through	Total	Hrly Total
5:15 AM	5:30 AM	15	5	29	5	5	106	165	
5:30 AM	5:45 AM	13	6	34	11	9	153	226	
5:45 AM	6:00 AM	12	4	34	5	22	140	217	
6:00 AM	6:15 AM	11	3	45	16	72	129	276	884
6:15 AM	6:30 AM	5	7	38	24	102	72	248	967
6:30 AM	6:45 AM	4	11	51	28	104	76	274	1015
6:45 AM	7:00 AM	4	16	58	36	126	93	333	1131
7:00 AM	7:15 AM	12	24	79	38	136	92	**381**	1236
7:15 AM	7:30 AM	9	11	59	33	84	109	305	1293
7:30 AM	7:45 AM	10	30	112	19	71	78	320	**1339**
7:45 AM	8:00 AM	9	38	92	21	53	96	309	1315
8:00 AM	8:15 AM	12	24	83	17	22	120	278	1212
8:15 AM	8:30 AM	10	29	94	12	15	120	280	1187
8:30 AM	8:45 AM	5	19	72	19	27	144	286	1153
8:45 AM	9:00 AM	13	11	77	14	15	136	266	1110
9:00 AM	9:15 AM	16	19	86	14	9	143	287	1119
9:15 AM	9:30 AM	13	14	77	15	11	108	238	1077
9:30 AM	9:45 AM	9	16	74	10	16	107	232	1023
9:45 AM	10:00 AM	13	23	87	13	9	96	241	998
10:00 AM	10:15 AM	14	16	88	9	12	112	251	962
10:15 AM	10:30 AM	10	28	88	9	16	122	273	997
10:30 AM	10:45 AM	14	21	74	10	17	95	231	996
10:45 AM	11:00 AM	7	37	105	12	16	122	299	1054
11:00 AM	11:15 AM	11	31	119	8	12	101	282	1085
11:15 AM	11:30 AM	7	37	102	15	11	114	286	1098
11:30 AM	11:45 AM	6	27	131	9	17	96	286	**1153**
11:45 AM	12:00 PM	13	21	93	11	8	108	254	1108
12:00 PM	12:15 PM	12	28	108	10	12	101	271	1097
12:15 PM	12:30 PM	6	37	107	10	10	101	271	1082
12:30 PM	12:45 PM	10	36	115	15	10	97	283	1079
12:45 PM	1:00 PM	8	37	120	13	20	109	307	1132
1:00 PM	1:15 PM	12	43	117	19	15	107	313	1174
1:15 PM	1:30 PM	12	24	114	18	19	104	291	1194
1:30 PM	1:45 PM	14	49	129	10	24	106	332	1243
1:45 PM	2:00 PM	16	40	115	14	12	114	311	1247
2:00 PM	2:15 PM	10	31	122	18	14	134	329	1263
2:15 PM	2:30 PM	12	23	111	13	29	171	359	1331
2:30 PM	2:45 PM	10	29	110	11	23	124	307	1306
2:45 PM	3:00 PM	8	40	134	13	13	108	316	1311
3:00 PM	3:15 PM	13	37	141	17	19	140	367	1349
3:15 PM	3:30 PM	9	61	164	17	13	122	386	1376
3:30 PM	3:45 PM	13	61	166	19	16	142	**417**	1486
3:45 PM	4:00 PM	13	52	159	10	23	154	411	1581
4:00 PM	4:15 PM	10	73	157	13	13	132	398	1612
4:15 PM	4:30 PM	14	53	151	22	23	144	407	**1633**
4:30 PM	4:45 PM	9	71	143	13	15	129	380	1596
4:45 PM	5:00 PM	11	80	131	20	14	124	380	1565
5:00 PM	5:15 PM	15	72	115	19	19	135	375	1542
5:15 PM	5:30 PM	14	67	151	20	15	111	378	1513
5:30 PM	5:45 PM	10	81	114	21	17	120	363	1496
5:45 PM	6:00 PM	12	52	128	12	18	114	336	1452
6:00 PM	6:15 PM	9	53	144	16	15	114	351	1428
6:15 PM	6:30 PM	10	49	133	9	13	104	318	1368

AM Peak Hour								
6:45 AM	7:45 AM	35	81	308	126	417	372	1339
Peak Hour Factor		0.73	0.84	0.97	0.83	0.77	1.01	0.88
Heavy Vehicles		5.7%	7.4%	4.5%	4.0%	2.2%	2.7%	3.4%
PM Peak Hour								
3:30 PM	4:30 PM	50	239	633	64	75	572	1633
Peak Hour Factor		0.96	0.98	0.95	0.84	1.17	1.01	0.98
Heavy Vehicles		6.0%	5.4%	3.0%	4.7%	2.7%	1.6%	3.0%

Saturday Turning Movement Count Data
Study Name: Kamehameha Hwy Kahekili Hwy Sat 1130-1530
Start Date: 10/29/2011 Saturday

Vehicular Traffic

		Westbound Kamehameha Hwy		Northbound Kahekili Hwy		Southbound Kamehameha Hwy			
Start Time	End Time	Left-Turn	Right-Turn	Through	Right-Turn	Left-Turn	Through	Total	Hrly Total
11:00 AM	11:15 AM	6	54	152	17	18	146	393	
11:15 AM	11:30 AM	13	43	144	18	17	118	353	
11:30 AM	11:45 AM	10	43	124	15	16	172	380	
11:45 AM	12:00 PM	13	47	157	13	16	124	370	1496
12:00 PM	12:15 PM	18	46	149	27	22	133	395	1498
12:15 PM	12:30 PM	11	59	128	16	20	136	370	1515
12:30 PM	12:45 PM	10	61	140	15	23	135	384	1519
12:45 PM	1:00 PM	8	49	167	16	24	171	435	1584
1:00 PM	1:15 PM	9	77	152	22	18	101	379	1568
1:15 PM	1:30 PM	9	60	141	17	17	149	393	1591
1:30 PM	1:45 PM	7	53	133	17	18	146	374	1581
1:45 PM	2:00 PM	14	55	142	15	21	154	401	1547
2:00 PM	2:15 PM	17	60	142	21	18	123	381	1549
2:15 PM	2:30 PM	11	62	137	17	16	156	399	1555
2:30 PM	2:45 PM	9	43	163	24	22	168	**429**	1610
2:45 PM	3:00 PM	13	47	154	16	16	146	392	1601
3:00 PM	3:15 PM	13	55	141	20	14	149	392	**1612**
3:15 PM	3:30 PM	14	48	133	16	16	140	367	1580
3:30 PM	3:45 PM	11	37	142	19	10	158	377	1528
3:45 PM	4:00 PM	10	38	144	19	17	159	387	1523

Saturday Peak Hour								
2:15 PM	3:15 PM	46	207	595	77	68	619	1612
Peak Hour Factor		1.28	1.20	0.91	0.80	0.77	0.92	0.94
Heavy Vehicles		6.5%	1.9%	2.4%	2.6%	4.4%	3.1%	2.8%

Sunday Turning Movement Count Data

Study Name Kam Hwy Kahekili Hwy Sunday

Start Date 3/11/2012

Vehicular Traffic

		Westbound Kamehameha Hwy		Northbound Kahekili Hwy		Southbound Kamehameha Hwy			
Start Time	End Time	Left-Turn	Right-Turn	Through	Right-Turn	Left-Turn	Through	Total	Hrly Total
12:30 PM	12:45 PM	16	40	116	9	19	129	329	
12:45 PM	1:00 PM	8	41	133	9	16	136	343	
1:00 PM	1:15 PM	11	38	120	15	19	127	330	
1:15 PM	1:30 PM	14	71	104	27	18	128	362	1364
1:30 PM	1:45 PM	20	58	119	9	19	105	330	1365
1:45 PM	2:00 PM	18	45	148	22	16	110	359	1381
2:00 PM	2:15 PM	6	56	131	20	15	140	368	1419
2:15 PM	2:30 PM	19	41	142	19	15	140	**376**	**1433**
2:30 PM	2:45 PM	8	46	106	15	22	132	329	1432
2:45 PM	3:00 PM	11	44	124	16	11	142	348	1421
3:00 PM	3:15 PM	7	29	106	9	16	119	286	1339
3:15 PM	3:30 PM	16	32	116	20	9	154	347	1310
3:30 PM	3:45 PM	8	37	109	16	12	114	296	1277
3:45 PM	4:00 PM	15	34	101	14	20	157	341	1270
4:00 PM	4:15 PM	10	35	98	17	14	154	328	1312
4:15 PM	4:30 PM	16	33	86	20	13	160	328	1293
Sunday Peak Hour									
1:30 PM	2:30 PM	63	200	540	70	65	495	1433	
Peak Hour Factor		0.83	1.22	0.95	0.92	1.08	0.88	0.95	
Heavy Vehicles		1.6%	1.5%	0.9%	2.9%	1.5%	2.2%	1.6%	

Sunday Turning Movement Count Data

Study Name Haleiwa Farmers Market Trip Generation

Start Date 6/10/2012

Vehicular Traffic

		Eastbound Kamehameha Hwy		Westbound Kamehameha Hwy		Farmers Market Southbound Street		Intersection		Farmers Market		
Start Time	End Time	Left-Turn	Through	Through	Right-Turn	Left-Turn	Right-Turn	Total	Hrly Total	Site Enter	Site Exit	Site Total	Hrly Total
9:00 AM	9:15 AM	10	47	56	20	2	13	148		30	15	45	
9:15 AM	9:30 AM	9	68	60	24	6	16	183		33	22	55	
9:30 AM	9:45 AM	10	66	49	21	4	16	166		31	20	51	
9:45 AM	10:00 AM	7	76	90	30	2	14	219	716	37	16	53	204
10:00 AM	10:15 AM	15	96	73	32	8	18	242	810	47	26	73	232
10:15 AM	10:30 AM	10	72	78	28	6	20	214	841	38	26	64	241
10:30 AM	10:45 AM	13	83	75	24	6	26	227	902	37	32	69	259
10:45 AM	11:00 AM	11	88	114	26	4	23	266	949	37	27	64	270
11:00 AM	11:15 AM	11	113	102	31	5	28	290	997	42	33	75	272
11:15 AM	11:30 AM	3	100	104	34	9	18	268	1051	37	27	64	272
11:30 AM	11:45 AM	10	121	107	31	8	21	298	1122	41	29	70	273
11:45 AM	12:00 PM	6	117	114	23	13	24	297	1153	29	37	66	**275**
12:00 PM	12:15 PM	9	94	112	18	5	26	264	1127	27	31	58	258
12:15 PM	12:30 PM	2	124	118	28	5	24	301	1160	30	29	59	253
12:30 PM	12:45 PM	6	114	99	20	5	21	265	1127	26	26	52	235
12:45 PM	1:00 PM	14	120	112	19	4	33	302	1132	33	37	70	239
1:00 PM	1:15 PM	1	121	125	18	12	19	296	1164	19	31	50	231
1:15 PM	1:30 PM	4	123	122	13	4	33	299	1162	17	37	54	226
1:30 PM	1:45 PM	3	128	133	2	14	25	305	**1202**	5	39	44	218
1:45 PM	2:00 PM	3	102	100	0	9	8	222	1122	3	17	20	168
2:00 PM	2:15 PM	1	106	93	0	2	6	208	1034	1	8	9	127
2:15 PM	2:30 PM	2	115	130	1	2	6	256	991	3	8	11	84
2:30 PM	2:45 PM	1	123	138	0	0	4	266	952	1	4	5	45
2:45 PM	3:00 PM	0	113	122	0	1	0	236	966	0	1	1	26
Peak Hour													
11:00 AM	12:00 PM	30	451	427	119	35	91	1153		149	126	275	
2:00 PM	3:00 PM	4	457	483	1	5	16	966		5	21	26	

TRAFFIC IMPACT ANALYSIS REPORT

FOR THE PROPOSED

TURTLE BAY RESORT MASTER PLAN

KAHUKU, OAHU, HAWAII

APPENDIX B

CAPACITY ANALYSIS WORKSHEETS

EXISTING TRAFFIC CONDITIONS

Intersection						
Intersection Delay (sec/veh):	3.8					

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Volume (vph)	82	169	182	62	70	84
Conflicting Peds.(#/hr)	1	0	0	1	7	0
Sign Control	Free	Free	Free	Free	Stop	Stop
Right Turn Channelized	None	None	Yield	Yield	Free	Free
Storage Length	0			0	0	0
Median Width		0	0		12	
Grade (%)		0%	0%		0%	
Peak Hour Factor	0.93	1.00	0.77	1.00	0.97	1.00
Heavy Vehicles(%)	4	13	6	7	6	7
Movement Flow Rate	88	169	236	62	72	84
Number of Lanes	0	1	1	0	1	1

Major/Minor	Major 1		Major 2			
Conflicting Flow Rate - All	305	0	0	0	619	275
Stage 1	-	-	-	-	274	-
Stage 2	-	-	-	-	345	-
Follow-up Headway	2.236	-	-	-	3.554	3.363
Pot Capacity-1 Maneuver	1244	-	-	-	446	752
Stage 1	-	-	-	-	763	-
Stage 2	-	-	-	-	708	-
Time blocked-Platoon(%)	0	-	-	-	0	0
Mov Capacity-1 Maneuver	1243	-	-	-	406	747
Mov Capacity-2 Maneuver	-	-	-	-	406	-
Stage 1	-	-	-	-	759	-
Stage 2	-	-	-	-	649	-

Approach	EB	WB	SB
HCM Control Delay (s)	2.8	0	12.9
HCM LOS	A	A	B

Lane	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (vph)					406	747
HCM Control Delay (s)	8.117	-	-	-	15.8	10.4
HCM Lane VC Ratio	0.071	-	-	-	0.178	0.112
HCM Lane LOS	A	-	-	-	C	B
HCM 95th Percentile Queue (veh)	0.229	-	-	-	0.639	0.378

Intersection						
Intersection Delay (sec/veh):	0.2					

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Volume (vph)	1	233	248	6	6	4
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
Right Turn Channelized	None	None	None	None	None	None
Storage Length	0			0	0	0
Median Width		0	0		12	
Grade (%)		0%	0%		0%	
Peak Hour Factor	1.00	0.82	0.87	1.00	1.00	1.00
Heavy Vehicles(%)	0	13	6	0	0	0
Movement Flow Rate	1	284	285	6	6	4
Number of Lanes	0	1	1	0	1	0

Major/Minor		Major 1	Major 2			
Conflicting Flow Rate - All	291	0	0	0	574	288
Stage 1	-	-	-	-	288	-
Stage 2	-	-	-	-	286	-
Follow-up Headway	2.2	-	-	-	3.5	3.3
Pot Capacity-1 Maneuver	1282	-	-	-	484	756
Stage 1	-	-	-	-	766	-
Stage 2	-	-	-	-	767	-
Time blocked-Platoon(%)	0	-	-	-	0	0
Mov Capacity-1 Maneuver	1282	-	-	-	484	756
Mov Capacity-2 Maneuver	-	-	-	-	484	-
Stage 1	-	-	-	-	766	-
Stage 2	-	-	-	-	766	-

Approach	EB	WB	SB
HCM Control Delay (s)	0	0	11.5
HCM LOS	A	A	B

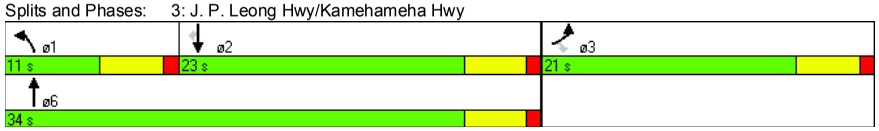
Lane	EBL	EBT	WBT	WBR	SBLn1
Capacity (vph)					565
HCM Control Delay (s)	7.81	-	-	-	11.5
HCM Lane VC Ratio	0.001	-	-	-	0.018
HCM Lane LOS	A	-	-	-	B
HCM 95th Percentile Queue (veh)	0.002	-	-	-	0.054

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	252	27	43	264	232	311
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1719	1615	1805	1792	1845	1568
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1719	1615	1805	1792	1845	1568
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		139				334
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.88	1.00	0.63	0.97	1.00	0.93
Heavy Vehicles (%)	5%	0%	0%	6%	3%	3%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	286	27	68	272	232	334
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	21.0	21.0	11.0	34.0	23.0	23.0
Total Split (%)	38.2%	38.2%	20.0%	61.8%	41.8%	41.8%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	12.7	12.7	6.0	24.5	20.8	20.8
Actuated g/C Ratio	0.26	0.26	0.12	0.49	0.42	0.42
v/c Ratio	0.65	0.05	0.31	0.31	0.30	0.39
Control Delay	24.4	0.2	26.1	8.3	13.9	3.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	24.4	0.2	26.1	8.3	13.9	3.7
LOS	C	A	C	A	B	A
Approach Delay	22.3			11.9	7.9	
Approach LOS	C			B	A	
Queue Length 50th (ft)	79	0	20	39	53	0
Queue Length 95th (ft)	140	0	36	82	107	45
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	564	623	221	1065	771	849
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.51	0.04	0.31	0.26	0.30	0.39

Intersection Summary	
Area Type:	Other
Cycle Length: 55	
Actuated Cycle Length: 49.7	
Natural Cycle: 55	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.65	
Intersection Signal Delay: 12.7	Intersection LOS: B
Intersection Capacity Utilization 42.0%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection	
Intersection Delay (sec/veh):	78

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	36	81	308	126	417	372
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	0.73	0.84	0.97	0.83	0.70	1.00
Heavy Vehicles(%)	6	7	5	4	2	3
Movement Flow Rate	49	96	318	152	596	372
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1			Major 2
Conflicting Flow Rate - All	1958	235	0	0	470	0
Stage 1	394	-	-	-	-	-
Stage 2	1564	-	-	-	-	-
Follow-up Headway	3.554	3.363	-	-	2.218	-
Pot Capacity-1 Maneuver	68	792	-	-	1092	-
Stage 1	673	-	-	-	-	-
Stage 2	186	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	# 21	792	-	-	1092	-
Mov Capacity-2 Maneuver	# 21	-	-	-	-	-
Stage 1	673	-	-	-	-	-
Stage 2	58	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	$ 797.6	0	7.5
HCM LOS	F	A	A

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			60		
HCM Control Delay (s)	-	-	$ 797.6	12.18	-
HCM Lane VC Ratio	-	-	2.429	0.546	-
HCM Lane LOS	-	-	F	B	-
HCM 95th Percentile Queue (veh)	-	-	14.49	3.413	-

Intersection	
Intersection Delay (sec/veh):	3.6

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Volume (vph)	104	240	277	76	70	91
Conflicting Peds.(#/hr)	0	0	0	0	3	1
Sign Control	Free	Free	Free	Free	Stop	Stop
Right Turn Channelized	None	None	Yield	Yield	Free	Free
Storage Length	0			0	0	0
Median Width		0	0		12	
Grade (%)		0%	0%		0%	
Peak Hour Factor	1.00	0.76	0.85	0.95	1.00	0.91
Heavy Vehicles(%)	2	3	5	8	4	7
Movement Flow Rate	104	316	326	80	70	100
Number of Lanes	0	1	1	0	1	1

Major/Minor		Major 1		Major 2		
Conflicting Flow Rate - All	409	0	0	0	893	369
Stage 1	-	-	-	-	369	-
Stage 2	-	-	-	-	524	-
Follow-up Headway	2.218	-	-	-	3.536	3.363
Pot Capacity-1 Maneuver	1150	-	-	-	309	666
Stage 1	-	-	-	-	695	-
Stage 2	-	-	-	-	590	-
Time blocked-Platoon(%)	0	-	-	-	0	0
Mov Capacity-1 Maneuver	1150	-	-	-	274	664
Mov Capacity-2 Maneuver	-	-	-	-	274	-
Stage 1	-	-	-	-	693	-
Stage 2	-	-	-	-	524	-

Approach	EB	WB	SB
HCM Control Delay (s)	2.1	0	16
HCM LOS	A	A	C

Lane	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (vph)					274	664
HCM Control Delay (s)	8.441	-	-	-	22.6	11.4
HCM Lane VC Ratio	0.09	-	-	-	0.255	0.151
HCM Lane LOS	A	-	-	-	C	B
HCM 95th Percentile Queue (veh)	0.298	-	-	-	0.991	0.528

Intersection	
Intersection Delay (sec/veh):	0.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Volume (vph)	2	304	345	7	7	3
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
Right Turn Channelized	None	None	None	None	None	None
Storage Length	0			0	0	0
Median Width		0	0		12	
Grade (%)		0%	0%		0%	
Peak Hour Factor	0.25	0.86	0.90	1.00	1.00	0.75
Heavy Vehicles(%)	0	3	5	0	0	0
Movement Flow Rate	8	353	383	7	7	4
Number of Lanes	0	1	1	0	1	0

Major/Minor		Major 1		Major 2		
Conflicting Flow Rate - All	390	0	0	0	756	387
Stage 1	-	-	-	-	387	-
Stage 2	-	-	-	-	369	-
Follow-up Headway	2.2	-	-	-	3.5	3.3
Pot Capacity-1 Maneuver	1180	-	-	-	379	665
Stage 1	-	-	-	-	691	-
Stage 2	-	-	-	-	704	-
Time blocked-Platoon(%)	0	-	-	-	0	0
Mov Capacity-1 Maneuver	1180	-	-	-	376	665
Mov Capacity-2 Maneuver	-	-	-	-	376	-
Stage 1	-	-	-	-	691	-
Stage 2	-	-	-	-	698	-

Approach	EB	WB	SB
HCM Control Delay (s)	0.2	0	13.3
HCM LOS	A	A	B

Lane	EBL	EBT	WBT	WBR	SBLn1
Capacity (vph)					447
HCM Control Delay (s)	8.072	-	-	-	13.3
HCM Lane VC Ratio	0.007	-	-	-	0.025
HCM Lane LOS	A	-	-	-	B
HCM 95th Percentile Queue (veh)	0.02	-	-	-	0.076

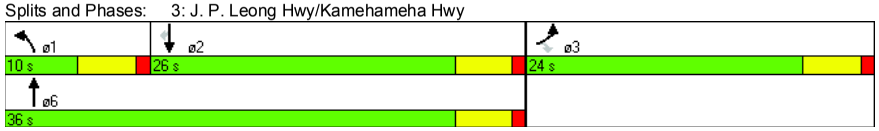
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	321	18	41	386	353	383
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1787	1615	1805	1900	1810	1583
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1787	1615	1805	1900	1810	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		127				407
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.95	0.64	0.60	1.00	1.00	0.94
Heavy Vehicles (%)	1%	0%	0%	0%	5%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	338	28	68	386	353	407
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	24.0	24.0	10.0	36.0	26.0	26.0
Total Split (%)	40.0%	40.0%	16.7%	60.0%	43.3%	43.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	14.5	14.5	5.1	28.1	22.7	22.7
Actuated g/C Ratio	0.27	0.27	0.10	0.53	0.43	0.43
v/c Ratio	0.69	0.05	0.39	0.38	0.45	0.45
Control Delay	25.6	0.2	32.2	9.3	15.8	3.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	25.6	0.2	32.2	9.3	15.8	3.7
LOS	C	A	C	A	B	A
Approach Delay	23.7			12.7	9.3	
Approach LOS	C			B	A	
Queue Length 50th (ft)	101	0	22	66	90	0
Queue Length 95th (ft)	176	0	38	131	173	50
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	656	673	174	1139	778	913
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.52	0.04	0.39	0.34	0.45	0.45

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 52.8
Natural Cycle: 55
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.69
Intersection Signal Delay: 13.6 — Intersection LOS: B
Intersection Capacity Utilization 52.2% — ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection	
Intersection Delay (sec/veh):	2.8

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	50	239	633	64	75	572
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	0.96	0.98	0.95	0.84	1.00	1.00
Heavy Vehicles(%)	6	5	3	5	3	2
Movement Flow Rate	52	244	666	76	75	572
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1		Major 2	
Conflicting Flow Rate - All	1426	371	0	0	742	0
Stage 1	704	-	-	-	-	-
Stage 2	722	-	-	-	-	-
Follow-up Headway	3.554	3.345	-	-	2.227	-
Pot Capacity-1 Maneuver	146	668	-	-	861	-
Stage 1	483	-	-	-	-	-
Stage 2	474	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	127	668	-	-	861	-
Mov Capacity-2 Maneuver	127	-	-	-	-	-
Stage 1	483	-	-	-	-	-
Stage 2	413	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	13.4	0	1.1
HCM LOS	B	A	A

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			722		
HCM Control Delay (s)	-	-	13.4	9.58	-
HCM Lane VC Ratio	-	-	0.41	0.087	-
HCM Lane LOS	-	-	B	A	-
HCM 95th Percentile Queue (veh)	-	-	2.008	0.285	-

Intersection	
Intersection Delay (sec/veh):	4.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Volume (vph)	117	328	322	95	74	104
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
Right Turn Channelized	None	None	Yield	Yield	Free	Free
Storage Length	0			0	0	0
Median Width		0	0		12	
Grade (%)		0%	0%		0%	
Peak Hour Factor	0.79	1.00	0.82	0.91	1.00	1.00
Heavy Vehicles(%)	3	2	5	4	3	2
Movement Flow Rate	148	328	393	104	74	104
Number of Lanes	0	1	1	0	1	1

Major/Minor		Major 1		Major 2		
Conflicting Flow Rate - All	497	0	0	0	1069	445
Stage 1	-	-	-	-	445	-
Stage 2	-	-	-	-	624	-
Follow-up Headway	2.227	-	-	-	3.527	3.318
Pot Capacity-1 Maneuver	1062	-	-	-	244	613
Stage 1	-	-	-	-	644	-
Stage 2	-	-	-	-	532	-
Time blocked-Platoon(%)	0	-	-	-	0	0
Mov Capacity-1 Maneuver	1062	-	-	-	203	613
Mov Capacity-2 Maneuver	-	-	-	-	203	-
Stage 1	-	-	-	-	644	-
Stage 2	-	-	-	-	442	-

Approach	EB	WB	SB
HCM Control Delay (s)	2.8	0	20.6
HCM LOS	A	A	C

Lane	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (vph)					203	613
HCM Control Delay (s)	8.938	-	-	-	32.6	12.1
HCM Lane VC Ratio	0.139	-	-	-	0.365	0.17
HCM Lane LOS	A	-	-	-	D	B
HCM 95th Percentile Queue (veh)	0.484	-	-	-	1.568	0.607

Intersection	
Intersection Delay (sec/veh):	0.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Volume (vph)	3	391	410	5	3	5
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
Right Turn Channelized	None	None	None	None	None	None
Storage Length	0			0	0	0
Median Width		0	0		12	
Grade (%)		0%	0%		0%	
Peak Hour Factor	0.75	0.95	0.98	1.00	0.75	0.42
Heavy Vehicles(%)	0	2	4	0	0	0
Movement Flow Rate	4	412	418	5	4	12
Number of Lanes	0	1	1	0	1	0

Major/Minor	Major 1		Major 2			
Conflicting Flow Rate - All	423	0	0	0	841	421
Stage 1	-	-	-	-	421	-
Stage 2	-	-	-	-	420	-
Follow-up Headway	2.2	-	-	-	3.5	3.3
Pot Capacity-1 Maneuver	1147	-	-	-	338	637
Stage 1	-	-	-	-	667	-
Stage 2	-	-	-	-	667	-
Time blocked-Platoon(%)	0	-	-	-	0	0
Mov Capacity-1 Maneuver	1147	-	-	-	336	637
Mov Capacity-2 Maneuver	-	-	-	-	336	-
Stage 1	-	-	-	-	667	-
Stage 2	-	-	-	-	664	-

Approach	EB	WB	SB
HCM Control Delay (s)	0.1	0	12.1
HCM LOS	A	A	B

Lane	EBL	EBT	WBT	WBR	SBLn1
Capacity (vph)					520
HCM Control Delay (s)	8.15	-	-	-	12.1
HCM Lane VC Ratio	0.003	-	-	-	0.031
HCM Lane LOS	A	-	-	-	B
HCM 95th Percentile Queue (veh)	0.01	-	-	-	0.095

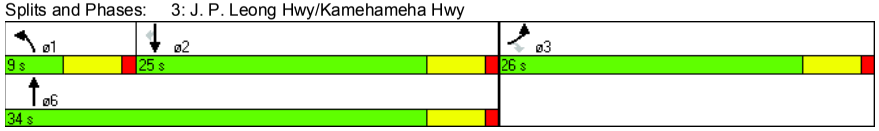
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	349	39	72	450	361	411
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1787	1615	1805	1845	1881	1583
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1787	1615	1805	1845	1881	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		127				472
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.83	0.70	1.00	1.00	0.95	0.87
Heavy Vehicles (%)	1%	0%	0%	3%	1%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	420	56	72	450	380	472
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	26.0	26.0	9.0	34.0	25.0	25.0
Total Split (%)	43.3%	43.3%	15.0%	56.7%	41.7%	41.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	16.9	16.9	4.1	25.6	20.8	20.8
Actuated g/C Ratio	0.32	0.32	0.08	0.49	0.39	0.39
v/c Ratio	0.74	0.09	0.51	0.50	0.51	0.52
Control Delay	25.1	0.4	42.6	12.3	17.7	4.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	25.1	0.4	42.6	12.3	17.7	4.2
LOS	C	A	D	B	B	A
Approach Delay	22.2			16.5	10.2	
Approach LOS	C			B	B	
Queue Length 50th (ft)	126	0	25	92	103	0
Queue Length 95th (ft)	190	0	#79	174	191	48
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	730	735	140	1041	741	909
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.58	0.08	0.51	0.43	0.51	0.52

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 52.7
Natural Cycle: 55
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.74
Intersection Signal Delay: 15.1 Intersection LOS: B
Intersection Capacity Utilization 54.8% ICU Level of Service A
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection

Intersection Delay (sec/veh): 2.9

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	46	207	595	77	68	619
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	1.00	1.00	0.91	0.80	0.77	0.92
Heavy Vehicles(%)	7	2	2	6	4	3
Movement Flow Rate	46	207	654	96	88	673
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1			Major 2
Conflicting Flow Rate - All	1551	375	0	0	750	0
Stage 1	702	-	-	-	-	-
Stage 2	849	-	-	-	-	-
Follow-up Headway	3.563	3.318	-	-	2.236	-
Pot Capacity-1 Maneuver	122	671	-	-	850	-
Stage 1	482	-	-	-	-	-
Stage 2	411	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	102	671	-	-	850	-
Mov Capacity-2 Maneuver	102	-	-	-	-	-
Stage 1	482	-	-	-	-	-
Stage 2	343	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	16.6	0	1.1
HCM LOS	C	A	A

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			561		
HCM Control Delay (s)	-	-	16.6	9.726	-
HCM Lane VC Ratio	-	-	0.451	0.104	-
HCM Lane LOS	-	-	C	A	-
HCM 95th Percentile Queue (veh)	-	-	2.324	0.347	-

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/3/11
Analysis Time Period	AM Peak Hour of Traffic
Highway	Kamehameha Highway
From/To	West of Kuilima Drive
Jurisdiction	
Analysis Year	Existing
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.94	
Lane width	12.0	ft	% Trucks and buses	8	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V	517	veh/h	
Directional split	51 / 49	%	

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.7	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.947	
Two-way flow rate,(note-1) vp	581	pc/h
Highest directional split proportion (note-2)	296	pc/h
Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h

Adjustment for no-passing zones, fnp	2.7	mi/h
Average travel speed, ATS	37.3	mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	0.992	
Two-way flow rate,(note-1) vp	554	pc/h
Highest directional split proportion (note-2)	283	
Base percent time-spent-following, BPTSF	38.6	%
Adj.for directional distribution and no-passing zones, fd/np	18.1	
Percent time-spent-following, PTSF	56.6	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.18	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	AM Peak Hour of Traffic
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	Existing
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.94	
Lane width	12.0	ft	% Trucks and buses	4	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1059 veh/h
Directional split 51 / 49 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.2	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.992	
Two-way flow rate,(note-1) vp	1136	pc/h
Highest directional split proportion (note-2)	579	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	2.0	mi/h

Average travel speed, ATS 33.7 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	0.996	
Two-way flow rate,(note-1) vp	1131	pc/h
Highest directional split proportion (note-2)	577	
Base percent time-spent-following, BPTSF	63.0	%
Adj.for directional distribution and no-passing zones, fd/np	10.5	
Percent time-spent-following, PTSF	73.5	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.35	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	AM Peak Hour of Traffic
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	Existing
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.89	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 1178 veh/h
Directional split 67 / 33 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.997	
Two-way flow rate,(note-1) vp	1328	pc/h
Highest directional split proportion (note-2)	890	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	1.6	mi/h

Average travel speed, ATS 30.6 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1324	pc/h
Highest directional split proportion (note-2)	887	
Base percent time-spent-following, BPTSF	68.8	%
Adj.for directional distribution and no-passing zones, fd/np	8.6	
Percent time-spent-following, PTSF	77.4	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.41	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/3/11
Analysis Time Period	PM Peak Hour of Traffic
Highway	Kamehameha Highway
From/To	West of Kuilima Drive
Jurisdiction	
Analysis Year	Existing
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.87	
Lane width	12.0	ft	% Trucks and buses	4	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V	728	veh/h	
Directional split	50 / 50	%	

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.2	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.992	
Two-way flow rate,(note-1) vp	843	pc/h
Highest directional split proportion (note-2)	422	pc/h
Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	2.1	mi/h

Average travel speed, ATS	35.9	mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	0.996	
Two-way flow rate,(note-1) vp	840	pc/h
Highest directional split proportion (note-2)	420	
Base percent time-spent-following, BPTSF	52.2	%
Adj.for directional distribution and no-passing zones, fd/np	12.7	
Percent time-spent-following, PTSF	64.9	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.26	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	PM Peak Hour of Traffic
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	Existing
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.95	
Lane width	12.0	ft	% Trucks and buses	2	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1443 veh/h
Directional split 51 / 49 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.998	
Two-way flow rate,(note-1) vp	1522	pc/h
Highest directional split proportion (note-2)	776	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.3	mi/h

Average travel speed, ATS 31.4 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1519	pc/h
Highest directional split proportion (note-2)	775	
Base percent time-spent-following, BPTSF	73.7	%
Adj.for directional distribution and no-passing zones, fd/np	6.7	
Percent time-spent-following, PTSF	80.4	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.48	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	PM Peak Hour of Traffic
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	Existing
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.99	
Lane width	12.0	ft	% Trucks and buses	5	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 1519 veh/h
Directional split 57 / 43 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.995	
Two-way flow rate,(note-1) vp	1542	pc/h
Highest directional split proportion (note-2)	879	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	1.3	mi/h

Average travel speed, ATS 29.2 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1534	pc/h
Highest directional split proportion (note-2)	874	
Base percent time-spent-following, BPTSF	74.0	%
Adj.for directional distribution and no-passing zones, fd/np	6.7	
Percent time-spent-following, PTSF	80.8	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.48	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/5/11
Analysis Time Period	Saturday Peak Hour of Traffic
Highway	Kamehameha Highway
From/To	West of Kuilima Drive
Jurisdiction	
Analysis Year	Existing
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.94	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V	867	veh/h	
Directional split	51 / 49	%	

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.2	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.994	
Two-way flow rate,(note-1) vp	928	pc/h
Highest directional split proportion (note-2)	473	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.9	mi/h

Average travel speed, ATS	35.4	mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	0.997	
Two-way flow rate,(note-1) vp	925	pc/h
Highest directional split proportion (note-2)	472	
Base percent time-spent-following, BPTSF	55.7	%
Adj.for directional distribution and no-passing zones, fd/np	11.6	
Percent time-spent-following, PTSF	67.3	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.29	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	10/29/2011
Analysis Time Period	Saturday Peak Hour of Traffic
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	Existing
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.92	
Lane width	12.0	ft	% Trucks and buses	2	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1571 veh/h
Directional split 51 / 49 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.998	
Two-way flow rate,(note-1) vp	1711	pc/h
Highest directional split proportion (note-2)	873	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.2	mi/h

Average travel speed, ATS 30.0 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1708	pc/h
Highest directional split proportion (note-2)	871	
Base percent time-spent-following, BPTSF	77.7	%
Adj.for directional distribution and no-passing zones, fd/np	5.7	
Percent time-spent-following, PTSF	83.4	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.53	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	10/29/2011
Analysis Time Period	Saturday Peak Hour of Traffic
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	Existing
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.94	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 1489 veh/h
Directional split 54 / 46 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.997	
Two-way flow rate,(note-1) vp	1589	pc/h
Highest directional split proportion (note-2)	858	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	1.3	mi/h

Average travel speed, ATS 28.9 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1584	pc/h
Highest directional split proportion (note-2)	855	
Base percent time-spent-following, BPTSF	75.2	%
Adj.for directional distribution and no-passing zones, fd/np	6.4	
Percent time-spent-following, PTSF	81.5	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.50	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

TRAFFIC IMPACT ANALYSIS REPORT

FOR THE PROPOSED

TURTLE BAY RESORT MASTER PLAN

KAHUKU, OAHU, HAWAII

APPENDIX C

CAPACITY ANALYSIS WORKSHEETS

2025 TRAFFIC CONDITIONS WITHOUT PROJECT

Intersection	
Intersection Delay (sec/veh):	4.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Volume (vph)	95	219	228	68	81	98
Conflicting Peds.(#/hr)	1	0	0	1	7	0
Sign Control	Free	Free	Free	Free	Stop	Stop
Right Turn Channelized	None	None	Yield	Yield	Free	Free
Storage Length	0			0	0	0
Median Width		0	0		12	
Grade (%)		0%	0%		0%	
Peak Hour Factor	0.88	0.79	1.00	0.94	0.92	0.98
Heavy Vehicles(%)	4	13	6	7	6	7
Movement Flow Rate	108	277	228	72	88	100
Number of Lanes	0	1	1	0	1	1

Major/Minor	Major 1		Major 2			
Conflicting Flow Rate - All	307	0	0	0	764	272
Stage 1	-	-	-	-	271	-
Stage 2	-	-	-	-	493	-
Follow-up Headway	2.236	-	-	-	3.554	3.363
Pot Capacity-1 Maneuver	1242	-	-	-	366	755
Stage 1	-	-	-	-	765	-
Stage 2	-	-	-	-	606	-
Time blocked-Platoon(%)	0	-	-	-	0	0
Mov Capacity-1 Maneuver	1241	-	-	-	324	750
Mov Capacity-2 Maneuver	-	-	-	-	324	-
Stage 1	-	-	-	-	761	-
Stage 2	-	-	-	-	540	-

Approach	EB	WB	SB
HCM Control Delay (s)	2.3	0	15
HCM LOS	A	A	C

Lane	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (vph)					324	750
HCM Control Delay (s)	8.177	-	-	-	20.2	10.5
HCM Lane VC Ratio	0.087	-	-	-	0.272	0.133
HCM Lane LOS	A	-	-	-	C	B
HCM 95th Percentile Queue (veh)	0.285	-	-	-	1.08	0.459

Intersection	
Intersection Delay (sec/veh):	1.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	1	282	17	19	268	6	24	0	18	6	0	4
Conflicting Peds.(#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
Right Turn Channelized	None	None	None	None	None	None	None	None	None	None	None	None
Storage Length	0		0	330		0	0		0	0		0
Median Width		12			12			0			0	
Grade (%)		0%			0%			0%			0%	
Peak Hour Factor	1.00	0.82	0.92	0.92	0.87	1.00	0.92	0.92	0.92	1.00	0.92	1.00
Heavy Vehicles(%)	0	13	50	50	6	0	50	5	50	0	5	0
Movement Flow Rate	1	344	18	21	308	6	26	0	20	6	0	4
Number of Lanes	0	1	0	1	1	0	0	1	0	0	1	0

Major/Minor	Major 1			Major 2			Minor 1			Minor 2		
Conflicting Flow Rate - All	314	0	0	362	0	0	710	711	353	718	717	157
Stage 1	-	-	-	-	-	-	355	355	-	353	353	-
Stage 2	-	-	-	-	-	-	355	356	-	365	364	-
Follow-up Headway	2.2	-	-	2.65	-	-	3.95	4.045	3.75	3.5	4.045	3.3
Pot Capacity-1 Maneuver	1258	-	-	974	-	-	293	354	595	347	352	894
Stage 1	-	-	-	-	-	-	574	624	-	668	626	-
Stage 2	-	-	-	-	-	-	574	624	-	658	619	-
Time blocked-Platoon(%)	0	-	-	0	-	-	0	0	0	0	0	0
Mov Capacity-1 Maneuver	1258	-	-	974	-	-	287	346	595	330	344	894
Mov Capacity-2 Maneuver	-	-	-	-	-	-	287	346	-	330	344	-
Stage 1	-	-	-	-	-	-	573	623	-	667	613	-
Stage 2	-	-	-	-	-	-	559	611	-	636	618	-

Approach	EB	WB	NB	SB
HCM Control Delay (s)	0	0.5	16.1	13.4
HCM LOS	A	A	C	B

Lane	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (vph)	369							441
HCM Control Delay (s)	16.1	7.864	0	-	8.776	0	-	13.4
HCM Lane VC Ratio	0.124	0.001	-	-	0.021	-	-	0.023
HCM Lane LOS	C	A	A	-	A	A	-	B
HCM 95th Percentile Queue (veh)	0.419	0.002	-	-	0.065	-	-	0.07

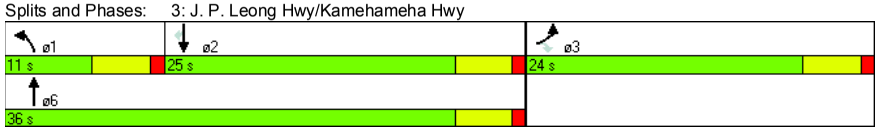
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	270	27	44	284	251	337
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1719	1615	1805	1792	1845	1568
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1719	1615	1805	1792	1845	1568
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		127				362
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.87	1.00	0.61	0.97	1.00	0.93
Heavy Vehicles (%)	5%	0%	0%	6%	3%	3%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	310	27	72	293	251	362
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	24.0	24.0	11.0	36.0	25.0	25.0
Total Split (%)	40.0%	40.0%	18.3%	60.0%	41.7%	41.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	14.1	14.1	6.0	28.2	22.2	22.2
Actuated g/C Ratio	0.27	0.27	0.11	0.54	0.42	0.42
v/c Ratio	0.67	0.05	0.35	0.30	0.32	0.42
Control Delay	25.4	0.2	29.2	8.5	14.6	3.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	25.4	0.2	29.2	8.5	14.6	3.7
LOS	C	A	C	A	B	A
Approach Delay	23.4			12.6	8.2	
Approach LOS	C			B	A	
Queue Length 50th (ft)	92	0	23	46	61	0
Queue Length 95th (ft)	155	0	39	99	124	49
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	636	678	211	1082	781	872
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.49	0.04	0.34	0.27	0.32	0.42

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 52.5
Natural Cycle: 55
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.67
Intersection Signal Delay: 13.3 — Intersection LOS: B
Intersection Capacity Utilization 44.0% — ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection

Intersection Delay (sec/veh): $ 473

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	42	101	386	152	512	456
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	0.75	0.84	0.98	0.83	0.77	1.00
Heavy Vehicles(%)	6	7	5	4	2	3
Movement Flow Rate	56	120	394	183	665	456
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1			Major 2
Conflicting Flow Rate - All	2272	289	0	0	577	0
Stage 1	486	-	-	-	-	-
Stage 2	1786	-	-	-	-	-
Follow-up Headway	3.554	3.363	-	-	2.218	-
Pot Capacity-1 Maneuver	# 43	738	-	-	996	-
Stage 1	610	-	-	-	-	-
Stage 2	144	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	# 5	738	-	-	996	-
Mov Capacity-2 Maneuver	# 5	-	-	-	-	-
Stage 1	610	-	-	-	-	-
Stage 2	# 15	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	$ 4971.9	0	9.2
HCM LOS	F	A	A

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			16		
HCM Control Delay (s)	-	-	$ 4971.9	15.552	-
HCM Lane VC Ratio	-	-	11.015	0.668	-
HCM Lane LOS	-	-	F	C	-
HCM 95th Percentile Queue (veh)	-	-	22.914	5.337	-

Intersection	
Intersection Delay (sec/veh):	4.4

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Volume (vph)	118	320	347	108	75	111
Conflicting Peds.(#/hr)	0	0	0	0	3	1
Sign Control	Free	Free	Free	Free	Stop	Stop
Right Turn Channelized	None	None	Yield	Yield	Free	Free
Storage Length	0			0	0	0
Median Width		0	0		12	
Grade (%)		0%	0%		0%	
Peak Hour Factor	0.92	0.80	0.85	0.87	0.99	0.90
Heavy Vehicles(%)	2	3	5	8	4	7
Movement Flow Rate	128	400	408	124	76	123
Number of Lanes	0	1	1	0	1	1

Major/Minor	Major 1		Major 2			
Conflicting Flow Rate - All	535	0	0	0	1129	473
Stage 1	-	-	-	-	473	-
Stage 2	-	-	-	-	656	-
Follow-up Headway	2.218	-	-	-	3.536	3.363
Pot Capacity-1 Maneuver	1033	-	-	-	224	581
Stage 1	-	-	-	-	623	-
Stage 2	-	-	-	-	513	-
Time blocked-Platoon(%)	0	-	-	-	0	0
Mov Capacity-1 Maneuver	1033	-	-	-	187	580
Mov Capacity-2 Maneuver	-	-	-	-	187	-
Stage 1	-	-	-	-	621	-
Stage 2	-	-	-	-	430	-

Approach	EB	WB	SB
HCM Control Delay (s)	2.2	0	22
HCM LOS	A	A	C

Lane	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (vph)					187	580
HCM Control Delay (s)	8.978	-	-	-	36.8	12.9
HCM Lane VC Ratio	0.124	-	-	-	0.405	0.213
HCM Lane LOS	A	-	-	-	E	B
HCM 95th Percentile Queue (veh)	0.424	-	-	-	1.808	0.799

Intersection	
Intersection Delay (sec/veh):	1.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	2	369	24	28	428	7	24	0	20	7	0	3
Conflicting Peds.(#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
Right Turn Channelized	None	None	None	None	None	None	None	None	None	None	None	None
Storage Length	0		0	330		0	0		0	0		0
Median Width		12			12			0			0	
Grade (%)		0%			0%			0%			0%	
Peak Hour Factor	0.25	0.86	0.92	0.92	0.90	1.00	0.92	0.92	0.92	1.00	0.92	0.75
Heavy Vehicles(%)	0	3	50	50	5	0	50	5	50	0	5	0
Movement Flow Rate	8	429	26	30	476	7	26	0	22	7	0	4
Number of Lanes	0	1	0	1	1	0	0	1	0	0	1	0

Major/Minor	Major 1			Major 2			Minor 1			Minor 2		
Conflicting Flow Rate - All	483	0	0	455	0	0	1000	1001	442	1009	1011	242
Stage 1	-	-	-	-	-	-	458	458	-	540	540	-
Stage 2	-	-	-	-	-	-	542	543	-	469	471	-
Follow-up Headway	2.2	-	-	2.65	-	-	3.95	4.045	3.75	3.5	4.045	3.3
Pot Capacity-1 Maneuver	1090	-	-	894	-	-	182	240	526	221	237	802
Stage 1	-	-	-	-	-	-	501	562	-	530	517	-
Stage 2	-	-	-	-	-	-	448	515	-	579	554	-
Time blocked-Platoon(%)	0	-	-	0	-	-	0	0	0	0	0	0
Mov Capacity-1 Maneuver	1090	-	-	894	-	-	175	230	526	205	227	802
Mov Capacity-2 Maneuver	-	-	-	-	-	-	175	230	-	205	227	-
Stage 1	-	-	-	-	-	-	496	556	-	525	500	-
Stage 2	-	-	-	-	-	-	431	498	-	550	548	-

Approach	EB	WB	NB	SB
HCM Control Delay (s)	0.1	0.5	22.7	18.3
HCM LOS	A	A	C	C

Lane	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (vph)	251							281
HCM Control Delay (s)	22.7	8.327	0	-	9.169	0	-	18.3
HCM Lane VC Ratio	0.191	0.007	-	-	0.034	-	-	0.039
HCM Lane LOS	C	A	A	-	A	A	-	C
HCM 95th Percentile Queue (veh)	0.688	0.022	-	-	0.106	-	-	0.122

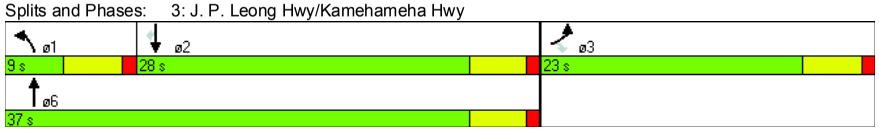
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	344	18	43	415	379	410
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1787	1615	1805	1900	1810	1583
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1787	1615	1805	1900	1810	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		127				423
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.98	1.00	1.00	1.00	0.85	0.97
Heavy Vehicles (%)	1%	0%	0%	0%	5%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	351	18	43	415	446	423
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	23.0	23.0	9.0	37.0	28.0	28.0
Total Split (%)	38.3%	38.3%	15.0%	61.7%	46.7%	46.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	14.2	14.2	4.1	27.5	24.4	24.4
Actuated g/C Ratio	0.27	0.27	0.08	0.53	0.47	0.47
v/c Ratio	0.72	0.03	0.30	0.41	0.52	0.44
Control Delay	26.6	0.1	31.2	9.4	14.7	3.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	26.6	0.1	31.2	9.4	14.7	3.3
LOS	C	A	C	A	B	A
Approach Delay	25.3			11.4	9.2	
Approach LOS	C			B	A	
Queue Length 50th (ft)	82	0	11	67	74	0
Queue Length 95th (ft)	189	0	42	137	197	48
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	631	652	141	1193	851	968
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.56	0.03	0.30	0.35	0.52	0.44

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 51.8
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.72
Intersection Signal Delay: 13.3 — Intersection LOS: B
Intersection Capacity Utilization 54.8% — ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection	
Intersection Delay (sec/veh):	13.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	61	296	782	77	93	706
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	0.95	0.99	0.95	0.84	1.00	1.00
Heavy Vehicles(%)	6	5	3	5	3	2
Movement Flow Rate	64	299	823	92	93	706
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1			Major 2
Conflicting Flow Rate - All	1761	458	0	0	915	0
Stage 1	869	-	-	-	-	-
Stage 2	892	-	-	-	-	-
Follow-up Headway	3.554	3.345	-	-	2.227	-
Pot Capacity-1 Maneuver	91	597	-	-	741	-
Stage 1	404	-	-	-	-	-
Stage 2	394	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	72	597	-	-	741	-
Mov Capacity-2 Maneuver	72	-	-	-	-	-
Stage 1	404	-	-	-	-	-
Stage 2	313	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	75.5	0	1.2
HCM LOS	F	A	A

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			371		
HCM Control Delay (s)	-	-	75.5	10.554	-
HCM Lane VC Ratio	-	-	0.979	0.126	-
HCM Lane LOS	-	-	F	B	-
HCM 95th Percentile Queue (veh)	-	-	11.193	0.428	-

Intersection	
Intersection Delay (sec/veh):	9.4

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Volume (vph)	149	375	413	105	105	109
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
Right Turn Channelized	None	None	Yield	Yield	Free	Free
Storage Length	0			0	0	0
Median Width		0	0		12	
Grade (%)		0%	0%		0%	
Peak Hour Factor	1.00	0.98	0.97	0.94	0.80	0.74
Heavy Vehicles(%)	3	2	5	4	3	2
Movement Flow Rate	149	383	426	112	131	147
Number of Lanes	0	1	1	0	1	1

Major/Minor		Major 1		Major 2		
Conflicting Flow Rate - All	538	0	0	0	1163	482
Stage 1	-	-	-	-	482	-
Stage 2	-	-	-	-	681	-
Follow-up Headway	2.227	-	-	-	3.527	3.318
Pot Capacity-1 Maneuver	1025	-	-	-	214	584
Stage 1	-	-	-	-	619	-
Stage 2	-	-	-	-	501	-
Time blocked-Platoon(%)	0	-	-	-	0	0
Mov Capacity-1 Maneuver	1025	-	-	-	174	584
Mov Capacity-2 Maneuver	-	-	-	-	174	-
Stage 1	-	-	-	-	619	-
Stage 2	-	-	-	-	408	-

Approach	EB	WB	SB
HCM Control Delay (s)	2.6	0	40.3
HCM LOS	A	A	E

Lane	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (vph)					174	584
HCM Control Delay (s)	9.109	-	-	-	70.8	13.2
HCM Lane VC Ratio	0.145	-	-	-	0.754	0.252
HCM Lane LOS	A	-	-	-	F	B
HCM 95th Percentile Queue (veh)	0.508	-	-	-	4.835	0.994

Intersection	
Intersection Delay (sec/veh):	1.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	3	460	18	18	496	5	16	0	16	3	0	5
Conflicting Peds.(#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
Right Turn Channelized	None	None	None	None	None	None	None	None	None	None	None	None
Storage Length	0		0	330		0	0		0	0		0
Median Width		12			12			0			0	
Grade (%)		0%			0%			0%			0%	
Peak Hour Factor	0.75	0.95	0.92	0.92	0.98	1.00	0.92	0.92	0.92	0.75	0.92	0.42
Heavy Vehicles(%)	0	2	50	50	4	0	50	5	50	0	5	0
Movement Flow Rate	4	484	20	20	506	5	17	0	17	4	0	12
Number of Lanes	0	1	0	1	1	0	0	1	0	0	1	0

Major/Minor	Major 1			Major 2			Minor 1			Minor 2		
Conflicting Flow Rate - All	511	0	0	504	0	0	1057	1053	494	1060	1061	256
Stage 1	-	-	-	-	-	-	502	502	-	549	549	-
Stage 2	-	-	-	-	-	-	555	551	-	511	512	-
Follow-up Headway	2.2	-	-	2.65	-	-	3.95	4.045	3.75	3.5	4.045	3.3
Pot Capacity-1 Maneuver	1065	-	-	854	-	-	165	223	490	204	221	788
Stage 1	-	-	-	-	-	-	472	537	-	524	512	-
Stage 2	-	-	-	-	-	-	440	510	-	549	532	-
Time blocked-Platoon(%)	0	-	-	0	-	-	0	0	0	0	0	0
Mov Capacity-1 Maneuver	1065	-	-	854	-	-	159	217	490	193	215	788
Mov Capacity-2 Maneuver	-	-	-	-	-	-	159	217	-	193	215	-
Stage 1	-	-	-	-	-	-	470	534	-	521	500	-
Stage 2	-	-	-	-	-	-	423	498	-	527	529	-

Approach	EB	WB	NB	SB
HCM Control Delay (s)	0.1	0.3	22.5	13.4
HCM LOS	A	A	C	B

Lane	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (vph)	240							444
HCM Control Delay (s)	22.5	8.393	0	-	9.314	0	-	13.4
HCM Lane VC Ratio	0.145	0.004	-	-	0.023	-	-	0.036
HCM Lane LOS	C	A	A	-	A	A	-	B
HCM 95th Percentile Queue (veh)	0.499	0.011	-	-	0.07	-	-	0.111

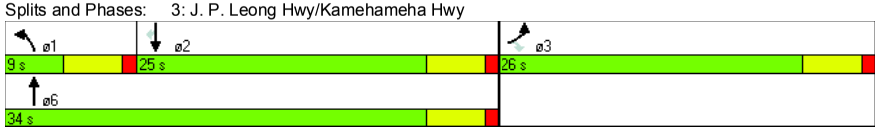
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	371	41	76	477	382	436
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1787	1615	1805	1845	1881	1583
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1787	1615	1805	1845	1881	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		127				501
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.83	0.68	1.00	1.00	0.95	0.87
Heavy Vehicles (%)	1%	0%	0%	3%	1%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	447	60	76	477	402	501
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	26.0	26.0	9.0	34.0	25.0	25.0
Total Split (%)	43.3%	43.3%	15.0%	56.7%	41.7%	41.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	17.5	17.5	4.1	27.2	20.4	20.4
Actuated g/C Ratio	0.32	0.32	0.07	0.50	0.37	0.37
v/c Ratio	0.79	0.10	0.57	0.52	0.57	0.55
Control Delay	28.7	0.7	47.1	12.7	19.8	4.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	28.7	0.7	47.1	12.7	19.8	4.5
LOS	C	A	D	B	B	A
Approach Delay	25.4			17.4	11.3	
Approach LOS	C			B	B	
Queue Length 50th (ft)	137	0	27	106	116	0
Queue Length 95th (ft)	204	0	#84	187	204	49
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	698	708	134	995	700	903
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.64	0.08	0.57	0.48	0.57	0.55

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 54.9
Natural Cycle: 55
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.79
Intersection Signal Delay: 16.7 Intersection LOS: B
Intersection Capacity Utilization 57.4% ICU Level of Service B
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection

Intersection Delay (sec/veh): 22.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	56	255	729	92	83	759
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	1.00	1.00	0.91	0.79	0.78	0.92
Heavy Vehicles(%)	7	2	2	6	4	3
Movement Flow Rate	56	255	801	116	106	825
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1			Major 2
Conflicting Flow Rate - All	1896	459	0	0	917	0
Stage 1	859	-	-	-	-	-
Stage 2	1037	-	-	-	-	-
Follow-up Headway	3.563	3.318	-	-	2.236	-
Pot Capacity-1 Maneuver	74	602	-	-	736	-
Stage 1	407	-	-	-	-	-
Stage 2	334	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	# 54	602	-	-	736	-
Mov Capacity-2 Maneuver	# 54	-	-	-	-	-
Stage 1	407	-	-	-	-	-
Stage 2	245	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	150.9	0	1.2
HCM LOS	F	A	A

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			265		
HCM Control Delay (s)	-	-	150.9	10.716	-
HCM Lane VC Ratio	-	-	1.174	0.145	-
HCM Lane LOS	-	-	F	B	-
HCM 95th Percentile Queue (veh)	-	-	14.05	0.504	-

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/3/11
Analysis Time Period	AM Peak Hour W/O Project
Highway	Kamehameha Highway
From/To	West of Kuilima Drive
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.93	
Lane width	12.0	ft	% Trucks and buses	8	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V	640	veh/h	
Directional split	51 / 49	%	

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.2	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.984	
Two-way flow rate,(note-1) vp	699	pc/h
Highest directional split proportion (note-2)	356	pc/h
Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h

Adjustment for no-passing zones, fnp	2.4	mi/h
Average travel speed, ATS	36.6	mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	0.992	
Two-way flow rate,(note-1) vp	694	pc/h
Highest directional split proportion (note-2)	354	
Base percent time-spent-following, BPTSF	45.7	%
Adj.for directional distribution and no-passing zones, fd/np	15.3	
Percent time-spent-following, PTSF	61.0	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.22	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	AM Peak Hour W/O Project
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.94	
Lane width	12.0	ft	% Trucks and buses	5	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1142 veh/h
Directional split 51 / 49 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.995	
Two-way flow rate,(note-1) vp	1221	pc/h
Highest directional split proportion (note-2)	623	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.8	mi/h

Average travel speed, ATS 33.2 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1215	pc/h
Highest directional split proportion (note-2)	620	
Base percent time-spent-following, BPTSF	65.6	%
Adj.for directional distribution and no-passing zones, fd/np	9.5	
Percent time-spent-following, PTSF	75.1	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.38	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	AM Peak Hour W/O Project
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.89	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 1455 veh/h
Directional split 67 / 33 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.997	
Two-way flow rate,(note-1) vp	1640	pc/h
Highest directional split proportion (note-2)	1099	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	1.3	mi/h

Average travel speed, ATS 28.5 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1635	pc/h
Highest directional split proportion (note-2)	1095	
Base percent time-spent-following, BPTSF	76.2	%
Adj.for directional distribution and no-passing zones, fd/np	6.3	
Percent time-spent-following, PTSF	82.5	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.51	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/3/11
Analysis Time Period	PM Peak Hour W/O Project
Highway	Kamehameha Highway
From/To	West of Kuilima Drive
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.85	
Lane width	12.0	ft	% Trucks and buses	4	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V	896	veh/h	
Directional split	51 / 49	%	

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.2	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.992	
Two-way flow rate,(note-1) vp	1063	pc/h
Highest directional split proportion (note-2)	542	pc/h
Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.7	mi/h

Average travel speed, ATS	34.6	mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	0.996	
Two-way flow rate,(note-1) vp	1058	pc/h
Highest directional split proportion (note-2)	540	
Base percent time-spent-following, BPTSF	60.5	%
Adj.for directional distribution and no-passing zones, fd/np	10.1	
Percent time-spent-following, PTSF	70.6	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.33	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	PM Peak Hour W/O Project
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.94	
Lane width	12.0	ft	% Trucks and buses	2	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1548 veh/h
Directional split 51 / 49 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.998	
Two-way flow rate,(note-1) vp	1650	pc/h
Highest directional split proportion (note-2)	842	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h

Estimated Free-Flow Speed:

Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.3	mi/h

Average travel speed, ATS 30.4 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1647	pc/h
Highest directional split proportion (note-2)	840	
Base percent time-spent-following, BPTSF	76.5	%
Adj.for directional distribution and no-passing zones, fd/np	6.0	
Percent time-spent-following, PTSF	82.5	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.52	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	PM Peak Hour W/O Project
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.99	
Lane width	12.0	ft	% Trucks and buses	5	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 1877 veh/h
Directional split 57 / 43 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.995	
Two-way flow rate,(note-1) vp	1905	pc/h
Highest directional split proportion (note-2)	1086	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	1.0	mi/h

Average travel speed, ATS 26.7 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1896	pc/h
Highest directional split proportion (note-2)	1081	
Base percent time-spent-following, BPTSF	81.1	%
Adj.for directional distribution and no-passing zones, fd/np	4.6	
Percent time-spent-following, PTSF	85.7	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.60	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/5/11
Analysis Time Period	Saturday Peak Hour W/O Project
Highway	Kamehameha Highway
From/To	West of Kuilima Drive
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.94	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V	1046	veh/h	
Directional split	50 / 50	%	

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.2	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.994	
Two-way flow rate,(note-1) vp	1119	pc/h
Highest directional split proportion (note-2)	560	pc/h
Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.6	mi/h

Average travel speed, ATS	34.3	mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	0.997	
Two-way flow rate,(note-1) vp	1116	pc/h
Highest directional split proportion (note-2)	558	
Base percent time-spent-following, BPTSF	62.5	%
Adj.for directional distribution and no-passing zones, fd/np	9.5	
Percent time-spent-following, PTSF	72.0	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.35	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	10/29/2011
Analysis Time Period	Saturday Peak Hour W/O Project
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.92	
Lane width	12.0	ft	% Trucks and buses	2	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V	1667	veh/h
Directional split	51 / 49	%

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.998	
Two-way flow rate,(note-1) vp	1816	pc/h
Highest directional split proportion (note-2)	926	pc/h
Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.1	mi/h

Average travel speed, ATS	29.3	mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1812	pc/h
Highest directional split proportion (note-2)	924	
Base percent time-spent-following, BPTSF	79.7	%
Adj.for directional distribution and no-passing zones, fd/np	5.1	
Percent time-spent-following, PTSF	84.8	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.57	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	10/29/2011
Analysis Time Period	Sat Peak Hr W/O Project
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.94	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 1826 veh/h
Directional split 54 / 46 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.997	
Two-way flow rate,(note-1) vp	1948	pc/h
Highest directional split proportion (note-2)	1052	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h

Estimated Free-Flow Speed:

Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	1.0	mi/h

Average travel speed, ATS 26.4 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1943	pc/h
Highest directional split proportion (note-2)	1049	
Base percent time-spent-following, BPTSF	81.9	%
Adj.for directional distribution and no-passing zones, fd/np	4.4	
Percent time-spent-following, PTSF	86.3	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.61	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

TRAFFIC IMPACT ANALYSIS REPORT

FOR THE PROPOSED

TURTLE BAY RESORT MASTER PLAN

KAHUKU, OAHU, HAWAII

APPENDIX D

CAPACITY ANALYSIS WORKSHEETS

2025 TRAFFIC CONDITIONS
WITH FULL BUILD OUT ALTERNATIVE

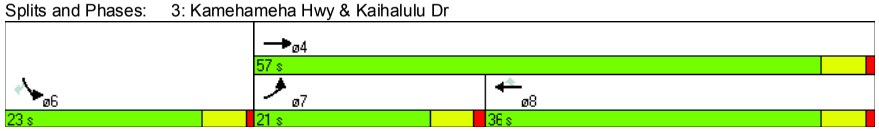
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	405	445	465	157	206	402
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	300			400	0	0
Storage Lanes	2			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	3367	1681	1792	1509	1703	1509
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	3367	1681	1792	1509	1703	1509
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				171		437
Link Speed (mph)		45	45		30	
Link Distance (ft)		500	3000		500	
Travel Time (s)		7.6	45.5		11.4	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	4%	13%	6%	7%	6%	7%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	440	484	505	171	224	437
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	21.0	57.0	36.0	36.0	23.0	23.0
Total Split (%)	26.3%	71.3%	45.0%	45.0%	28.8%	28.8%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	13.7	43.3	24.5	24.5	18.3	18.3
Actuated g/C Ratio	0.19	0.60	0.34	0.34	0.26	0.26
v/c Ratio	0.68	0.48	0.83	0.27	0.52	0.62
Control Delay	33.9	9.3	34.0	4.1	30.3	7.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	33.9	9.3	34.0	4.1	30.3	7.3
LOS	C	A	C	A	C	A
Approach Delay		21.0	26.5		15.1	
Approach LOS		C	C		B	
Queue Length 50th (ft)	96	104	204	0	90	0
Queue Length 95th (ft)	152	164	326	37	172	76
Internal Link Dist (ft)		420	2920		420	
Turn Bay Length (ft)	300			400		
Base Capacity (vph)	762	1237	786	758	434	710
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.58	0.39	0.64	0.23	0.52	0.62

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 71.7
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.83
Intersection Signal Delay: 20.9 — Intersection LOS: C
Intersection Capacity Utilization 59.9% — ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 3: Kamehameha Hwy & Kaihalulu Dr



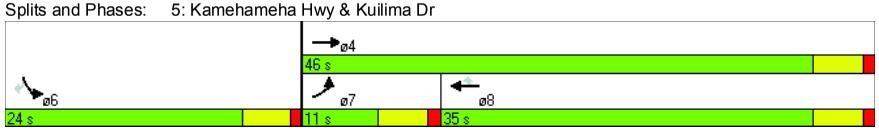
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	149	502	471	180	238	151
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200			400	0	0
Storage Lanes	2			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	3367	1681	1792	1509	1703	1509
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	3363	1681	1792	1480	1677	1490
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				196		164
Link Speed (mph)		45	45		25	
Link Distance (ft)		500	5500		500	
Travel Time (s)		7.6	83.3		13.6	
Confl. Peds. (#/hr)	1			1	7	
Confl. Bikes (#/hr)				12		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	4%	13%	6%	7%	6%	7%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	162	546	512	196	259	164
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	21.0	21.0	21.0	21.0	21.0
Total Split (s)	11.0	46.0	35.0	35.0	24.0	24.0
Total Split (%)	15.7%	65.7%	50.0%	50.0%	34.3%	34.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Min	Min
Act Effct Green (s)	6.6	29.5	21.4	21.4	13.8	13.8
Actuated g/C Ratio	0.12	0.54	0.39	0.39	0.25	0.25
v/c Ratio	0.40	0.60	0.73	0.28	0.60	0.33
Control Delay	30.3	11.4	22.0	3.4	26.6	6.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	30.3	11.4	22.0	3.4	26.6	6.0
LOS	C	B	C	A	C	A
Approach Delay		15.7	16.8		18.6	
Approach LOS		B	B		B	
Queue Length 50th (ft)	27	101	144	0	78	0
Queue Length 95th (ft)	63	211	272	33	166	41
Internal Link Dist (ft)		420	5420		420	
Turn Bay Length (ft)	200			400		

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Base Capacity (vph)	407	1269	1084	972	652	672
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.40	0.43	0.47	0.20	0.40	0.24

Intersection Summary

Area Type: Other
Cycle Length: 70
Actuated Cycle Length: 54.2
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.73
Intersection Signal Delay: 16.8 — Intersection LOS: B
Intersection Capacity Utilization 54.7% — ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 5: Kamehameha Hwy & Kuilima Dr



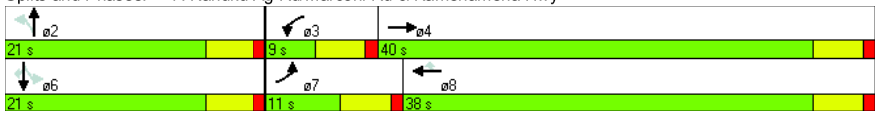
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	82	641	17	19	548	73	24	0	18	73	0	79
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200		0	330		400	0		0	0		200
Storage Lanes	1		0	1		1	0		0	0		1
Taper Length (ft)	100			100			100			100		
Satd. Flow (prot)	1805	1661	0	1203	1792	1615	0	1160	0	0	1805	1615
Flt Permitted	0.950			0.950				0.792			0.727	
Satd. Flow (perm)	1805	1661	0	1203	1792	1570	0	944	0	0	1381	1615
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		3				109		109				109
Link Speed (mph)		45			45			30			25	
Link Distance (ft)		500			1200			500			500	
Travel Time (s)		7.6			18.2			11.4			13.6	
Confl. Bikes (#/hr)						10						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	0%	13%	50%	50%	6%	0%	50%	2%	50%	0%	2%	0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	89	715	0	21	596	79	0	46	0	0	79	86
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases						8	2			6		6
Detector Phase	7	4		3	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	9.0	21.0		9.0	21.0	21.0	21.0	21.0		21.0	21.0	21.0
Total Split (s)	11.0	40.0		9.0	38.0	38.0	21.0	21.0		21.0	21.0	21.0
Total Split (%)	15.7%	57.1%		12.9%	54.3%	54.3%	30.0%	30.0%		30.0%	30.0%	30.0%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Lost Time (s)	5.0	5.0		5.0	5.0	5.0		5.0			5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag	Lag						
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	Min
Act Effct Green (s)	6.4	29.8		4.3	23.0	23.0		8.8			8.8	8.8
Actuated g/C Ratio	0.13	0.59		0.08	0.45	0.45		0.17			0.17	0.17
v/c Ratio	0.39	0.73		0.21	0.73	0.10		0.18			0.33	0.23
Control Delay	32.1	14.7		32.8	18.7	1.6		1.6			25.7	5.6
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Delay	32.1	14.7		32.8	18.7	1.6		1.6			25.7	5.6
LOS	C	B		C	B	A		A			C	A
Approach Delay		16.6			17.2			1.6			15.2	
Approach LOS		B			B			A			B	
Queue Length 50th (ft)	26	109		6	146	0		0			22	0
Queue Length 95th (ft)	#89	#437		28	282	12		2			63	24
Internal Link Dist (ft)		420			1120			420			420	
Turn Bay Length (ft)	200			330		400						200
Base Capacity (vph)	229	1202		102	1222	1105		392			469	620

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Starvation Cap Reductn	0	0		0	0	0		0			0	0
Spillback Cap Reductn	0	0		0	0	0		0			0	0
Storage Cap Reductn	0	0		0	0	0		0			0	0
Reduced v/c Ratio	0.39	0.59		0.21	0.49	0.07		0.12			0.17	0.14

Intersection Summary

Area Type: Other
Cycle Length: 70
Actuated Cycle Length: 50.7
Natural Cycle: 65
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.73
Intersection Signal Delay: 16.3 — Intersection LOS: B
Intersection Capacity Utilization 59.7% — ICU Level of Service B
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 7: Kahuku Ag Rd/Marconi Rd & Kamehameha Hwy



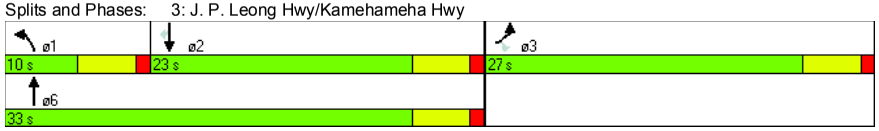
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	447	27	44	469	406	543
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1719	1615	1805	1792	1845	1568
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1719	1615	1805	1792	1845	1568
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		127				578
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.88	1.00	0.61	0.97	1.00	0.94
Heavy Vehicles (%)	5%	0%	0%	6%	3%	3%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	508	27	72	484	406	578
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	27.0	27.0	10.0	33.0	23.0	23.0
Total Split (%)	45.0%	45.0%	16.7%	55.0%	38.3%	38.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	18.9	18.9	5.1	23.8	18.5	18.5
Actuated g/C Ratio	0.36	0.36	0.10	0.45	0.35	0.35
v/c Ratio	0.83	0.04	0.41	0.60	0.63	0.63
Control Delay	30.6	0.1	33.7	15.2	23.0	5.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	30.6	0.1	33.7	15.2	23.0	5.4
LOS	C	A	C	B	C	A
Approach Delay	29.1			17.6	12.6	
Approach LOS	C			B	B	
Queue Length 50th (ft)	160	0	26	120	130	0
Queue Length 95th (ft)	#300	0	40	202	#249	63
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	734	763	175	975	645	924
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.69	0.04	0.41	0.50	0.63	0.63

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 53
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.83
Intersection Signal Delay: 18.2 — Intersection LOS: B
Intersection Capacity Utilization 62.0% — ICU Level of Service B
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection

Intersection Delay (sec/veh): 82.8

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	42	134	509	152	577	515
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	0.75	0.83	0.96	0.83	0.77	1.00
Heavy Vehicles(%)	6	7	5	4	2	3
Movement Flow Rate	56	161	530	183	749	515
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1			Major 2
Conflicting Flow Rate - All	2635	357	0	0	713	0
Stage 1	622	-	-	-	-	-
Stage 2	2013	-	-	-	-	-
Follow-up Headway	3.554	3.363	-	-	2.218	-
Pot Capacity-1 Maneuver	# 25	676	-	-	887	-
Stage 1	528	-	-	-	-	-
Stage 2	110	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	# 25	676	-	-	887	-
Mov Capacity-2 Maneuver	# 25	-	-	-	-	-
Stage 1	528	-	-	-	-	-
Stage 2	110	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	$ 744.4	0	15.8
HCM LOS	F	A	C

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			90		
HCM Control Delay (s)	-	-	$ 744.4	26.698	-
HCM Lane VC Ratio	-	-	2.416	0.845	-
HCM Lane LOS	-	-	F	D	-
HCM 95th Percentile Queue (veh)	-	-	20.007	10.239	-

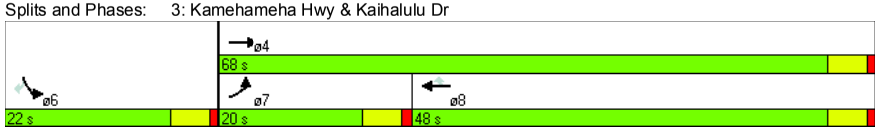
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	455	581	631	250	186	497
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	300			400	0	0
Storage Lanes	2			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	3433	1845	1810	1495	1736	1509
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	3433	1845	1810	1495	1736	1509
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				272		405
Link Speed (mph)		45	45		30	
Link Distance (ft)		500	3000		500	
Travel Time (s)		7.6	45.5		11.4	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	2%	3%	5%	8%	4%	7%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	495	632	686	272	202	540
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	20.0	68.0	48.0	48.0	22.0	22.0
Total Split (%)	22.2%	75.6%	53.3%	53.3%	24.4%	24.4%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	14.5	55.6	36.0	36.0	17.2	17.2
Actuated g/C Ratio	0.17	0.67	0.43	0.43	0.21	0.21
v/c Ratio	0.82	0.51	0.87	0.34	0.56	0.85
Control Delay	47.2	8.3	34.5	3.0	38.5	24.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	47.2	8.3	34.5	3.0	38.5	24.1
LOS	D	A	C	A	D	C
Approach Delay		25.4	25.6		28.1	
Approach LOS		C	C		C	
Queue Length 50th (ft)	135	140	315	0	101	66
Queue Length 95th (ft)	#226	208	469	40	179	#272
Internal Link Dist (ft)		420	2920		420	
Turn Bay Length (ft)	300			400		
Base Capacity (vph)	627	1416	948	912	359	633
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.79	0.45	0.72	0.30	0.56	0.85

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 82.9
Natural Cycle: 80
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.87
Intersection Signal Delay: 26.1 — Intersection LOS: C
Intersection Capacity Utilization 72.3% — ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Kamehameha Hwy & Kaihalulu Dr



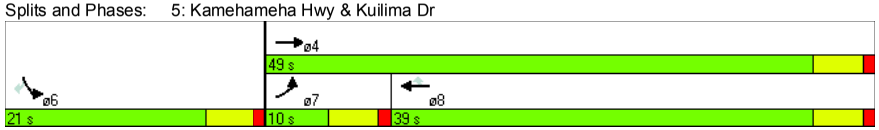
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	183	584	694	338	219	187
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200			400	0	0
Storage Lanes	2			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	3406	1815	1781	1471	1715	1503
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	3406	1815	1781	1446	1703	1482
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				367		203
Link Speed (mph)		45	45		25	
Link Distance (ft)		500	5500		500	
Travel Time (s)		7.6	83.3		13.6	
Confl. Peds. (#/hr)					3	1
Confl. Bikes (#/hr)				12		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	2%	3%	5%	8%	4%	7%
Bus Blockages (#/hr)	4	4	4	4	3	1
Shared Lane Traffic (%)						
Lane Group Flow (vph)	199	635	754	367	238	203
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	21.0	21.0	21.0	21.0	21.0
Total Split (s)	10.0	49.0	39.0	39.0	21.0	21.0
Total Split (%)	14.3%	70.0%	55.7%	55.7%	30.0%	30.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Min	Min
Act Effct Green (s)	5.1	40.7	30.5	30.5	13.2	13.2
Actuated g/C Ratio	0.08	0.64	0.48	0.48	0.21	0.21
v/c Ratio	0.74	0.55	0.89	0.42	0.68	0.44
Control Delay	49.9	9.1	30.6	2.9	34.7	7.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	49.9	9.1	30.6	2.9	34.7	7.2
LOS	D	A	C	A	C	A
Approach Delay		18.9	21.5		22.0	
Approach LOS		B	C		C	
Queue Length 50th (ft)	43	126	260	0	92	0
Queue Length 95th (ft)	#97	217	#493	39	162	48
Internal Link Dist (ft)		420	5420		420	

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Turn Bay Length (ft)	200			400		
Base Capacity (vph)	270	1270	963	950	436	528
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.74	0.50	0.78	0.39	0.55	0.38

Intersection Summary

Area Type: Other
Cycle Length: 70
Actuated Cycle Length: 64
Natural Cycle: 65
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.89
Intersection Signal Delay: 20.7 — Intersection LOS: C
Intersection Capacity Utilization 66.4% — ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 5: Kamehameha Hwy & Kuilima Dr



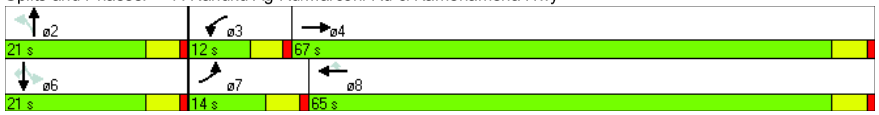
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	94	685	24	28	911	95	24	0	20	88	0	97
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200		0	330		400	0		0	0		200
Storage Lanes	1		0	1		1	0		0	0		1
Taper Length (ft)	100			100			100			100		
Satd. Flow (prot)	1805	1655	0	1203	1792	1615	0	1157	0	0	1805	1615
Flt Permitted	0.950			0.950				0.796			0.726	
Satd. Flow (perm)	1805	1655	0	1203	1792	1573	0	946	0	0	1379	1615
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		3				103		76				105
Link Speed (mph)		45			45			30			25	
Link Distance (ft)		500			1200			500			500	
Travel Time (s)		7.6			18.2			11.4			13.6	
Confl. Bikes (#/hr)						10						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	0%	13%	50%	50%	6%	0%	50%	2%	50%	0%	2%	0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	102	771	0	30	990	103	0	48	0	0	96	105
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases						8	2			6		6
Detector Phase	7	4		3	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	9.0	21.0		9.0	21.0	21.0	21.0	21.0		21.0	21.0	21.0
Total Split (s)	14.0	67.0		12.0	65.0	65.0	21.0	21.0		21.0	21.0	21.0
Total Split (%)	14.0%	67.0%		12.0%	65.0%	65.0%	21.0%	21.0%		21.0%	21.0%	21.0%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Lost Time (s)	5.0	5.0		5.0	5.0	5.0		5.0			5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag	Lag						
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	Min
Act Effct Green (s)	8.8	57.1		6.8	53.1	53.1		11.1			11.1	11.1
Actuated g/C Ratio	0.10	0.67		0.08	0.62	0.62		0.13			0.13	0.13
v/c Ratio	0.55	0.69		0.31	0.89	0.10		0.25			0.54	0.35
Control Delay	54.0	14.6		52.0	26.7	2.0		7.0			50.3	11.6
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Delay	54.0	14.6		52.0	26.7	2.0		7.0			50.3	11.6
LOS	D	B		D	C	A		A			D	B
Approach Delay		19.2			25.1			7.0			30.1	
Approach LOS		B			C			A			C	
Queue Length 50th (ft)	60	272		18	449	0		0			56	0
Queue Length 95th (ft)	#134	483		49	#845	20		16			108	46
Internal Link Dist (ft)		420			1120			420			420	
Turn Bay Length (ft)	200			330		400						200
Base Capacity (vph)	203	1217		105	1282	1154		250			276	407

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Starvation Cap Reductn	0	0		0	0	0		0			0	0
Spillback Cap Reductn	0	0		0	0	0		0			0	0
Storage Cap Reductn	0	0		0	0	0		0			0	0
Reduced v/c Ratio	0.50	0.63		0.29	0.77	0.09		0.19			0.35	0.26

Intersection Summary

Area Type: Other
Cycle Length: 100
Actuated Cycle Length: 85.1
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.89
Intersection Signal Delay: 22.9 — Intersection LOS: C
Intersection Capacity Utilization 74.9% — ICU Level of Service D
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 7: Kahuku Ag Rd/Marconi Rd & Kamehameha Hwy



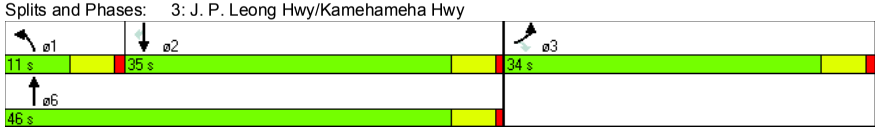
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	561	18	43	676	596	646
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1787	1615	1805	1900	1810	1583
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1787	1615	1805	1900	1810	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		95				687
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.95	0.64	0.60	1.00	1.00	0.94
Heavy Vehicles (%)	1%	0%	0%	0%	5%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	591	28	72	676	596	687
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	34.0	34.0	11.0	46.0	35.0	35.0
Total Split (%)	42.5%	42.5%	13.8%	57.5%	43.8%	43.8%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	27.2	27.2	6.0	38.7	30.4	30.4
Actuated g/C Ratio	0.36	0.36	0.08	0.51	0.40	0.40
v/c Ratio	0.92	0.04	0.51	0.70	0.83	0.66
Control Delay	47.1	0.1	49.4	19.3	34.2	5.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	47.1	0.1	49.4	19.3	34.2	5.1
LOS	D	A	D	B	C	A
Approach Delay	45.0			22.2	18.6	
Approach LOS	D			C	B	
Queue Length 50th (ft)	276	0	35	241	272	0
Queue Length 95th (ft)	#474	0	50	366	#464	68
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	689	681	144	1035	722	1044
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.86	0.04	0.50	0.65	0.83	0.66

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 76.1
Natural Cycle: 80
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.92
Intersection Signal Delay: 25.8 — Intersection LOS: C
Intersection Capacity Utilization 75.1% — ICU Level of Service D
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection	
Intersection Delay (sec/veh):	106.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	61	347	920	77	116	875
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	0.95	0.99	0.96	0.84	1.00	0.99
Heavy Vehicles(%)	6	5	3	5	3	2
Movement Flow Rate	64	351	958	92	116	884
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1			Major 2
Conflicting Flow Rate - All	2120	525	0	0	1050	0
Stage 1	1004	-	-	-	-	-
Stage 2	1116	-	-	-	-	-
Follow-up Headway	3.554	3.345	-	-	2.227	-
Pot Capacity-1 Maneuver	# 54	547	-	-	659	-
Stage 1	348	-	-	-	-	-
Stage 2	308	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	# 35	547	-	-	659	-
Mov Capacity-2 Maneuver	# 35	-	-	-	-	-
Stage 1	348	-	-	-	-	-
Stage 2	201	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	$ 627.7	0	1.3
HCM LOS	F	A	A

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			183		
HCM Control Delay (s)	-	-	$ 627.7	11.626	-
HCM Lane VC Ratio	-	-	2.266	0.176	-
HCM Lane LOS	-	-	F	B	-
HCM 95th Percentile Queue (veh)	-	-	33.594	0.635	-

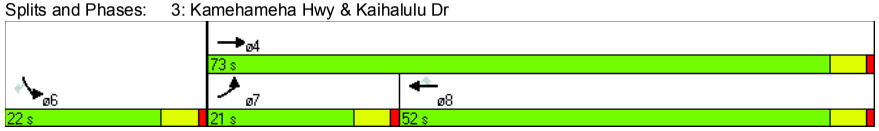
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	418	677	748	190	197	461
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	300			400	0	0
Storage Lanes	2			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	3400	1863	1810	1553	1752	1583
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	3400	1863	1810	1553	1752	1583
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				207		370
Link Speed (mph)		45	45		30	
Link Distance (ft)		500	3000		500	
Travel Time (s)		7.6	45.5		11.4	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	3%	2%	5%	4%	3%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	454	736	813	207	214	501
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	21.0	73.0	52.0	52.0	22.0	22.0
Total Split (%)	22.1%	76.8%	54.7%	54.7%	23.2%	23.2%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	15.2	64.0	43.8	43.8	17.1	17.1
Actuated g/C Ratio	0.17	0.70	0.48	0.48	0.19	0.19
v/c Ratio	0.80	0.56	0.94	0.24	0.65	0.84
Control Delay	49.1	8.5	42.0	2.7	46.3	24.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	49.1	8.5	42.0	2.7	46.3	24.6
LOS	D	A	D	A	D	C
Approach Delay		24.0	34.0		31.1	
Approach LOS		C	C		C	
Queue Length 50th (ft)	137	178	430	0	122	74
Queue Length 95th (ft)	#206	259	#688	35	#214	#259
Internal Link Dist (ft)		420	2920		420	
Turn Bay Length (ft)	300			400		
Base Capacity (vph)	600	1398	938	905	328	597
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.76	0.53	0.87	0.23	0.65	0.84

Intersection Summary

Area Type: Other
Cycle Length: 95
Actuated Cycle Length: 91.2
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.94
Intersection Signal Delay: 29.2 Intersection LOS: C
Intersection Capacity Utilization 76.2% ICU Level of Service D
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Kamehameha Hwy & Kaihalulu Dr



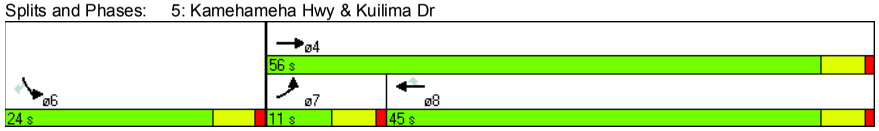
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	191	683	729	277	282	209
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200			400	0	0
Storage Lanes	2			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	3386	1848	1795	1540	1738	1571
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	3386	1848	1795	1514	1738	1550
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				301		227
Link Speed (mph)		45	45		25	
Link Distance (ft)		500	5500		500	
Travel Time (s)		7.6	83.3		13.6	
Confl. Bikes (#/hr)				12		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	3%	2%	5%	4%	3%	2%
Bus Blockages (#/hr)	2	2	2	2	2	2
Shared Lane Traffic (%)						
Lane Group Flow (vph)	208	742	792	301	307	227
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	21.0	21.0	21.0	21.0	21.0
Total Split (s)	11.0	56.0	45.0	45.0	24.0	24.0
Total Split (%)	13.8%	70.0%	56.3%	56.3%	30.0%	30.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Min	Min
Act Effct Green (s)	6.1	47.2	36.0	36.0	16.7	16.7
Actuated g/C Ratio	0.08	0.64	0.49	0.49	0.23	0.23
v/c Ratio	0.75	0.63	0.91	0.34	0.79	0.43
Control Delay	53.8	11.4	34.1	2.6	43.7	6.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	53.8	11.4	34.1	2.6	43.7	6.8
LOS	D	B	C	A	D	A
Approach Delay		20.7	25.4		28.0	
Approach LOS		C	C		C	
Queue Length 50th (ft)	54	198	335	0	142	0
Queue Length 95th (ft)	#110	305	#575	37	#257	53
Internal Link Dist (ft)		420	5420		420	
Turn Bay Length (ft)	200			400		

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Base Capacity (vph)	279	1295	986	967	453	572
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.75	0.57	0.80	0.31	0.68	0.40

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 74
Natural Cycle: 70
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.91
Intersection Signal Delay: 24.2 — Intersection LOS: C
Intersection Capacity Utilization 71.9% — ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 5: Kamehameha Hwy & Kuilima Dr



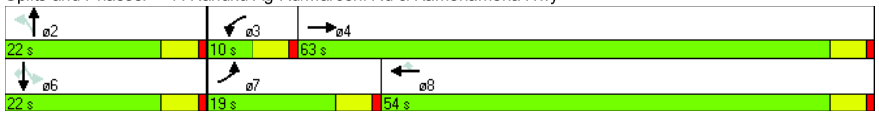
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	169	778	18	18	825	138	16	0	16	130	0	165
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200		0	330		400	0		0	0		200
Storage Lanes	1		0	1		1	0		0	0		1
Taper Length (ft)	100			100			100			100		
Satd. Flow (prot)	1805	1664	0	1203	1792	1615	0	1152	0	0	1805	1615
Flt Permitted	0.950			0.950				0.823			0.735	
Satd. Flow (perm)	1805	1664	0	1203	1792	1571	0	972	0	0	1396	1615
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		2				150		138				179
Link Speed (mph)		45			45			30			25	
Link Distance (ft)		500			1200			500			500	
Travel Time (s)		7.6			18.2			11.4			13.6	
Confl. Bikes (#/hr)						10						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	0%	13%	50%	50%	6%	0%	50%	2%	50%	0%	2%	0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	184	866	0	20	897	150	0	34	0	0	141	179
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases						8	2			6		6
Detector Phase	7	4		3	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	9.0	21.0		9.0	21.0	21.0	21.0	21.0		21.0	21.0	21.0
Total Split (s)	19.0	63.0		10.0	54.0	54.0	22.0	22.0		22.0	22.0	22.0
Total Split (%)	20.0%	66.3%		10.5%	56.8%	56.8%	23.2%	23.2%		23.2%	23.2%	23.2%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Lost Time (s)	5.0	5.0		5.0	5.0	5.0		5.0			5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag	Lag						
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	Min
Act Effct Green (s)	12.6	60.8		5.1	46.8	46.8		13.4			13.4	13.4
Actuated g/C Ratio	0.14	0.69		0.06	0.53	0.53		0.15			0.15	0.15
v/c Ratio	0.71	0.75		0.29	0.94	0.17		0.13			0.67	0.45
Control Delay	53.9	16.7		54.1	39.9	2.6		1.0			51.9	9.5
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Delay	53.9	16.7		54.1	39.9	2.6		1.0			51.9	9.5
LOS	D	B		D	D	A		A			D	A
Approach Delay		23.2			34.9			1.0			28.2	
Approach LOS		C			C			A			C	
Queue Length 50th (ft)	103	232		12	468	0		0			78	0
Queue Length 95th (ft)	#197	#683		36	#781	29		0			141	56
Internal Link Dist (ft)		420			1120			420			420	
Turn Bay Length (ft)	200			330		400						200
Base Capacity (vph)	291	1178		69	1010	950		301			273	459

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Starvation Cap Reductn	0	0		0	0	0		0			0	0
Spillback Cap Reductn	0	0		0	0	0		0			0	0
Storage Cap Reductn	0	0		0	0	0		0			0	0
Reduced v/c Ratio	0.63	0.74		0.29	0.89	0.16		0.11			0.52	0.39

Intersection Summary

Area Type: Other
Cycle Length: 95
Actuated Cycle Length: 88.1
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.94
Intersection Signal Delay: 28.6 — Intersection LOS: C
Intersection Capacity Utilization 78.0% — ICU Level of Service D
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 7: Kahuku Ag Rd/Marconi Rd & Kamehameha Hwy



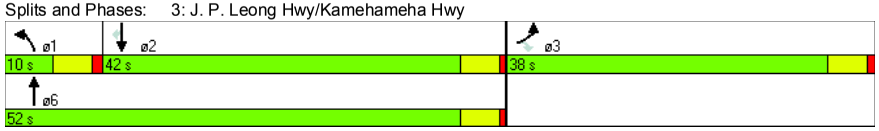
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	608	64	45	738	666	593
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1787	1615	1805	1845	1881	1583
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1787	1615	1805	1845	1881	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		91				659
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	1.00	0.70	1.00	0.89	0.90	0.90
Heavy Vehicles (%)	1%	0%	0%	3%	1%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	608	91	45	829	740	659
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	38.0	38.0	10.0	52.0	42.0	42.0
Total Split (%)	42.2%	42.2%	11.1%	57.8%	46.7%	46.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	31.1	31.1	5.0	43.4	37.8	37.8
Actuated g/C Ratio	0.37	0.37	0.06	0.51	0.45	0.45
v/c Ratio	0.93	0.14	0.42	0.88	0.88	0.62
Control Delay	48.8	5.1	53.1	30.9	37.6	4.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	48.8	5.1	53.1	30.9	37.6	4.4
LOS	D	A	D	C	D	A
Approach Delay	43.1			32.0	22.0	
Approach LOS	D			C	C	
Queue Length 50th (ft)	327	0	25	387	399	0
Queue Length 95th (ft)	#540	15	#64	#625	#639	64
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	702	689	107	1032	840	1071
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.87	0.13	0.42	0.80	0.88	0.62

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 84.6
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.93
Intersection Signal Delay: 29.9 Intersection LOS: C
Intersection Capacity Utilization 80.9% ICU Level of Service D
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection

Intersection Delay (sec/veh): 218.6

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	56	347	997	92	104	958
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	1.00	1.00	0.91	0.79	0.80	0.95
Heavy Vehicles(%)	7	2	2	6	4	3
Movement Flow Rate	56	347	1096	116	130	1008
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1			Major 2
Conflicting Flow Rate - All	2422	606	0	0	1212	0
Stage 1	1154	-	-	-	-	-
Stage 2	1268	-	-	-	-	-
Follow-up Headway	3.563	3.318	-	-	2.236	-
Pot Capacity-1 Maneuver	# 34	497	-	-	569	-
Stage 1	294	-	-	-	-	-
Stage 2	258	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	# 16	497	-	-	569	-
Mov Capacity-2 Maneuver	# 16	-	-	-	-	-
Stage 1	294	-	-	-	-	-
Stage 2	124	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	$ 1489.2	0	1.5
HCM LOS	F	A	A

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			98		
HCM Control Delay (s)	-	-	$ 1489.2	13.19	-
HCM Lane VC Ratio	-	-	4.112	0.228	-
HCM Lane LOS	-	-	F	B	-
HCM 95th Percentile Queue (veh)	-	-	41.745	0.874	-

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/3/11
Analysis Time Period	AM Peak Hour W/FBO Alternative
Highway	Kamehameha Highway
From/To	West of Kaihalulu Drive
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.92	
Lane width	12.0	ft	% Trucks and buses	8	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1717 veh/h
Directional split 50 / 50 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.992	
Two-way flow rate,(note-1) vp	1881	pc/h
Highest directional split proportion (note-2)	941	pc/h
Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h

Adjustment for no-passing zones, fnp	0.8	mi/h
Average travel speed, ATS	29.1	mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1866	pc/h
Highest directional split proportion (note-2)	933	
Base percent time-spent-following, BPTSF	80.6	%
Adj.for directional distribution and no-passing zones, fd/np	3.9	
Percent time-spent-following, PTSF	84.5	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.59	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	AM Peak Hour W/FBO Alt.
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.94	
Lane width	12.0	ft	% Trucks and buses	5	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1865 veh/h
Directional split 51 / 49 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.995	
Two-way flow rate,(note-1) vp	1994	pc/h
Highest directional split proportion (note-2)	1017	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h

Estimated Free-Flow Speed:

Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.0	mi/h

Average travel speed, ATS 28.0 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1984	pc/h
Highest directional split proportion (note-2)	1012	
Base percent time-spent-following, BPTSF	82.5	%
Adj.for directional distribution and no-passing zones, fd/np	4.2	
Percent time-spent-following, PTSF	86.7	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.62	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	AM Peak Hour W/FBO Alternative
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.89	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 1735 veh/h
Directional split 63 / 37 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.997	
Two-way flow rate,(note-1) vp	1955	pc/h
Highest directional split proportion (note-2)	1232	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	1.0	mi/h

Average travel speed, ATS 26.3 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1949	pc/h
Highest directional split proportion (note-2)	1228	
Base percent time-spent-following, BPTSF	82.0	%
Adj.for directional distribution and no-passing zones, fd/np	4.3	
Percent time-spent-following, PTSF	86.3	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.61	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/3/11
Analysis Time Period	PM Peak Hour W/FBO Alternative
Highway	Kamehameha Highway
From/To	West of Kaihalulu Drive
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.92	
Lane width	12.0	ft	% Trucks and buses	4	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 2154 veh/h
Directional split 52 / 48 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.996	
Two-way flow rate,(note-1) vp	2351	pc/h
Highest directional split proportion (note-2)	1223	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	0.7	mi/h

Average travel speed, ATS 25.5 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	2341	pc/h
Highest directional split proportion (note-2)	1217	
Base percent time-spent-following, BPTSF	87.2	%
Adj.for directional distribution and no-passing zones, fd/np	2.4	
Percent time-spent-following, PTSF	89.7	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.73	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	PM Peak Hour W/FBO Alt
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.99	
Lane width	12.0	ft	% Trucks and buses	2	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 2479 veh/h
Directional split 50 / 50 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.998	
Two-way flow rate,(note-1) vp	2509	pc/h
Highest directional split proportion (note-2)	1255	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	0.9	mi/h

Average travel speed, ATS 24.1 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	2504	pc/h
Highest directional split proportion (note-2)	1252	
Base percent time-spent-following, BPTSF	88.9	%
Adj.for directional distribution and no-passing zones, fd/np	2.6	
Percent time-spent-following, PTSF	91.5	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.78	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	PM Peak Hour W/FBO Alternative
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.99	
Lane width	12.0	ft	% Trucks and buses	5	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 2258 veh/h
Directional split 56 / 44 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.995	
Two-way flow rate,(note-1) vp	2292	pc/h
Highest directional split proportion (note-2)	1284	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	0.9	mi/h

Average travel speed, ATS 23.8 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	2281	pc/h
Highest directional split proportion (note-2)	1277	
Base percent time-spent-following, BPTSF	86.5	%
Adj.for directional distribution and no-passing zones, fd/np	3.2	
Percent time-spent-following, PTSF	89.7	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.72	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/5/11
Analysis Time Period	Sat Peak Hr W/FBO Alternative
Highway	Kamehameha Highway
From/To	West of Kaihalulu Drive
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.92	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 2290 veh/h
Directional split 53 / 47 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.997	
Two-way flow rate,(note-1) vp	2497	pc/h
Highest directional split proportion (note-2)	1323	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h

Estimated Free-Flow Speed:

Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	0.7	mi/h

Average travel speed, ATS 24.4 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	2489	pc/h
Highest directional split proportion (note-2)	1319	
Base percent time-spent-following, BPTSF	88.8	%
Adj.for directional distribution and no-passing zones, fd/np	2.1	
Percent time-spent-following, PTSF	90.8	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.78	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	10/29/2011
Analysis Time Period	Sat. Peak Hr W/FBO Alternative
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.91	
Lane width	12.0	ft	% Trucks and buses	2	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 2574 veh/h
Directional split 52 / 48 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.998	
Two-way flow rate,(note-1) vp	2834	pc/h
Highest directional split proportion (note-2)	1474	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	0.8	mi/h

Average travel speed, ATS 21.7 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	2829	pc/h
Highest directional split proportion (note-2)	1471	
Base percent time-spent-following, BPTSF	91.7	%
Adj.for directional distribution and no-passing zones, fd/np	1.9	
Percent time-spent-following, PTSF	93.6	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.89	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	10/29/2011
Analysis Time Period	Sat Peak Hr W/FBO Alternative
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.95	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 2389 veh/h
Directional split 56 / 44 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.997	
Two-way flow rate,(note-1) vp	2522	pc/h
Highest directional split proportion (note-2)	1412	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	0.9	mi/h

Average travel speed, ATS 22.0 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	2515	pc/h
Highest directional split proportion (note-2)	1408	
Base percent time-spent-following, BPTSF	89.0	%
Adj.for directional distribution and no-passing zones, fd/np	2.4	
Percent time-spent-following, PTSF	91.5	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.79	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

TRAFFIC IMPACT ANALYSIS REPORT

FOR THE PROPOSED

TURTLE BAY RESORT MASTER PLAN

KAHUKU, OAHU, HAWAII

APPENDIX E

CAPACITY ANALYSIS WORKSHEETS

2025 TRAFFIC CONDITIONS
WITH RESORT RESIDENTIAL ALTERNATIVE

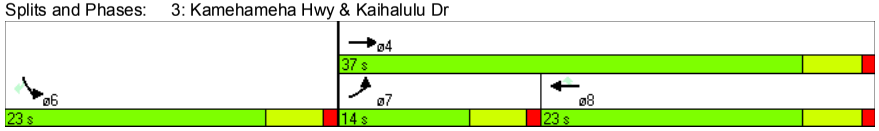
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	141	350	360	55	51	128
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	300			400	0	200
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1736	1681	1792	1509	1703	1509
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1736	1681	1792	1509	1703	1509
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				127		139
Link Speed (mph)		45	45		30	
Link Distance (ft)		500	3000		500	
Travel Time (s)		7.6	45.5		11.4	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	4%	13%	6%	7%	6%	7%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	153	380	391	60	55	139
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	14.0	37.0	23.0	23.0	23.0	23.0
Total Split (%)	23.3%	61.7%	38.3%	38.3%	38.3%	38.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	8.4	26.0	15.6	15.6	18.6	18.6
Actuated g/C Ratio	0.15	0.47	0.28	0.28	0.34	0.34
v/c Ratio	0.57	0.48	0.77	0.12	0.10	0.23
Control Delay	33.7	11.3	30.7	0.9	15.8	4.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	33.7	11.3	30.7	0.9	15.8	4.8
LOS	C	B	C	A	B	A
Approach Delay		17.7	26.7		7.9	
Approach LOS		B	C		A	
Queue Length 50th (ft)	52	75	125	0	14	0
Queue Length 95th (ft)	#117	130	#241	4	36	33
Internal Link Dist (ft)		420	2920		420	
Turn Bay Length (ft)	300			400		200
Base Capacity (vph)	294	1012	606	595	576	603
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.52	0.38	0.65	0.10	0.10	0.23

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 54.9
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.77
Intersection Signal Delay: 19.6 — Intersection LOS: B
Intersection Capacity Utilization 42.6% — ICU Level of Service A
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Kamehameha Hwy & Kaihalulu Dr

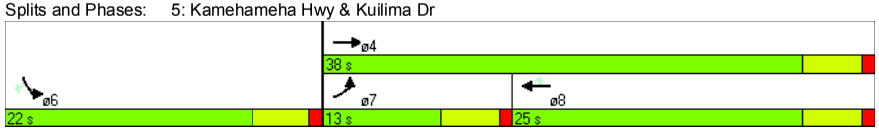


Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	83	318	331	111	135	84
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200			400	0	0
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1736	1681	1792	1509	1703	1509
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1734	1681	1792	1478	1680	1490
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				127		127
Link Speed (mph)		45	45		25	
Link Distance (ft)		500	5500		500	
Travel Time (s)		7.6	83.3		13.6	
Confl. Peds. (#/hr)	1			1	7	
Confl. Bikes (#/hr)				12		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	4%	13%	6%	7%	6%	7%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	90	346	360	121	147	91
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	21.0	21.0	21.0	21.0	21.0
Total Split (s)	13.0	38.0	25.0	25.0	22.0	22.0
Total Split (%)	21.7%	63.3%	41.7%	41.7%	36.7%	36.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Min	Min
Act Effct Green (s)	7.7	20.5	14.2	14.2	9.8	9.8
Actuated g/C Ratio	0.19	0.49	0.34	0.34	0.24	0.24
v/c Ratio	0.28	0.42	0.59	0.21	0.37	0.20
Control Delay	22.0	7.8	17.6	4.0	19.5	3.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	22.0	7.8	17.6	4.0	19.5	3.5
LOS	C	A	B	A	B	A
Approach Delay		10.7	14.2		13.4	
Approach LOS		B	B		B	
Queue Length 50th (ft)	22	41	82	0	35	0
Queue Length 95th (ft)	65	97	169	26	84	18
Internal Link Dist (ft)		420	5420		420	
Turn Bay Length (ft)	200			400		

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Base Capacity (vph)	376	1320	971	859	784	755
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.24	0.26	0.37	0.14	0.19	0.12

Intersection Summary	
Area Type:	Other
Cycle Length: 60	
Actuated Cycle Length: 41.5	
Natural Cycle: 55	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.59	
Intersection Signal Delay: 12.7	Intersection LOS: B
Intersection Capacity Utilization 42.0%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 5: Kamehameha Hwy & Kuilima Dr



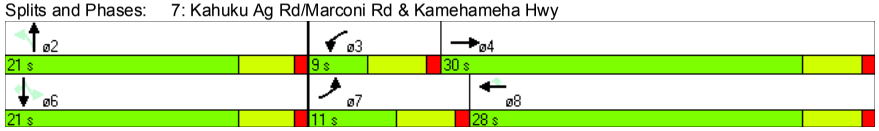
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	53	383	17	19	377	46	24	0	18	37	0	41
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200		0	330		400	0		0	0		200
Storage Lanes	1		0	1		1	0		0	0		1
Taper Length (ft)	100			100			100			100		
Satd. Flow (prot)	1805	1649	0	1203	1792	1615	0	1160	0	0	1805	1615
Flt Permitted	0.950			0.950				0.803			0.727	
Satd. Flow (perm)	1805	1649	0	1203	1792	1567	0	957	0	0	1381	1615
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		4				127		127				127
Link Speed (mph)		45			45			30			25	
Link Distance (ft)		500			1200			500			500	
Travel Time (s)		7.6			18.2			11.4			13.6	
Confl. Bikes (#/hr)						10						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	0%	13%	50%	50%	6%	0%	50%	2%	50%	0%	2%	0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	58	434	0	21	410	50	0	46	0	0	40	45
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases						8	2			6		6
Detector Phase	7	4		3	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	9.0	21.0		9.0	21.0	21.0	21.0	21.0		21.0	21.0	21.0
Total Split (s)	11.0	30.0		9.0	28.0	28.0	21.0	21.0		21.0	21.0	21.0
Total Split (%)	18.3%	50.0%		15.0%	46.7%	46.7%	35.0%	35.0%		35.0%	35.0%	35.0%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Lost Time (s)	5.0	5.0		5.0	5.0	5.0		5.0			5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag	Lag						
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	Min
Act Effct Green (s)	6.4	16.5		4.4	14.5	14.5		7.2			7.2	7.2
Actuated g/C Ratio	0.18	0.46		0.12	0.40	0.40		0.20			0.20	0.20
v/c Ratio	0.18	0.57		0.14	0.57	0.07		0.16			0.14	0.11
Control Delay	19.3	10.7		22.8	12.9	0.2		1.1			17.7	0.5
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Delay	19.3	10.7		22.8	12.9	0.2		1.1			17.7	0.5
LOS	B	B		C	B	A		A			B	A
Approach Delay		11.7			12.0			1.1			8.6	
Approach LOS		B			B			A			A	
Queue Length 50th (ft)	8	43		3	40	0		0			5	0
Queue Length 95th (ft)	45	162		24	158	1		0			33	0
Internal Link Dist (ft)		420			1120			420			420	
Turn Bay Length (ft)	200			330		400						200
Base Capacity (vph)	331	1271		147	1262	1141		533			676	856

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Starvation Cap Reductn	0	0		0	0	0		0			0	0
Spillback Cap Reductn	0	0		0	0	0		0			0	0
Storage Cap Reductn	0	0		0	0	0		0			0	0
Reduced v/c Ratio	0.18	0.34		0.14	0.32	0.04		0.09			0.06	0.05

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 36
Natural Cycle: 55
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.57
Intersection Signal Delay: 11.2 — Intersection LOS: B
Intersection Capacity Utilization 46.1% — ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 7: Kahuku Ag Rd/Marconi Rd & Kamehameha Hwy



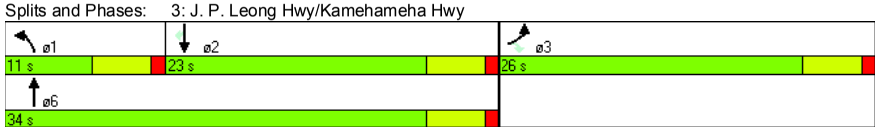
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	309	27	44	326	281	376
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1719	1615	1805	1792	1845	1568
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1719	1615	1805	1792	1845	1568
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		127				404
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.88	1.00	0.61	0.97	1.00	0.93
Heavy Vehicles (%)	5%	0%	0%	6%	3%	3%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	351	27	72	336	281	404
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	26.0	26.0	11.0	34.0	23.0	23.0
Total Split (%)	43.3%	43.3%	18.3%	56.7%	38.3%	38.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	15.1	15.1	6.1	25.5	19.7	19.7
Actuated g/C Ratio	0.30	0.30	0.12	0.50	0.39	0.39
v/c Ratio	0.69	0.05	0.33	0.37	0.39	0.47
Control Delay	24.1	0.1	28.5	10.1	16.7	4.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	24.1	0.1	28.5	10.1	16.7	4.3
LOS	C	A	C	B	B	A
Approach Delay	22.3			13.3	9.4	
Approach LOS	C			B	A	
Queue Length 50th (ft)	101	0	22	58	72	0
Queue Length 95th (ft)	170	0	39	125	147	54
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	732	760	219	1054	713	854
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.48	0.04	0.33	0.32	0.39	0.47

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 50.9
Natural Cycle: 55
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.69
Intersection Signal Delay: 13.8 — Intersection LOS: B
Intersection Capacity Utilization 47.7% — ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection

Intersection Delay (sec/veh): $ 401.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	42	97	373	152	503	450
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	0.75	0.84	0.97	0.83	0.77	1.00
Heavy Vehicles(%)	6	7	5	4	2	3
Movement Flow Rate	56	115	385	183	653	450
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1			Major 2
Conflicting Flow Rate - All	2233	285	0	0	568	0
Stage 1	477	-	-	-	-	-
Stage 2	1756	-	-	-	-	-
Follow-up Headway	3.554	3.363	-	-	2.218	-
Pot Capacity-1 Maneuver	# 46	742	-	-	1004	-
Stage 1	616	-	-	-	-	-
Stage 2	149	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	# 6	742	-	-	1004	-
Mov Capacity-2 Maneuver	# 6	-	-	-	-	-
Stage 1	616	-	-	-	-	-
Stage 2	# 20	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	$ 4253.7	0	8.9
HCM LOS	F	A	A

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			18		
HCM Control Delay (s)	-	-	$ 4253.7	15.002	-
HCM Lane VC Ratio	-	-	9.526	0.651	-
HCM Lane LOS	-	-	F	C	-
HCM 95th Percentile Queue (veh)	-	-	22.095	5.014	-

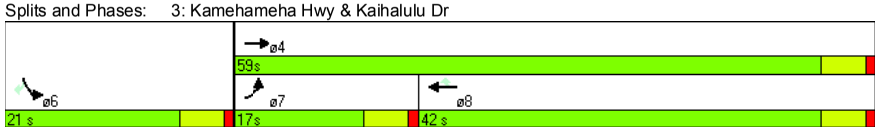
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	102	466	499	17	19	99
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	300			400	0	200
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1770	1845	1810	1495	1736	1509
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1770	1845	1810	1495	1736	1509
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				95		108
Link Speed (mph)		45	45		30	
Link Distance (ft)		500	3000		500	
Travel Time (s)		7.6	45.5		11.4	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	2%	3%	5%	8%	4%	7%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	111	507	542	18	21	108
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	17.0	59.0	42.0	42.0	21.0	21.0
Total Split (%)	21.3%	73.8%	52.5%	52.5%	26.3%	26.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	9.3	35.2	24.2	24.2	17.1	17.1
Actuated g/C Ratio	0.15	0.56	0.38	0.38	0.27	0.27
v/c Ratio	0.43	0.49	0.78	0.03	0.04	0.22
Control Delay	33.7	9.0	26.2	0.1	23.9	7.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	33.7	9.0	26.2	0.1	23.9	7.4
LOS	C	A	C	A	C	A
Approach Delay		13.4	25.3		10.1	
Approach LOS		B	C		B	
Queue Length 50th (ft)	41	97	185	0	6	0
Queue Length 95th (ft)	99	150	307	0	27	40
Internal Link Dist (ft)		420	2920		420	
Turn Bay Length (ft)	300			400		200
Base Capacity (vph)	360	1537	1136	973	471	488
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.31	0.33	0.48	0.02	0.04	0.22

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 63
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.78
Intersection Signal Delay: 18.2 — Intersection LOS: B
Intersection Capacity Utilization 47.7% — ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 3: Kamehameha Hwy & Kaihalulu Dr



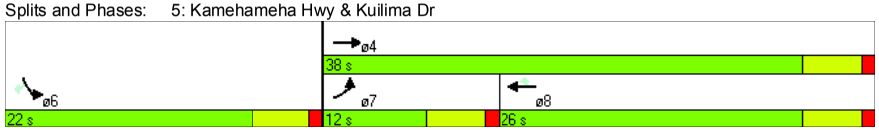
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	103	382	422	159	125	94
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200			400	0	0
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1741	1815	1781	1471	1715	1503
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1741	1815	1781	1443	1705	1482
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				173		127
Link Speed (mph)		45	45		25	
Link Distance (ft)		500	5500		500	
Travel Time (s)		7.6	83.3		13.6	
Confl. Peds. (#/hr)					3	1
Confl. Bikes (#/hr)				12		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	2%	3%	5%	8%	4%	7%
Bus Blockages (#/hr)	4	4	4	4	3	1
Shared Lane Traffic (%)						
Lane Group Flow (vph)	112	415	459	173	136	102
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	21.0	21.0	21.0	21.0	21.0
Total Split (s)	12.0	38.0	26.0	26.0	22.0	22.0
Total Split (%)	20.0%	63.3%	43.3%	43.3%	36.7%	36.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Min	Min
Act Effct Green (s)	7.2	25.2	16.6	16.6	9.4	9.4
Actuated g/C Ratio	0.16	0.55	0.36	0.36	0.21	0.21
v/c Ratio	0.41	0.41	0.71	0.27	0.38	0.25
Control Delay	26.7	7.0	20.9	3.8	21.6	4.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	26.7	7.0	20.9	3.8	21.6	4.8
LOS	C	A	C	A	C	A
Approach Delay		11.2	16.2		14.4	
Approach LOS		B	B		B	
Queue Length 50th (ft)	30	50	109	0	35	0
Queue Length 95th (ft)	#86	112	#219	31	79	23
Internal Link Dist (ft)		420	5420		420	

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Turn Bay Length (ft)	200			400		
Base Capacity (vph)	292	1313	897	812	699	679
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.38	0.32	0.51	0.21	0.19	0.15

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 45.6
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.71
Intersection Signal Delay: 14.0 — Intersection LOS: B
Intersection Capacity Utilization 47.6% — ICU Level of Service A
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 5: Kamehameha Hwy & Kuilima Dr



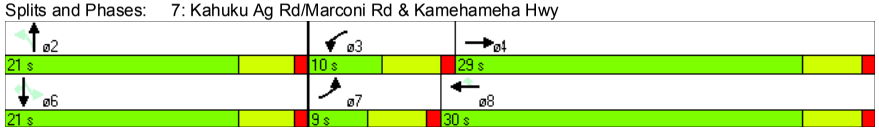
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	45	438	24	28	497	40	24	0	20	52	0	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200		0	330		400	0		0	0		200
Storage Lanes	1		0	1		1	0		0	0		1
Taper Length (ft)	100			100			100			100		
Satd. Flow (prot)	1805	1788	0	1203	1810	1615	0	1157	0	0	1805	1615
Flt Permitted	0.950			0.950				0.806			0.726	
Satd. Flow (perm)	1805	1788	0	1203	1810	1568	0	958	0	0	1379	1615
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		5				127		127				127
Link Speed (mph)		45			45			30			25	
Link Distance (ft)		500			1200			493			500	
Travel Time (s)		7.6			18.2			11.2			13.6	
Confl. Bikes (#/hr)						10						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	0%	3%	50%	50%	5%	0%	50%	2%	50%	0%	2%	0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	49	502	0	30	540	43	0	48	0	0	57	65
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases						8	2			6		6
Detector Phase	7	4		3	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	9.0	21.0		9.0	21.0	21.0	21.0	21.0		21.0	21.0	21.0
Total Split (s)	9.0	29.0		10.0	30.0	30.0	21.0	21.0		21.0	21.0	21.0
Total Split (%)	15.0%	48.3%		16.7%	50.0%	50.0%	35.0%	35.0%		35.0%	35.0%	35.0%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Lost Time (s)	5.0	5.0		5.0	5.0	5.0		5.0			5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag	Lag						
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	Min
Act Effct Green (s)	4.4	16.9		5.5	17.2	17.2		7.8			7.8	7.8
Actuated g/C Ratio	0.11	0.44		0.14	0.45	0.45		0.20			0.20	0.20
v/c Ratio	0.24	0.64		0.18	0.67	0.06		0.16			0.21	0.15
Control Delay	24.2	13.8		23.4	14.2	0.1		1.2			18.8	1.9
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Delay	24.2	13.8		23.4	14.2	0.1		1.2			18.8	1.9
LOS	C	B		C	B	A		A			B	A
Approach Delay		14.7			13.6			1.2			9.8	
Approach LOS		B			B			A			A	
Queue Length 50th (ft)	9	54		5	61	0		0			9	0
Queue Length 95th (ft)	43	204		30	216	0		0			42	8
Internal Link Dist (ft)		420			1120			413			420	
Turn Bay Length (ft)	200			330		400						200
Base Capacity (vph)	206	1227		171	1289	1153		506			630	807

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Starvation Cap Reductn	0	0		0	0	0		0			0	0
Spillback Cap Reductn	0	0		0	0	0		0			0	0
Storage Cap Reductn	0	0		0	0	0		0			0	0
Reduced v/c Ratio	0.24	0.41		0.18	0.42	0.04		0.09			0.09	0.08

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 38.6
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.67
Intersection Signal Delay: 13.3 — Intersection LOS: B
Intersection Capacity Utilization 51.2% — ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 7: Kahuku Ag Rd/Marconi Rd & Kamehameha Hwy



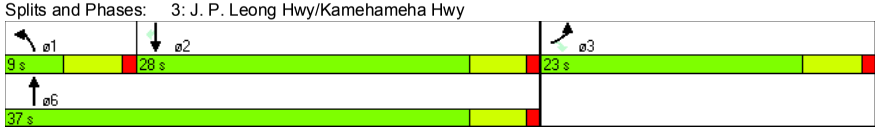
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	382	18	43	560	422	458
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1787	1615	1805	1900	1810	1583
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1787	1615	1805	1900	1810	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		127				472
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.97	1.00	1.00	0.99	0.85	0.97
Heavy Vehicles (%)	1%	0%	0%	0%	5%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	394	18	43	566	496	472
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	23.0	23.0	9.0	37.0	28.0	28.0
Total Split (%)	38.3%	38.3%	15.0%	61.7%	46.7%	46.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	15.2	15.2	4.1	27.0	23.8	23.8
Actuated g/C Ratio	0.29	0.29	0.08	0.52	0.46	0.46
v/c Ratio	0.76	0.03	0.31	0.58	0.60	0.48
Control Delay	29.0	0.1	31.5	12.0	16.8	3.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	29.0	0.1	31.5	12.0	16.8	3.5
LOS	C	A	C	B	B	A
Approach Delay	27.7			13.4	10.3	
Approach LOS	C			B	B	
Queue Length 50th (ft)	95	0	12	113	96	0
Queue Length 95th (ft)	#244	0	42	203	225	50
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	624	647	140	1180	824	978
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.63	0.03	0.31	0.48	0.60	0.48

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 52.3
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.76
Intersection Signal Delay: 14.9 — Intersection LOS: B
Intersection Capacity Utilization 59.2% — ICU Level of Service B
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection	
Intersection Delay (sec/veh):	11.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	61	290	768	77	91	693
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	0.95	0.98	0.96	0.84	1.00	1.00
Heavy Vehicles(%)	6	5	3	5	3	2
Movement Flow Rate	64	296	800	92	91	693
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1			Major 2
Conflicting Flow Rate - All	1721	446	0	0	892	0
Stage 1	846	-	-	-	-	-
Stage 2	875	-	-	-	-	-
Follow-up Headway	3.554	3.345	-	-	2.227	-
Pot Capacity-1 Maneuver	96	606	-	-	756	-
Stage 1	414	-	-	-	-	-
Stage 2	401	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	77	606	-	-	756	-
Mov Capacity-2 Maneuver	77	-	-	-	-	-
Stage 1	414	-	-	-	-	-
Stage 2	322	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	60.2	0	1.2
HCM LOS	F	A	A

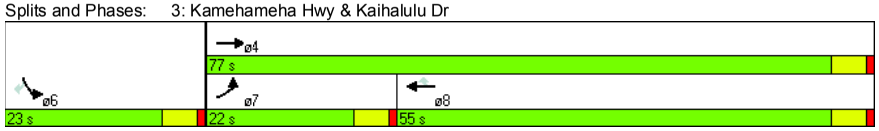
Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			392		
HCM Control Delay (s)	-	-	60.2	10.412	-
HCM Lane VC Ratio	-	-	0.919	0.12	-
HCM Lane LOS	-	-	F	B	-
HCM 95th Percentile Queue (veh)	-	-	9.799	0.409	-

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	171	598	630	37	62	192
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	300			400	0	200
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1752	1863	1810	1553	1752	1583
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1752	1863	1810	1553	1752	1583
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				76		209
Link Speed (mph)		45	45		30	
Link Distance (ft)		500	3000		500	
Travel Time (s)		7.6	45.5		11.4	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	3%	2%	5%	4%	3%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	186	650	685	40	67	209
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	22.0	77.0	55.0	55.0	23.0	23.0
Total Split (%)	22.0%	77.0%	55.0%	55.0%	23.0%	23.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	13.4	55.1	36.5	36.5	18.5	18.5
Actuated g/C Ratio	0.16	0.66	0.44	0.44	0.22	0.22
v/c Ratio	0.66	0.53	0.87	0.06	0.17	0.41
Control Delay	47.6	8.8	34.2	0.9	33.0	7.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	47.6	8.8	34.2	0.9	33.0	7.9
LOS	D	A	C	A	C	A
Approach Delay		17.5	32.3		14.0	
Approach LOS		B	C		B	
Queue Length 50th (ft)	93	153	316	0	29	0
Queue Length 95th (ft)	185	220	489	5	76	61
Internal Link Dist (ft)		420	2920		420	
Turn Bay Length (ft)	300			400		200
Base Capacity (vph)	365	1593	1109	981	386	512
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.51	0.41	0.62	0.04	0.17	0.41

Intersection Summary	
Area Type:	Other
Cycle Length: 100	
Actuated Cycle Length: 83.9	
Natural Cycle: 70	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.87	
Intersection Signal Delay: 22.8	Intersection LOS: C
Intersection Capacity Utilization 58.6%	ICU Level of Service B
Analysis Period (min) 15	

Splits and Phases: 3: Kamehameha Hwy & Kaihalulu Dr



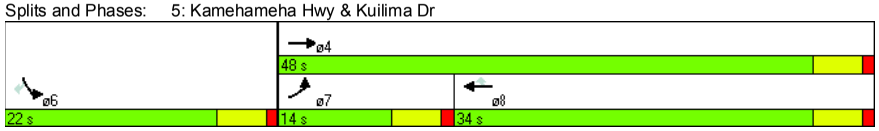
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	125	535	533	175	177	134
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200			400	0	0
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1738	1848	1795	1540	1738	1571
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1738	1848	1795	1512	1738	1550
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				190		146
Link Speed (mph)		45	45		25	
Link Distance (ft)		500	5500		500	
Travel Time (s)		7.6	83.3		13.6	
Confl. Bikes (#/hr)				12		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	3%	2%	5%	4%	3%	2%
Bus Blockages (#/hr)	2	2	2	2	2	2
Shared Lane Traffic (%)						
Lane Group Flow (vph)	136	582	579	190	192	146
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	21.0	21.0	21.0	21.0	21.0
Total Split (s)	14.0	48.0	34.0	34.0	22.0	22.0
Total Split (%)	20.0%	68.6%	48.6%	48.6%	31.4%	31.4%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Min	Min
Act Effct Green (s)	8.9	32.8	22.9	22.9	12.1	12.1
Actuated g/C Ratio	0.16	0.58	0.41	0.41	0.22	0.22
v/c Ratio	0.50	0.54	0.79	0.26	0.51	0.33
Control Delay	34.4	8.8	25.6	3.4	27.8	6.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	34.4	8.8	25.6	3.4	27.8	6.9
LOS	C	A	C	A	C	A
Approach Delay		13.7	20.1		18.8	
Approach LOS		B	C		B	
Queue Length 50th (ft)	48	96	180	0	66	0
Queue Length 95th (ft)	#124	197	#372	34	128	40
Internal Link Dist (ft)		420	5420		420	
Turn Bay Length (ft)	200			400		

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Base Capacity (vph)	312	1387	1025	945	591	623
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.44	0.42	0.56	0.20	0.32	0.23

Intersection Summary

Area Type: Other
Cycle Length: 70
Actuated Cycle Length: 56.1
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.79
Intersection Signal Delay: 17.3 — Intersection LOS: B
Intersection Capacity Utilization 57.3% — ICU Level of Service B
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 5: Kamehameha Hwy & Kuilima Dr



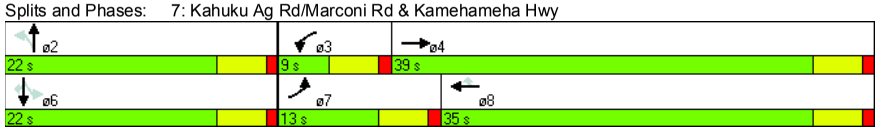
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	125	569	18	18	579	103	16	0	16	81	0	113
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200		0	330		400	0		0	0		200
Storage Lanes	1		0	1		1	0		0	0		1
Taper Length (ft)	100			100			100			100		
Satd. Flow (prot)	1805	1812	0	1203	1812	1615	0	1152	0	0	1805	1615
Flt Permitted	0.950			0.950				0.828			0.735	
Satd. Flow (perm)	1805	1812	0	1203	1812	1569	0	977	0	0	1396	1615
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		3				112		109				123
Link Speed (mph)		45			45			30			25	
Link Distance (ft)		500			1200			500			500	
Travel Time (s)		7.6			18.2			11.4			13.6	
Confl. Bikes (#/hr)						10						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	0%	2%	50%	50%	4%	0%	50%	2%	50%	0%	2%	0%
Bus Blockages (#/hr)	0	2	0	0	2	0	0	0	0	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	136	638	0	20	629	112	0	34	0	0	88	123
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases						8	2			6		6
Detector Phase	7	4		3	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	9.0	21.0		9.0	21.0	21.0	21.0	21.0		21.0	21.0	21.0
Total Split (s)	13.0	39.0		9.0	35.0	35.0	22.0	22.0		22.0	22.0	22.0
Total Split (%)	18.6%	55.7%		12.9%	50.0%	50.0%	31.4%	31.4%		31.4%	31.4%	31.4%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Lost Time (s)	5.0	5.0		5.0	5.0	5.0		5.0			5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag	Lag						
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	Min
Act Effct Green (s)	8.2	31.4		4.5	23.5	23.5		9.4			9.4	9.4
Actuated g/C Ratio	0.15	0.59		0.08	0.44	0.44		0.18			0.18	0.18
v/c Ratio	0.49	0.60		0.20	0.79	0.15		0.13			0.36	0.32
Control Delay	33.4	10.4		33.8	22.7	3.1		1.0			27.3	7.9
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Delay	33.4	10.4		33.8	22.7	3.1		1.0			27.3	7.9
LOS	C	B		C	C	A		A			C	A
Approach Delay		14.4			20.1			1.0			16.0	
Approach LOS		B			C			A			B	
Queue Length 50th (ft)	45	90		7	176	0		0			28	0
Queue Length 95th (ft)	#122	293		28	#347	24		0			68	38
Internal Link Dist (ft)		420			1120			420			420	
Turn Bay Length (ft)	200			330		400						200

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Base Capacity (vph)	301	1278		100	1096	993		417			495	652
Starvation Cap Reductn	0	0		0	0	0		0			0	0
Spillback Cap Reductn	0	0		0	0	0		0			0	0
Storage Cap Reductn	0	0		0	0	0		0			0	0
Reduced v/c Ratio	0.45	0.50		0.20	0.57	0.11		0.08			0.18	0.19

Intersection Summary

Area Type: Other
Cycle Length: 70
Actuated Cycle Length: 53.3
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.79
Intersection Signal Delay: 16.8 Intersection LOS: B
Intersection Capacity Utilization 58.4% ICU Level of Service B
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 7: Kahuku Ag Rd/Marconi Rd & Kamehameha Hwy



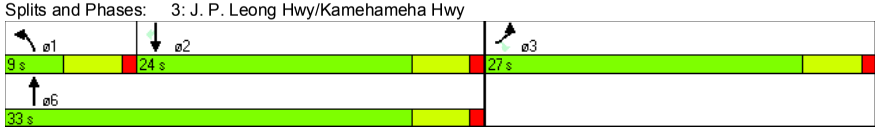
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	440	41	76	567	459	523
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1787	1615	1805	1845	1881	1583
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1787	1615	1805	1845	1881	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		127				588
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.84	0.68	1.00	1.00	0.97	0.89
Heavy Vehicles (%)	1%	0%	0%	3%	1%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	524	60	76	567	473	588
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	27.0	27.0	9.0	33.0	24.0	24.0
Total Split (%)	45.0%	45.0%	15.0%	55.0%	40.0%	40.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	19.4	19.4	4.1	26.2	19.4	19.4
Actuated g/C Ratio	0.35	0.35	0.07	0.47	0.35	0.35
v/c Ratio	0.84	0.09	0.58	0.66	0.72	0.63
Control Delay	31.9	0.7	48.2	16.3	26.5	5.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	31.9	0.7	48.2	16.3	26.5	5.3
LOS	C	A	D	B	C	A
Approach Delay	28.7			20.1	14.7	
Approach LOS	C			C	B	
Queue Length 50th (ft)	165	0	28	148	154	0
Queue Length 95th (ft)	#278	0	#84	246	#294	59
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	718	725	132	944	653	933
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.73	0.08	0.58	0.60	0.72	0.63

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 55.8
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.84
Intersection Signal Delay: 19.8 Intersection LOS: B
Intersection Capacity Utilization 65.2% ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection

Intersection Delay (sec/veh): 19

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	56	250	718	92	82	748
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	1.00	1.00	0.92	0.79	0.76	0.92
Heavy Vehicles(%)	7	2	2	6	4	3
Movement Flow Rate	56	250	780	116	108	813
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1			Major 2
Conflicting Flow Rate - All	1867	448	0	0	896	0
Stage 1	838	-	-	-	-	-
Stage 2	1029	-	-	-	-	-
Follow-up Headway	3.563	3.318	-	-	2.236	-
Pot Capacity-1 Maneuver	77	611	-	-	749	-
Stage 1	416	-	-	-	-	-
Stage 2	337	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	57	611	-	-	749	-
Mov Capacity-2 Maneuver	57	-	-	-	-	-
Stage 1	416	-	-	-	-	-
Stage 2	248	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	128.3	0	1.2
HCM LOS	F	A	A

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			275		
HCM Control Delay (s)	-	-	128.3	10.614	-
HCM Lane VC Ratio	-	-	1.113	0.144	-
HCM Lane LOS	-	-	F	B	-
HCM 95th Percentile Queue (veh)	-	-	12.823	0.502	-

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/3/11
Analysis Time Period	AM Peak Hour W/Resort Res Alt
Highway	Kamehameha Highway
From/To	West of Kaihalulu Drive
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.92	
Lane width	12.0	ft	% Trucks and buses	8	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V	979	veh/h	
Directional split	50 / 50	%	

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.2	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.984	
Two-way flow rate,(note-1) vp	1081	pc/h
Highest directional split proportion (note-2)	541	pc/h
Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h

Adjustment for no-passing zones, fnp	1.6	mi/h
Average travel speed, ATS	34.5	mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	0.992	
Two-way flow rate,(note-1) vp	1073	pc/h
Highest directional split proportion (note-2)	537	
Base percent time-spent-following, BPTSF	61.1	%
Adj.for directional distribution and no-passing zones, fd/np	10.0	
Percent time-spent-following, PTSF	71.0	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.34	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	AM Peak Hour W/Resort Alt.
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.95	
Lane width	12.0	ft	% Trucks and buses	5	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1306 veh/h
Directional split 51 / 49 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.995	
Two-way flow rate,(note-1) vp	1382	pc/h
Highest directional split proportion (note-2)	705	pc/h
Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.4	mi/h

Average travel speed, ATS 32.3 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1375	pc/h
Highest directional split proportion (note-2)	701	
Base percent time-spent-following, BPTSF	70.1	%
Adj.for directional distribution and no-passing zones, fd/np	7.6	
Percent time-spent-following, PTSF	77.8	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.43	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	AM Peak Hour W/Resort Res Alt
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.89	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 1569 veh/h
Directional split 65 / 35 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.997	
Two-way flow rate,(note-1) vp	1768	pc/h
Highest directional split proportion (note-2)	1149	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	1.1	mi/h

Average travel speed, ATS 27.6 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1763	pc/h
Highest directional split proportion (note-2)	1146	
Base percent time-spent-following, BPTSF	78.8	%
Adj.for directional distribution and no-passing zones, fd/np	5.5	
Percent time-spent-following, PTSF	84.2	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.55	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/3/11
Analysis Time Period	PM Peak Hour W/Resort Res Alt
Highway	Kamehameha Highway
From/To	West of Kaihalulu Drive
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.92	
Lane width	12.0	ft	% Trucks and buses	4	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1166 veh/h
Directional split 51 / 49 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.996	
Two-way flow rate,(note-1) vp	1272	pc/h
Highest directional split proportion (note-2)	649	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.3	mi/h

Average travel speed, ATS 33.4 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1267	pc/h
Highest directional split proportion (note-2)	646	
Base percent time-spent-following, BPTSF	67.2	%
Adj.for directional distribution and no-passing zones, fd/np	7.7	
Percent time-spent-following, PTSF	74.8	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.40	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	PM Peak Hour W/Resort Alt
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.94	
Lane width	12.0	ft	% Trucks and buses	2	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V	1722	veh/h	
Directional split	51 / 49	%	

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.998	
Two-way flow rate,(note-1) vp	1836	pc/h
Highest directional split proportion (note-2)	936	pc/h
Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.1	mi/h

Average travel speed, ATS	29.2	mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1832	pc/h
Highest directional split proportion (note-2)	934	
Base percent time-spent-following, BPTSF	80.0	%
Adj.for directional distribution and no-passing zones, fd/np	5.0	
Percent time-spent-following, PTSF	85.0	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.57	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	PM Peak Hour W/Resort Res Alt
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.99	
Lane width	12.0	ft	% Trucks and buses	5	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 2005 veh/h
Directional split 57 / 43 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.995	
Two-way flow rate,(note-1) vp	2035	pc/h
Highest directional split proportion (note-2)	1160	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	1.0	mi/h

Average travel speed, ATS 25.7 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	2025	pc/h
Highest directional split proportion (note-2)	1154	
Base percent time-spent-following, BPTSF	83.1	%
Adj.for directional distribution and no-passing zones, fd/np	4.0	
Percent time-spent-following, PTSF	87.1	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.64	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/5/11
Analysis Time Period	Sat Peak Hr W/Resort Res Alt
Highway	Kamehameha Highway
From/To	West of Kaihalulu Drive
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.92	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 822 veh/h
Directional split 52 / 48 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.2	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.994	
Two-way flow rate,(note-1) vp	899	pc/h
Highest directional split proportion (note-2)	467	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	2.0	mi/h

Average travel speed, ATS 35.5 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	0.997	
Two-way flow rate,(note-1) vp	896	pc/h
Highest directional split proportion (note-2)	466	
Base percent time-spent-following, BPTSF	54.5	%
Adj.for directional distribution and no-passing zones, fd/np	11.8	
Percent time-spent-following, PTSF	66.3	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.28	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	10/29/2011
Analysis Time Period	Sat. Peak Hr W/Resort Alt
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.93	
Lane width	12.0	ft	% Trucks and buses	2	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1990 veh/h
Directional split 50 / 50 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.998	
Two-way flow rate,(note-1) vp	2144	pc/h
Highest directional split proportion (note-2)	1072	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	0.9	mi/h

Average travel speed, ATS 26.9 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	2140	pc/h
Highest directional split proportion (note-2)	1070	
Base percent time-spent-following, BPTSF	84.8	%
Adj.for directional distribution and no-passing zones, fd/np	3.7	
Percent time-spent-following, PTSF	88.4	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.67	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	10/29/2011
Analysis Time Period	Sat Peak Hr W/Resort Res Alt
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.94	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 2056 veh/h
Directional split 54 / 46 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.997	
Two-way flow rate,(note-1) vp	2194	pc/h
Highest directional split proportion (note-2)	1185	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	0.9	mi/h

Average travel speed, ATS 24.6 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	2187	pc/h
Highest directional split proportion (note-2)	1181	
Base percent time-spent-following, BPTSF	85.4	%
Adj.for directional distribution and no-passing zones, fd/np	3.5	
Percent time-spent-following, PTSF	88.9	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.69	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

TRAFFIC IMPACT ANALYSIS REPORT

FOR THE PROPOSED

TURTLE BAY RESORT MASTER PLAN

KAHUKU, OAHU, HAWAII

APPENDIX F

CAPACITY ANALYSIS WORKSHEETS

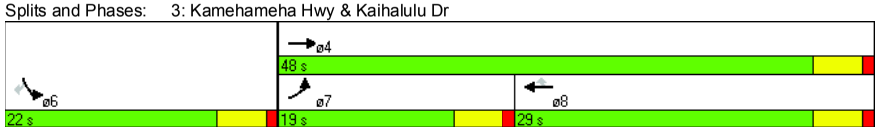
2025 TRAFFIC CONDITIONS
WITH CONSERVATION PARTNER ALTERNATIVE

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	182	362	371	68	73	173
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	300			400	0	200
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1736	1681	1792	1509	1703	1509
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1736	1681	1792	1509	1703	1509
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				109		188
Link Speed (mph)		45	45		30	
Link Distance (ft)		500	3000		500	
Travel Time (s)		7.6	45.5		11.4	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	4%	13%	6%	7%	6%	7%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	198	393	403	74	79	188
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	19.0	48.0	29.0	29.0	22.0	22.0
Total Split (%)	27.1%	68.6%	41.4%	41.4%	31.4%	31.4%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	11.4	35.0	18.5	18.5	17.3	17.3
Actuated g/C Ratio	0.18	0.56	0.30	0.30	0.28	0.28
v/c Ratio	0.62	0.42	0.76	0.14	0.17	0.34
Control Delay	33.9	9.0	30.2	2.4	21.1	5.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	33.9	9.0	30.2	2.4	21.1	5.9
LOS	C	A	C	A	C	A
Approach Delay		17.3	25.9		10.4	
Approach LOS		B	C		B	
Queue Length 50th (ft)	70	75	139	0	23	0
Queue Length 95th (ft)	140	124	236	14	60	45
Internal Link Dist (ft)		420	2920		420	
Turn Bay Length (ft)	300			400		200
Base Capacity (vph)	395	1175	699	655	471	553
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.50	0.33	0.58	0.11	0.17	0.34

Intersection Summary	
Area Type:	Other
Cycle Length: 70	
Actuated Cycle Length: 62.4	
Natural Cycle: 60	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.76	
Intersection Signal Delay: 19.0	Intersection LOS: B
Intersection Capacity Utilization 46.2%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 3: Kamehameha Hwy & Kaihalulu Dr

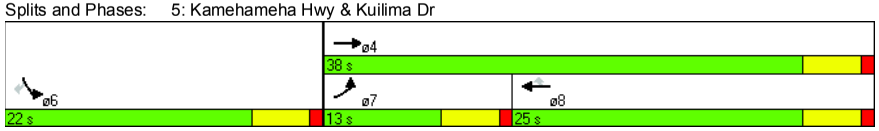


Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	100	335	339	128	156	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200			400	0	0
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1736	1681	1792	1509	1703	1509
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1734	1681	1792	1478	1680	1490
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				139		127
Link Speed (mph)		45	45		25	
Link Distance (ft)		500	5500		500	
Travel Time (s)		7.6	83.3		13.6	
Confl. Peds. (#/hr)	1			1	7	
Confl. Bikes (#/hr)				12		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	4%	13%	6%	7%	6%	7%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	109	364	368	139	170	109
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	21.0	21.0	21.0	21.0	21.0
Total Split (s)	13.0	38.0	25.0	25.0	22.0	22.0
Total Split (%)	21.7%	63.3%	41.7%	41.7%	36.7%	36.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Min	Min
Act Effct Green (s)	7.7	23.7	14.4	14.4	10.4	10.4
Actuated g/C Ratio	0.17	0.53	0.32	0.32	0.23	0.23
v/c Ratio	0.37	0.41	0.64	0.25	0.43	0.25
Control Delay	24.7	7.8	20.5	4.4	21.1	4.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	24.7	7.8	20.5	4.4	21.1	4.9
LOS	C	A	C	A	C	A
Approach Delay		11.7	16.1		14.8	
Approach LOS		B	B		B	
Queue Length 50th (ft)	27	46	87	0	42	0
Queue Length 95th (ft)	77	109	179	30	95	25
Internal Link Dist (ft)		420	5420		420	
Turn Bay Length (ft)	200			400		

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Base Capacity (vph)	340	1229	879	795	710	695
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.32	0.30	0.42	0.17	0.24	0.16

Intersection Summary	
Area Type: Other	
Cycle Length: 60	
Actuated Cycle Length: 45.1	
Natural Cycle: 55	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.64	
Intersection Signal Delay: 14.1	Intersection LOS: B
Intersection Capacity Utilization 44.5%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 5: Kamehameha Hwy & Kuilima Dr

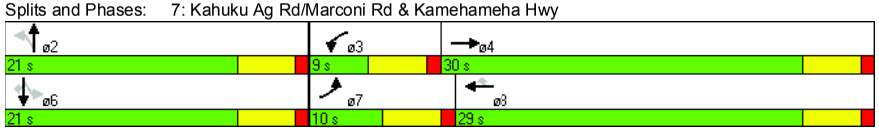


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	48	426	17	19	407	41	24	0	18	33	0	36
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200		0	330		400	0		0	0		200
Storage Lanes	1		0	1		1	0		0	0		1
Taper Length (ft)	100			100			100			100		
Satd. Flow (prot)	1805	1805	0	1203	1812	1615	0	1160	0	0	1805	1615
Flt Permitted	0.950			0.950				0.805			0.727	
Satd. Flow (perm)	1805	1805	0	1203	1812	1568	0	960	0	0	1381	1615
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		4				127		127				127
Link Speed (mph)		45			45			30			25	
Link Distance (ft)		500			1200			500			500	
Travel Time (s)		7.6			18.2			11.4			13.6	
Confl. Bikes (#/hr)						10						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	0%	2%	50%	50%	4%	0%	50%	2%	50%	0%	2%	0%
Bus Blockages (#/hr)	0	2	0	0	2	0	0	0	0	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	52	481	0	21	442	45	0	46	0	0	36	39
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases						8	2			6		6
Detector Phase	7	4		3	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	9.0	21.0		9.0	21.0	21.0	21.0	21.0		21.0	21.0	21.0
Total Split (s)	10.0	30.0		9.0	29.0	29.0	21.0	21.0		21.0	21.0	21.0
Total Split (%)	16.7%	50.0%		15.0%	48.3%	48.3%	35.0%	35.0%		35.0%	35.0%	35.0%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Lost Time (s)	5.0	5.0		5.0	5.0	5.0		5.0			5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag	Lag						
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	Min
Act Effct Green (s)	5.5	16.6		4.4	14.9	14.9		7.1			7.1	7.1
Actuated g/C Ratio	0.15	0.46		0.12	0.42	0.42		0.20			0.20	0.20
v/c Ratio	0.19	0.57		0.14	0.59	0.06		0.16			0.13	0.09
Control Delay	20.4	10.3		22.7	12.6	0.2		1.2			17.7	0.4
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Delay	20.4	10.3		22.7	12.6	0.2		1.2			17.7	0.4
LOS	C	B		C	B	A		A			B	A
Approach Delay		11.3			12.0			1.2			8.7	
Approach LOS		B			B			A			A	
Queue Length 50th (ft)	8	48		3	43	0		0			5	0
Queue Length 95th (ft)	42	173		24	163	0		0			30	0
Internal Link Dist (ft)		420			1120			420			420	
Turn Bay Length (ft)	200			330		400						200

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Base Capacity (vph)	275	1386		146	1328	1183		533			674	854
Starvation Cap Reductn	0	0		0	0	0		0			0	0
Spillback Cap Reductn	0	0		0	0	0		0			0	0
Storage Cap Reductn	0	0		0	0	0		0			0	0
Reduced v/c Ratio	0.19	0.35		0.14	0.33	0.04		0.09			0.05	0.05

Intersection Summary	
Area Type:	Other
Cycle Length: 60	
Actuated Cycle Length: 35.9	
Natural Cycle: 55	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.59	
Intersection Signal Delay: 11.0	Intersection LOS: B
Intersection Capacity Utilization 48.4%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 7: Kahuku Ag Rd/Marconi Rd & Kamehameha Hwy



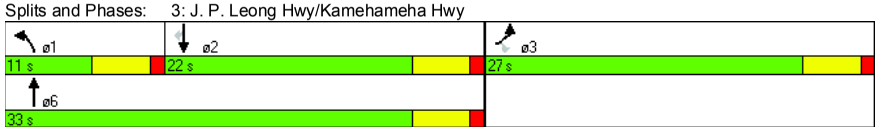
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	330	27	44	347	300	401
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1719	1615	1805	1792	1845	1568
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1719	1615	1805	1792	1845	1568
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		127				427
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.88	1.00	0.61	0.96	1.00	0.94
Heavy Vehicles (%)	5%	0%	0%	6%	3%	3%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	375	27	72	361	300	427
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	27.0	27.0	11.0	33.0	22.0	22.0
Total Split (%)	45.0%	45.0%	18.3%	55.0%	36.7%	36.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	15.6	15.6	6.1	24.1	18.4	18.4
Actuated g/C Ratio	0.31	0.31	0.12	0.48	0.37	0.37
v/c Ratio	0.70	0.05	0.33	0.42	0.44	0.51
Control Delay	23.5	0.1	28.2	11.1	18.0	4.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	23.5	0.1	28.2	11.1	18.0	4.7
LOS	C	A	C	B	B	A
Approach Delay	22.0			13.9	10.2	
Approach LOS	C			B	B	
Queue Length 50th (ft)	107	0	22	65	79	0
Queue Length 95th (ft)	178	0	39	141	162	57
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	783	804	224	1038	677	845
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.48	0.03	0.32	0.35	0.44	0.51

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 50.1
Natural Cycle: 55
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.70
Intersection Signal Delay: 14.3 — Intersection LOS: B
Intersection Capacity Utilization 49.9% — ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection

Intersection Delay (sec/veh): $ 506.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	42	102	386	152	508	455
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	0.75	0.85	0.97	0.83	0.77	1.00
Heavy Vehicles(%)	6	7	5	4	2	3
Movement Flow Rate	56	120	398	183	660	455
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1			Major 2
Conflicting Flow Rate - All	2265	291	0	0	581	0
Stage 1	490	-	-	-	-	-
Stage 2	1775	-	-	-	-	-
Follow-up Headway	3.554	3.363	-	-	2.218	-
Pot Capacity-1 Maneuver	# 44	736	-	-	993	-
Stage 1	608	-	-	-	-	-
Stage 2	145	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	# 5	736	-	-	993	-
Mov Capacity-2 Maneuver	# 5	-	-	-	-	-
Stage 1	608	-	-	-	-	-
Stage 2	# 16	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	$ 5324.5	0	9.2
HCM LOS	F	A	A

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			15		
HCM Control Delay (s)	-	-	$ 5324.5	15.49	-
HCM Lane VC Ratio	-	-	11.733	0.664	-
HCM Lane LOS	-	-	F	C	-
HCM 95th Percentile Queue (veh)	-	-	22.995	5.272	-

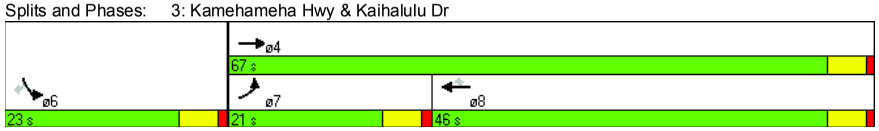
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	163	464	515	51	45	158
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	300			400	0	200
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1770	1845	1810	1495	1736	1509
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1770	1845	1810	1495	1736	1509
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				85		172
Link Speed (mph)		45	45		30	
Link Distance (ft)		500	3000		500	
Travel Time (s)		7.6	45.5		11.4	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	2%	3%	5%	8%	4%	7%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	177	504	560	55	49	172
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	21.0	67.0	46.0	46.0	23.0	23.0
Total Split (%)	23.3%	74.4%	51.1%	51.1%	25.6%	25.6%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	12.2	45.4	28.0	28.0	18.5	18.5
Actuated g/C Ratio	0.16	0.61	0.38	0.38	0.25	0.25
v/c Ratio	0.61	0.45	0.82	0.09	0.11	0.34
Control Delay	40.1	8.5	31.4	1.8	27.1	7.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	40.1	8.5	31.4	1.8	27.1	7.3
LOS	D	A	C	A	C	A
Approach Delay		16.7	28.8		11.7	
Approach LOS		B	C		B	
Queue Length 50th (ft)	76	106	224	0	18	0
Queue Length 95th (ft)	160	158	361	10	54	52
Internal Link Dist (ft)		420	2920		420	
Turn Bay Length (ft)	300			400		200
Base Capacity (vph)	392	1554	1027	885	432	505
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.45	0.32	0.55	0.06	0.11	0.34

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 74.1
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.82
Intersection Signal Delay: 20.9 — Intersection LOS: C
Intersection Capacity Utilization 52.0% — ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 3: Kamehameha Hwy & Kaihalulu Dr



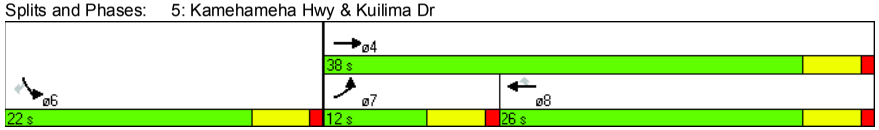
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	120	389	453	191	148	113
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200			400	0	0
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1741	1815	1781	1471	1715	1503
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1741	1815	1781	1443	1705	1482
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				208		127
Link Speed (mph)		45	45		25	
Link Distance (ft)		500	5500		500	
Travel Time (s)		7.6	83.3		13.6	
Confl. Peds. (#/hr)					3	1
Confl. Bikes (#/hr)				12		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	2%	3%	5%	8%	4%	7%
Bus Blockages (#/hr)	4	4	4	4	3	1
Shared Lane Traffic (%)						
Lane Group Flow (vph)	130	423	492	208	161	123
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	21.0	21.0	21.0	21.0	21.0
Total Split (s)	12.0	38.0	26.0	26.0	22.0	22.0
Total Split (%)	20.0%	63.3%	43.3%	43.3%	36.7%	36.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Min	Min
Act Effct Green (s)	7.3	26.3	17.7	17.7	10.2	10.2
Actuated g/C Ratio	0.15	0.55	0.37	0.37	0.21	0.21
v/c Ratio	0.49	0.42	0.74	0.31	0.44	0.29
Control Delay	31.1	7.4	23.1	3.8	22.5	6.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	31.1	7.4	23.1	3.8	22.5	6.2
LOS	C	A	C	A	C	A
Approach Delay		13.0	17.4		15.4	
Approach LOS		B	B		B	
Queue Length 50th (ft)	39	55	124	0	45	0
Queue Length 95th (ft)	#108	122	#281	35	91	32
Internal Link Dist (ft)		420	5420		420	

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Turn Bay Length (ft)	200			400		
Base Capacity (vph)	280	1273	860	804	670	656
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.46	0.33	0.57	0.26	0.24	0.19

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 47.5
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.74
Intersection Signal Delay: 15.4 — Intersection LOS: B
Intersection Capacity Utilization 51.4% — ICU Level of Service A
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 5: Kamehameha Hwy & Kuilima Dr



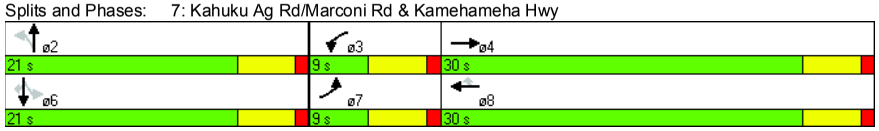
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	473	24	28	565	35	24	0	20	47	0	55
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200		0	330		400	0		0	0		200
Storage Lanes	1		0	1		1	0		0	0		1
Taper Length (ft)	100			100			100			100		
Satd. Flow (prot)	1805	1794	0	1203	1812	1615	0	1157	0	0	1805	1615
Flt Permitted	0.950			0.950				0.803			0.726	
Satd. Flow (perm)	1805	1794	0	1203	1812	1568	0	954	0	0	1379	1615
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		5				127		127				127
Link Speed (mph)		45			45			30			25	
Link Distance (ft)		500			1200			500			500	
Travel Time (s)		7.6			18.2			11.4			13.6	
Confl. Bikes (#/hr)						10						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	0%	2%	50%	50%	4%	0%	50%	2%	50%	0%	2%	0%
Bus Blockages (#/hr)	0	2	0	0	2	0	0	0	0	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	43	540	0	30	614	38	0	48	0	0	51	60
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases						8	2			6		6
Detector Phase	7	4		3	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	9.0	21.0		9.0	21.0	21.0	21.0	21.0		21.0	21.0	21.0
Total Split (s)	9.0	30.0		9.0	30.0	30.0	21.0	21.0		21.0	21.0	21.0
Total Split (%)	15.0%	50.0%		15.0%	50.0%	50.0%	35.0%	35.0%		35.0%	35.0%	35.0%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Lost Time (s)	5.0	5.0		5.0	5.0	5.0		5.0			5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag	Lag						
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	Min
Act Effct Green (s)	4.3	18.3		4.3	18.3	18.3		7.5			7.5	7.5
Actuated g/C Ratio	0.11	0.47		0.11	0.47	0.47		0.19			0.19	0.19
v/c Ratio	0.22	0.65		0.23	0.73	0.05		0.17			0.19	0.15
Control Delay	24.1	13.1		26.1	15.9	0.1		1.3			19.2	1.5
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Delay	24.1	13.1		26.1	15.9	0.1		1.3			19.2	1.5
LOS	C	B		C	B	A		A			B	A
Approach Delay		13.9			15.4			1.3			9.7	
Approach LOS		B			B			A			A	
Queue Length 50th (ft)	7	58		5	71	0		0			8	0
Queue Length 95th (ft)	39	212		#34	#265	0		0			39	6
Internal Link Dist (ft)		420			1120			420			420	
Turn Bay Length (ft)	200			330		400						200

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Base Capacity (vph)	199	1300		133	1312	1170		492			609	784
Starvation Cap Reductn	0	0		0	0	0		0			0	0
Spillback Cap Reductn	0	0		0	0	0		0			0	0
Storage Cap Reductn	0	0		0	0	0		0			0	0
Reduced v/c Ratio	0.22	0.42		0.23	0.47	0.03		0.10			0.08	0.08

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 39.3
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.73
Intersection Signal Delay: 13.9 — Intersection LOS: B
Intersection Capacity Utilization 50.8% — ICU Level of Service A
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 7: Kahuku Ag Rd/Marconi Rd & Kamehameha Hwy



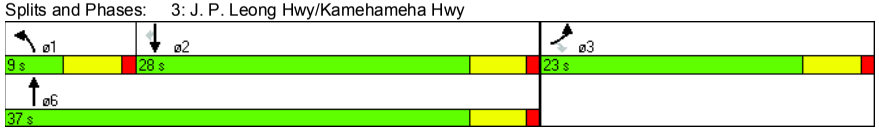
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	410	18	43	494	451	487
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1787	1615	1805	1900	1810	1583
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1787	1615	1805	1900	1810	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		127				497
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.98	1.00	1.00	1.00	0.86	0.98
Heavy Vehicles (%)	1%	0%	0%	0%	5%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	418	18	43	494	524	497
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	23.0	23.0	9.0	37.0	28.0	28.0
Total Split (%)	38.3%	38.3%	15.0%	61.7%	46.7%	46.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	15.8	15.8	4.1	26.7	23.6	23.6
Actuated g/C Ratio	0.30	0.30	0.08	0.51	0.45	0.45
v/c Ratio	0.78	0.03	0.31	0.51	0.65	0.51
Control Delay	30.2	0.1	31.8	11.2	18.5	3.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	30.2	0.1	31.8	11.2	18.5	3.6
LOS	C	A	C	B	B	A
Approach Delay	28.9			12.8	11.3	
Approach LOS	C			B	B	
Queue Length 50th (ft)	102	0	12	98	109	0
Queue Length 95th (ft)	#267	0	42	169	#252	51
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	620	643	139	1172	810	983
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.67	0.03	0.31	0.42	0.65	0.51

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 52.6
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.78
Intersection Signal Delay: 15.5 — Intersection LOS: B
Intersection Capacity Utilization 62.3% — ICU Level of Service B
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection	
Intersection Delay (sec/veh):	13.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	61	295	780	77	93	709
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	0.95	0.98	0.96	0.84	1.00	1.00
Heavy Vehicles(%)	6	5	3	5	3	2
Movement Flow Rate	64	301	813	92	93	709
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1			Major 2
Conflicting Flow Rate - All	1754	453	0	0	905	0
Stage 1	859	-	-	-	-	-
Stage 2	895	-	-	-	-	-
Follow-up Headway	3.554	3.345	-	-	2.227	-
Pot Capacity-1 Maneuver	92	601	-	-	747	-
Stage 1	408	-	-	-	-	-
Stage 2	393	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	73	601	-	-	747	-
Mov Capacity-2 Maneuver	73	-	-	-	-	-
Stage 1	408	-	-	-	-	-
Stage 2	312	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	71.7	0	1.2
HCM LOS	F	A	A

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			378		
HCM Control Delay (s)	-	-	71.7	10.503	-
HCM Lane VC Ratio	-	-	0.966	0.124	-
HCM Lane LOS	-	-	F	B	-
HCM 95th Percentile Queue (veh)	-	-	10.932	0.424	-

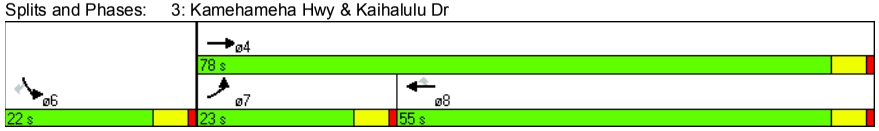
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	209	599	642	59	74	231
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	300			400	0	200
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1752	1863	1810	1553	1752	1583
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1752	1863	1810	1553	1752	1583
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				76		251
Link Speed (mph)		45	45		30	
Link Distance (ft)		500	3000		500	
Travel Time (s)		7.6	45.5		11.4	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	3%	2%	5%	4%	3%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	227	651	698	64	80	251
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	23.0	78.0	55.0	55.0	22.0	22.0
Total Split (%)	23.0%	78.0%	55.0%	55.0%	22.0%	22.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	15.2	58.2	37.9	37.9	17.4	17.4
Actuated g/C Ratio	0.18	0.68	0.44	0.44	0.20	0.20
v/c Ratio	0.73	0.52	0.88	0.09	0.23	0.48
Control Delay	50.4	8.1	34.9	2.9	35.4	8.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	50.4	8.1	34.9	2.9	35.4	8.4
LOS	D	A	C	A	D	A
Approach Delay		19.0	32.2		14.9	
Approach LOS		B	C		B	
Queue Length 50th (ft)	120	146	340	0	39	0
Queue Length 95th (ft)	#241	211	504	17	88	66
Internal Link Dist (ft)		420	2920		420	
Turn Bay Length (ft)	300			400		200
Base Capacity (vph)	376	1577	1081	958	355	521
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.60	0.41	0.65	0.07	0.23	0.48

Intersection Summary

Area Type: Other
Cycle Length: 100
Actuated Cycle Length: 85.9
Natural Cycle: 75
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.88
Intersection Signal Delay: 23.4 Intersection LOS: C
Intersection Capacity Utilization 62.0% ICU Level of Service B
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Kamehameha Hwy & Kaihalulu Dr



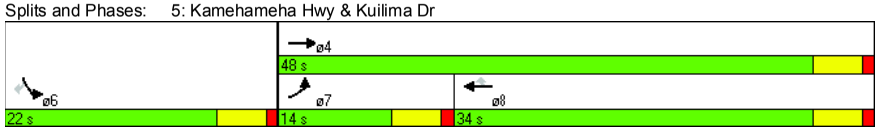
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	142	531	543	198	200	155
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200			400	0	0
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1738	1848	1795	1540	1738	1571
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1738	1848	1795	1512	1738	1550
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				215		168
Link Speed (mph)		45	45		25	
Link Distance (ft)		500	5500		500	
Travel Time (s)		7.6	83.3		13.6	
Confl. Bikes (#/hr)				12		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	3%	2%	5%	4%	3%	2%
Bus Blockages (#/hr)	2	2	2	2	2	2
Shared Lane Traffic (%)						
Lane Group Flow (vph)	154	577	590	215	217	168
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	21.0	21.0	21.0	21.0	21.0
Total Split (s)	14.0	48.0	34.0	34.0	22.0	22.0
Total Split (%)	20.0%	68.6%	48.6%	48.6%	31.4%	31.4%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	8.6	39.0	25.4	25.4	17.1	17.1
Actuated g/C Ratio	0.13	0.59	0.38	0.38	0.26	0.26
v/c Ratio	0.68	0.53	0.86	0.30	0.48	0.32
Control Delay	46.3	10.0	32.9	3.4	26.5	6.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	46.3	10.0	32.9	3.4	26.5	6.0
LOS	D	B	C	A	C	A
Approach Delay		17.7	25.1		17.6	
Approach LOS		B	C		B	
Queue Length 50th (ft)	64	122	214	0	81	0
Queue Length 95th (ft)	#145	194	#383	36	144	43
Internal Link Dist (ft)		420	5420		420	
Turn Bay Length (ft)	200			400		

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Base Capacity (vph)	238	1208	791	787	449	525
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.65	0.48	0.75	0.27	0.48	0.32

Intersection Summary

Area Type: Other
Cycle Length: 70
Actuated Cycle Length: 66.2
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.86
Intersection Signal Delay: 20.7 — Intersection LOS: C
Intersection Capacity Utilization 60.0% — ICU Level of Service B
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 5: Kamehameha Hwy & Kuilima Dr



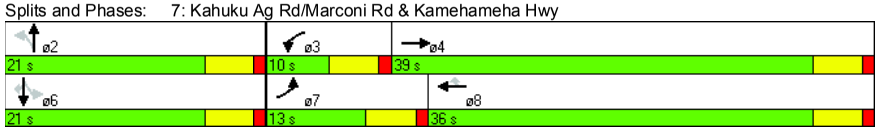
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	118	595	18	18	624	98	16	0	16	73	0	104
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200		0	330		400	0		0	0		200
Storage Lanes	1		0	1		1	0		0	0		1
Taper Length (ft)	100			100			100			100		
Satd. Flow (prot)	1805	1815	0	1203	1812	1615	0	1152	0	0	1805	1615
Flt Permitted	0.950			0.950				0.828			0.735	
Satd. Flow (perm)	1805	1815	0	1203	1812	1569	0	977	0	0	1396	1615
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		3				109		109				113
Link Speed (mph)		45			45			30			25	
Link Distance (ft)		500			1200			500			500	
Travel Time (s)		7.6			18.2			11.4			13.6	
Confl. Bikes (#/hr)						10						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	0%	2%	50%	50%	4%	0%	50%	2%	50%	0%	2%	0%
Bus Blockages (#/hr)	0	2	0	0	2	0	0	0	0	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	128	667	0	20	678	107	0	34	0	0	79	113
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases						8	2			6		6
Detector Phase	7	4		3	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	9.0	21.0		9.0	21.0	21.0	21.0	21.0		21.0	21.0	21.0
Total Split (s)	13.0	39.0		10.0	36.0	36.0	21.0	21.0		21.0	21.0	21.0
Total Split (%)	18.6%	55.7%		14.3%	51.4%	51.4%	30.0%	30.0%		30.0%	30.0%	30.0%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Lost Time (s)	5.0	5.0		5.0	5.0	5.0		5.0			5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag	Lag						
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	Min
Act Effct Green (s)	8.1	32.8		5.5	25.1	25.1		9.1			9.1	9.1
Actuated g/C Ratio	0.15	0.60		0.10	0.46	0.46		0.17			0.17	0.17
v/c Ratio	0.48	0.61		0.16	0.81	0.14		0.13			0.34	0.31
Control Delay	33.4	10.5		31.7	23.7	2.9		1.1			28.0	8.3
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Delay	33.4	10.5		31.7	23.7	2.9		1.1			28.0	8.3
LOS	C	B		C	C	A		A			C	A
Approach Delay		14.2			21.1			1.1			16.4	
Approach LOS		B			C			A			B	
Queue Length 50th (ft)	45	93		7	194	0		0			27	0
Queue Length 95th (ft)	#114	318		28	#413	22		0			63	37
Internal Link Dist (ft)		420			1120			420			420	
Turn Bay Length (ft)	200			330		400						200

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Base Capacity (vph)	293	1291		122	1103	997		390			453	600
Starvation Cap Reductn	0	0		0	0	0		0			0	0
Spillback Cap Reductn	0	0		0	0	0		0			0	0
Storage Cap Reductn	0	0		0	0	0		0			0	0
Reduced v/c Ratio	0.44	0.52		0.16	0.61	0.11		0.09			0.17	0.19

Intersection Summary	
Area Type:	Other
Cycle Length: 70	
Actuated Cycle Length: 54.6	
Natural Cycle: 60	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.81	
Intersection Signal Delay: 17.2	Intersection LOS: B
Intersection Capacity Utilization 60.4%	ICU Level of Service B
Analysis Period (min) 15	

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 7: Kahuku Ag Rd/Marconi Rd & Kamehameha Hwy



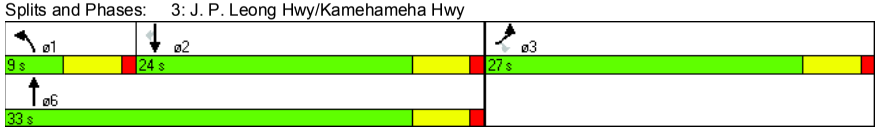
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	461	41	76	594	473	538
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1787	1615	1805	1845	1881	1583
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1787	1615	1805	1845	1881	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		127				611
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.83	0.68	1.00	1.00	0.96	0.88
Heavy Vehicles (%)	1%	0%	0%	3%	1%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	555	60	76	594	493	611
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	27.0	27.0	9.0	33.0	24.0	24.0
Total Split (%)	45.0%	45.0%	15.0%	55.0%	40.0%	40.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	20.2	20.2	4.1	26.1	19.3	19.3
Actuated g/C Ratio	0.36	0.36	0.07	0.46	0.34	0.34
v/c Ratio	0.87	0.09	0.58	0.70	0.77	0.65
Control Delay	34.4	0.7	49.1	17.7	28.8	5.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	34.4	0.7	49.1	17.7	28.8	5.5
LOS	C	A	D	B	C	A
Approach Delay	31.1			21.2	15.9	
Approach LOS	C			C	B	
Queue Length 50th (ft)	179	0	28	158	163	0
Queue Length 95th (ft)	#298	0	#84	264	#312	57
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	708	716	130	930	643	943
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.78	0.08	0.58	0.64	0.77	0.65

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 56.5
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.87
Intersection Signal Delay: 21.3 Intersection LOS: C
Intersection Capacity Utilization 67.1% ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection

Intersection Delay (sec/veh): 89.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	56	297	853	92	96	868
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	1.00	1.00	0.91	0.79	0.78	0.93
Heavy Vehicles(%)	7	2	2	6	4	3
Movement Flow Rate	56	297	937	116	123	933
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1		Major 2	
Conflicting Flow Rate - All	2174	527	0	0	1053	0
Stage 1	995	-	-	-	-	-
Stage 2	1179	-	-	-	-	-
Follow-up Headway	3.563	3.318	-	-	2.236	-
Pot Capacity-1 Maneuver	# 49	551	-	-	653	-
Stage 1	350	-	-	-	-	-
Stage 2	285	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	# 30	551	-	-	653	-
Mov Capacity-2 Maneuver	# 30	-	-	-	-	-
Stage 1	350	-	-	-	-	-
Stage 2	174	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	$ 621.7	0	1.4
HCM LOS	F	A	A

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			158		
HCM Control Delay (s)	-	-	$ 621.7	11.789	-
HCM Lane VC Ratio	-	-	2.234	0.188	-
HCM Lane LOS	-	-	F	B	-
HCM 95th Percentile Queue (veh)	-	-	28.948	0.69	-

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/3/11
Analysis Time Period	AM Peak Hr W/Conservation Alt
Highway	Kamehameha Highway
From/To	West of Kaihalulu Drive
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.92	
Lane width	12.0	ft	% Trucks and buses	8	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1088 veh/h
Directional split 50 / 50 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.992	
Two-way flow rate,(note-1) vp	1192	pc/h
Highest directional split proportion (note-2)	596	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h

Adjustment for no-passing zones, fnp	1.4	mi/h
Average travel speed, ATS	33.8	mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	0.992	
Two-way flow rate,(note-1) vp	1192	pc/h
Highest directional split proportion (note-2)	596	
Base percent time-spent-following, BPTSF	64.9	%
Adj.for directional distribution and no-passing zones, fd/np	8.6	
Percent time-spent-following, PTSF	73.5	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.37	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	AM Peak Hr W/Conservation Alt
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.95	
Lane width	12.0	ft	% Trucks and buses	5	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1384 veh/h
Directional split 51 / 49 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.995	
Two-way flow rate,(note-1) vp	1464	pc/h
Highest directional split proportion (note-2)	747	pc/h
Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.4	mi/h

Average travel speed, ATS 31.8 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1457	pc/h
Highest directional split proportion (note-2)	743	
Base percent time-spent-following, BPTSF	72.2	%
Adj.for directional distribution and no-passing zones, fd/np	7.0	
Percent time-spent-following, PTSF	79.2	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.46	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	AM Peak Hr W/Conservation Alt
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.89	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 1597 veh/h
Directional split 65 / 35 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.997	
Two-way flow rate,(note-1) vp	1800	pc/h
Highest directional split proportion (note-2)	1170	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	1.1	mi/h

Average travel speed, ATS 27.4 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1794	pc/h
Highest directional split proportion (note-2)	1166	
Base percent time-spent-following, BPTSF	79.3	%
Adj.for directional distribution and no-passing zones, fd/np	5.3	
Percent time-spent-following, PTSF	84.6	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.56	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/3/11
Analysis Time Period	PM Peak Hr W/Conservation Alt
Highway	Kamehameha Highway
From/To	West of Kaihalulu Drive
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.92	
Lane width	12.0	ft	% Trucks and buses	4	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1300 veh/h
Directional split 52 / 48 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.996	
Two-way flow rate,(note-1) vp	1419	pc/h
Highest directional split proportion (note-2)	738	pc/h
Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.0	mi/h

Average travel speed, ATS 32.4 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1413	pc/h
Highest directional split proportion (note-2)	735	
Base percent time-spent-following, BPTSF	71.1	%
Adj.for directional distribution and no-passing zones, fd/np	6.1	
Percent time-spent-following, PTSF	77.2	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.44	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	PM Peak Hour W/Resort Alt
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.96	
Lane width	12.0	ft	% Trucks and buses	2	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1842 veh/h
Directional split 51 / 49 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.998	
Two-way flow rate,(note-1) vp	1923	pc/h
Highest directional split proportion (note-2)	981	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.0	mi/h

Average travel speed, ATS 28.5 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1919	pc/h
Highest directional split proportion (note-2)	979	
Base percent time-spent-following, BPTSF	81.5	%
Adj.for directional distribution and no-passing zones, fd/np	4.5	
Percent time-spent-following, PTSF	86.0	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.60	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	PM Peak Hr W/Conservation Alt
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.99	
Lane width	12.0	ft	% Trucks and buses	5	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 2040 veh/h
Directional split 57 / 43 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.995	
Two-way flow rate,(note-1) vp	2071	pc/h
Highest directional split proportion (note-2)	1180	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	1.0	mi/h

Average travel speed, ATS 25.5 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	2061	pc/h
Highest directional split proportion (note-2)	1175	
Base percent time-spent-following, BPTSF	83.7	%
Adj.for directional distribution and no-passing zones, fd/np	3.8	
Percent time-spent-following, PTSF	87.5	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.65	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/5/11
Analysis Time Period	Sat Peak Hr W/Conservation Alt
Highway	Kamehameha Highway
From/To	West of Kaihalulu Drive
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.92	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1677 veh/h
Directional split 52 / 48 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.997	
Two-way flow rate,(note-1) vp	1828	pc/h
Highest directional split proportion (note-2)	951	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	0.8	mi/h

Average travel speed, ATS 29.5 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1823	pc/h
Highest directional split proportion (note-2)	948	
Base percent time-spent-following, BPTSF	79.9	%
Adj.for directional distribution and no-passing zones, fd/np	4.2	
Percent time-spent-following, PTSF	84.0	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.57	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	10/29/2011
Analysis Time Period	Sat Peak Hr W/Conservation Alt
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.92	
Lane width	12.0	ft	% Trucks and buses	2	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 2061 veh/h
Directional split 51 / 49 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.998	
Two-way flow rate,(note-1) vp	2245	pc/h
Highest directional split proportion (note-2)	1145	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	0.9	mi/h

Average travel speed, ATS 26.2 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	2240	pc/h
Highest directional split proportion (note-2)	1142	
Base percent time-spent-following, BPTSF	86.0	%
Adj.for directional distribution and no-passing zones, fd/np	3.4	
Percent time-spent-following, PTSF	89.4	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.70	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	10/29/2011
Analysis Time Period	Sat Peak Hr W/Conservation Alt
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.94	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 2107 veh/h
Directional split 54 / 46 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.997	
Two-way flow rate,(note-1) vp	2248	pc/h
Highest directional split proportion (note-2)	1214	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	0.9	mi/h

Average travel speed, ATS 24.2 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	2241	pc/h
Highest directional split proportion (note-2)	1210	
Base percent time-spent-following, BPTSF	86.1	%
Adj.for directional distribution and no-passing zones, fd/np	3.3	
Percent time-spent-following, PTSF	89.4	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.70	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

TRAFFIC IMPACT ANALYSIS REPORT

FOR THE PROPOSED

TURTLE BAY RESORT MASTER PLAN

KAHUKU, OAHU, HAWAII

APPENDIX G

CAPACITY ANALYSIS WORKSHEETS

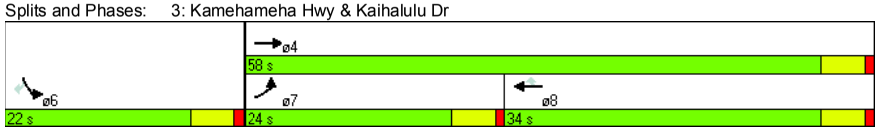
2025 TRAFFIC CONDITIONS WITH PROPOSED ACTION

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	196	405	413	68	69	185
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	300			400	0	200
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1736	1681	1792	1509	1703	1509
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1736	1681	1792	1509	1703	1509
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				95		201
Link Speed (mph)		45	45		30	
Link Distance (ft)		500	3000		500	
Travel Time (s)		7.6	45.5		11.4	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	4%	13%	6%	7%	6%	7%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	213	440	449	74	75	201
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	24.0	58.0	34.0	34.0	22.0	22.0
Total Split (%)	30.0%	72.5%	42.5%	42.5%	27.5%	27.5%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	13.4	39.9	21.4	21.4	17.4	17.4
Actuated g/C Ratio	0.20	0.59	0.32	0.32	0.26	0.26
v/c Ratio	0.62	0.44	0.79	0.14	0.17	0.37
Control Delay	34.2	8.7	32.4	3.4	24.6	6.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	34.2	8.7	32.4	3.4	24.6	6.7
LOS	C	A	C	A	C	A
Approach Delay		17.0	28.3		11.5	
Approach LOS		B	C		B	
Queue Length 50th (ft)	81	87	165	0	24	0
Queue Length 95th (ft)	160	138	293	19	67	52
Internal Link Dist (ft)		420	2920		420	
Turn Bay Length (ft)	300			400		200
Base Capacity (vph)	499	1349	787	716	438	537
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.43	0.33	0.57	0.10	0.17	0.37

Intersection Summary	
Area Type:	Other
Cycle Length: 80	
Actuated Cycle Length: 67.5	
Natural Cycle: 60	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.79	
Intersection Signal Delay: 20.1	Intersection LOS: C
Intersection Capacity Utilization 48.9%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 3: Kamehameha Hwy & Kaihalulu Dr



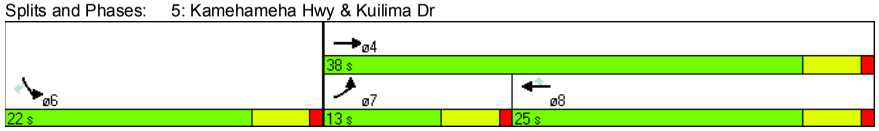
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	118	357	364	144	182	117
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200			400	0	0
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1736	1681	1792	1509	1703	1509
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1734	1681	1792	1478	1680	1490
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				157		127
Link Speed (mph)		45	45		25	
Link Distance (ft)		500	5500		500	
Travel Time (s)		7.6	83.3		13.6	
Confl. Peds. (#/hr)	1			1	7	
Confl. Bikes (#/hr)				12		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	4%	13%	6%	7%	6%	7%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	128	388	396	157	198	127
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	21.0	21.0	21.0	21.0	21.0
Total Split (s)	13.0	38.0	25.0	25.0	22.0	22.0
Total Split (%)	21.7%	63.3%	41.7%	41.7%	36.7%	36.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Min	Min
Act Effct Green (s)	8.0	24.6	15.3	15.3	11.4	11.4
Actuated g/C Ratio	0.17	0.52	0.32	0.32	0.24	0.24
v/c Ratio	0.44	0.44	0.68	0.27	0.48	0.28
Control Delay	27.7	8.6	22.2	4.4	21.9	5.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	27.7	8.6	22.2	4.4	21.9	5.9
LOS	C	A	C	A	C	A
Approach Delay		13.4	17.1		15.6	
Approach LOS		B	B		B	
Queue Length 50th (ft)	35	53	99	0	51	0
Queue Length 95th (ft)	#101	128	205	33	109	33
Internal Link Dist (ft)		420	5420		420	
Turn Bay Length (ft)	200			400		

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Base Capacity (vph)	327	1188	845	780	683	673
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.39	0.33	0.47	0.20	0.29	0.19

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 47.1
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.68
Intersection Signal Delay: 15.4 — Intersection LOS: B
Intersection Capacity Utilization 48.3% — ICU Level of Service A
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 5: Kamehameha Hwy & Kuilima Dr



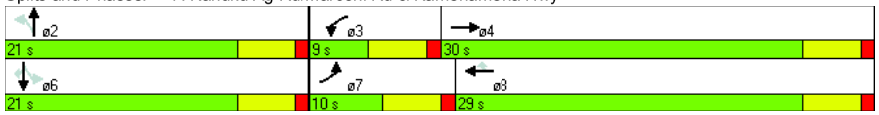
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	69	453	17	19	415	58	24	0	18	63	0	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200		0	330		400	0		0	200		200
Storage Lanes	1		0	1		1	0		0	0		1
Taper Length (ft)	100			100			100			100		
Satd. Flow (prot)	1805	1654	0	1203	1792	1615	0	1160	0	0	1805	1615
Flt Permitted	0.950			0.950				0.795			0.727	
Satd. Flow (perm)	1805	1654	0	1203	1792	1568	0	948	0	0	1381	1615
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		4				127		127				127
Link Speed (mph)		45			45			30			25	
Link Distance (ft)		500			1200			500			500	
Travel Time (s)		7.6			18.2			11.4			13.6	
Confl. Bikes (#/hr)						10						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	0%	13%	50%	50%	6%	0%	50%	2%	50%	0%	2%	0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	75	510	0	21	451	63	0	46	0	0	68	76
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases						8	2			6		6
Detector Phase	7	4		3	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	9.0	21.0		9.0	21.0	21.0	21.0	21.0		21.0	21.0	21.0
Total Split (s)	10.0	30.0		9.0	29.0	29.0	21.0	21.0		21.0	21.0	21.0
Total Split (%)	16.7%	50.0%		15.0%	48.3%	48.3%	35.0%	35.0%		35.0%	35.0%	35.0%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Lost Time (s)	5.0	5.0		5.0	5.0	5.0		5.0			5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag	Lag						
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	Min
Act Effct Green (s)	5.5	19.7		4.4	16.1	16.1		8.0			8.0	8.0
Actuated g/C Ratio	0.14	0.49		0.11	0.40	0.40		0.20			0.20	0.20
v/c Ratio	0.30	0.62		0.16	0.63	0.09		0.16			0.25	0.18
Control Delay	24.3	11.9		25.2	15.2	0.7		1.2			19.4	2.7
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Delay	24.3	11.9		25.2	15.2	0.7		1.2			19.4	2.7
LOS	C	B		C	B	A		A			B	A
Approach Delay		13.5			13.9			1.2			10.6	
Approach LOS		B			B			A			B	
Queue Length 50th (ft)	18	59		5	90	0		0			15	0
Queue Length 95th (ft)	#61	217		25	182	4		0			48	13
Internal Link Dist (ft)		420			1120			420			420	
Turn Bay Length (ft)	200			330		400						200
Base Capacity (vph)	247	1166		131	1177	1073		486			605	778

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Starvation Cap Reductn	0	0		0	0	0		0			0	0
Spillback Cap Reductn	0	0		0	0	0		0			0	0
Storage Cap Reductn	0	0		0	0	0		0			0	0
Reduced v/c Ratio	0.30	0.44		0.16	0.38	0.06		0.09			0.11	0.10

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 40
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.63
Intersection Signal Delay: 12.9 — Intersection LOS: B
Intersection Capacity Utilization 49.8% — ICU Level of Service A
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 7: Kahuku Ag Rd/Marconi Rd & Kamehameha Hwy

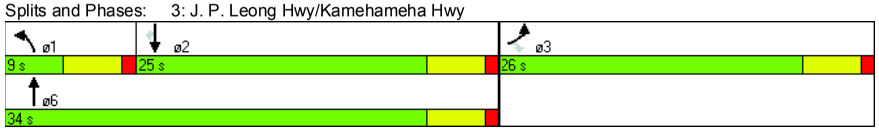


Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	344	27	44	361	316	423
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1719	1615	1805	1792	1845	1568
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1719	1615	1805	1792	1845	1568
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		127				450
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.88	1.00	0.61	0.97	1.00	0.94
Heavy Vehicles (%)	5%	0%	0%	6%	3%	3%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	391	27	72	372	316	450
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	26.0	26.0	9.0	34.0	25.0	25.0
Total Split (%)	43.3%	43.3%	15.0%	56.7%	41.7%	41.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	16.6	16.6	4.1	25.9	21.0	21.0
Actuated g/C Ratio	0.31	0.31	0.08	0.49	0.40	0.40
v/c Ratio	0.72	0.05	0.51	0.42	0.43	0.50
Control Delay	25.0	0.1	42.7	11.2	16.4	4.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	25.0	0.1	42.7	11.2	16.4	4.2
LOS	C	A	D	B	B	A
Approach Delay	23.4			16.3	9.2	
Approach LOS	C			B	A	
Queue Length 50th (ft)	116	0	24	71	81	0
Queue Length 95th (ft)	194	0	41	140	157	54
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	701	734	140	1009	736	896
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.56	0.04	0.51	0.37	0.43	0.50

Intersection Summary	
Area Type:	Other
Cycle Length: 60	
Actuated Cycle Length: 52.7	
Natural Cycle: 55	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.72	
Intersection Signal Delay: 14.8	Intersection LOS: B
Intersection Capacity Utilization 51.5%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection
Intersection Delay (sec/veh): $ 608.6

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	42	103	393	152	513	458
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	0.75	0.83	0.96	0.83	0.77	1.00
Heavy Vehicles(%)	6	7	5	4	2	3
Movement Flow Rate	56	124	409	183	666	458
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1			Major 2
Conflicting Flow Rate - All	2291	297	0	0	592	0
Stage 1	501	-	-	-	-	-
Stage 2	1790	-	-	-	-	-
Follow-up Headway	3.554	3.363	-	-	2.218	-
Pot Capacity-1 Maneuver	# 42	731	-	-	984	-
Stage 1	601	-	-	-	-	-
Stage 2	143	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	# 4	731	-	-	984	-
Mov Capacity-2 Maneuver	# 4	-	-	-	-	-
Stage 1	601	-	-	-	-	-
Stage 2	# 13	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	$ 6350.5	0	9.5
HCM LOS	F	A	A

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			13		
HCM Control Delay (s)	-	-	$ 6350.5	15.962	-
HCM Lane VC Ratio	-	-	13.854	0.677	-
HCM Lane LOS	-	-	F	C	-
HCM 95th Percentile Queue (veh)	-	-	23.733	5.522	-

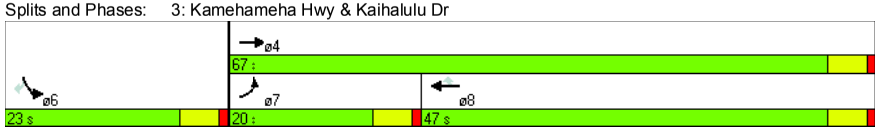
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	173	541	573	51	39	186
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	300			400	0	200
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1770	1845	1810	1495	1736	1509
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1770	1845	1810	1495	1736	1509
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				85		202
Link Speed (mph)		45	45		30	
Link Distance (ft)		500	3000		500	
Travel Time (s)		7.6	45.5		11.4	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	2%	3%	5%	8%	4%	7%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	188	588	623	55	42	202
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	20.0	67.0	47.0	47.0	23.0	23.0
Total Split (%)	22.2%	74.4%	52.2%	52.2%	25.6%	25.6%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	12.4	49.0	31.4	31.4	18.4	18.4
Actuated g/C Ratio	0.16	0.63	0.40	0.40	0.24	0.24
v/c Ratio	0.66	0.51	0.85	0.08	0.10	0.39
Control Delay	44.8	9.0	32.9	1.7	28.4	7.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	44.8	9.0	32.9	1.7	28.4	7.4
LOS	D	A	C	A	C	A
Approach Delay		17.7	30.4		11.0	
Approach LOS		B	C		B	
Queue Length 50th (ft)	87	132	268	0	17	0
Queue Length 95th (ft)	#174	196	414	10	48	56
Internal Link Dist (ft)		420	2920		420	
Turn Bay Length (ft)	300			400		200
Base Capacity (vph)	350	1495	1001	865	411	512
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.54	0.39	0.62	0.06	0.10	0.39

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 77.6
Natural Cycle: 65
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.85
Intersection Signal Delay: 21.8 — Intersection LOS: C
Intersection Capacity Utilization 55.6% — ICU Level of Service B
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Kamehameha Hwy & Kaihalulu Dr



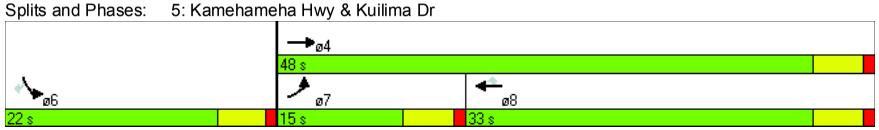
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	144	437	478	238	188	146
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200			400	0	0
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1741	1815	1781	1471	1715	1503
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1741	1815	1781	1444	1703	1482
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				259		159
Link Speed (mph)		45	45		25	
Link Distance (ft)		500	5500		500	
Travel Time (s)		7.6	83.3		13.6	
Confl. Peds. (#/hr)					3	1
Confl. Bikes (#/hr)				12		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	2%	3%	5%	8%	4%	7%
Bus Blockages (#/hr)	4	4	4	4	3	1
Shared Lane Traffic (%)						
Lane Group Flow (vph)	157	475	520	259	204	159
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	21.0	21.0	21.0	21.0	21.0
Total Split (s)	15.0	48.0	33.0	33.0	22.0	22.0
Total Split (%)	21.4%	68.6%	47.1%	47.1%	31.4%	31.4%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Min	Min
Act Effct Green (s)	9.6	32.7	22.0	22.0	12.5	12.5
Actuated g/C Ratio	0.17	0.58	0.39	0.39	0.22	0.22
v/c Ratio	0.53	0.45	0.74	0.36	0.54	0.35
Control Delay	34.0	7.9	24.1	3.7	28.0	6.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	34.0	7.9	24.1	3.7	28.0	6.9
LOS	C	A	C	A	C	A
Approach Delay		14.4	17.4		18.7	
Approach LOS		B	B		B	
Queue Length 50th (ft)	54	74	162	0	68	0
Queue Length 95th (ft)	#138	151	296	40	136	42
Internal Link Dist (ft)		420	5420		420	

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Turn Bay Length (ft)	200			400		
Base Capacity (vph)	341	1370	979	910	572	600
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.46	0.35	0.53	0.28	0.36	0.27

Intersection Summary

Area Type: Other
Cycle Length: 70
Actuated Cycle Length: 56.2
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.74
Intersection Signal Delay: 16.6 — Intersection LOS: B
Intersection Capacity Utilization 56.1% — ICU Level of Service B
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 5: Kamehameha Hwy & Kuilima Dr



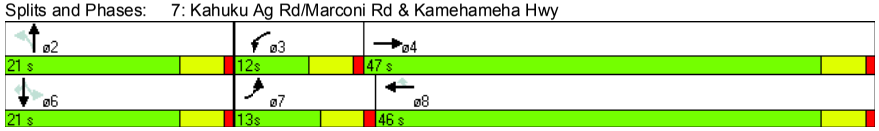
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	78	523	24	28	610	69	24	0	20	70	0	82
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200		0	330		400	0		0	200		200
Storage Lanes	1		0	1		1	0		0	0		1
Taper Length (ft)	100			100			100			100		
Satd. Flow (prot)	1805	1796	0	1203	1810	1615	0	1157	0	0	1805	1615
Flt Permitted	0.950			0.950				0.805			0.726	
Satd. Flow (perm)	1805	1796	0	1203	1810	1571	0	956	0	0	1379	1615
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		4				95		95				95
Link Speed (mph)		45			45			30			25	
Link Distance (ft)		500			1200			500			500	
Travel Time (s)		7.6			18.2			11.4			13.6	
Confl. Bikes (#/hr)						10						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	0%	3%	50%	50%	5%	0%	50%	2%	50%	0%	2%	0%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	85	594	0	30	663	75	0	48	0	0	76	89
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases						8	2			6		6
Detector Phase	7	4		3	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	9.0	21.0		9.0	21.0	21.0	21.0	21.0		21.0	21.0	21.0
Total Split (s)	13.0	47.0		12.0	46.0	46.0	21.0	21.0		21.0	21.0	21.0
Total Split (%)	16.3%	58.8%		15.0%	57.5%	57.5%	26.3%	26.3%		26.3%	26.3%	26.3%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Lost Time (s)	5.0	5.0		5.0	5.0	5.0		5.0			5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag	Lag						
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	Min
Act Effct Green (s)	7.9	31.3		7.1	25.8	25.8		9.3			9.3	9.3
Actuated g/C Ratio	0.14	0.56		0.13	0.46	0.46		0.17			0.17	0.17
v/c Ratio	0.33	0.59		0.20	0.79	0.10		0.20			0.33	0.26
Control Delay	31.7	11.9		32.5	21.3	1.9		3.3			29.7	8.4
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Delay	31.7	11.9		32.5	21.3	1.9		3.3			29.7	8.4
LOS	C	B		C	C	A		A			C	A
Approach Delay		14.4			19.8			3.3			18.2	
Approach LOS		B			B			A			B	
Queue Length 50th (ft)	27	78		10	187	0		0			24	0
Queue Length 95th (ft)	82	282		39	346	13		7			71	34
Internal Link Dist (ft)		420			1120			420			420	
Turn Bay Length (ft)	200			330		400						200
Base Capacity (vph)	296	1344		172	1330	1180		377			452	593

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Starvation Cap Reductn	0	0		0	0	0		0			0	0
Spillback Cap Reductn	0	0		0	0	0		0			0	0
Storage Cap Reductn	0	0		0	0	0		0			0	0
Reduced v/c Ratio	0.29	0.44		0.17	0.50	0.06		0.13			0.17	0.15

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 55.7
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.79
Intersection Signal Delay: 16.9 — Intersection LOS: B
Intersection Capacity Utilization 58.1% — ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 7: Kahuku Ag Rd/Marconi Rd & Kamehameha Hwy



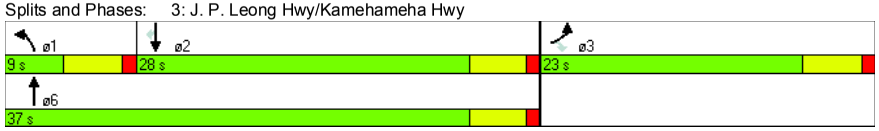
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	429	18	43	516	468	506
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1787	1615	1805	1900	1810	1583
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1787	1615	1805	1900	1810	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		127				511
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.98	1.00	1.00	1.00	0.87	0.99
Heavy Vehicles (%)	1%	0%	0%	0%	5%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	438	18	43	516	538	511
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	23.0	23.0	9.0	37.0	28.0	28.0
Total Split (%)	38.3%	38.3%	15.0%	61.7%	46.7%	46.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	16.3	16.3	4.1	26.6	23.4	23.4
Actuated g/C Ratio	0.31	0.31	0.08	0.50	0.44	0.44
v/c Ratio	0.80	0.03	0.31	0.54	0.67	0.52
Control Delay	31.2	0.1	32.0	11.8	19.6	3.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	31.2	0.1	32.0	11.8	19.6	3.7
LOS	C	A	C	B	B	A
Approach Delay	30.0			13.4	11.8	
Approach LOS	C			B	B	
Queue Length 50th (ft)	109	0	13	108	117	0
Queue Length 95th (ft)	#286	0	42	180	#295	52
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	615	639	138	1163	798	983
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.71	0.03	0.31	0.44	0.67	0.52

Intersection Summary

Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 53
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.80
Intersection Signal Delay: 16.3 — Intersection LOS: B
Intersection Capacity Utilization 64.2% — ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection	
Intersection Delay (sec/veh):	5

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	61	322	851	77	104	75
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	0.95	0.99	0.96	0.84	1.00	1.00
Heavy Vehicles(%)	6	5	3	5	3	2
Movement Flow Rate	64	325	886	92	104	75
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1			Major 2
Conflicting Flow Rate - All	1215	489	0	0	978	0
Stage 1	932	-	-	-	-	-
Stage 2	283	-	-	-	-	-
Follow-up Headway	3.554	3.345	-	-	2.227	-
Pot Capacity-1 Maneuver	197	573	-	-	702	-
Stage 1	377	-	-	-	-	-
Stage 2	756	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	166	573	-	-	702	-
Mov Capacity-2 Maneuver	166	-	-	-	-	-
Stage 1	377	-	-	-	-	-
Stage 2	639	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	16.9	0	6.4
HCM LOS	C	A	A

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			686		
HCM Control Delay (s)	-	-	16.9	11.018	-
HCM Lane VC Ratio	-	-	0.568	0.148	-
HCM Lane LOS	-	-	C	B	-
HCM 95th Percentile Queue (veh)	-	-	3.592	0.518	-

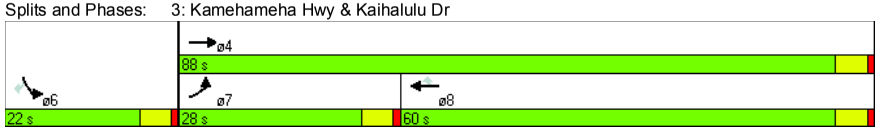
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	234	667	694	64	81	247
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	300			400	0	200
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1752	1863	1810	1553	1752	1583
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1752	1863	1810	1553	1752	1583
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				70		268
Link Speed (mph)		45	45		30	
Link Distance (ft)		500	3000		500	
Travel Time (s)		7.6	45.5		11.4	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	3%	2%	5%	4%	3%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	254	725	754	70	88	268
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	10.0	22.0	22.0	22.0	22.0	22.0
Total Split (s)	28.0	88.0	60.0	60.0	22.0	22.0
Total Split (%)	25.5%	80.0%	54.5%	54.5%	20.0%	20.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	18.3	67.9	44.5	44.5	17.5	17.5
Actuated g/C Ratio	0.19	0.71	0.47	0.47	0.18	0.18
v/c Ratio	0.76	0.55	0.90	0.09	0.28	0.53
Control Delay	53.7	7.9	38.2	3.9	41.4	9.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	53.7	7.9	38.2	3.9	41.4	9.4
LOS	D	A	D	A	D	A
Approach Delay		19.8	35.3		17.3	
Approach LOS		B	D		B	
Queue Length 50th (ft)	153	174	411	0	50	0
Queue Length 95th (ft)	259	244	#633	23	105	74
Internal Link Dist (ft)		420	2920		420	
Turn Bay Length (ft)	300			400		200
Base Capacity (vph)	433	1603	1070	946	319	508
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.59	0.45	0.70	0.07	0.28	0.53

Intersection Summary

Area Type: Other
Cycle Length: 110
Actuated Cycle Length: 95.6
Natural Cycle: 80
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.90
Intersection Signal Delay: 25.3 Intersection LOS: C
Intersection Capacity Utilization 66.5% ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Kamehameha Hwy & Kaihalulu Dr



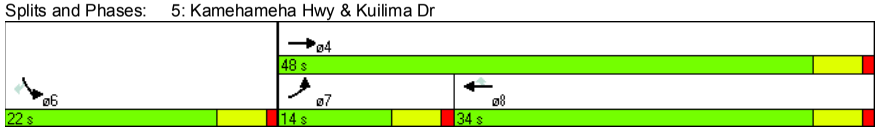
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	164	584	585	224	227	173
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200			400	0	0
Storage Lanes	1			1	1	1
Taper Length (ft)	100				100	
Satd. Flow (prot)	1738	1848	1795	1540	1738	1571
Flt Permitted	0.950				0.950	
Satd. Flow (perm)	1738	1848	1795	1512	1738	1550
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				243		188
Link Speed (mph)		45	45		25	
Link Distance (ft)		500	5500		500	
Travel Time (s)		7.6	83.3		13.6	
Confl. Bikes (#/hr)				12		1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	3%	2%	5%	4%	3%	2%
Bus Blockages (#/hr)	2	2	2	2	2	2
Shared Lane Traffic (%)						
Lane Group Flow (vph)	178	635	636	243	247	188
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	7	4	8		6	
Permitted Phases				8		6
Detector Phase	7	4	8	8	6	6
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	21.0	21.0	21.0	21.0	21.0
Total Split (s)	14.0	48.0	34.0	34.0	22.0	22.0
Total Split (%)	20.0%	68.6%	48.6%	48.6%	31.4%	31.4%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Min	Min
Act Effct Green (s)	8.9	39.8	25.8	25.8	13.6	13.6
Actuated g/C Ratio	0.14	0.63	0.41	0.41	0.21	0.21
v/c Ratio	0.73	0.55	0.87	0.32	0.67	0.39
Control Delay	48.9	9.4	33.3	3.4	33.1	6.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	48.9	9.4	33.3	3.4	33.1	6.7
LOS	D	A	C	A	C	A
Approach Delay		18.1	25.1		21.7	
Approach LOS		B	C		C	
Queue Length 50th (ft)	72	125	223	0	94	0
Queue Length 95th (ft)	#175	225	#430	38	164	45
Internal Link Dist (ft)		420	5420		420	
Turn Bay Length (ft)	200			400		

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Base Capacity (vph)	250	1273	834	832	473	558
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.71	0.50	0.76	0.29	0.52	0.34

Intersection Summary

Area Type: Other
Cycle Length: 70
Actuated Cycle Length: 63.6
Natural Cycle: 65
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.87
Intersection Signal Delay: 21.7 — Intersection LOS: C
Intersection Capacity Utilization 65.0% — ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 5: Kamehameha Hwy & Kuilima Dr



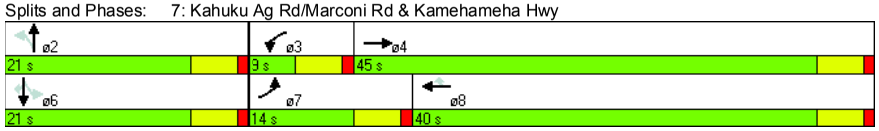
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	152	641	18	18	655	127	16	0	16	100	0	138
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	200		0	330		400	0		0	200		200
Storage Lanes	1		0	1		1	0		0	0		1
Taper Length (ft)	100			100			100			100		
Satd. Flow (prot)	1805	1817	0	1203	1812	1615	0	1152	0	0	1805	1615
Flt Permitted	0.950			0.950				0.825			0.735	
Satd. Flow (perm)	1805	1817	0	1203	1812	1570	0	974	0	0	1396	1615
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		3				138		102				150
Link Speed (mph)		45			45			30			25	
Link Distance (ft)		500			1200			500			500	
Travel Time (s)		7.6			18.2			11.4			13.6	
Confl. Bikes (#/hr)						10						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	0%	2%	50%	50%	4%	0%	50%	2%	50%	0%	2%	0%
Bus Blockages (#/hr)	0	2	0	0	2	0	0	0	0	0	0	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	165	717	0	20	712	138	0	34	0	0	109	150
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases						8	2			6		6
Detector Phase	7	4		3	8	8	2	2		6	6	6
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	9.0	21.0		9.0	21.0	21.0	21.0	21.0		21.0	21.0	21.0
Total Split (s)	14.0	45.0		9.0	40.0	40.0	21.0	21.0		21.0	21.0	21.0
Total Split (%)	18.7%	60.0%		12.0%	53.3%	53.3%	28.0%	28.0%		28.0%	28.0%	28.0%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Lost Time (s)	5.0	5.0		5.0	5.0	5.0		5.0			5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag	Lag						
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	Min
Act Effct Green (s)	8.9	41.6		4.1	29.1	29.1		10.5			10.5	10.5
Actuated g/C Ratio	0.14	0.65		0.06	0.46	0.46		0.16			0.16	0.16
v/c Ratio	0.66	0.61		0.26	0.87	0.17		0.14			0.48	0.38
Control Delay	44.4	10.7		41.6	29.0	2.9		1.2			33.1	8.3
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0			0.0	0.0
Total Delay	44.4	10.7		41.6	29.0	2.9		1.2			33.1	8.3
LOS	D	B		D	C	A		A			C	A
Approach Delay		17.0			25.1			1.2			18.7	
Approach LOS		B			C			A			B	
Queue Length 50th (ft)	66	121		8	234	0		0			41	0
Queue Length 95th (ft)	#169	375		31	#485	27		0			89	44
Internal Link Dist (ft)		420			1120			420			420	
Turn Bay Length (ft)	200			330		400						200

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Base Capacity (vph)	261	1253		77	1021	945		326			359	527
Starvation Cap Reductn	0	0		0	0	0		0			0	0
Spillback Cap Reductn	0	0		0	0	0		0			0	0
Storage Cap Reductn	0	0		0	0	0		0			0	0
Reduced v/c Ratio	0.63	0.57		0.26	0.70	0.15		0.10			0.30	0.28

Intersection Summary

Area Type: Other
Cycle Length: 75
Actuated Cycle Length: 63.9
Natural Cycle: 70
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.87
Intersection Signal Delay: 20.4 — Intersection LOS: C
Intersection Capacity Utilization 65.2% — ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 7: Kahuku Ag Rd/Marconi Rd & Kamehameha Hwy



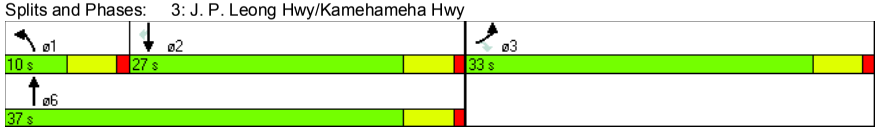
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	473	41	76	609	490	559
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0			450
Storage Lanes	1	1	1			1
Taper Length (ft)	100		100			
Satd. Flow (prot)	1787	1615	1805	1845	1881	1583
Flt Permitted	0.950		0.950			
Satd. Flow (perm)	1787	1615	1805	1845	1881	1583
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		109				643
Link Speed (mph)	30			30	30	
Link Distance (ft)	220			382	754	
Travel Time (s)	5.0			8.7	17.1	
Peak Hour Factor	0.83	0.68	1.00	1.00	0.95	0.87
Heavy Vehicles (%)	1%	0%	0%	3%	1%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	570	60	76	609	516	643
Turn Type	NA	Perm	Prot	NA	NA	Perm
Protected Phases	3		1	6	2	
Permitted Phases		3				2
Detector Phase	3	3	1	6	2	2
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.0	21.0	9.0	9.0	21.0	21.0
Total Split (s)	33.0	33.0	10.0	37.0	27.0	27.0
Total Split (%)	47.1%	47.1%	14.3%	52.9%	38.6%	38.6%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	23.9	23.9	5.1	30.0	22.5	22.5
Actuated g/C Ratio	0.37	0.37	0.08	0.47	0.35	0.35
v/c Ratio	0.86	0.09	0.53	0.71	0.78	0.66
Control Delay	33.5	1.2	47.0	19.9	32.0	5.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	33.5	1.2	47.0	19.9	32.0	5.7
LOS	C	A	D	B	C	A
Approach Delay	30.4			22.9	17.4	
Approach LOS	C			C	B	
Queue Length 50th (ft)	209	0	32	199	204	0
Queue Length 95th (ft)	292	0	#89	321	#377	58
Internal Link Dist (ft)	140			302	674	
Turn Bay Length (ft)						450
Base Capacity (vph)	798	781	143	942	660	972
Starvation Cap Reductn	0	0	0	0	0	0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.71	0.08	0.53	0.65	0.78	0.66

Intersection Summary

Area Type: Other
Cycle Length: 70
Actuated Cycle Length: 64.2
Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.86
Intersection Signal Delay: 22.2 — Intersection LOS: C
Intersection Capacity Utilization 68.7% — ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: J. P. Leong Hwy/Kamehameha Hwy



Intersection

Intersection Delay (sec/veh): 95.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Volume (vph)	56	301	866	92	96	876
Conflicting Peds.(#/hr)	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
Right Turn Channelized	Yield	Yield	Yield	Yield	None	None
Storage Length	0	0		200	0	
Median Width	12		0			0
Grade (%)	0%		0%			0%
Peak Hour Factor	1.00	1.00	0.91	0.79	0.79	0.93
Heavy Vehicles(%)	7	2	2	6	4	3
Movement Flow Rate	56	301	952	116	122	942
Number of Lanes	1	0	1	1	0	1

Major/Minor			Major 1			Major 2
Conflicting Flow Rate - All	2196	534	0	0	1068	0
Stage 1	1010	-	-	-	-	-
Stage 2	1186	-	-	-	-	-
Follow-up Headway	3.563	3.318	-	-	2.236	-
Pot Capacity-1 Maneuver	# 48	546	-	-	645	-
Stage 1	344	-	-	-	-	-
Stage 2	283	-	-	-	-	-
Time blocked-Platoon(%)	0	0	-	-	0	-
Mov Capacity-1 Maneuver	# 29	546	-	-	645	-
Mov Capacity-2 Maneuver	# 29	-	-	-	-	-
Stage 1	344	-	-	-	-	-
Stage 2	171	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay (s)	$ 660.2	0	1.4
HCM LOS	F	A	A

Lane	NBT	NBR	WBLn1	SBL	SBT
Capacity (vph)			154		
HCM Control Delay (s)	-	-	$ 660.2	11.872	-
HCM Lane VC Ratio	-	-	2.318	0.188	-
HCM Lane LOS	-	-	F	B	-
HCM 95th Percentile Queue (veh)	-	-	29.859	0.689	-

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/3/11
Analysis Time Period	AM Peak Hour W/Proposed Action
Highway	Kamehameha Highway
From/To	West of Kaihalulu Drive
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.92	
Lane width	12.0	ft	% Trucks and buses	8	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1199 veh/h
Directional split 50 / 50 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.992	
Two-way flow rate,(note-1) vp	1314	pc/h
Highest directional split proportion (note-2)	657	pc/h
Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h

Adjustment for no-passing zones, fnp	1.2	mi/h
Average travel speed, ATS	33.1	mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1303	pc/h
Highest directional split proportion (note-2)	652	
Base percent time-spent-following, BPTSF	68.2	%
Adj.for directional distribution and no-passing zones, fd/np	7.2	
Percent time-spent-following, PTSF	75.4	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.41	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	AM Peak Hour W/Proposed Action
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.95	
Lane width	12.0	ft	% Trucks and buses	5	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1444 veh/h
Directional split 51 / 49 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.995	
Two-way flow rate,(note-1) vp	1528	pc/h
Highest directional split proportion (note-2)	779	pc/h
Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.3	mi/h

Average travel speed, ATS 31.3 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1520	pc/h
Highest directional split proportion (note-2)	775	
Base percent time-spent-following, BPTSF	73.7	%
Adj.for directional distribution and no-passing zones, fd/np	6.7	
Percent time-spent-following, PTSF	80.4	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.48	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	AM Peak Hour W/Proposed Action
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.89	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 1631 veh/h
Directional split 65 / 35 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.997	
Two-way flow rate,(note-1) vp	1838	pc/h
Highest directional split proportion (note-2)	1195	pc/h
Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	1.1	mi/h

Average travel speed, ATS 27.2 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1833	pc/h
Highest directional split proportion (note-2)	1191	
Base percent time-spent-following, BPTSF	80.0	%
Adj.for directional distribution and no-passing zones, fd/np	5.0	
Percent time-spent-following, PTSF	85.0	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.57	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/3/11
Analysis Time Period	PM Peak Hour W/Proposed Action
Highway	Kamehameha Highway
From/To	West of Kaihalulu Drive
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.92	
Lane width	12.0	ft	% Trucks and buses	4	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1473 veh/h
Directional split 52 / 48 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.996	
Two-way flow rate,(note-1) vp	1607	pc/h
Highest directional split proportion (note-2)	836	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	0.9	mi/h

Average travel speed, ATS 31.1 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1601	pc/h
Highest directional split proportion (note-2)	833	
Base percent time-spent-following, BPTSF	75.5	%
Adj.for directional distribution and no-passing zones, fd/np	5.2	
Percent time-spent-following, PTSF	80.7	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.50	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	PM Peak Hour W/Proposed Action
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.96	
Lane width	12.0	ft	% Trucks and buses	2	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1919 veh/h
Directional split 51 / 49 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.998	
Two-way flow rate,(note-1) vp	2003	pc/h
Highest directional split proportion (note-2)	1022	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	1.0	mi/h

Average travel speed, ATS 28.0 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1999	pc/h
Highest directional split proportion (note-2)	1019	
Base percent time-spent-following, BPTSF	82.7	%
Adj.for directional distribution and no-passing zones, fd/np	4.1	
Percent time-spent-following, PTSF	86.8	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.63	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/1/2011
Analysis Time Period	PM Peak Hour W/Proposed Action
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.99	
Lane width	12.0	ft	% Trucks and buses	5	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 2072 veh/h
Directional split 57 / 43 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.995	
Two-way flow rate,(note-1) vp	2103	pc/h
Highest directional split proportion (note-2)	1199	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	0.9	mi/h

Average travel speed, ATS 25.2 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	2093	pc/h
Highest directional split proportion (note-2)	1193	
Base percent time-spent-following, BPTSF	84.1	%
Adj.for directional distribution and no-passing zones, fd/np	3.7	
Percent time-spent-following, PTSF	87.9	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.66	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	11/5/11
Analysis Time Period	Sat Peak Hr W/Proposed Action
Highway	Kamehameha Highway
From/To	West of Kaihalulu Drive
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.92	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	50	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V 1828 veh/h
Directional split 51 / 49 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.997	
Two-way flow rate,(note-1) vp	1993	pc/h
Highest directional split proportion (note-2)	1016	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	0.8	mi/h

Average travel speed, ATS 28.3 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	1987	pc/h
Highest directional split proportion (note-2)	1013	
Base percent time-spent-following, BPTSF	82.6	%
Adj.for directional distribution and no-passing zones, fd/np	3.4	
Percent time-spent-following, PTSF	85.9	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.62	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	10/29/2011
Analysis Time Period	Sat. Peak Hr W/Proposed Action
Highway	Kamehameha Highway
From/To	Haleiwa to Kawailoa
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class	Class 1				
Shoulder width	6.0	ft	Peak-hour factor, PHF	0.93	
Lane width	12.0	ft	% Trucks and buses	2	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	2	/mi
Up/down		%			

Two-way hourly volume, V	2124	veh/h
Directional split	51 / 49	%

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.998	
Two-way flow rate,(note-1) vp	2288	pc/h
Highest directional split proportion (note-2)	1167	pc/h
Free-Flow Speed from Field Measurement:		
Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	0.5	mi/h
Free-flow speed, FFS	44.5	mi/h
Adjustment for no-passing zones, fnp	0.9	mi/h

Average travel speed, ATS	25.8	mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	2284	pc/h
Highest directional split proportion (note-2)	1165	
Base percent time-spent-following, BPTSF	86.6	%
Adj.for directional distribution and no-passing zones, fd/np	3.2	
Percent time-spent-following, PTSF	89.8	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.71	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

HCS+: Two-Lane Highways Release 5.4

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Two-Way Two-Lane Highway Segment Analysis

Analyst	RSO
Agency/Co.	Traffic Management Consultant
Date Performed	10/29/2011
Analysis Time Period	Sat Peak Hr W/Proposed Action
Highway	Kamehameha Highway
From/To	Hygienic Store
Jurisdiction	
Analysis Year	2025
Description	Turtle Bay Resort Master Plan

Input Data

Highway class Class 1

Shoulder width	6.0	ft	Peak-hour factor, PHF	0.94	
Lane width	12.0	ft	% Trucks and buses	3	%
Segment length	0.0	mi	% Recreational vehicles	0	%
Terrain type	Level		% No-passing zones	80	%
Grade: Length		mi	Access points/mi	10	/mi
Up/down		%			

Two-way hourly volume, V 2137 veh/h
Directional split 55 / 45 %

Average Travel Speed

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.1	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor,	0.997	
Two-way flow rate,(note-1) vp	2280	pc/h
Highest directional split proportion (note-2)	1254	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed, SFM	-	mi/h
Observed volume, Vf	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed, BFFS	45.0	mi/h
Adj. for lane and shoulder width, fLS	0.0	mi/h
Adj. for access points, fA	2.5	mi/h
Free-flow speed, FFS	42.5	mi/h
Adjustment for no-passing zones, fnp	0.9	mi/h

Average travel speed, ATS 23.9 mi/h

Percent Time-Spent-Following

Grade adjustment factor, fG	1.00	
PCE for trucks, ET	1.0	
PCE for RVs, ER	1.0	
Heavy-vehicle adjustment factor, fHV	1.000	
Two-way flow rate,(note-1) vp	2273	pc/h
Highest directional split proportion (note-2)	1250	
Base percent time-spent-following, BPTSF	86.4	%
Adj.for directional distribution and no-passing zones, fd/np	3.2	
Percent time-spent-following, PTSF	89.6	%

Level of Service and Other Performance Measures

Level of service, LOS	E	
Volume to capacity ratio, v/c	0.71	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h

Notes:
1. If vp >= 3200 pc/h, terminate analysis-the LOS is F.
2. If highest directional split vp >= 1700 pc/h, terminate analysis-the LOS is F.

TRAFFIC IMPACT ANALYSIS REPORT
FOR THE PROPOSED
TURTLE BAY RESORT MASTER PLAN
KAHUKU, OAHU, HAWAII

APPENDIX H
TRAFFIC SIGNAL WARRANT ANALYSIS WORKSHEET
KAMEHAMEHA HIGHWAY AND KUILIMA DRIVE

TRAFFIC SIGNAL WARRANTS

Project: Turtle Bay Resort Master Plan SEIS
Prepared By: The Traffic Management Consultant
Data Date: Start Date: 11/03/2011 (Thurs)
Major Street: Kamehameha Highway — Critical Approach Speed 35 mph — No. of Lanes 2
Minor Street: Kuilima Drive — Critical Approach Speed 25 mph — No. of Lanes 4

Critical speed on major street (mph) ≥ 40 ☐
or
Population in built up area of isolated community ≤ 10,000 ☑

WARRANT 1 - Eight-Hour Vehicular Volume

Condition A - Minimum Vehicular Volume
(Ref.: MUTCD, Table 4C-1)

100% Satisfied	**YES** ☐	**NO** ☑
80% Satisfied	**YES** ☐	**NO** ☑
70% Satisfied	**YES** ☑	**NO** ☐
56% Satisfied	**YES** ☑	**NO** ☐

	Minimum Vehicular Volume				Hourly Vehicular Volumes							
STREET-APPROACH LANES	100%	80%	70%	56%	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM
Major Street-1 Lane (Each Approaches)	500	400	350	280	442	495	554	657	697	640	665	512
Minor Street-2 Lanes (Each Approaches)	200	160	140	112	132	154	143	142	161	179	148	133

Condition B - Interruption of Continuous Traffic
(Ref.: MUTCD, Table 4C-1)

100% Satisfied	**YES** ☐	**NO** ☑
80% Satisfied	**YES** ☐	**NO** ☑
70% Satisfied	**YES** ☑	**NO** ☐
56% Satisfied	**YES** ☑	**NO** ☐

	Minimum Vehicular Volume				Hourly Vehicular Volumes							
STREET-APPROACH LANES	100%	80%	70%	56%	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM
Major Street-2 Lanes (Each Approaches)	750	600	425	420	442	495	554	657	697	640	665	512
Minor Street-2 Lanes (Each Approaches)	100	80	70	56	132	154	143	142	161	179	148	133

WARRANT 2 - Four Hour Volume
(Ref.: MUTCD, Figures 4C-1 & 4C-2)

100% Satisfied	**YES** ☐	**NO** ☑
70% Satisfied	**YES** ☐	**NO** ☑

	Minimum Volume		Hourly Vehicular Volumes			
STREET - APPROACH LANES	100%	70%	1:00 PM	2:00 PM	3:00 PM	4:00 PM
Major Street - 2 Lanes (Both Approaches)	1400	1000	657	697	640	665
Minor Street - 2 Lanes	115	80	142	161	179	148

WARRANT 4 - Pedestrian Volume

Condition A - Four Hour Volumes
(Ref.: MUTCD, Figures 4C-5 & 4C-6)

100% Satisfied	**YES** ☐	**NO** ☑
70% Satisfied	**YES** ☐	**NO** ☑

	THRESHOLD VOLUME		HOURLY VOLUMES			
STREET - APPROACH LANES	100%	70%	2:15 PM	5:00 PM	6:00 PM	7:00 PM
Major Street (Both Approaches)	1100	770	836	622	536	392
Pedestrians Crossing Major Street	107	75	13	24	17	13

WARRANT 7 - Crash Experience **Satisfied** **YES** ☐ **NO** ☑

REQUIREMENT	WARRANT		Fulfilled	
One Warrant Satisfied 80%	Warrant 1-Minimum Vehicular Volume or		YES ☐	NO ☑
	Warrant 2-Interruption of Continuous Traffic or			
	Warrant 3-Minimum Pedestrian Volume			
Signal will not seriously disrupt progressive traffic flow			YES ☐	NO ☑
Adequate trial of less restrictive remedies has failed to reduce accidents frequency			YES ☐	NO ☑
Accidents within 12 month period susceptible to correction (Minimum 5 accidents*)			YES ☐	NO ☑

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APPENDIX J:

AIR IMPACT ANALYSIS

AIR QUALITY STUDY

FOR THE PROPOSED

TURTLE BAY RESORT EXPANSION PROJECT

KAHUKU, OAHU, HAWAII

Prepared for:

Lee Sichter LLC

August 2012

B.D. NEAL & ASSOCIATES

*Applied Meteorology * Air Quality * Computer Science*

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5 Estimated Worst-Case 8-Hour Carbon Monoxide Concentrations Along Roadways Near Turtle Bay Expansion Project

6 Estimated Annual Electrical Demand for Turtle Bay Expansion Project

7 Estimated Indirect Air Pollution Emissions from Turtle Bay Expansion Project Electrical Demand

8 Estimated Annual Solid Waste Disposal Demand for Turtle Bay Expansion Project

9 Estimated Indirect Air Pollution Emissions from Turtle Bay Expansion Project Solid Waste Disposal Demand

1.0 SUMMARY

Turtle Bay Resort is proposing the Turtle Bay Resort Expansion Project at Turtle Bay, Oahu. A Supplemental Environmental Impact Statement (SEIS) is required before the expansion project can be implemented. This report was prepared to support the SEIS. The SEIS recommends a Proposed Action and three alternatives. The three alternatives are referred to as: Conservation Partner Alternative, Full Build-Out Alternative and Resort Residential Alternative. As discussed in the SEIS, the Proposed Action is expected to be completed and fully occupied by 2025. This study examines the potential short- and long-term air quality impacts that could occur as a result of implementation of the Proposed Action and suggests mitigation 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 generally comparable to the national standards although the state standards for carbon monoxide 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 windward and coastal situation. Winds are predominantly trade winds from the east-northeast except for occasional periods when kona storms may generate strong winds from the south or when the trade winds are weak and landbreeze-seabreeze circulations may develop. There are no published wind data for the area, but ventilation is good much of the time due to the exposure to the trade winds. Temperatures in the project area are generally very moderate with average daily temperatures ranging from about 68°F to 81°F. The extreme minimum temperature recorded at the nearby (former) Kahuku weather station is 48°F, while the extreme maximum temperature is 95°F. Average annual rainfall amounts to about 40 inches with summer months being the driest.

Currently, there are no Hawaii Department of Health air monitoring stations located at North Shore or Windward areas of Oahu. All Department of Health air monitoring stations on Oahu are located in leeward areas where there is more human activity and more air pollution emission sources. Data from these stations suggest that all air quality standards are currently being met. Windward areas, such as the project area, very likely have better air quality.

With implementation of the Proposed Action, 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 computer modeling study was undertaken to estimate current ambient concentrations of carbon monoxide at intersections in the project vicinity and to predict future levels both with and without the Proposed Action. 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 2025 without the project, carbon monoxide concentrations were predicted to generally remain about the same in the project area, and worst-case concentrations should remain well within air quality standards. With the Proposed Action or any of the three project alternatives in the year 2025, project-related traffic would result in higher carbon monoxide concentrations compared to the without-project case at some locations, but worst-case concentrations should remain well within air quality standards. The Full Build-Out Alternative would result in the highest concentrations while the Resort Residential the least, although there is not a significant difference. 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 impacts from the Proposed Action or any of the three project alternatives will likely be negligible.

2.0 INTRODUCTION

Turtle Bay Resort is proposing the Turtle Bay Resort Expansion

Project at the existing Turtle Bay Resort on the island of Oahu. The project site is located along the North Shore of Oahu at Turtle Bay (see Figure 1 for project location). A Proposed Action, together with three alternatives, is being evaluated. The three alternatives are referred to as: Full Build-Out Alternative, Conservation Partner Alternative and Resort Residential Alternative.

The Proposed Action includes two new hotels totaling 625 units, 590 resort residential units, 160 community housing units, 73 acres of new parks, a new equestrian center, a farmers market, a low-density commercial and cultural activity center and reconfiguration of the two existing golf courses from 36 holes to 27. The Full Build-Out Alternative includes 2,500 new hotel units, 910 resort residential units, and 90 residential housing units. The Conservation Partner Alternative proposes 440 new hotel units, 252 new resort residential units, 48 community housing units and the conversion of the existing Fazio Golf Course to other uses. The Resort Residential Alternative would provide for 500 new residential units and both existing 18-hole golf courses would be retained. It is expected that the Proposed Action or one of the alternatives will be selected for development. The development is expected to be completed and fully occupied by 2025.

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 potential 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 national AAQS are reviewed periodically, and multiple revisions have occurred over the past 30 years. In general, the national AAQS have become more stringent with the passage of time and as more information and evidence become available concerning the detrimental effects of air pollution. Changes to the Hawaii AAQS over the past several years have tended to follow revisions to the national AAQS, making several of the

Hawaii AAQS the same as the national AAQS.

4.0 REGIONAL AND LOCAL CLIMATOLOGY

Regional and local climatology significantly affects the air quality of a given location. Wind, temperature, atmospheric turbulence, mixing height and rainfall all influence air quality. Although the climate of Hawaii is relatively moderate throughout most of the state, significant differences in these parameters may occur from one location to another. Most differences in regional and local climates within the state are caused by the mountainous topography.

Hawaii lies well within the belt of northeasterly trade winds generated by the semi-permanent Pacific high pressure cell to the north and east. On the island of Oahu, the Koolau and Waianae Mountain Ranges are oriented almost perpendicular to the trade winds, which accounts for much of the variation in the local climatology of the island. The site of the proposed project is located on the windward side of the Koolau Mountains at the northern tip of Oahu near Kahuku Point.

There are no published wind data for this area of Oahu. However, based on the project location and the good exposure to the tradewind flow, ventilation can be expected to be good much of the time. Wind energy resource maps for the Kahuku area [1] suggest that wind speeds are frequently in the upper range. Winds can be expected to come mostly from the east or northeast direction due

to the prevailing tradewind flow and to the local terrain effects.

Air pollution emissions from motor vehicles, the formation of photochemical smog and smoke plume rise all depend in part on air temperature. Colder temperatures tend to result in higher emissions of contaminants from automobiles but lower concentrations of photochemical smog and ground-level concentrations of air pollution from elevated plumes. In Hawaii, the annual and daily variation of temperature depend to a large degree on elevation above sea level, distance inland and exposure to the trade winds. Average temperatures at locations near sea level generally are warmer than those at higher elevations. Areas exposed to the trade winds tend to have the least temperature variation, while inland and leeward areas often have the most. The project's coastal, windward location results in relatively persistent and moderate temperatures. Based on more than 50 years of data collected at the former nearby Kahuku weather station, average annual daily minimum and maximum temperatures in the project area are 68°F and 81°F, respectively [2]. The extreme minimum temperature on record is 48°F, and the extreme maximum is 95°F.

Small scale, random motions in the atmosphere (turbulence) cause air pollutants to be dispersed as a function of distance or time from the point of emission. Turbulence is caused by both mechanical and thermal forces in the atmosphere. It is oftentimes measured and described in terms of Pasquill-Gifford stability class. Stability class 1 is the most turbulent and class 6 the

least. Thus, air pollution dissipates the best during stability class 1 conditions and the worst when stability class 6 prevails. In the Kahuku area, stability class 5 or 6 is generally the highest stability class that occurs, developing during clear, calm nighttime or early morning hours when temperature inversions form due to radiational cooling. Stability classes 1 through 4 occur during the daytime, depending mainly on the amount of cloud cover and incoming solar radiation and the onset and extent of the sea breeze.

Mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Low mixing heights can result in high ground-level air pollution concentrations because contaminants emitted from or near the surface can become trapped within the mixing layer. In Hawaii, minimum mixing heights tend to be high because of mechanical mixing caused by the trade winds and because of the temperature moderating effect of the surrounding ocean. Low mixing heights may sometimes occur, however, at inland locations and even at times along coastal areas early in the morning following a clear, cool, windless night. Coastal areas also may experience low mixing levels during sea breeze conditions when cooler ocean air rushes in over warmer land. Mixing heights in Hawaii typically are above 3000 feet (1000 meters).

Rainfall can have a beneficial effect 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 Kahuku area receives moderate amounts of precipitation due to its windward and near sea level location. Average annual rainfall amounts to about 40 inches with monthly amounts of about 4 to 5 inches in winter and about 1 to 2 inches in summer [2].

5.0 PRESENT AIR QUALITY

Present air quality in the project area is mostly affected by air pollutants from motor vehicles, agricultural operations and to a lesser extent by natural sources. Table 3 presents an air pollutant emission summary for the island of Oahu for calendar year 1993. This is the most recent information available. The emission rates shown in the table pertain to manmade emissions only, i.e., emissions from natural sources are not included. As suggested in the table, much of the particulate emissions on Oahu originate from area sources, such as the mineral products industry and agriculture. Sulfur oxides are emitted almost exclusively by point sources, such as power plants and refineries. Nitrogen oxides emissions emanate predominantly from industrial point sources, although area sources (mostly motor vehicle traffic) also contribute a significant share. The majority of carbon monoxide emissions occur from area sources (motor vehicle traffic), while hydrocarbons are emitted mainly from point sources. Based on previous emission inventories that have been reported for Oahu, emissions of particulate and nitrogen oxides may have increased during the past several years, while emissions of sulfur oxides,

carbon monoxide and hydrocarbons probably have declined.

Kamehameha Highway, which passes near the project area to the south, is a major arterial roadway that presently carries moderate to heavy levels of vehicle traffic during peak traffic hours. Emissions from motor vehicles using this roadway, primarily nitrogen oxides and carbon monoxide, will tend to be carried away from the project site by the prevailing winds.

Natural sources of air pollution emissions that also could affect the project area but cannot be quantified very accurately include the ocean (sea spray), plants (aero-allergens), wind-blown dust, and perhaps distant volcanoes on the island of Hawaii.

The State Department of Health operates a network of air quality monitoring stations at various locations on Oahu. Each station, however, typically does not monitor the full complement of air quality parameters, and no stations are located on the windward side of the island or anywhere near to the project site. Thus, air quality data from stations at leeward locations will be discussed, but this data is probably only marginally representative of the project area. Table 3 shows annual summaries of air quality measurements that were made at leeward Oahu locations for several of the regulated air pollutants for the period 2006 through 2010. These are the most recent data that are currently available.

During the 2006-2010 period, sulfur dioxide was monitored by the State Department of Health at an air quality station located at Kapolei. Concentrations monitored were consistently low compared to the standards. Annual second-highest 3-hour concentrations (which are most relevant to the air quality standards) ranged from 0.004 to 0.011 parts per million (ppm), while the annual second-highest 24-hour concentrations ranged from 0.003 to 0.004 ppm. Annual average concentrations were only about 0.001 to 0.002 ppm. There were no exceedances of the state/national 3-hour or 24-hour AAQS for sulfur dioxide during the 5-year period. Data pertaining to the new 1-hour standard have not yet been reported.

Particulate matter less than 10 microns in diameter (PM-10) is also measured at the Kapolei monitoring station. Annual second-highest 24-hour PM-10 concentrations ranged from 36 to 58 $\mu g/m^3$ between 2006 and 2010. Average annual concentrations ranged from 16 to 18 $\mu g/m^3$. All values reported were within the state and national AAQS.

Particulate matter less than 2.5 microns in diameter (PM-2.5) measured at the Kapolei monitoring station had annual 98th percentile 24-hour concentrations ranging from 7 to 21 $\mu g/m^3$ between 2006 and 2010. Average annual concentrations ranged from 4 to 6 $\mu g/m^3$. All values reported were within the state and national AAQS.

Carbon monoxide measurements were also made at the Kapolei monitoring station. The annual second-highest 1-hour concentrations ranged from 0.9 to 2.6 ppm. The annual second-highest 8-hour concentrations ranged from 0.7 to 1.2 ppm. These values are well within the standards, and no exceedances of the state or national 1-hour or 8-hour AAQS were reported.

Nitrogen dioxide is also monitored by the Department of Health at the Kapolei monitoring station. Annual average concentrations of this pollutant ranged from 0.003 to 0.005 ppm, safely inside the state and national AAQS.

The nearest available ozone measurements were obtained at Sand Island. The fourth-highest 8-hour concentrations (which are most relevant to the standard) for the period 2006 through 2010 ranged between 0.033 and 0.048 ppm, well inside the state and federal standards. The 8-hour standard for ozone did not exist prior to 2002. Prior to 2002, the now obsolete state 1-hour standard was typically exceeded several times each year.

Although not shown in the table, the nearest and most recent measurements of ambient lead concentrations that have been reported were made at the downtown Honolulu monitoring station between 1996 and 1997. Average quarterly concentrations were near or below the detection limit, and no exceedances of the state AAQS were recorded. Monitoring for this parameter was discontinued during 1997.

It is probable that air pollution concentrations measured at leeward locations are higher than those present on the windward coast where the project is located. Based on the data and discussion presented above, it appears likely that the State of Hawaii AAQS for sulfur dioxide, nitrogen dioxide, particulate matter, ozone and lead are currently being met in the project area. While carbon monoxide measurements at the Kapolei monitoring station suggest that concentrations are within the state and national standards, local "hot spots" may exist near traffic-congested intersections. The potential for this within the specific project area is examined later in this report.

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 [3] 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 [4] 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 annual standard for nitrogen dioxide is not likely to be violated by short-term construction equipment emissions. Also, the new short-term (1-hour) standard for nitrogen dioxide is based on a three-year average; thus it is unlikely that relatively short-term construction emissions would exceed the standard. Carbon monoxide emissions from diesel engines are low and should be relatively insignificant compared to vehicular emissions on nearby roadways.

Project construction activities could occasionally 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 required further emission reductions, which have been phased in since 1994. Additional restrictions were signed into law during the Clinton administration, and these began to take effect during the past 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 20 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, six scenarios were selected for the carbon monoxide modeling study: (1) year 2012 with present conditions, (2) year 2025 without the project, (3) year 2025 with the project Conservation Partner Alternative, (4) year 2025 with the project Full Build-Out Alternative, (5) year 2025 with the Proposed Action, and (6) year 2025 with the project Resort Residential Alternative. To begin the modeling study of the six 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 key intersections identified in the traffic study were also selected for air quality analysis. These included the following intersections:

- Kamehameha Highway at Kuilima Drive
- Kamehameha Highway at Marconi Road
- Kamehameha Highway at Kaihalulu Drive (the project's new lateral roadway)

The traffic impact report for the project [5] describes the existing and 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 four 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 weekday morning, weekday afternoon and Saturday peak traffic periods. These same periods were evaluated in the air

quality impact assessment.

The EPA computer model MOBILE6.2 [6] was used to calculate vehicular carbon monoxide emissions for each year studied. One of the key inputs to MOBILE6.2 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 33.2% light-duty gasoline-powered automobiles, 53.9% light-duty gasoline-powered trucks and vans, 3.6% heavy-duty gasoline-powered vehicles, 0.2% light-duty diesel-powered vehicles, 8.6% heavy-duty diesel-powered trucks and buses, and 0.5% 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. This reflects the nationwide trend of driver preferences in motor vehicles.

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 MOBILE6.2 generally have an inverse relationship to the ambient temperature.

After computing vehicular carbon monoxide emissions through the use of MOBILE6.2, these data were then input to an atmospheric dispersion model. EPA air quality modeling guidelines [7]

currently recommend that the computer model CAL3QHC [8] be used to assess carbon monoxide concentrations at roadway intersections, or in areas where its use has previously been established, CALINE4 [9] may be used. CALINE4 was used extensively in Hawaii in the 1990's to assess air quality impacts at roadway intersections, but 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 had become outdated. Studies have shown that CALINE4 may tend to over-predict maximum concentrations in some situations. For the past several years, CAL3QHC has been used in Hawaii to assess air quality impacts near roadway intersections, and 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, the two existing study intersection

(Kamehameha Highway at Kuilima Drive and Kamehameha Highway at Marconi Road) are unsignalized. For the future without project scenario, in accordance with the traffic report, these intersections were assumed to remain unsignalized. For the future scenarios with the project, in accordance with the traffic report, these intersections, as well as a new intersection at Kamehameha Highway and Kaihalulu Drive, were assumed to become 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 MOBILE6.2 based on assumed free-flow vehicle speeds corresponding to the posted speed limits.

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 scenarios. 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 weekday morning cases, while atmospheric stability category 4 was assumed for the weekday and Saturday 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 2012. 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 six scenarios: year 2012 with existing traffic, year 2025 without the project, year 2025 with the Proposed Action, year 2025 with the project Full Build-Out Alternative, year 2025 with the project Conservation Partner Alternative and year 2025 with the project Resort Residential Alternative. 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 (2012) case was 1.7 ppm. This was projected to occur during both the weekday morning peak traffic hour and the Saturday peak traffic period near the intersection of Kamehameha Highway and Kuilima Drive. Concentrations at other locations and times studied were 1.3 ppm or lower. All predicted worst-case 1-hour concentrations for the 2012 scenario were within both the national AAQS of 35 ppm and the state standard of 9 ppm.

In the year 2025 without the proposed project, the highest worst-case 1-hour concentration was predicted to occur during the Saturday peak traffic hour at the intersection of Kamehameha

Highway and Kuilima Drive. A value of 1.8 ppm was predicted to occur at this location and time. Peak-hour worst-case values at the other locations and times studied for the 2025 without project scenario ranged between 1.0 and 1.6 ppm. Compared to the existing case, concentrations generally remained about the same, and all projected worst-case concentrations for this scenario remained well within the state and national standards.

In the year 2025, the full build-out alternative was predicted to result in the highest worst-case 1-hour concentration. This was predicted to occur during the weekday morning at the intersection of Kamehameha Highway and Kuilima Drive with a value of 3.1 ppm. Other concentrations for this alternative ranged between 2.0 and 2.9 ppm. The Proposed Action and other project alternatives generally resulted in slightly lower concentrations, but the difference amongst them was relatively small. Although the predicted concentrations with any development increased compared to the without project scenario, the values remained well 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 [10] concluded that 1-hour to 8-hour persistence factors could typically be expected to range from 0.4 to 0.5. EPA guidelines [11] 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 [12] 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 2012 scenario, the estimated worst-case 8-hour carbon monoxide concentrations for the two locations studied were 0.6 ppm at the Kamehameha Highway/Marconi Road intersection and 0.8 ppm at the Kamehameha Highway/Kuilima Drive intersection. The estimated worst-case concentrations for the existing case were within both the state standard of 4.4 ppm and the national limit of 9 ppm.

For the year 2025 without project scenario, worst-case concentrations ranged between 0.6 and 0.9 ppm, with the highest concentration occurring at Kamehameha Highway and Kuilima Drive. All predicted concentrations were within the standards.

For the 2025 with Proposed Action or alternatives, worst-case concentrations were predicted to increase somewhat compared to the without project case. At the three intersections studied, predicted worst-case concentrations ranged from 1.0 to 1.6 ppm with the highest concentration occurring at the intersection of Kamehameha Highway and Kaihalulu Drive in the Full Build-Out Alternative. All predicted 8-hour concentrations for the Proposed Action and alternatives were 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 Action also will cause indirect air pollution emissions from power generating facilities as a consequence of electrical power usage. **The estimated annual electrical demands of the Proposed Action and alternatives are shown in Table 6. The highest electrical demand, 107 million kilowatt-hours per year, would occur with the Full Build-Out Alternative, while the Resort Residential Alternative would have the least at 31 million kilowatt-hours per year.** Electrical power for the development will most probably be provided mainly by oil-fired generating facilities located on Oahu, but some of the power could also come from sources burning other fuels, such as H-Power and the AES coal-fired power plant at Campbell Industrial Park, or from renewable energy resources that are currently being developed. In order to meet the electrical power needs of the Proposed Action, power generating facilities may be required to burn more fuel and hence more air pollution may be emitted at these facilities. Table 7 presents estimates of the indirect air pollution emissions that would result from the Proposed Action’s electrical demand assuming all power is provided by burning more fuel oil at Oahu's power plants. These values can be compared to the island-wide emission estimates for 1993 given in Table 3. The Full Build-Out Alternative would have the highest emissions, while the Resort Residential Alternative would have the least. The Proposed Action or alternatives would result in relatively small emissions from project electrical demand. The estimated indirect emissions from the electrical

demand amounts to less than 0.1 percent of the present air pollution emissions occurring on Oahu.

7.3 Solid Waste Disposal

Solid waste generated by the Proposed Action or alternatives is not expected to exceed the amounts indicated in Table 8. As indicated in the table, the estimated amounts assume 70 percent recycling/reuse diversion. Most project refuse will likely be hauled away and burned at the H-Power facility at Campbell Industrial Park to generate electricity. Burning of the waste to generate electricity will result in emissions of particulate, carbon monoxide and other contaminants, but these will be offset to some extent by reducing the amount of fuel oil that may be required to generate electricity for the project. Table 9 gives emission estimates assuming all project solid waste is burned at H-Power. These values can be compared to the island-wide emission estimates for 1993 given in Table 2. The estimated potential indirect emissions from project solid waste disposal demand amount to less than 0.1 percent of the present air pollution emissions occurring on Oahu. The emissions from the Proposed Action or alternatives are relatively small. The Full Build-Out Alternative would result in the most emissions and the Resort Residential Alternative the least.

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 Action or alternative is completed and fully occupied, carbon monoxide concentrations in the project area will likely increase due to emissions from project-related motor vehicle traffic. The Full Build-Out Alternative would likely have the most impact, while the Resort Residential Alternative the least, but worst-case concentrations should remain within both the state and the national ambient air quality standards with the Proposed Action or any of the three project alternatives studied. 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 waste materials generated by the project will likely be negligible based on the magnitudes of the estimated emissions compared to the current island-wide emissions.

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Figure 1 - Project Location

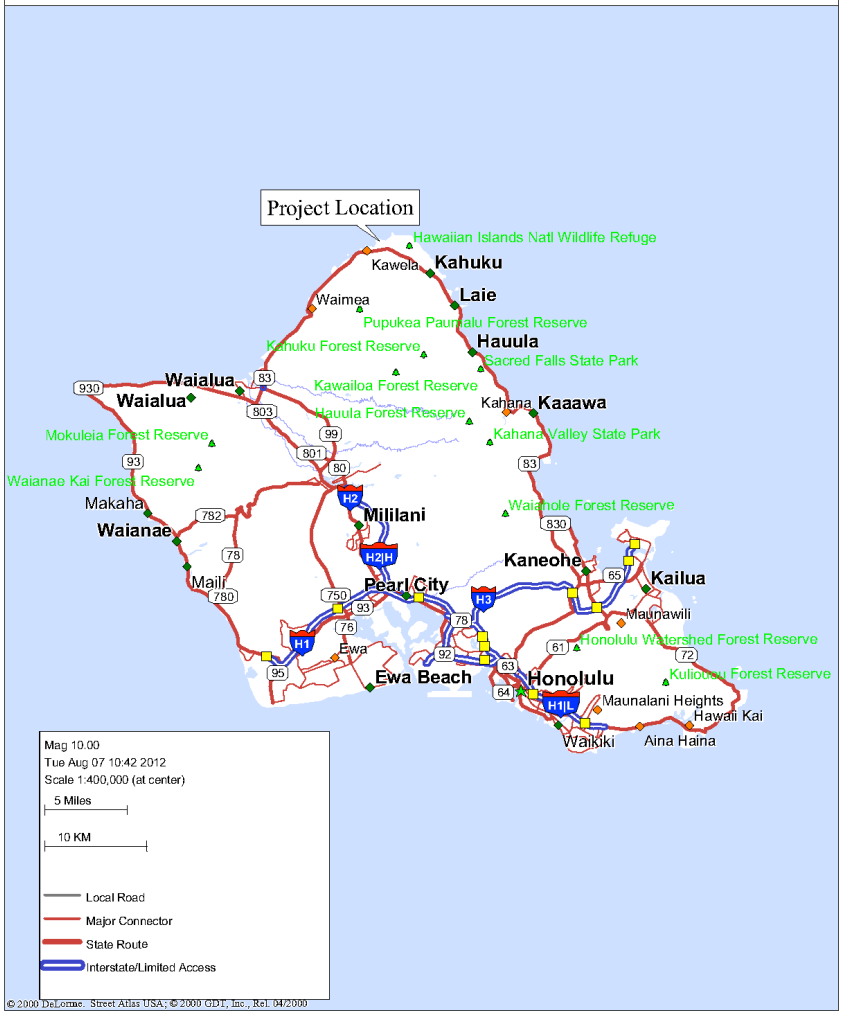

Table 1

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)	$\mu g/m^3$	Annual	-	-	50
		24 Hours	150[a]	150[a]	150[b]
Particulate Matter (<2.5 microns)	$\mu g/m^3$	Annual	15[c]	15[c]	-
		24 Hours	35[d]	35[d]	-
Sulfur Dioxide	ppm	Annual	-	-	0.03
		24 Hours	-	-	0.14[b]
		3 Hours	-	0.5[b]	0.5[b]
		1 Hour	0.075[e]	-	-
Nitrogen Dioxide	ppm	Annual	0.053	0.053	0.04
		1 Hour	0.100[f]	-	-
Carbon Monoxide	ppm	8 Hours	9[b]	-	4.4[b]
		1 Hour	35[b]	-	9[b]
Ozone	ppm	8 Hours	0.075[g]	0.075[g]	0.08[g]
Lead	$\mu g/m^3$	3 Months	0.15[h]	0.15[h]	-
		Quarter	1.5[i]	1.5[i]	1.5[i]
Hydrogen Sulfide	ppm	1 Hour	-	-	0.035[b]

[a] Not to be exceeded more than once per year on average over three years.
[b] Not to be exceeded more than once per year.
[c] Three-year average of the weighted annual arithmetic mean.
[d] 98th percentile value of the 24-hour concentrations averaged over three years.
[e] Three-year average of annual fourth-highest daily 1-hour maximum.
[f] 98th percentile value of the daily 1-hour maximum averaged over three years.
[g] Three-year average of annual fourth-highest daily 8-hour maximum.
[h] Rolling 3-month average.
[i] Quarterly average.

Table 2

AIR POLLUTION EMISSIONS INVENTORY FOR ISLAND OF OAHU, 1993

Air Pollutant	Point Sources (tons/year)	Area Sources (tons/year)	Total (tons/year)
Particulate	25,891	49,374	75,265
Sulfur Oxides	39,230	nil	39,230
Nitrogen Oxides	92,436	31,141	123,577
Carbon Monoxide	28,757	121,802	150,559
Hydrocarbons	4,160	421	4,581

Source: Final Report, "Review, Revise and Update of the Hawaii Emissions Inventory Systems for the State of Hawaii", prepared for Hawaii Department of Health by J.L. Shoemaker & Associates, Inc., 1996

Table 3

ANNUAL SUMMARIES OF AIR QUALITY MEASUREMENTS FOR MONITORING STATIONS NEAREST TURTLE BAY EXPANSION PROJECT

Parameter / Location	2006	2007	2008	2009	2010
Sulfur Dioxide / Kapolei					
3-Hour Averaging Period:					
Highest Concentration (ppm)	0.005	0.010	0.009	0.010	0.012
2nd Highest Concentration (ppm)	0.004	0.008	0.009	0.007	0.011
No. of State AAQS Exceedances	0	0	0	0	0
24-Hour Averaging Period:					
Highest Concentration (ppm)	0.003	0.003	0.005	0.003	0.004
2nd Highest Concentration (ppm)	0.003	0.003	0.003	0.003	0.004
No. of State AAQS Exceedances	0	0	0	0	0
Annual Average Concentration (ppm)	0.002	0.002	0.001	0.001	0.001
Particulate (PM-10) / Kapolei					
24-Hour Averaging Period:					
Highest Concentration ($\mu g/m^3$)	59	75(a)	61	37	59
2nd Highest Concentration ($\mu g/m^3$)	58	57	44	36	58
No. of State AAQS Exceedances	0	0	0	0	0
Annual Average Concentration ($\mu g/m^3$)	16	17	18	16	16
Particulate (PM-2.5) / Kapolei					
24-Hour Averaging Period:					
Highest Concentration ($\mu g/m^3$)	34(a)	20	35	25	61(a)
98th percentile Concentration ($\mu g/m^3$)	7	8	21	13	12
No. of State AAQS Exceedances	0	0	0	0	1(a)
Annual Average Concentration ($\mu g/m^3$)	4	4	5	6	4
Carbon Monoxide / Kapolei					
1-Hour Averaging Period:					
Highest Concentration (ppm)	1.4	3.8	2.2	3.7	1.6
2nd Highest Concentration (ppm)	1.4	0.9	1.7	2.6	1.5
No. of State AAQS Exceedances	0	0	0	0	0
8-Hour Averaging Period:					
Highest Concentration (ppm)	1.0	0.8	0.7	1.2	1.0
2nd Highest Concentration (ppm)	1.0	0.7	0.7	1.2	0.8
No. of State AAQS Exceedances	0	0	0	0	0
Nitrogen Dioxide / Kapolei					
Annual Average Concentration (ppm)	0.005	0.005	0.004	0.004	0.003
Ozone / Sand Island					
8-Hour Averaging Period:					
Highest Concentration (ppm)	0.042	0.035	0.048	0.049	0.052
4th Highest Concentration (ppm)	0.042	0.033	0.043	0.048	0.047
No. of State AAQS Exceedances	0	0	0	0	0

(a) Data flagged due to fireworks. SOURCE: STATE OF HAWAII DEPARTMENT OF HEALTH, "ANNUAL SUMMARIES" HAWAII AIR QUALITY DATA, 2006 - 2010"

Table 4

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR TURTLE BAY EXPANSION PROJECT (parts per million)

Roadway Intersection	Year/Scenario								
	2012/Present			2025/Without Project			2025/Proposed Action		
	AM	PM	Sat.	AM	PM	Sat.	AM	PM	Sat.
Kamehameha Highway at Kuilima Drive	1.7	1.3	1.7	1.6	1.4	1.8	2.4	1.9	2.1
Kamehameha Highway at Marconi Road	1.3	1.0	1.0	1.3	1.0	1.1	2.1	1.6	2.2
Kamehameha Highway at Kaihalulu Drive	-	-	-	-	-	-	2.6	1.6	2.0

Hawaii State AAQS: 9
National AAQS: 35

(Continued)

Table 4 (cont.)

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR TURTLE BAY EXPANSION PROJECT (parts per million)

Roadway Intersection	Year/Scenario								
	2025/Full Build-Out			2025/Conservation Partner			2025/Resort Residential		
	AM	PM	Sat.	AM	PM	Sat.	AM	PM	Sat.
Kamehameha Highway at Kuilima Drive	2.9	2.1	2.2	2.2	1.7	2.0	2.2	1.6	2.0
Kamehameha Highway at Marconi Road	2.7	2.0	2.2	1.9	1.3	1.7	1.9	1.3	1.7
Kamehameha Highway at Kaihalulu Drive	3.1	2.6	2.4	2.4	1.5	2.0	2.0	1.4	1.8

Hawaii State AAQS: 9
National AAQS: 35

Table 5

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR TURTLE BAY EXPANSION PROJECT (parts per million)

Roadway Intersection	Year/Scenario		
	2012/Present	2025/Without Project	2025/Proposed Action
Kamehameha Highway at Kuilima Drive	0.8	0.9	1.2
Kamehameha Highway at Marconi Road	0.6	0.6	1.1
Kamehameha Highway at Kaihalulu Drive	-	-	1.3

Hawaii State AAQS: 4.4
National AAQS: 9

(Continued)

Table 5 (cont.)

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR TURTLE BAY EXPANSION PROJECT (parts per million)

Roadway Intersection	Year/Scenario		
	2025/Full Build-Out	2025/Conservation Partner	2025/Resort Residential
Kamehameha Highway at Kuilima Drive	1.4	1.1	1.1
Kamehameha Highway at Marconi Road	1.4	1.0	1.0
Kamehameha Highway at Kaihalulu Drive	1.6	1.2	1.0

Hawaii State AAQS: 4.4
National AAQS: 9

Table 6

ESTIMATED ANNUAL ELECTRICAL DEMAND FOR TURTLE BAY EXPANSION PROJECT

Project	Estimated Annual Electrical Demand (million kilowatt-hours
Proposed Action	70
Full Build-Out Alternative	107
Conservation Partner Alternative	46
Resort Residential Alternative	31

Source: Personal communication via email from Cheryl Palesh, Belt Collins Hawaii LLC, to Barry D. Neal, B.D. Neal & Associates, Turtle Bay Resort Monthly Electrical Demand Estimates, August 22, 2012.

Table 7

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM TURTLE BAY EXPANSION PROJECT ELECTRICAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)			
	Proposed Action	Full Build-Out	Conservation Partner	Resort Residential
Particulate	2	3	1	1
Sulfur Dioxide	24	36	16	11
Carbon Monoxide	2	3	1	1
Volatile Organics	1	1	<1	<1
Nitrogen Oxides	10	16	7	4

[a]Based on U.S. EPA emission factors for utility boilers [3]. Assumes electrical demand indicated in Table 6 and low-sulfur oil used to generate power.

Table 8

ESTIMATED ANNUAL SOLID WASTE DISPOSAL DEMAND FOR TURTLE BAY EXPANSION PROJECT

Project	Estimated Annual Solid Waste Disposal Demand (tons)[a]
Proposed Action	2,626
Full Build-Out Alternative	3,686
Conservation Partner Alternative	1,173
Resort Residential Alternative	1,106

[a]Assumes 70 percent recycling/reuse diversion.

Source: Personal communication via email from Lee Sichter, Lee Sichter LLC, to Barry D. Neal, B.D. Neal & Associates, Turtle Bay Resort Annual Solid Waste Disposal Demand Estimates, August 14, 2012.

Table 9

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM TURTLE BAY EXPANSION PROJECT SOLID WASTE DISPOSAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)			
	Proposed Action	Full Build-Out	Conservation Partner	Resort Residential
Particulate	0.2	0.2	0.1	0.1
Sulfur Dioxide	0.6	0.8	0.2	0.2
Carbon Monoxide	2.5	3.5	1.1	1.1
Nitrogen Oxides	6.6	9.2	2.9	2.8
Lead	0.3	0.4	0.1	0.1

[a]Assumes solid waste disposal demands indicated in Table 8 and that solid waste is burned in a refuse-derived fuel-fired power plant equipped with spray dryer and fabric filter. Emission rates based on U.S. EPA emission factors for refuse-derived fuel-fired combustors [3].

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APPENDIX K:

NOISE IMPACT ANALYSIS

K

ACOUSTIC STUDY FOR THE TURTLE BAY RESORT MASTER PLAN KAHUKU, OAHU, HAWAII

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AUGUST 2012

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CHAPTER I. SUMMARY

The existing and future traffic noise levels in the vicinity of the proposed Master Plan for the Turtle Bay Resort at Kawela Bay, Oahu 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 2025.

Along the existing Kamehameha Highway, traffic noise levels were expected to increase by 1.2 to 4.3 DNL (Day-Night Average Sound Level) between CY 2011 and CY 2025 as a result of both project and non-project traffic. Traffic noise increases due to project traffic were predicted to range from 0.2 to 3.3 DNL which were greater than the range of the noise increases caused by non-project traffic (1.0 to 1.2 DNL) on Kamehameha Highway. These increases in traffic noise levels associated with project traffic were considered to be moderate to high.

Future traffic noise levels at existing and planned noise sensitive locations along Kamehameha Highway in the project environs were expected to exceed 65 DNL without noise mitigation measures. Existing residences west of Kawela Bay and two existing residences located approximately 0.7 miles east of Kuilima Drive were predicted to experience future traffic noise levels greater than 65 DNL. Future project residents located along Kamehameha Highway may be impacted by traffic noise if adequate setback distances are not provided from the highway or if sound attenuation walls or berms are not included in the project. Due to the relatively short setback distances of existing residences west of Kawela Bay, approximately thirteen of these residences currently experience traffic noise levels greater than 65 DNL. By 2025, an additional five residences were predicted to experience traffic noise levels greater than 65 DNL.

Unavoidable, but temporary, noise impacts may occur during the construction of the proposed project. Because construction activities may be audible at the developed properties of Kuilima Estates and Ocean Villas, the resort's hotel and spa buildings, and at single family residences along Kamehameha Highway, the acoustic environment from construction of the project 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 are recommended to minimize construction noise impacts.

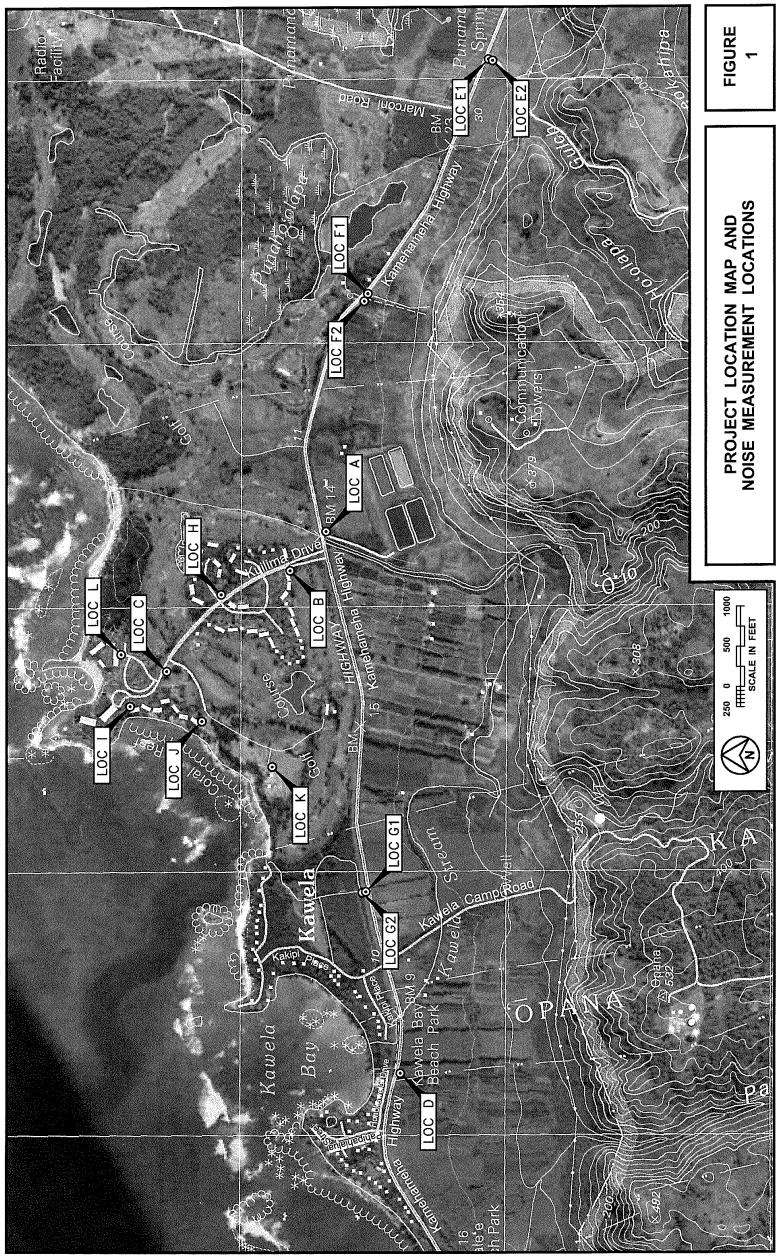


FIGURE 1

PROJECT LOCATION MAP AND NOISE MEASUREMENT LOCATIONS

CHAPTER II. PURPOSE

The objectives of this study were to describe the existing and future noise environment in the environs of the proposed Master Plan for the Turtle Bay Resort Project at Kawela Bay on the island of Oahu. Traffic noise level increases and impacts associated with the proposed Master Plan 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 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. 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 roadway is a high speed freeway. Due to noise shielding effects from intervening

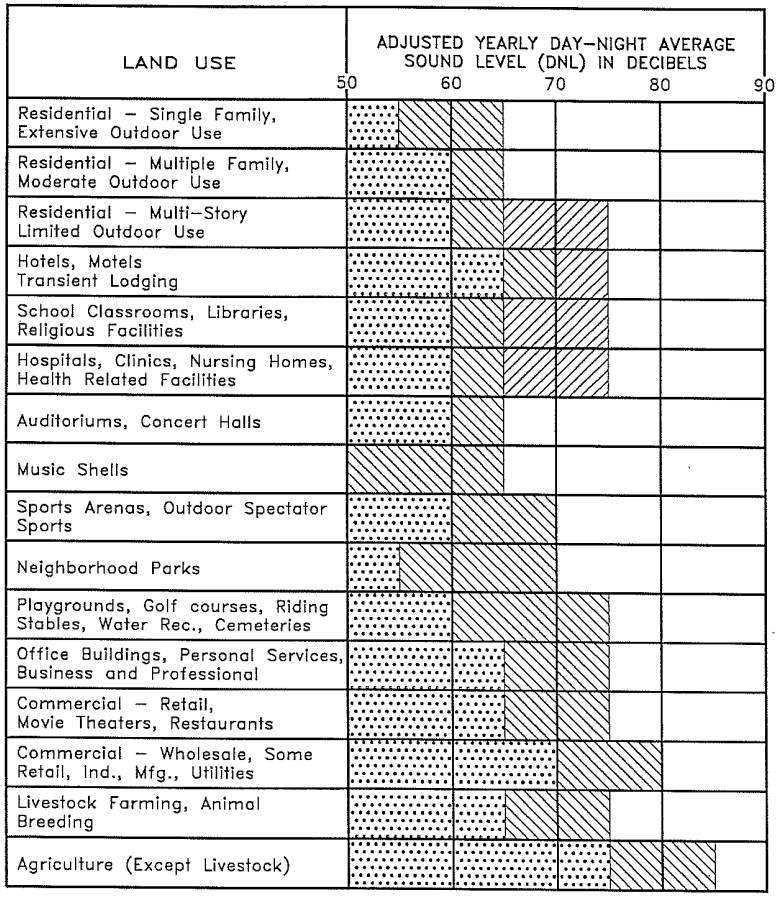
TABLE 1

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.



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

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 our open-living conditions, the predominant use of naturally ventilated dwellings, and the relatively low exterior-to-interior sound attenuation afforded by these naturally ventilated structures, 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 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.

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 5). The noise limits apply on all islands of the State, including Oahu. 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 proposed project site is located on lands designated for single family and multifamily residential, commercial, and agricultural uses, various DOH noise limits would be applicable along the lot boundary lines or receptor locations for 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. For agricultural uses, the State DOH limit is 70 dBA during both the daytime and nighttime periods. 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

Existing traffic and background ambient noise levels were measured at fifteen locations in the project environs to provide a basis for developing the traffic noise contours along Kamehameha Highway; and for determining the existing background ambient noise levels in the project area. The locations of the measurement sites are shown in Figure 1. Noise measurements were performed during February 2012. The traffic noise measurement results, and their comparisons with computer model predictions of existing traffic noise levels are summarized in Table 2. The results of the traffic noise measurements were compared with calculations of existing traffic noise levels to validate the computer model used.

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 6). 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 7) and Hawaii State Department of Transportation counts on Kamehameha Highway (Reference 8) were the primary sources of data inputs to the model.

For existing and future traffic, it was assumed that the average noise levels, or Leq(h), during the weekday PM peak hour were 0.3 dB greater than the weekday 24-hour DNL along any roadway segment in the project environs. This assumption was based on computations of both the weekday and weekend day hourly Leq's and the 24-hour DNL's of traffic noise on Kamehameha Highway and Kuilima Drive (see Figures 3 through 5). Because the weekend peak hour Leq(h) was slightly higher than the weekday PM peak hour Leq(h), the weekly, 7-day average DNL value was determined to be 0.1 to 0.3 dB higher than the 5-day, weekday DNL value. Therefore, the weekly, 7-day average DNL values were assumed be equal to the weekday PM peak hour Leq's in all calculations and modeling.

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 7). 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.

Evaluations of the potential noise impacts associated with the four Master Plan alternatives (see Figures 6 through 9) for Turtle Bay Resort were provided, with all evaluations referenced to the Proposed Action shown in Figure 6. These evaluations

TABLE 2

TRAFFIC AND BACKGROUND 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)
A. 50 FT from the center-line of Kamehameha Hwy. (2/09/12)	1050 TO 1150	45	478	25	14	66.5	66.5
B. 57 FT from the center-line of Kuilima Drive (2/09/12)	1059 TO 1159	25	272	7	7	56.9	57.3
C. 50 FT from the center-line of Kuilima Drive (2/09/12)	1252 TO 1352	25	209	2	8	56.6	56.6
D 50 FT from the center-line of Kamehameha Hwy. (2/09/12)	1500 TO 1600	55	709	5	5	70.5 (w siren) 68.6 (wo siren)	68.0
D 50 FT from the center-line of Kamehameha Hwy. (2/10/12)	0700 TO 0800	55	427	10	7	68.1	66.6
E1. 50 FT from the center-line of Kamehameha Hwy. (2/10/12)	0940 TO 1040	55	364	5	3	69.1	69.3

TABLE 2 (CONTINUED)

TRAFFIC AND BACKGROUND 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)
E2. 100 FT from the center-line of Kamehameha Hwy. (2/10/12)	0940 TO 1040	55	364	5	3	62.8	62.6
F1. 50 FT from the center-line of Kamehameha Hwy. (2/10/12)	1056 TO 1156	55	505	13	7	67.5	67.2
F2. 95 FT from the center-line of Kamehameha Hwy. (2/10/12)	1056 TO 1156	55	505	13	7	60.2	62.0
F1. 50 FT from the center-line of Kamehameha Hwy. (2/10/12)	1454 TO 1554	55	814	6	8	69.9	68.7
F2. 95 FT from the center-line of Kamehameha Hwy. (2/10/12)	1454 TO 1554	55	814	6	8	63.3	63.7
G1. 50 FT from the center-line of Kamehameha Hwy. (2/10/12)	1613 TO 1713	55	753	6	6	68.0	68.3

TABLE 2 (CONTINUED)

TRAFFIC AND BACKGROUND 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)
G2. 100 FT from the center-line of Kamehameha Hwy. (2/10/12)	1613 TO 1713	55	753	6	6	60.9	61.6
H. On Kuilima Dr. at Eleku Kuilima Place (2/11/12)	0414 TO 0430	N/A	N/A	N/A	N/A	45.3	N/A
I. At Hotel Beach Cottage; east end. (2/11/12)	0807 TO 0837	N/A	N/A	N/A	N/A	54.1	N/A
J. At Hotel Beach Cottage west end with helo noise. (2/11/12)	0845 TO 0857	N/A	N/A	N/A	N/A	61.2	N/A
K. At Horse Stables (2/11/12)	0912 TO 0922	N/A	N/A	N/A	N/A	52.3	N/A
L. At Ocean Villas. (2/11/12)	0945 TO 1000	N/A	N/A	N/A	N/A	52.4	N/A

FIGURE 3

HOURLY VARIATIONS OF TRAFFIC NOISE AT 50 FT SETBACK DISTANCE FROM THE CENTERLINE OF KAMEHAMEHA HIGHWAY WEST OF KUILIMA DRIVE (STA. B72008300907; JANUARY 19, 2011)

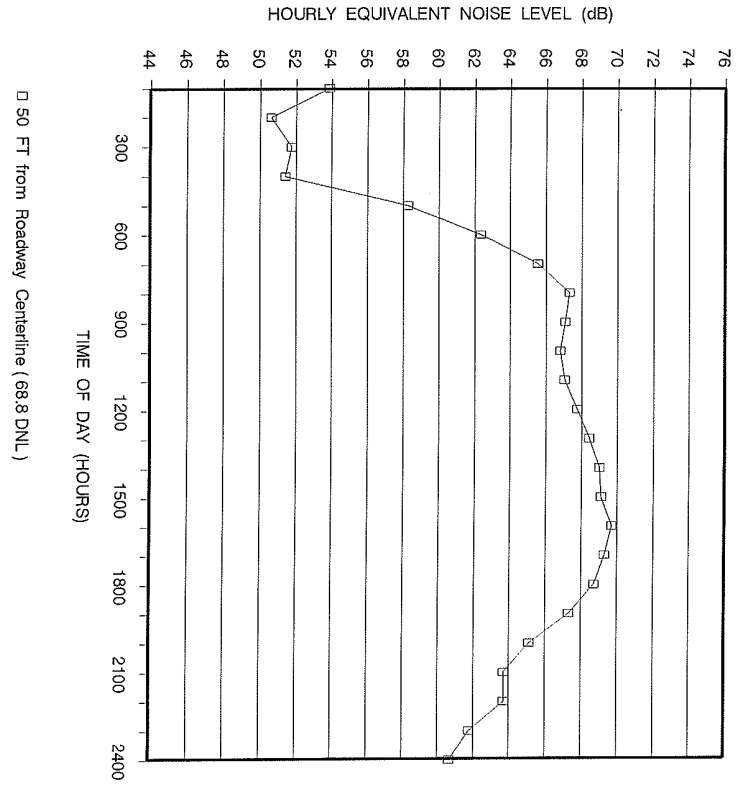
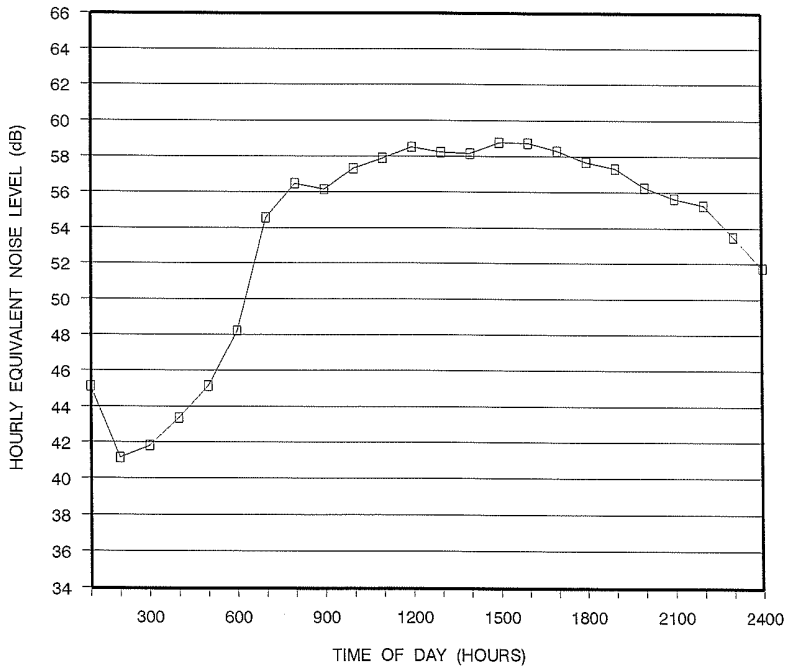


FIGURE 4

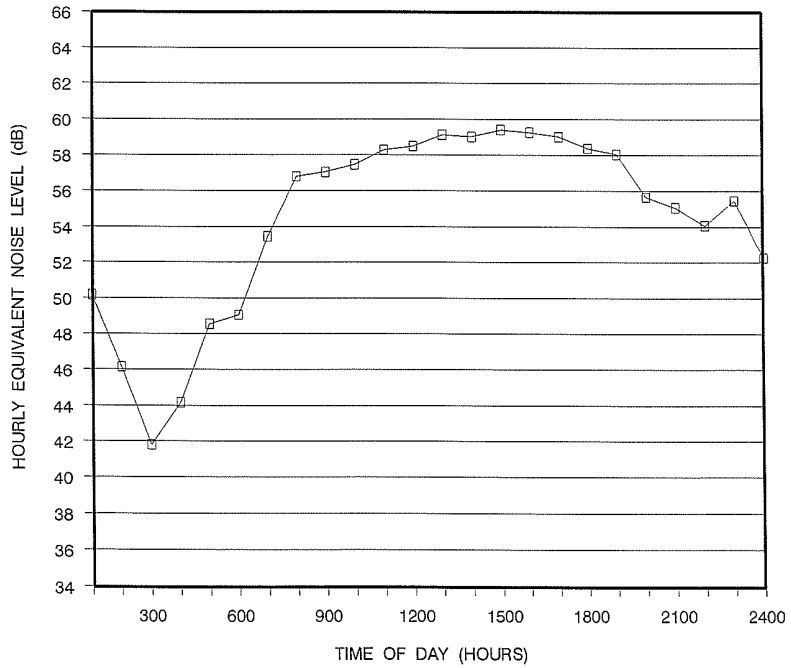
HOURLY VARIATIONS OF TRAFFIC NOISE AT 50 FT SETBACK DISTANCE FROM THE CENTERLINE OF KUILIMA DRIVE AT KAMEHAMEHA HIGHWAY (WEEKDAY; NOVEMBER 3, 2011)



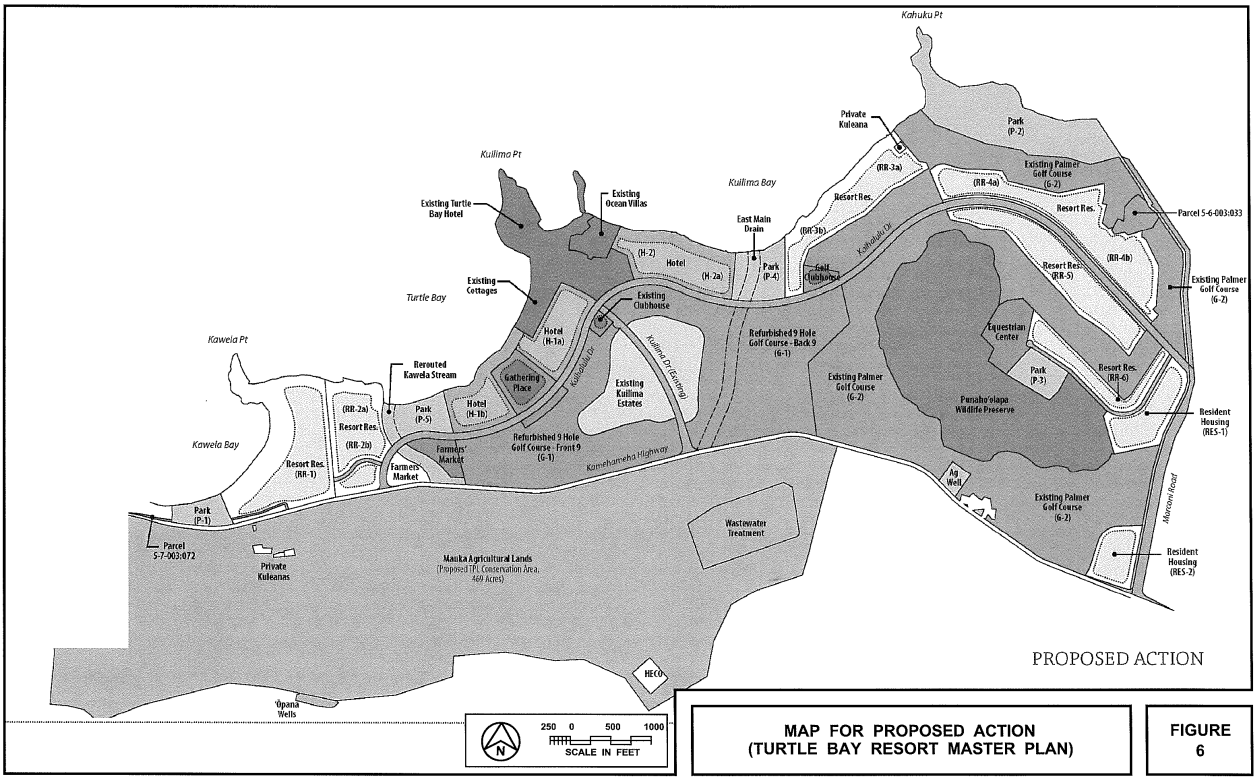
□ 50 FT from Roadway Centerline (58.5 DNL)

FIGURE 5

HOURLY VARIATIONS OF TRAFFIC NOISE AT 50 FT SETBACK DISTANCE FROM THE CENTERLINE OF KUILIMA DRIVE AT KAMEHAMEHA HIGHWAY (WEEKEND DAY; NOVEMBER 5, 2011)

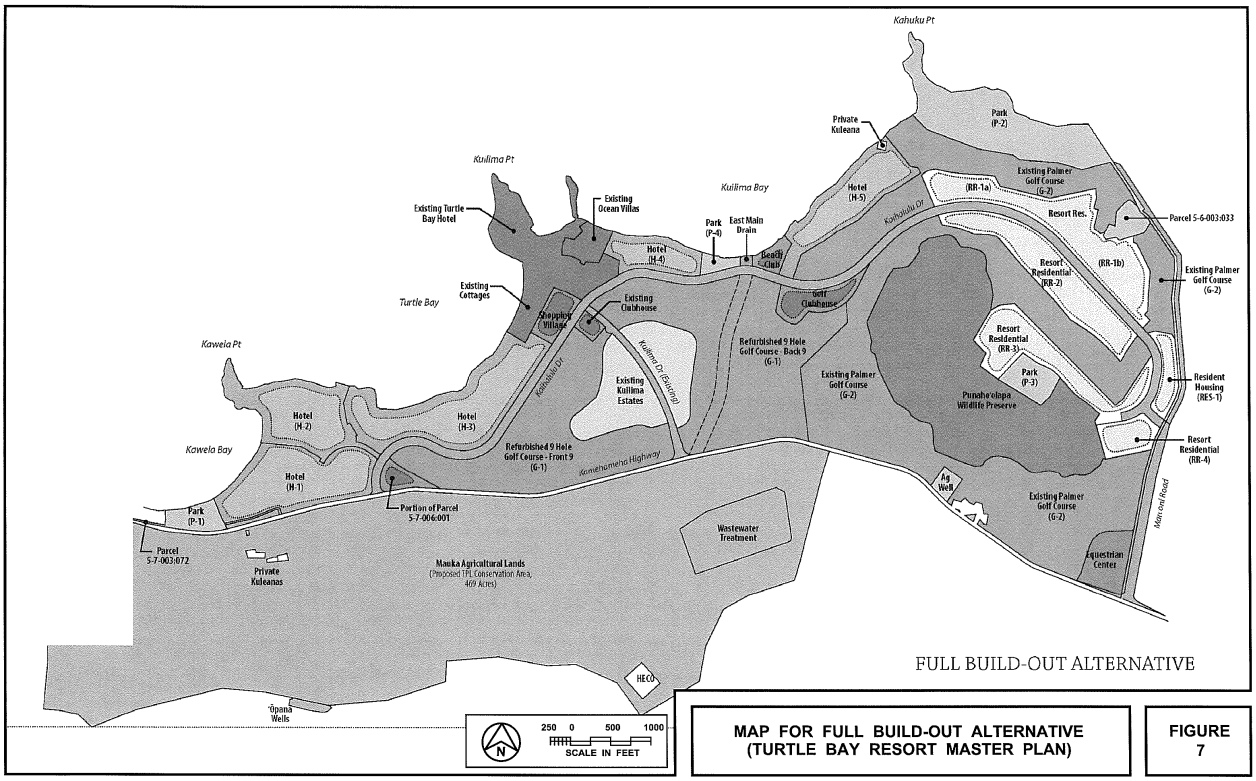


□ 50 FT from Roadway Centerline (59.2 DNL)



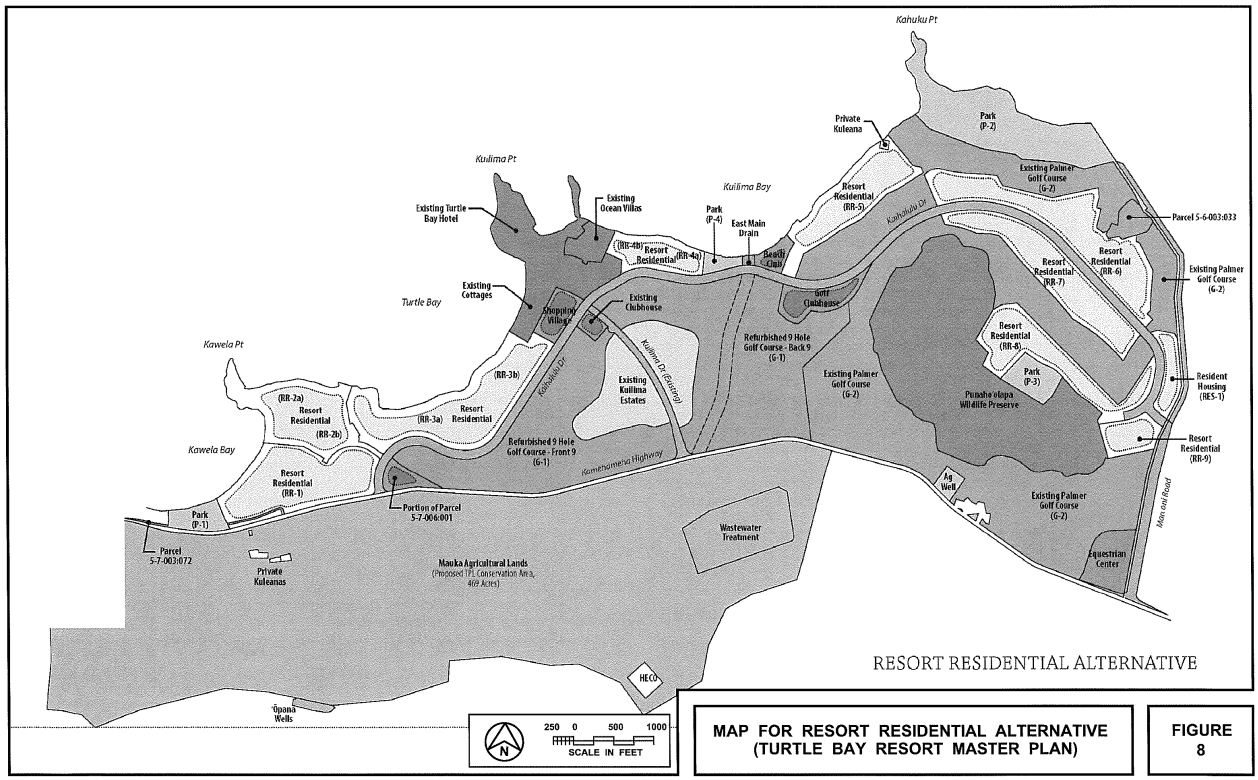
MAP FOR PROPOSED ACTION (TURTLE BAY RESORT MASTER PLAN)

FIGURE 6



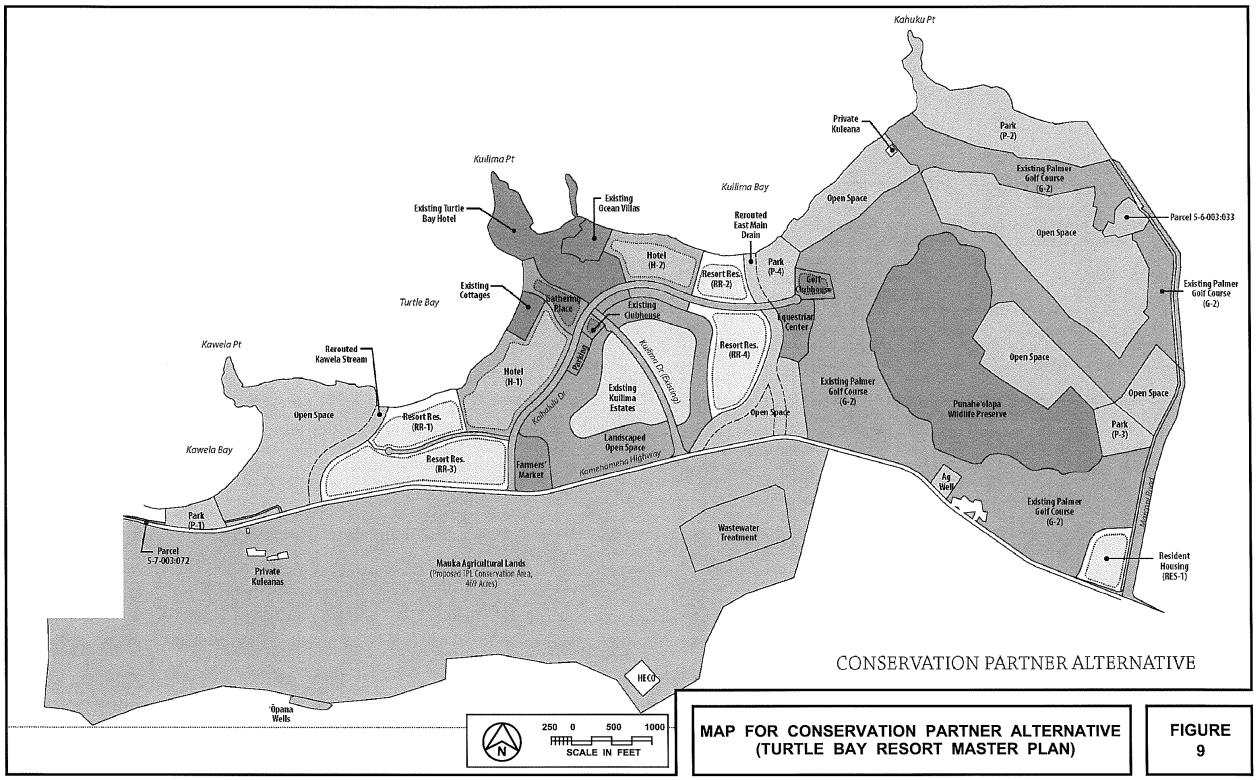
MAP FOR FULL BUILD-OUT ALTERNATIVE (TURTLE BAY RESORT MASTER PLAN)

FIGURE 7



MAP FOR RESORT RESIDENTIAL ALTERNATIVE (TURTLE BAY RESORT MASTER PLAN)

FIGURE 8



MAP FOR CONSERVATION PARTNER ALTERNATIVE (TURTLE BAY RESORT MASTER PLAN)

FIGURE 9

were qualitative in nature. Quantitative evaluations were performed for the Proposed Action and the Do Nothing Alternative. Discussions of potential traffic and construction noise impacts, and mitigation measures were included in these evaluations.

CHAPTER V. EXISTING NOISE ENVIRONMENT

The existing traffic noise levels in the project environs are controlled by traffic along Kamehameha Highway. Within the Turtle Bay Resort lands, existing background noise levels along the mauka boundaries are controlled by traffic along Kamehameha Highway. Traffic along Kuilima Drive controls background ambient noise levels in the middle section of the resort at the Kuilima Estates. Along the makai boundaries of the resort, surf and resort activities control the background ambient noise levels.

Calculations of existing traffic noise levels during the weekday and weekend PM peak traffic hours are presented in Table 3. The hourly Leq (or Equivalent Sound Level) contribution from each roadway section in the project environs was calculated for comparison with forecasted traffic noise levels with and without the project. The PM peak hour Leq's for a weekday and weekend day were calculated using traffic data from Reference 7. The existing setback distances from the roadways' centerlines to their associated 65, 70, and 75 DNL contours were also calculated as shown in Table 4. 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 4, it was concluded that the existing 65 DNL traffic noise contour is located approximately 59 to 75 FT from the centerline of Kamehameha Highway west of Kuilima Drive, and approximately 57 to 100 FT from the centerline of Kamehameha Highway east of Kuilima Drive.

One existing residence located makai of Kamehameha Highway and approximately 0.70 miles east of Kuilima Drive is located within the existing 65 DNL traffic noise contour, with approximately 68 DNL noise exposure level. The existing traffic noise level at this residence is in the "Significant Exposure, Normally Unacceptable" category (see Table 1).

Approximately thirteen existing residences located makai of Kamehameha Highway and between Pahipahialua Street and Pahipahialua Beach Park are located within the existing 65 DNL traffic noise contour, with traffic noise levels ranging from 66 to 70 DNL. Existing traffic noise levels at these thirteen residences are in the "Significant Exposure, Normally Unacceptable" category (see Table 1).

Existing traffic noise levels along Kuilima Drive at Kuilima Estates are less than 65 DNL along the Rights-of-Way, and the traffic noise contributions from Kuilima Drive range from approximately 54 to 59 DNL at the six multifamily dwelling units closest to Kuilima Drive. Traffic noise contributions from Kamehameha Highway are relatively low, and less than 48 DNL at Kuilima Estates.

Existing background noise levels at the interior portions of the project site beyond 500 feet from Kamehameha Highway are low (between 45 and 55 DNL) due to their large setback distances from Kamehameha Highway. At these interior locations

TABLE 3

EXISTING (CY 2011) TRAFFIC VOLUMES AND NOISE LEVELS ALONG ROADWAYS IN PROJECT AREA (PM PEAK HOUR)

LOCATION	SPEED (MPH)	TOTAL VPH	****** VOLUMES (VPH) ******** AUTOS	M TRUCKS	H TRUCKS	50' Leq	75' Leq	100' Leq
Weekday:								
Kamehameha Hwy. West of Kuilima Dr. (Posted 35 mph)	45	712	701	5	6	66.7	62.7	60.1
Kamehameha Hwy. West of Kuilima Dr. (Posted 45 mph)	55	712	701	5	6	69.1	65.0	62.3
Kamehameha Hwy. East of Kuilima Dr. (Posted 35 mph)	45	663	652	5	6	66.4	62.5	59.8
Kamehameha Hwy. East of Kuilima Dr. (Posted 45 mph)	55	663	652	5	6	68.8	64.8	62.0
Kuilima Dr. At Kamehameha Hwy.	25	341	325	6	10	58.9	55.7	53.5
Kamehameha Hwy. West of Marconi Dr. (Posted 35 mph)	45	654	643	5	6	66.3	62.4	59.8
Kamehameha Hwy. West of Marconi Dr. (Posted 45 mph)	55	654	643	5	6	68.7	64.7	62.0
Kamehameha Hwy. East of Marconi Dr. (Posted 35 mph)	45	663	652	5	6	66.4	62.5	59.8
Kamehameha Hwy. East of Marconi Dr. (Posted 45 mph)	55	663	652	5	6	71.8	67.8	65.0
Marconi Rd. At Kamehameha Hwy.	25	19	19	0	0	46.7	44.0	41.7
Saturday:								
Kamehameha Hwy. West of Kuilima Dr. (Posted 35 mph)	45	871	856	7	8	67.6	63.7	61.0
Kamehameha Hwy. West of Kuilima Dr. (Posted 45 mph)	55	871	856	7	8	70.0	66.0	63.2
Kamehameha Hwy. East of Kuilima Dr. (Posted 35 mph)	45	819	806	6	7	67.3	63.4	60.7
Kamehameha Hwy. East of Kuilima Dr. (Posted 45 mph)	55	819	806	6	7	69.7	65.7	62.9
Kuilima Dr. At Kamehameha Hwy.	25	390	371	7	12	59.5	56.4	54.2
Kamehameha Hwy. West of Marconi Dr. (Posted 35 mph)	45	809	796	6	7	67.2	63.3	60.7
Kamehameha Hwy. West of Marconi Dr. (Posted 45 mph)	55	809	796	6	7	69.6	65.6	62.9
Kamehameha Hwy. East of Marconi Dr. (Posted 35 mph)	45	809	796	6	7	67.2	63.3	60.7
Kamehameha Hwy. East of Marconi Dr. (Posted 45 mph)	55	809	796	6	7	72.6	68.6	65.9
Marconi Rd. At Kamehameha Hwy.	25	16	16	0	0	41.1	38.2	35.4

TABLE 4

EXISTING AND CY 2025 DISTANCES TO 65, 70, AND 75 DNL CONTOURS

STREET SECTION	65 DNL SETBACK (FT) EXISTING	CY 2025	70 DNL SETBACK (FT) EXISTING	CY 2025	75 DNL SETBACK (FT) EXISTING	CY 2025
Kamehameha Hwy. West of Kaihalulu Dr. (Posted 35 mph)	59	87	36	50	22	28
Kamehameha Hwy. West of Kaihalulu Dr. (Posted 45 mph)	75	122	46	66	28	37
Kamehameha Hwy. from Kaihalulu to Kuilima (With Median)	75	81	46	46	28	26
Kamehameha Hwy. from Kaihalulu to Kuilima (W/O Median)	75	82	46	45	28	25
Kamehameha Hwy. East of Kuilima Dr. (Posted 35 mph)	58	84	34	48	20	27
Kamehameha Hwy. East of Kuilima Dr. (Posted 45 mph)	73	116	44	63	27	35
Kamehameha Hwy. West of Marconi Dr. (Posted 35 mph)	57	84	34	48	20	27
Kamehameha Hwy. West of Marconi Dr. (Posted 45 mph)	73	116	44	63	26	35
Kamehameha Hwy. East of Marconi Dr. (Posted 35 mph)	58	84	34	48	20	27
Kamehameha Hwy. East of Marconi Dr. (Posted 45 mph)	100	173	60	90	36	49
Kaihalulu Dr. At Kamehameha Hwy.	N/A	29	N/A	15	N/A	7
Kuilima Dr. At Kamehameha Hwy.	23	33	12	17	7	9
Marconi Rd. At Kamehameha Hwy.	3	15	2	8	1	4

Notes:

(1) All setback distances are from the roadways' centerlines.
(2) See TABLES 3 and 5 for traffic volume, speed, and mix assumptions.
(3) Setback distances are for ground level receptors.
(4) "Loose Soil" conditions assumed along all roadways.
(5) DNL values represent 7-day, weekly averages.
(6) With medians and 35 mph posted within 600' of intersections on Kamehameha Highway.
(7) Without medians and 45 mph posted beyond 600' of intersections on Kamehameha Highway, except 35 mph posted between Kuilima Dr and Kaihalulu Dr.

on the project site, distant traffic, helicopter noise, and the natural sounds of surf, birds, and winds in foliage are the dominant noise sources. Between traffic, helicopter, surf, bird, or wind noise events, background ambient noise levels drop to a range of 40 to 45 dBA. During calm wind periods, background ambient noise levels decrease to levels less than 45 dBA at the interior locations removed from Kamehameha Highway, Kuilima Drive, and the shoreline. The minimum background ambient noise levels at these interior locations are controlled by distant traffic, surf, and wind noise.

CHAPTER VI. FUTURE NOISE ENVIRONMENT

Figure 6 depicts the Proposed Action for the Turtle Bay Resort Master Plan. The future traffic noise levels and potential traffic noise impacts associated with the Proposed Action were examined by calculating future traffic noise levels in CY 2025 along Kamehameha Highway, Kuilima Drive, Marconi Road, and the proposed Kaihalulu Drive with the Proposed Action. In addition, future traffic noise levels in CY 2025 along Kamehameha Highway, Kuilima Drive, and Marconi Road were calculated for the Do Nothing (or No Build) Alternative. Future traffic noise levels under the Proposed Action and Do Nothing Alternative were compared with each other as well as with the existing traffic noise levels described in the previous chapter.

Predictions of future traffic noise levels were made using the traffic volume assignments of Reference 7 for CY 2025 with and without the Proposed Action. The future assignments of project plus non-project traffic on the roadway sections which would service the project are shown in Table 5 for the weekday and weekend PM peak hours of traffic. As indicated in Table 6, by CY 2025 and following complete project build-out of the Proposed Action, traffic noise levels on Kamehameha Highway in the areas fronting the project are predicted to increase by 1.2 to 4.3 DNL. The traffic noise increases due to project traffic range from 0.2 to 3.3 DNL. These increases in traffic noise levels are considered to be moderate to high, and reflect the growth in forecasted project and non-project traffic in the project environs by CY 2025.

Table 4 summarizes the predicted increases in the future setback distances to the 65, 70, and 75 DNL traffic noise contour lines along the roadways in the project environs and attributable to both project plus non-project traffic in CY 2025 under the Proposed Action. The setback distances in Table 4 do not include the beneficial effects of noise shielding from terrain features and buildings, or the detrimental effects of additive contributions of noise from intersecting streets. As indicated in Table 4, the setback distances to the 65 DNL contour are predicted to range from 81 to 173 FT from the centerline of Kamehameha Highway following project build-out in CY 2025 under the Proposed Action. The setback distances to the 65 DNL contour are predicted to increase from 23 to 33 FT from the centerline of Kuilima Drive following project build-out in CY 2025. Along the proposed Kaihalulu Drive access road through the project site, the setback distance to the 65 DNL contour is predicted to be approximately 29 FT from the centerline of that roadway.

Table 7 presents the predicted traffic noise levels resulting from both non-project and project traffic on Kamehameha Highway, Kuilima Drive, and Kaihalulu Drive by CY 2025 at various noise sensitive receptor locations in the project environs, and as measured by the DNL descriptor system. The applicable locations of the noise sensitive receptors in the project environs are shown in Figure 10. As indicated in Table 7, future traffic noise levels at existing and planned noise sensitive locations along Kamehameha Highway in the project environs are expected to exceed 65 DNL

TABLE 6

CALCULATIONS OF PROJECT AND NON-PROJECT TRAFFIC NOISE CONTRIBUTIONS (CY 2025) (PM PEAK HOUR LEQ OR DNL)

STREET SECTION	NOISE LEVEL INCREASE DUE TO: NON-PROJECT TRAFFIC	PROJECT TRAFFIC
Kamehameha Hwy. West of Kaihalulu Dr. (Posted 35 mph)	1.0	2.6
Kamehameha Hwy. West of Kaihalulu Dr. (Posted 45 mph)	1.0	3.3
Kaihalulu Dr. At Kamehameha Hwy.	N/A	16.2
Kamehameha Hwy. from Kaihalulu to Kuilima (With Median)	1.0	1.8
Kamehameha Hwy. from Kaihalulu to Kuilima (W/O Median)	1.0	0.2
Kamehameha Hwy. East of Kuilima Dr. (Posted 35 mph)	1.1	2.4
Kamehameha Hwy. East of Kuilima Dr. (Posted 45 mph)	1.1	3.1
Kuilima Dr. At Kamehameha Hwy.	0.8	2.4
Kamehameha Hwy. West of Marconi Dr. (Posted 35 mph)	1.1	2.4
Kamehameha Hwy. West of Marconi Dr. (Posted 45 mph)	1.1	3.1
Kamehameha Hwy. East of Marconi Dr. (Posted 35 mph)	1.2	2.3
Kamehameha Hwy. East of Marconi Dr. (Posted 45 mph)	1.2	3.0
Marconi Rd. At Kamehameha Hwy.	0.0	8.4

Notes:

1. With medians and 35 mph posted within 600' of intersections on Kamehameha Highway.
2. Without medians and 45 mph posted beyond 600' of intersections on Kamehameha Highway, except 35 mph posted between Kuilima Dr. and Kaihalulu Dr.
3. At 50' from centerline of Kaihalulu Dr., future traffic noise levels predicted to be 16.2 DNL above existing background noise levels.

TABLE 5

FUTURE (CY 2025) TRAFFIC VOLUMES AND NOISE LEVELS ALONG ROADWAYS IN PROJECT AREA (PROPOSED ACTION; PM PEAK HOUR, BUILD)

LOCATION	SPEED (MPH)	TOTAL VPH	***** VOLUMES (VPH) ******** AUTOS	M TRUCKS	H TRUCKS	50' Leq	75' Leq	100' Leq
Weekday:								
Kamehameha Hwy. West of Kaihalulu Dr. (Posted 35 mph)	45	1,473	1,449	11	13	70.0	66.5	63.7
Kamehameha Hwy. West of Kaihalulu Dr. (Posted 45 mph)	55	1,473	1,449	11	13	72.4	68.9	66.6
Kaihalulu Dr. At Kamehameha Hwy.	25	449	428	8	13	61.2	58.3	56.1
Kamehameha Hwy. from Kaihalulu to Kuilima (With Median)	45	1,205	1,185	9	11	69.2	65.7	62.9
Kamehameha Hwy. from Kaihalulu to Kuilima (W/O Median)	45	1,205	1,185	9	11	69.1	65.7	63.5
Kamehameha Hwy. East of Kuilima Dr. (Posted 35 mph)	45	1,341	1,319	10	12	69.6	66.1	63.3
Kamehameha Hwy. East of Kuilima Dr. (Posted 45 mph)	55	1,341	1,319	10	12	72.0	68.5	66.2
Kuilima Dr. At Kamehameha Hwy.	25	716	683	12	21	61.9	58.8	56.7
Kamehameha Hwy. West of Marconi Dr. (Posted 35 mph)	45	1,341	1,319	10	12	69.6	66.1	63.3
Kamehameha Hwy. West of Marconi Dr. (Posted 45 mph)	55	1,341	1,319	10	12	72.0	68.5	66.2
Kamehameha Hwy. East of Marconi Dr. (Posted 35 mph)	45	1,320	1,298	10	12	69.6	66.1	63.3
Kamehameha Hwy. East of Marconi Dr. (Posted 45 mph)	55	1,320	1,298	10	12	74.9	71.4	69.2
Marconi Rd. At Kamehameha Hwy.	25	299	294	2	3	55.3	52.1	50.1
Saturday:								
Kamehameha Hwy. West of Kaihalulu Dr. (Posted 35 mph)	45	1,784	1,755	13	16	70.9	67.4	64.6
Kamehameha Hwy. West of Kaihalulu Dr. (Posted 45 mph)	55	1,784	1,755	13	16	73.2	69.7	67.5
Kaihalulu Dr. At Kamehameha Hwy.	25	616	588	10	18	60.4	57.3	55.1
Kamehameha Hwy. from Kaihalulu to Kuilima (With Median)	45	1,478	1,454	11	13	70.1	66.6	63.7
Kamehameha Hwy. from Kaihalulu to Kuilima (W/O Median)	45					70.0	66.6	64.4
Kamehameha Hwy. East of Kuilima Dr. (Posted 35 mph)	45	1,630	1,603	12	15	70.5	67.0	64.2
Kamehameha Hwy. East of Kuilima Dr. (Posted 45 mph)	55	1,630	1,603	12	15	72.8	69.3	67.1
Kuilima Dr. At Kamehameha Hwy.	25	774	738	13	23	61.4	58.3	56.1
Kamehameha Hwy. West of Marconi Dr. (Posted 35 mph)	45	1,630	1,603	12	15	70.5	67.0	64.2
Kamehameha Hwy. West of Marconi Dr. (Posted 45 mph)	55	1,630	1,603	12	15	72.8	69.3	67.1
Kamehameha Hwy. East of Marconi Dr. (Posted 35 mph)	45	1,592	1,566	12	14	70.4	66.9	64.1
Kamehameha Hwy. East of Marconi Dr. (Posted 45 mph)	55	1,592	1,566	12	14	75.7	72.2	70.0
Marconi Rd. At Kamehameha Hwy.	25	518	509	4	5	57.6	54.5	52.5

Notes:

1. With medians and 35 mph posted within 600' of intersections on Kamehameha Highway.
2. Without medians and 45 mph posted beyond 600' of intersections on Kamehameha Highway, except 35 mph posted between Kuilima Dr and Kaihalulu Dr.

TABLE 7

PREDICTED TRAFFIC NOISE LEVELS AT VARIOUS RECEPTOR LOCATIONS
(4.92 FT HIGH RECEPTOR, 2025 DNL, WITH PROPOSED ACTION)

RECEPTOR LOCATION	SETBACK DIST. FROM EXIST. C.L.	2025 DNL W/O MITIGATION	2025 DNL WITH MITIGATION
Receiver #W1 (RR-1)	110 FT	66.9	61.0
Receiver #W2 (RR-1)	120 FT	66.4	60.2
Receiver #W3 (RR-1)	120 FT	65.9	60.2
Receiver #W4 (RR-2b)	135 FT	63.8	N/A
Receiver #W5 (RR-2b)	115 FT	65.1	60.4
Receiver #W6 (RR-2b)	310 FT	58.2	N/A
Receiver #E1 (TMK: 5-6-003:036)	48 FT	72.1	64.9
Receiver #E2 (TMK: 5-6-003:036)	106 FT	65.7	60.9
Receiver #E3 (RES-2)	110 FT	64.9	N/A
Receiver #E4 (RES-2))	120 FT	64.1	N/A
Receiver #E5 (RES-2)	454 FT	53.1	N/A

Notes:

1. Traffic noise levels include contributions from intersecting roadways.
2. "Loose Soil" ground attenuation assumed.
3. Minimum 6 foot high sound attenuation walls assumed for noise mitigation.

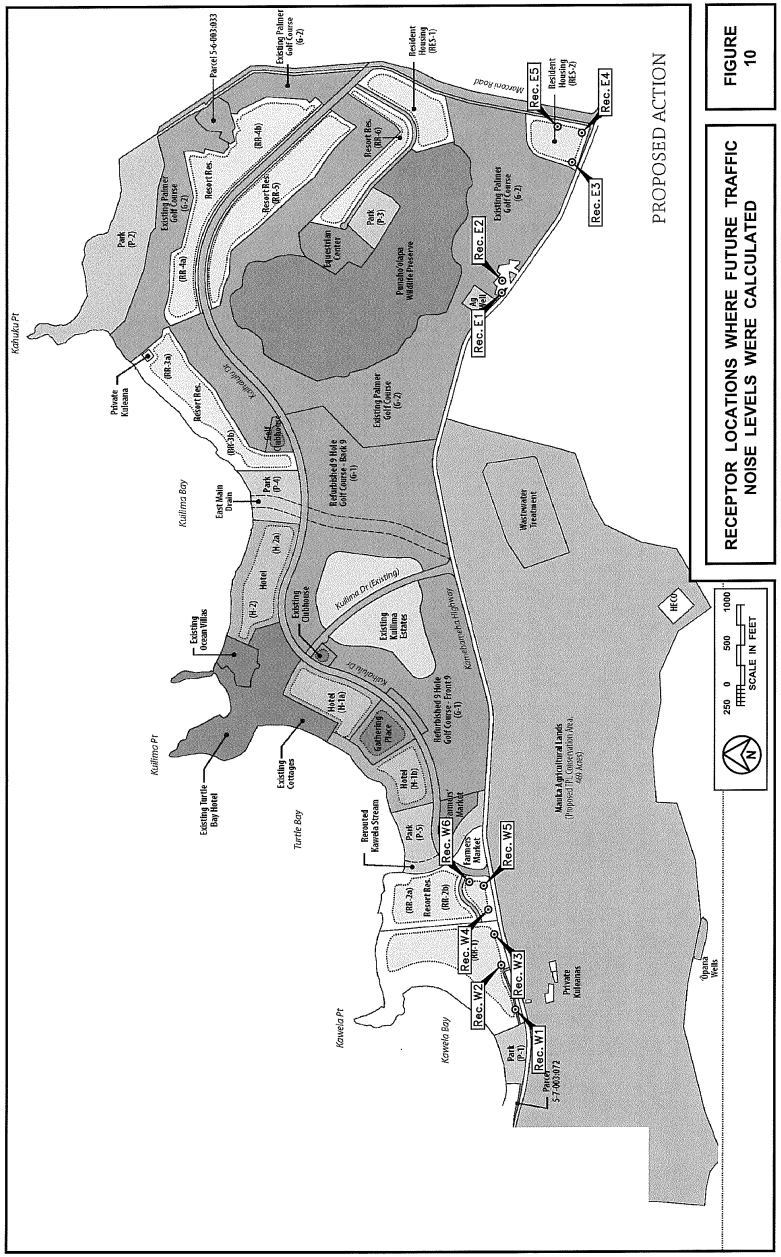


FIGURE 10

RECEPTOR LOCATIONS WHERE FUTURE TRAFFIC NOISE LEVELS WERE CALCULATED

without noise mitigation measures. Existing residences west of Kawela Bay and two existing residences located approximately 0.7 miles east of Kuilima Drive are predicted to experience future traffic noise levels greater than 65 DNL.

Calculations of future traffic noise levels under the Proposed Action at noise sensitive receptor locations shown in Figure 10 are presented in Table 7. Primarily as a result of forecasted traffic along Kamehameha Highway, future traffic noise levels at the Resort Residential (RR-1 and RR-2b) lots at locations W1, W2, W3, and W5 which front the highway are predicted to exceed the 65 DNL FHA/HUD noise standard. Due to even smaller setback distances from the highway, the Park (P-1) west of the Resort Residential (RR-1) lots will also experience traffic noise levels greater than 65 DNL. The proposed Resident Housing (RES-2) lots at locations E3, E4, and E5 west of the Marconi Road intersection should experience traffic noise levels which do not exceed the FHA/HUD standard of 65 DNL. Exceedances of the 65 DNL FHA/HUD noise standard are also expected at the two existing residences (E1 and E2) 0.7 miles east of the Kuilima Drive intersection. At one of the residences (E1), existing traffic noise levels currently exceed 65 DNL.

Along Kamehameha Highway west of the project to Pahipahialua Beach Park, the number of existing residences which experience traffic noise levels greater than 65 DNL will increase from thirteen to eighteen by 2025 under the Proposed Action. From Table 4, the setback distance to the 65 DNL contour in this residential area west of the project is predicted to increase from 75 to 122 FT setback distance to the highway centerline.

Along Kuilima Drive, and probably along the new Kaihalulu Drive, existing and future residences are predicted to experience traffic noise levels below 65 DNL, and be in the "Moderate Exposure, Acceptable" noise exposure category of Table 1.

CHAPTER VII. DISCUSSION OF PROJECT RELATED NOISE IMPACTS AND POSSIBLE NOISE MITIGATION MEASURES

Traffic Noise with Proposed Action. The increases in traffic noise levels attributable to the Proposed Action from the present to CY 2025 are predicted to range from 0.2 to 3.3 DNL along Kamehameha Highway, where traffic noise levels are expected to continue to be above 65 DNL along the highway Rights-of-Way. These increases in traffic noise levels along Kamehameha Highway which are attributable to the Proposed Action are considered to be in the moderate to high category, and are greater than the traffic noise level increases of approximately 1.0 DNL expected as a result of non-project traffic. Except for the two existing residences east of Kuilima Drive, the lands along the highway Rights-of-Way are generally vacant between Kawela Bay and Marconi Road. The closest noise sensitive residences beyond the project area are located west of Kawela Bay. Along public roadways, where traffic noise levels result from both project and non-project traffic, traffic noise mitigation measures are implemented by private land owners. Government agencies (such as the Hawaii State Department of Transportation, Highways Division) typically address traffic noise impacts within the limits of construction during public roadway improvement projects, and include traffic noise mitigation measures if they are considered to be "reasonable and feasible."

At noise sensitive receptor locations W1, W2, W3, W5, E1, and E2 (see Figure 10), future traffic noise levels with the Proposed Action are predicted to exceed the 65 DNL FHA/HUD noise standard. At locations W1, W2, W3, E1, and E2, reductions in the posted speed limit from 45 miles per hour to 35 miles per hour would reduce predicted traffic noise levels by approximately 2 DNL and to levels below the 65 DNL FHA/HUD noise standard at locations W3, W5, and E2. Predicted future traffic noise levels at receptor locations W1, W3, and E1 would still remain above 65 DNL with or without a 10 miles per hour reduction in the posted speed limit.

Other possible traffic noise mitigation measures are: increasing the setback distances of the receptors from the highway; constructing sound attenuating walls or berms between the highway and the receptors; or closure and air conditioning of the affected dwellings. Increasing the setback distances of future residences to 122 FT from the centerline of Kamehameha Highway should be considered as a possible noise mitigation measure. Alternately, the addition of approximately 6 FT high sound attenuating walls (or berms) would reduce future traffic noise levels below 65 DNL at single story structures in the Resort Residential area and at the two existing residences at locations E1 and E2. For two story (or higher) structures, the wall/berm height requirements increase due to the higher elevations of receptors on the upper floors. 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.

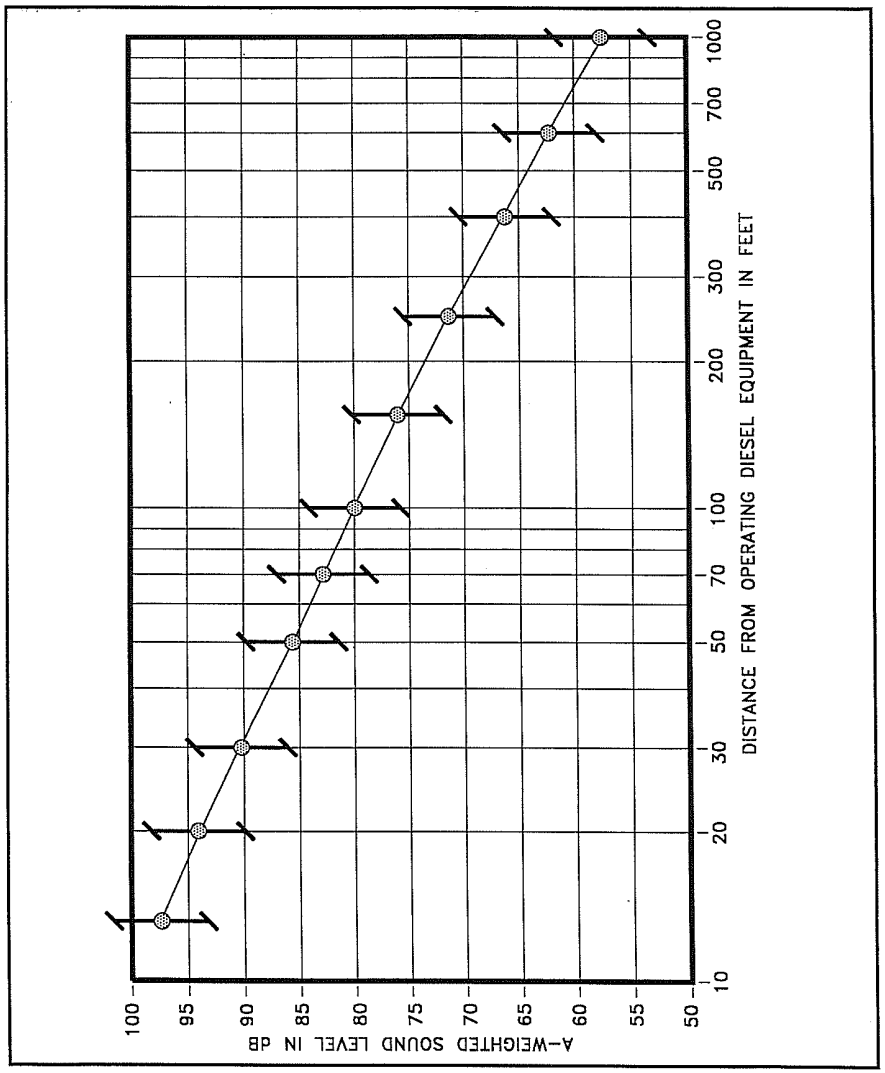
At existing receptor locations W1, W2, W3, W5, E1, and E2, the effectiveness of sound attenuating walls was examined. These results are shown in Table 7. Driveways to each residence will limit the sound attenuation performance of 6 FT high walls to approximately 4 to 7 dB, but these levels of attenuation should be sufficient to reduce future traffic noise to levels below 65 DNL at the affected dwellings.

Traffic Noise with Other Development Alternatives. A qualitative evaluation was performed to identify the differences in potential traffic noise levels among the Proposed Action and the three Master Plan Alternatives shown in Figures 6 through 9. The four Master Plan Alternatives (including the Proposed Action) were ranked in respect to the following:

- Increase in future traffic noise levels along Kamehameha Highway at existing residences west of Kuilima Drive due to the project;
- Increase in future traffic noise levels along Kamehameha Highway at existing residences east of Kuilima Drive due to the project;
- Increase in future traffic noise levels along Kuilima Drive at existing residences along Kuilima Drive;
- Potential traffic noise mitigation measures at existing and future residences along Kamehameha Highway within project limits; and
- Potential traffic noise mitigation measures at existing residences along Kamehameha Highway beyond project limits to Pahipahialua Beach Park.

The resulting rankings of the four alternatives, from lowest traffic noise impact to highest traffic noise impact were: Resort Residential Alternative; Conservation Partner Alternative; Proposed Action; and Full Build-Out Alternative. Future traffic volumes were lower under the Resort Residential and Conservation Partner Alternative, so they would cause the least traffic noise impacts at existing residences within and beyond the project area. In respect to minimizing traffic noise impacts on future residences within the project area, the Full Build-Out Alternative was ranked highest (or best) due to the location of hotel units and the Equestrian Center rather than residences next to Kamehameha Highway. Nevertheless, in all other aspects, the Full Build-Out Alternative was expected to cause the greatest noise impacts.

Construction Noise. Audible construction noise will probably be unavoidable during the entire project construction period. The total time period for construction is unknown, but it is anticipated that the actual work will be moving from one location on the project site to another during that 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 11. Risks of adverse noise impacts during construction are highest at the existing hotel Cottages and Ocean Villas, and the



ANTICIPATED RANGE OF CONSTRUCTION NOISE LEVELS VS. DISTANCE

FIGURE 11

existing residences at Kuilima Estates. 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.

Elimination 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 Oahu (Reference 5), is another noise mitigation measure which can be applied to this project. Figure 12 depicts the normally permitted hours of construction for 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.

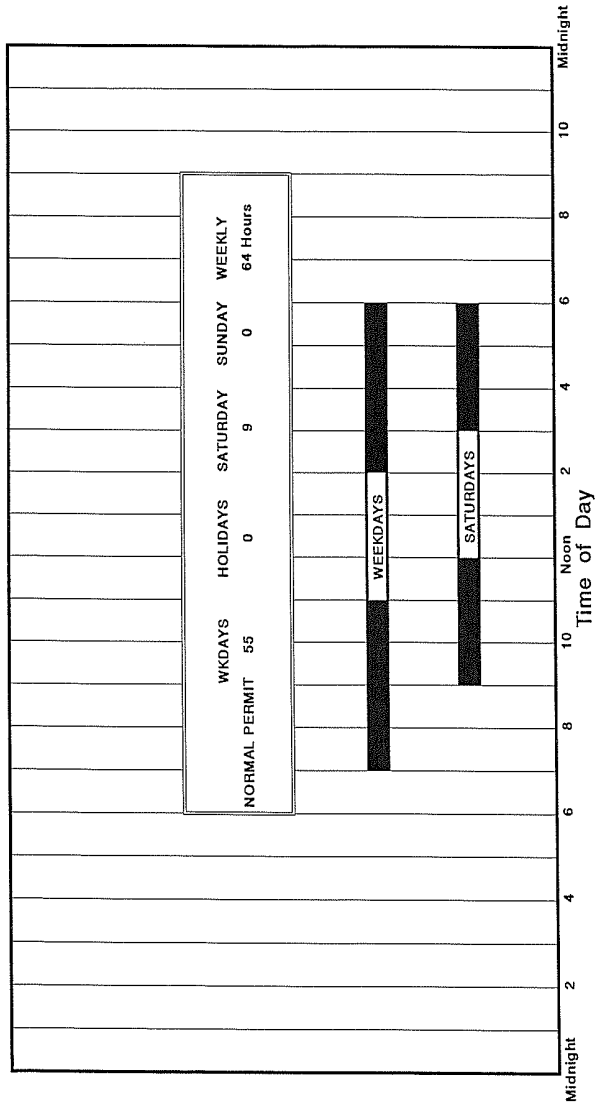


FIGURE 12

AVAILABLE WORK HOURS UNDER DOH PERMIT PROCEDURES FOR CONSTRUCTION NOISE

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) "Title 11, Administrative Rules, Chapter 46, Community Noise Control;" Hawaii State Department of Health; September 23, 1996.

(6) "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).

(7) Existing and Future Traffic Volumes for the Turtle Bay Resort Master Plan; The Traffic Management Consultant; November 2011 and August 8, 2012.

(8) 24-Hour Traffic Counts, Station B72008300907, Kamehameha Highway West of Kuilima Drive; State Department of Transportation; January 19, 2011.

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 (4) Over Time(T)	$L_{eq(T)}$	$L_{Aeq(T)}$	$L_{Beq(T)}$	$L_{peq(T)}$
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 YEAR 2025 (PROPOSED ACTION) TRAFFIC VOLUMES
DURING PM PEAK HOUR AND SATURDAY PEAK HOUR

ROADWAY LANES	******** CY 2011 *********		*** CY 2025 (NO BUILD) **		*** CY 2025 (BUILD) ****	
	WEEKDAY	SATURDAY	WEEKDAY	SATURDAY	WEEKDAY	SATURDAY
Kamehameha Hwy. West of Kaihalulu Dr. (EB)	344	445	438	524	714	892
Kamehameha Hwy. West of Kaihalulu Dr. (WB)	368	426	458	522	759	892
Two-Way	712	871	896	1,046	1,473	1,784
Kamehameha Hwy. East of Kaihalulu Dr. (EB)	344	445	438	524	580	753
Kamehameha Hwy. East of Kaihalulu Dr. (WB)	368	426	458	522	624	725
Two-Way	712	871	896	1,046	1,204	1,478
Kaihalulu Dr. at Kamehameha Hwy. (NB)	N/A	N/A	N/A	N/A	224	294
Kaihalulu Dr. at Kamehameha Hwy. (SB)	N/A	N/A	N/A	N/A	225	322
Two-Way	N/A	N/A	N/A	N/A	449	616
Kamehameha Hwy. West of Kuilima Dr. (EB)	344	445	438	524	581	753
Kamehameha Hwy. West of Kuilima Dr. (WB)	368	426	458	522	624	725
Two-Way	712	871	896	1,046	1,205	1,478
Kamehameha Hwy. East of Kuilima Dr. (EB)	310	402	395	480	625	836
Kamehameha Hwy. East of Kuilima Dr. (WB)	353	417	455	518	716	794
Two-Way	663	819	850	998	1,341	1,630
Kuilima Dr. at Kamehameha Hwy. (NB)	180	212	226	254	382	380
Kuilima Dr. at Kamehameha Hwy. (SB)	161	178	186	214	334	394
Two-Way	341	390	412	468	716	774
Kamehameha Hwy. West of Marconi Rd. (EB)	306	394	395	480	625	836
Kamehameha Hwy. West of Marconi Rd. (WB)	348	415	455	518	716	794
Two-Way	654	809	850	998	1,341	1,630
Kamehameha Hwy. East of Marconi Rd. (EB)	311	394	396	478	613	795
Kamehameha Hwy. East of Marconi Rd. (WB)	352	415	463	520	707	797
Two-Way	663	809	859	998	1,320	1,592
Marconi Rd. at Kamehameha Hwy. (NB)	9	8	9	8	147	279
Marconi Rd. at Kamehameha Hwy. (SB)	10	8	10	8	152	239
Two-Way	19	16	19	16	299	518

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APPENDIX L:

CULTURAL AND NATURAL RESOURCES MANAGEMENT PLAN

L

TURTLE BAY RESORT
CULTURAL MANAGEMENT PLAN

Executive Summary

Introduction: The guidelines and procedures outlined in the Turtle Bay Resort (TBR) Cultural Management Plan (CMP) are to be used to ensure the protection of historic properties (which includes human remains) discovered at TBR, including during planning, construction, operations and maintenance. These procedures have been prepared to plan for and respond to such contingencies in a culturally appropriate manner, as well as to facilitate the archaeological monitoring and the timely completion of TBR related activities.

The major components of this CMP include:

- Process to be followed in the event of an inadvertent discovery of human remains;
- Roles and responsibilities for TBR, Ku‘iwalu and the Archaeological Consultant;
- A call-out list for the project(s) with names, titles, phone and/or cellular numbers of everyone that may need to be contacted.

If historic properties are discovered, the CMP should facilitate rapid responses for taking prudent action to resolve the incident as soon as possible including:

1. Identification, determination of jurisdiction and notification;
2. Assisting the relevant authorities with their investigations;
3. Monitoring the situation and appropriately informing all of those affected;
4. Acknowledging the various responsibilities;
5. Implement restoration action as necessary; and
6. Documentation of the entire incident.

Project Requirements: TBR is required to comply with Chapter 6E, Hawai‘i Revised Statutes, and the applicable administrative rules. An Archaeological Monitoring Plan (AMP) was prepared for portion of the Alpha Road Construction within the Turtle Bay Resort Development Area dated April 2006. Although the AMP may not cover the entire TBR project site, the Archaeological Monitoring Provisions provides adequate guidelines for all subsurface activities.

Cultural Management Plan

1.0 Purpose: The guidelines and procedures outlined in this CMP will be used to plan for, report and respond to any inadvertent discovery of historic properties, including human remains (incidents) on all activities related to TBR.

2.0 Objectives:

- Enable those involved to respond in a timely and culturally appropriate manner;
- Maintain TBR’s credibility and minimize negative public and government agency’s reaction by effectively resolving the incident;
- Minimize work stoppage;
- Minimize liability exposure to TBR in compliance with laws and regulations; and
- Human remains must be accorded full dignity and respect and if at all possible, burial places should not be disturbed. If it is not feasible to protect a burial from future construction activities, consultation with appropriate parties for the culturally appropriate treatment of the human remains shall be a priority consideration.

3.0 Archaeological Specifications:

- There shall be an on-site archaeological monitor during all ground disturbance activities, unless otherwise amended by TBR’s Project Manager in consultation with the State Historic Preservation Division (SHPD); and
- Any other SHPD requirements.

4.0 Incident in Progress:

- *TBR’s Project Manager’s Responsibilities:*
  - Project Manager (PM) will be kept informed of all potential subsurface activities or construction and operations related activities within TBR, in particular, activities within the shoreline or beach areas, to ensure compliance with the CMP and applicable regulations;
  - Contact and retain the services of an archaeological monitor for all appropriate subsurface activity. If the PM is uncertain whether to have an on-site archaeological monitor, than he will consult with the Archaeological Consultant (AC) or Ku‘iwalu for assistance;
  - Immediately contact the AC upon the discovery of historic properties, specifically the discovery of human remains if the archaeologist is not onsite;
  - As the owner’s representative the PM will coordinate with the owner, TBR personnel, AC and Ku‘iwalu on all relevant matters related to the incident;
  - Immediately notify the call out list when alerted to a possible incident; and
  - Coordinate with the owner, TBR, and AC when work may resume.

- *TBR personnel (for ongoing maintenance or operations actions) or Contractor’s (for all other construction related activities)Responsibilities:*

- Confer with the PM on all excavation or installation of permanent equipment within the shoreline or beach area to ensure compliance with applicable regulations, i.e., conservation district use, special management area, etc.;
- Cease all work in the affected area upon the discovery of potential historic properties, including human remains and said area shall not be disturbed until it is inspected by the AC;
- Immediately notify the PM regarding the incident;
- Stake or flag off affected area to prevent additional disturbances;
- Coordinate restoration efforts with AC as necessary; and
- Resume work upon notice by the PM.

- *Archaeological Consultant's (AC) Responsibilities*:
  - Respond within 24 hours or sooner from notification of the discovery of human remains;
  - Stop construction activity when historic properties, including human remains, are found although the AC may redirect construction activity to another area;
  - Determine jurisdiction of the inadvertent discovery (human, over 50 years, and ethnicity);
  - Make all required notifications when human remains have been discovered (SHPD, Honolulu Police Department (HPD), O'ahu Island Burial Council (OIBC));
  - Notify the PM when work may resume;
  - Provide adequate information and summary of the incident regarding the discovery of historic properties, including human remains to Ku'iwalu who will prepare talking points on the incident; and
  - Comply with all requirements of SHPD or applicable regulations, including all appropriate documentation.

- *Ku'iwalu's Responsibilities:*
  - Coordinate and facilitate resolution of the incident and handle communications with the public including and appropriate regulatory agencies (including SHPD) when notified of an incident;
  - If human remains are involved, contact the Kahuku Burial Committee (KBC) members or any recognized lineal or cultural descendants of the discovery of human remains;
  - Consult with interested parties in the preparation and distribution of information and statements to the community, news media, and other groups, as required including draft and distribute talking points regarding the incident,
  - Provide incident follow-up and project status to the OIBC, SHPD, KBC, and other relevant organizations and or individuals, as required; and
  - Evaluate efficacy of the CMP and update as needed.

APPROVED BY: _____ DATE: AUG 7, 2012

DREW STOTESBURY
ceo | turtle bay resort | o'ahu

CALL-OUT LIST

State Historic Preservation Division:	
Pua Aiu, Administrator	(808) 692-8015 (on O'ahu)
HPD	911
TBR:	
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Danna Holck	(808) 293-6040 (o) / (808) 226-4034 (m)
Matt Hall (If Golf Courses involved)	(808) 795-3615 (o) / (808) 294-1699 (m)
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Dawn Naomi Chang	(808) 539-3583 (o) / (808) 728-5655 (m)
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O'ahu Island Burial Council:	
Hinaleimoana Kalu, Chair	(808) 225-4123
Steve Hoag, area OIBC representative	

APPENDIX M:

TRIP GENERATION SURVEY REPORT

M

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QUANTIFICATION OF TURTLE BAY RESORT TRAFFIC PATTERNS REPORT

SMS Affiliations and Associations:

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International Survey Research
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SMS Consulting, LLC
3i Marketing & Communications

Prepared by:

SMS Research & Marketing Services, Inc.
December, 2011

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Quantification of Turtle Bay Resort Traffic Patterns Report

OBJECTIVE

The primary objective of this project is to understand and summarize the travel patterns of Turtle Bay Resort guests and tenants as they arrive and depart from the property.

METHODOLOGY

Fielding was conducted from October 31, 2011 to November 6; 2011, fielding times are shown in Table 1 below. A total of nine interviewers were trained and set up at one of four different entrances and locations at Turtle Bay (Appendix B).

Interviewers conducted a very brief one minute survey with cars entering and leaving the Turtle Bay Resort. The survey guide can be found in Appendix A. At the beginning of the study respondents were very cooperative and willing to participate; however, there were spikes of repeat refusals on November 2 and again on November 4 from hotel and condo guests staying at Turtle Bay who were tired of doing the survey with us.

A total of 4,800 surveys were completed; however, there were another 1,000 surveys conducted that were repeat refusals over the seven day period. The margin of error of the completed interviews is +/-1 percent at 95 percent confidence interval. Interviewers tried to interview every car, but if there was heavy traffic interviewers resorted to interviewing every third car instead. Furthermore, if an interviewer noticed a bus, he/she stopped interviewing cars that were in front of the bus and allowed it to pass before continuing to interview cars. This was done to not disrupt the scheduled arrival and departure times of tour buses. Throughout the seven days approximately 3,800 cars were not interviewed due to these missed cars and heavy rains.

There were some noteworthy events that occurred at Turtle Bay that may have affected the traffic flow. Thursday (11/3) there was a pre-golf tournament dinner, with the golf tournament taking place on Friday (11/4). On Saturday (11/5) a concert was held at Turtle Bay.

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Table 1: Fielding dates

	Monday 10/31/11	Tuesday 11/1/11	Wednesday 11/2/11	Thursday 11/3/11	Friday 11/4/11	Saturday 11/5/11	Sunday 11/6/11
7:00AM							
8:00AM							
9:00AM							
10:00AM							
11:00AM							
12:00PM							
1:00PM							
2:00PM							
3:00PM							
4:00PM							
5:00PM							
6:00PM							
7:00PM							
8:00PM							

RESULTS

This is a summary of the analysis executed to-date. As discussed, there is an extensive amount of data, and it can be reviewed in multiple manners. SMS will be pleased to provide additional data as needed.

The following tables summarize the major traffic patterns by segments, day part, and weekend vs. weekday.

Following is a breakdown of the drivers interviewed:

Table 2: Breakdown of drivers interviewed

DRIVERS INTERVIEWED		
	Number	Percent
Tourist - Hotel guest	1,070	16.8
Tourist - Condo guest	159	2.5
Tourist - Visiting	696	10.9
Oahu resident - Hotel guest	166	2.6
Oahu resident - Condo guest	328	5.2
Oahu resident - Visiting	1,299	20.4
NI resident - Hotel guest	6	0.1
NI resident - Condo guest	1	0.0
NI resident - Visiting	11	0.2
Employee	687	10.8
Condo resident	224	3.5
Construction	83	1.3
Drop off	72	1.1
Doesn't speak English	9	0.1
Repeat refusal	980	15.4
Total	5,791	90.9
No Driver Classification	577	9.1
Total	**6,368**	**100.0**

Table 3: Arriving respondents by point of origin and driver definition

	Total		Driver Definition									
	Count	Col %	TBR hotel/condo		TBR visitor		TBR condo resident		Employee		Others	
			Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %
Waialua	29	1.2%	4	0.5%	10	0.9%	1	0.9%	14	5.3%		
Haleiwa	202	8.6%	69	8.9%	84	7.3%	13	11.6%	32	12.1%	4	6.3%
Laniakea to Waimea bay	34	1.4%	18	2.3%	12	1.0%	2	1.8%	2	0.8%		
Three Tables beach to Kawela Beach	289	12.2%	81	10.5%	129	11.2%	19	17.0%	54	20.4%	6	9.5%
Kahuku	165	7.0%	61	7.9%	51	4.4%	13	11.6%	31	11.7%	9	14.3%
Laie	214	9.1%	67	8.7%	99	8.6%	22	19.6%	25	9.4%	1	1.6%
Hauula	83	3.5%	10	1.3%	34	3.0%	2	1.8%	34	12.8%	3	4.8%
Kaaawa	13	0.6%	5	0.6%	5	0.4%	1	0.9%	2	0.8%		
Windward	141	6.0%	34	4.4%	89	7.7%	4	3.6%	7	2.6%	7	11.1%
East Honolulu	20	0.8%	4	0.5%	13	1.1%	2	1.8%	1	0.4%		
Honolulu	728	30.8%	267	34.6%	405	35.2%	10	8.9%	25	9.4%	21	33.3%
Central Oahu	164	6.9%	36	4.7%	100	8.7%	4	3.6%	22	8.3%	2	3.2%
Leeward Oahu	141	6.0%	22	2.9%	99	8.6%	6	5.4%	6	2.3%	8	12.7%
Other	138	5.8%	93	12.1%	20	1.7%	13	11.6%	10	3.8%	2	3.2%
Total	2,361	100.0%	771	100.0%	1,150	100.0%	112	100.0%	265	100.0%	63	100.0%

SMS,Inc. (Turtle Bay 2011)

Table 4: Departing respondents by destination and driver definition

	Total		Driver Description									
	Count	Col %	TBR hotel/condo		TBR visitor		TBR condo resident		Employee		Others	
			Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %
Waialua	38	1.8%	4	0.5%	9	1.1%			24	7.1%	1	1.6%
Haleiwa	221	10.5%	97	11.7%	63	8.0%	8	9.3%	48	14.2%	5	8.2%
Laniakea to Waimea bay	19	0.9%	8	1.0%	9	1.1%			2	0.6%		
Three Tables beach to Kawela Beach	257	12.2%	100	12.0%	97	12.4%	11	12.8%	46	13.6%	3	4.9%
Kahuku	175	8.3%	46	5.5%	44	5.6%	13	15.1%	67	19.8%	5	8.2%
Laie	233	11.1%	97	11.7%	68	8.7%	15	17.4%	48	14.2%	5	8.2%
Hauula	58	2.8%	11	1.3%	25	3.2%	1	1.2%	21	6.2%		
Kaaawa	18	0.9%	5	0.6%	4	0.5%			9	2.7%		
Windward	130	6.2%	34	4.1%	75	9.6%	4	4.7%	12	3.5%	5	8.2%
East Honolulu	18	0.9%	3	0.4%	11	1.4%	1	1.2%	2	0.6%	1	1.6%
Honolulu	468	22.3%	193	23.2%	240	30.6%	4	4.7%	16	4.7%	15	24.6%
Central Oahu	126	6.0%	38	4.6%	56	7.1%	2	2.3%	26	7.7%	4	6.6%
Leeward Oahu	99	4.7%	22	2.6%	55	7.0%			11	3.2%	11	18.0%
Other	151	7.2%	113	13.6%	18	2.3%	14	16.3%	2	0.6%	4	6.6%
Unknown	92	4.4%	61	7.3%	11	1.4%	13	15.1%	5	1.5%	2	3.3%
Total	2,103	100.0%	832	100.0%	785	100.0%	86	100.0%	339	100.0%	61	100.0%

SMS,Inc. (Turtle Bay 2011)

Table 5: Arriving respondents by point of origin and direction

	Total		Directional distribution of arriving traffic			
			West		East	
	Count	Col %	Count	Col %	Count	Col %
Waialua	29	1.3%	28	2.0%	1	0.1%
Haleiwa	194	8.5%	185	13.2%	9	1.0%
Laniakea to Waimea bay	34	1.5%	30	2.1%	4	0.5%
Three Tables beach to Kawela Beach	275	12.1%	265	18.9%	10	1.2%
Kahuku	159	7.0%	26	1.9%	133	15.3%
Laie	210	9.3%	22	1.6%	188	21.6%
Hauula	80	3.5%	8	0.6%	72	8.3%
Kaaawa	14	0.6%	1	0.1%	13	1.5%
Windward	140	6.2%	25	1.8%	115	13.2%
East Honolulu	20	0.9%	15	1.1%	5	0.6%
Honolulu	709	31.2%	477	34.0%	232	26.7%
Central Oahu	159	7.0%	138	9.9%	21	2.4%
Leeward Oahu	139	6.1%	124	8.9%	15	1.7%
Other	108	4.8%	57	4.1%	51	5.9%
Total	2,270	100.0%	1,401	100.0%	869	100.0%

SMS,Inc. (Turtle Bay 2011)

Table 6: Departing respondents by destination and direction

	Total		Directional distribution of departing traffic			
			West		East	
	Count	Col %	Count	Col %	Count	Col %
Waialua	38	1.9%	37	3.1%	1	0.1%
Haleiwa	221	11.0%	208	17.5%	13	1.6%
Laniakea to Waimea bay	18	0.9%	18	1.5%		
Three Tables beach to Kawela Beach	242	12.1%	235	19.8%	7	0.9%
Kahuku	174	8.7%	19	1.6%	155	18.9%
Laie	234	11.7%	28	2.4%	206	25.1%
Hauula	55	2.7%	7	0.6%	48	5.9%
Kaaawa	18	0.9%			18	2.2%
Windward	126	6.3%	27	2.3%	99	12.1%
East Honolulu	19	0.9%	9	0.8%	10	1.2%
Honolulu	465	23.2%	300	25.3%	165	20.1%
Central Oahu	123	6.1%	109	9.2%	14	1.7%
Leeward Oahu	96	4.8%	81	6.8%	15	1.8%
Other	121	6.0%	77	6.5%	44	5.4%
Unknown	57	2.8%	32	2.7%	25	3.0%
Total	2,007	100.0%	1,187	100.0%	820	100.0%

SMS,Inc. (Turtle Bay 2011)

Table 7.1: Arriving respondents by point of origin and day part

	Start Time																							
	8am - 9am				9am - 10am				10am - 11am				11am - 12pm				12pm - 1pm				1pm - 2pm			
	Weekday vs Weekend				Weekday vs Weekend				Weekday vs Weekend				Weekday vs Weekend				Weekday vs Weekend				Weekday vs Weekend			
	Count		Weekday		Weekend		Weekday		Weekend		Weekday		Weekend		Weekday		Weekend		Weekday		Weekend		Weekday	
		Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %
Waialua	30	1.3%	3	3.2%	1	1.8%			4	2.5%			1	0.7%			1	0.6%	1	0.9%				
Haleiwa	207	8.7%	4	4.2%	7	12.5%	9	4.6%	6	17.1%	12	7.5%	2	5.1%	15	9.9%	4	5.6%	15	8.4%	6	5.6%		
Laniakea to Waimea bay	34	1.4%					1	0.5%			3	1.9%	1	2.6%	2	1.3%	2	2.8%			1	0.9%		
Three Tables beach to Kawela Beach	294	12.3%	22	24.4%	7	20.0%	16	16.8%	10	17.9%	20	10.2%	2	5.7%	18	11.3%	4	11.3%	19	10.7%	9	8.3%		
Kahuku	166	6.9%	7	7.8%			10	10.5%			13	6.6%	1	2.9%	13	8.1%	14	9.2%	7	9.7%	15	8.4%	6	5.6%
Laie	216	9.0%	10	11.1%	5	14.3%	9	9.5%	5	8.9%	21	10.7%	4	11.4%	7	4.4%	12	7.9%	7	9.7%	26	14.6%	9	8.3%
Hauula	84	3.5%	6	6.7%	4	11.4%	6	6.3%			6	3.1%	6	17.1%	3	1.9%	1	2.6%	6	3.9%			4	3.7%
Kaaawa	14	0.6%	2	2.2%									1	2.9%	1	0.6%			1	0.7%	1	1.4%	1	0.9%
Windward	142	5.9%	4	4.4%	5	14.3%	3	3.2%	3	5.4%	13	6.6%	2	5.7%	11	6.9%	7	4.6%	5	6.9%	16	9.0%	12	11.1%
East Honolulu	19	0.8%	2	2.2%			1	1.1%	2	3.6%	3	1.5%			2	1.3%	1	0.7%			1	0.6%	1	0.9%
Honolulu	737	30.8%	13	14.4%	3	8.6%	19	20.0%	16	28.6%	59	30.1%	7	20.0%	58	36.3%	11	28.2%	52	34.2%	56	31.5%	38	35.5%
Central Oahu	165	6.9%	8	8.9%	5	14.3%	9	9.5%	8	14.3%	26	13.3%	1	2.9%	10	6.3%	4	10.3%	3	2.0%	2	2.8%	10	5.6%
Leeward Oahu	142	5.9%	8	8.9%	3	8.6%	7	7.4%	4	7.1%	14	7.1%	4	11.4%	11	6.9%	3	7.7%	12	7.9%	5	6.9%	8	4.5%
Other	139	5.8%	1	1.1%	1	2.9%	8	8.4%			11	5.6%	1	2.9%	7	4.4%	2	5.1%	9	5.9%	4	5.6%	6	3.4%
Total	2,389	100.0%	90	100.0%	35	100.0%	95	100.0%	56	100.0%	196	100.0%	35	100.0%	160	100.0%	39	100.0%	152	100.0%	72	100.0%	178	100.0%

Table 7.2: Arriving respondents by point of origin and day part

	Start Time																							
	2pm - 3pm				3pm - 4pm				4pm - 5pm				5pm - 6pm				6pm - 7pm				7pm - 8pm			
	Weekday vs Weekend				Weekday vs Weekend				Weekday vs Weekend				Weekday vs Weekend				Weekday vs Weekend				Weekday vs Weekend			
	Count		Weekday		Weekend		Weekday		Weekend		Weekday		Weekend		Weekday		Weekend		Weekday		Weekend		Weekday	
		Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %
Waialua	3	1.6%	1	1.4%	2	1.0%	3	3.6%	1	0.9%	1	1.3%	1	1.0%	2	2.5%					2	3.3%		
Haleiwa	9	4.9%	8	10.8%	20	9.8%	7	8.4%	11	9.8%	6	7.5%	16	16.0%	5	6.2%	15	15.5%	4	7.3%	14	23.3%	6	14.6%
Laniakea to Waimea bay	5	2.7%	1	1.4%	3	1.5%	2	2.4%	2	1.8%	1	1.3%	2	2.0%	2	2.5%	1	1.0%	2	3.6%	2	3.3%	1	2.4%
Three Tables beach to Kawela Beach	21	11.4%	7	9.5%	20	9.8%	8	9.6%	10	8.9%	14	17.5%	14	14.0%	5	6.2%	16	16.5%	11	20.0%	3	4.9%	7	17.1%
Kahuku	17	9.2%	6	8.1%	15	7.4%	1	1.2%	8	7.1%	6	7.5%	8	8.0%	3	3.7%	6	6.2%	3	5.5%	4	6.6%	2	4.9%
Laie	12	6.5%	2	2.7%	20	9.8%	2	2.4%	10	8.9%	2	2.5%	11	11.0%	3	3.7%	13	13.4%	7	12.7%	10	16.4%	4	9.8%
Hauula	15	8.1%	3	4.1%	1	0.5%	1	1.2%	3	2.7%	2	2.5%	4	4.0%			2	2.1%	1	1.8%	3	4.9%	3	7.3%
Kaaawa	2	1.1%			1	1.2%							1	1.0%			1	1.0%			1	1.6%		
Windward	7	3.8%	4	5.4%	10	4.9%	6	7.2%	5	4.5%	2	2.5%	7	7.0%	5	6.2%	4	4.1%	3	5.5%	1	1.6%	2	4.9%
East Honolulu			1	1.4%	2	1.0%	1	1.2%			1	1.3%			1	1.2%								
Honolulu	65	35.1%	28	37.8%	76	37.3%	30	36.1%	36	32.1%	24	30.0%	23	23.0%	39	48.1%	26	26.8%	12	21.8%	17	27.9%	8	19.5%
Central Oahu	15	8.1%	3	4.1%	15	7.4%	5	6.0%	9	8.0%	7	8.8%	4	4.0%	5	6.2%	4	4.1%	4	7.3%	1	1.6%	1	2.4%
Leeward Oahu	7	3.8%	3	4.1%	8	3.9%	7	8.4%	8	7.1%	8	10.0%	3	3.0%	2	2.5%	3	3.1%	5	9.1%	1	1.6%	1	2.4%
Other	7	3.8%	7	9.5%	12	5.9%	9	10.8%	6	8.0%	6	7.5%	6	6.0%	9	11.1%	6	6.2%	3	5.5%	2	3.3%	6	14.6%
Total	185	100.0%	74	100.0%	204	100.0%	83	100.0%	112	100.0%	80	100.0%	100	100.0%	81	100.0%	97	100.0%	55	100.0%	61	100.0%	41	100.0%

Table 9: Arriving respondents by day part and direction

	Total		Directional distribution of arriving traffic			
			West		East	
	Count	Col %	Count	Col %	Count	Col %
8am - 9am	122	4.6%	79	4.9%	43	4.2%
9am - 10am	146	5.5%	99	6.1%	47	4.6%
10am - 11am	238	9.0%	142	8.8%	96	9.5%
11am - 12pm	202	7.7%	130	8.0%	72	7.1%
12pm - 1pm	223	8.5%	131	8.1%	92	9.1%
1pm - 2pm	306	11.6%	155	9.6%	151	14.9%
2pm - 3pm	302	11.5%	181	11.2%	121	11.9%
3pm - 4pm	320	12.1%	214	13.2%	106	10.5%
4pm - 5pm	242	9.2%	147	9.1%	95	9.4%
5pm - 6pm	226	8.6%	142	8.8%	84	8.3%
6pm - 7pm	184	7.0%	112	6.9%	72	7.1%
7pm - 8pm	123	4.7%	89	5.5%	34	3.4%
Total	2,634	100.0%	1,621	100.0%	1,013	100.0%

Table 10: Departing respondents by day part and direction

	Total		Directional distribution of departing traffic			
			West		East	
	Count	Col %	Count	Col %	Count	Col %
8am - 9am	100	4.1%	68	4.6%	32	3.3%
9am - 10am	142	5.8%	92	6.2%	50	5.1%
10am - 11am	182	7.4%	107	7.2%	75	7.6%
11am - 12pm	242	9.8%	157	10.6%	85	8.6%
12pm - 1pm	258	10.5%	148	10.0%	110	11.2%
1pm - 2pm	250	10.1%	144	9.7%	106	10.8%
2pm - 3pm	255	10.3%	155	10.5%	100	10.2%
3pm - 4pm	317	12.8%	175	11.8%	142	14.4%
4pm - 5pm	247	10.0%	147	9.9%	100	10.2%
5pm - 6pm	211	8.6%	116	7.8%	95	9.7%
6pm - 7pm	163	6.6%	110	7.4%	53	5.4%
7pm - 8pm	100	4.1%	64	4.3%	36	3.7%
Total	2,467	100.0%	1,483	100.0%	984	100.0%

Table 8.1: Departing respondents by destination and day part

	Start Time																							
	8am - 9am				9am - 10am				10am - 11am				11am - 12pm				12pm - 1pm				1pm - 2pm			
	Count	Col %	Weekday vs Weekend				Weekday vs Weekend				Weekday vs Weekend				Weekday vs Weekend				Weekday vs Weekend			
			Weekday		Weekend		Weekday		Weekend		Weekday		Weekend		Weekday		Weekend		Weekday		Weekend	
			Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %
Waialua	38	1.8%									3	1.8%					1	0.5%			3	1.3%
Haleiwa	223	10.5%	7	8.0%	3	3.4%	6	5.2%	2	1.7%	11	7.5%					20	10.8%	4	2.2%	14	6.1%
Laniakea to Waimea bay	19	0.9%			1	1.1%	1	0.9%							4	2.3%	2	1.1%				
Three Tables beach to Kawela Beach	257	12.1%	14	16.1%	4	4.6%	17	14.7%	2	1.7%	13	8.9%	1	0.7%	15	8.8%	10	5.4%	7	3.8%	27	11.7%
Kahuku	176	8.3%	3	3.4%			2	1.7%	1	0.9%	9	6.2%	2	1.4%	15	8.8%	13	7.0%	5	2.7%	29	12.6%
Laie	235	11.1%	6	6.9%	1	1.1%	8	6.9%	3	2.6%	10	6.8%	4	2.7%	16	9.4%	13	7.0%	2	1.1%	17	7.4%
Hauula	58	2.7%					1	0.9%			3	2.1%			2	1.2%	1	0.6%	1	0.5%	6	2.6%
Kaaawa	19	0.9%					1	0.9%			3	2.1%	1	0.7%			1	0.5%	4	2.2%	1	0.4%
Windward	132	6.2%	1	1.1%	3	3.4%	5	4.3%	2	1.7%	5	3.4%			9	5.3%	5	2.7%			13	5.6%
East Honolulu	19	0.9%	3	3.4%			2	1.7%			1	0.7%			1	0.6%	2	1.1%			1	0.4%
Honolulu	475	22.4%	19	21.8%	3	3.4%	27	23.3%	7	6.0%	33	22.6%	3	2.1%	38	22.2%	35	18.8%	10	5.4%	35	15.2%
Central Oahu	126	5.9%	3	3.4%			3	2.6%	2	1.7%	7	4.8%	1	0.7%	7	4.1%	1	0.5%	3	1.6%	12	5.2%
Leeward Oahu	99	4.7%	1	1.1%			1	0.9%			5	3.4%			4	2.3%	2	1.2%	4	2.2%	9	3.9%
Other	151	7.1%	8	9.2%	3	3.4%	13	11.2%	6	5.2%	20	13.7%	5	3.4%	11	6.4%	3	1.8%	5	2.7%	7	3.0%
Unknown	94	4.4%	3	3.4%	1	1.1%	3	2.6%	1	0.9%	7	4.8%	2	1.4%	7	4.1%			4	2.2%	11	4.8%
Total	2,121	100.0%	68	78.2%	19	21.8%	90	77.6%	26	22.4%	127	87.0%	19	13.0%	146	85.4%	25	14.6%	137	73.7%	185	80.1%

Table 8.2: Departing respondents by destination and day part

	Start Time																					
	2pm - 3pm				3pm - 4pm				4pm - 5pm				5pm - 6pm				6pm - 7pm				7pm - 8pm	
	Weekday vs Weekend				Weekday vs Weekend				Weekday vs Weekend				Weekday vs Weekend				Weekday vs Weekend				Weekday vs Weekend	
	Weekday		Weekend		Weekday		Weekend		Weekday		Weekend		Weekday		Weekend		Weekday		Weekend		Weekday	
	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %	Count	Col %
Waialua	1	0.4%			3	1.1%	1	0.4%	6	2.7%	3	1.3%	5	2.7%			4	2.6%	3	3.1%	1	1.0%
Haleiwa	20	8.2%	8	3.3%	27	9.6%	6	2.1%	14	6.3%	6	2.7%	14	7.5%	2	1.1%	17	11.2%	3	2.0%	17	17.5%
Laniakea to Waimea bay	2	0.8%			1	0.4%	3	1.1%	2	0.9%			1	0.5%			2	1.3%			2	2.1%
Three Tables beach to Kawela Beach	27	11.0%	3	1.2%	21	7.5%	4	1.4%	21	9.4%	10	4.5%	10	5.4%	9	4.8%	11	7.2%	12	7.9%	9	9.3%
Kahuku	9	3.7%	4	1.6%	20	7.1%	5	1.8%	12	5.4%	12	5.4%	9	4.8%	1	0.5%	11	7.2%	2	1.3%	5	5.2%
Laie	18	7.3%	6	2.4%	28	10.0%	9	3.2%	19	8.5%	8	3.6%	21	11.3%	10	5.4%	15	9.9%	1	0.7%	10	10.3%
Hauula	2	0.8%	3	1.2%	7	2.5%	2	0.7%	9	4.0%	3	1.3%	2	1.1%	2	1.1%	5	3.3%	1	0.7%	3	3.1%
Kaaawa	2	0.8%	2	0.8%	3	1.1%			2	0.9%	2	0.9%	1	0.5%								
Windward	7	2.9%	7	2.9%	12	4.3%	18	6.4%	2	0.9%	5	2.2%	16	8.6%	2	1.1%	5	3.3%	5	3.3%	2	2.1%
East Honolulu	1	0.4%	1	0.4%	1	0.4%									1	0.5%			1	0.7%	1	1.0%
Honolulu	42	17.1%	26	10.6%	32	11.4%	25	8.9%	23	10.3%	21	9.4%	25	13.4%	11	5.9%	10	6.6%	16	10.5%	10	10.3%
Central Oahu	11	4.5%	7	2.9%	7	2.5%	8	2.9%	15	6.7%	5	2.2%	7	3.8%	7	3.8%	6	3.9%	2	1.3%	7	7.2%
Leeward Oahu	13	5.3%	4	1.6%	10	3.6%	7	2.5%	6	2.7%	5	2.2%	2	1.1%	7	3.8%	3	2.0%			2	2.1%
Other	7	2.9%	6	2.4%	7	2.5%	2	0.7%	3	1.3%	3	1.3%	8	4.3%	6	3.2%	4	2.6%	3	2.0%	1	1.0%
Unknown	5	2.0%	1	0.4%	8	2.9%	3	1.1%	2	0.9%	4	1.8%	6	3.2%	1	0.5%	7	4.6%	2	1.3%	3	3.1%
Total	167	68.2%	78	31.8%	187	66.8%	93	33.2%	136	60.7%	88	39.3%	127	68.3%	59	31.7%	100	65.8%	52	34.2%	73	75.3%

Table 11: Arriving respondents by point of origin by weekday vs. weekend

	Total		Weekday vs Weekend			
			Weekday		Weekend	
	Count	Col %	Count	Col %	Count	Col %
Waialua	30	1.3%	21	1.3%	9	1.2%
Haleiwa	207	8.6%	144	8.8%	63	8.2%
Laniakea to Waimea bay	34	1.4%	21	1.3%	13	1.7%
Three Tables beach to Kawela Beach	295	12.3%	196	12.0%	99	13.0%
Kahuku	167	7.0%	131	8.0%	36	4.7%
Laie	216	9.0%	161	9.8%	55	7.2%
Hauula	84	3.5%	59	3.6%	25	3.3%
Kaaawa	14	0.6%	10	0.6%	4	0.5%
Windward	142	5.9%	88	5.4%	54	7.1%
East Honolulu	20	0.8%	12	0.7%	8	1.0%
Honolulu	743	31.0%	504	30.8%	239	31.3%
Central Oahu	165	6.9%	114	7.0%	51	6.7%
Leeward Oahu	142	5.9%	90	5.5%	52	6.8%
Other	140	5.8%	84	5.1%	56	7.3%
Total	2,399	100.0%	1,635	100.0%	764	100.0%

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Table 12: Departing respondents by point of origin by weekday vs. weekend

	Total		Weekday vs Weekend			
			Weekday		Weekend	
	Count	Col %	Count	Col %	Count	Col %
Waialua	38	1.8%	29	1.9%	9	1.5%
Haleiwa	225	10.6%	183	11.8%	42	7.2%
Laniakea to Waimea bay	19	0.9%	15	1.0%	4	0.7%
Three Tables beach to Kawela Beach	258	12.1%	195	12.6%	63	10.8%
Kahuku	177	8.3%	138	8.9%	39	6.7%
Laie	236	11.1%	182	11.7%	54	9.3%
Hauula	59	2.8%	43	2.8%	16	2.8%
Kaaawa	19	0.9%	14	0.9%	5	0.9%
Windward	132	6.2%	82	5.3%	50	8.6%
East Honolulu	19	0.9%	13	0.8%	6	1.0%
Honolulu	477	22.4%	330	21.3%	147	25.3%
Central Oahu	126	5.9%	86	5.6%	40	6.9%
Leeward Oahu	100	4.7%	66	4.3%	34	5.9%
Other	151	7.1%	100	6.5%	51	8.8%
Unknown	94	4.4%	73	4.7%	21	3.6%
Total	2,130	100.0%	1,549	100.0%	581	100.0%

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Table 13: Total arrivals by direction and weekday vs. weekend

	Total		Directional distribution of arriving traffic			
			West		East	
	Count	Col %	Count	Col %	Count	Col %
Weekday	1,638	61.9%	989	60.7%	649	63.8%
Weekend	1,008	38.1%	640	39.3%	368	36.2%
Total	2,646	100.0%	1,629	100.0%	1,017	100.0%

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Table 14: Total departures by direction and weekday vs. weekend

	Total		Directional distribution of departing traffic			
			West		East	
	Count	Col %	Count	Col %	Count	Col %
Weekday	1,626	65.6%	966	64.9%	660	66.7%
Weekend	851	34.4%	522	35.1%	329	33.3%
Total	2,477	100.0%	1,488	100.0%	989	100.0%

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Table 15: Arriving respondents by point of origin – hotel vs. condominium

	Total		Hotel guest vs. Condo guest/resident			
			Hotel guest		Condo guest/resident	
	Count	Col %	Count	Col %	Count	Col %
Waialua	5	0.6%	2	0.4%	3	0.9%
Haleiwa	82	9.3%	53	9.5%	29	8.9%
Laniakea to Waimea bay	20	2.3%	12	2.2%	8	2.5%
Three Tables beach to Kawela Beach	100	11.3%	52	9.3%	48	14.8%
Kahuku	74	8.4%	33	5.9%	41	12.6%
Laie	89	10.1%	46	8.2%	43	13.2%
Hauula	12	1.4%	5	0.9%	7	2.2%
Kaaawa	6	0.7%	5	0.9%	1	0.3%
Windward	38	4.3%	19	3.4%	19	5.8%
East Honolulu	6	0.7%	4	0.7%	2	0.6%
Honolulu	277	31.4%	227	40.7%	50	15.4%
Central Oahu	40	4.5%	24	4.3%	16	4.9%
Leeward Oahu	28	3.2%	11	2.0%	17	5.2%
Other	106	12.0%	65	11.6%	41	12.6%
Total	883	100.0%	558	100.0%	325	100.0%

SMS,Inc. (Turtle Bay 2011)

Table 16: Departing respondents by point of origin – hotel vs. condominium

	Total		Hotel guest vs. Condo guest/resident			
	Count	Col %	Hotel guest		Condo guest/resident	
			Count	Col %	Count	Col %
Waialua	4	0.4%	1	0.2%	3	1.0%
Haleiwa	105	11.4%	80	13.1%	25	8.1%
Laniakea to Waimea bay	8	0.9%	5	0.8%	3	1.0%
Three Tables beach to Kawela Beach	111	12.1%	64	10.5%	47	15.3%
Kahuku	59	6.4%	29	4.7%	30	9.8%
Laie	112	12.2%	72	11.8%	40	13.0%
Hauula	12	1.3%	4	0.7%	8	2.6%
Kaaawa	5	0.5%	4	0.7%	1	0.3%
Windward	38	4.1%	19	3.1%	19	6.2%
East Honolulu	4	0.4%	2	0.3%	2	0.7%
Honolulu	197	21.5%	176	28.8%	21	6.8%
Central Oahu	40	4.4%	23	3.8%	17	5.5%
Leeward Oahu	22	2.4%	18	2.9%	4	1.3%
Other	127	13.8%	81	13.3%	46	15.0%
Unknown	74	8.1%	33	5.4%	41	13.4%
Total	918	100.0%	611	100.0%	307	100.0%

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Table 17: Respondents traveling west who left and returned to Turtle Bay same day

	Count	Col %
Turtle Bay	6	1.6%
Three Tables to Kawela Beach	70	19.1%
Laniakea to Waimea	76	20.7%
Haleiwa	62	16.9%
Waialua	2	0.5%
Honolulu	46	12.5%
Central Oahu	22	6.0%
Leeward Oahu	6	1.6%
Other	77	21.0%
Total	367	100.0%

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Table 18: Respondents traveling east who left and returned to Turtle Bay same day

	Count	Col %
Kahuku	48	19.8%
Laie	86	35.5%
Hauula	3	1.2%
Kaaawa	5	2.1%
Windward	13	5.4%
East Honolulu	4	1.7%
Honolulu	17	7.0%
Central Oahu	1	0.4%
Leeward Oahu	3	1.2%
Other	58	24.0%
Total	242	100.0%

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Table 19: Final Destination of respondents traveling west

	Departing	Final Destination
Turtle bay	988	-
Three Tables to Kawela Beach	753	235
Laniakea to Waimea	735	18
Haleiwa	527	208
Waialua	490	37
Honolulu	190	300
Central Oahu	81	109
Leeward Oahu	0	81

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Table 20: Final Destination of respondents traveling east

	Departing	Final Destination
Turtle Bay	730	-
Kahuku	575	155
Laie	369	206
Hauula	321	48
Kaaawa	303	18
Windward	204	99
East Honolulu	194	10
Honolulu	29	165
Central Oahu	15	14
Leeward Oahu	0	15

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APPENDIX

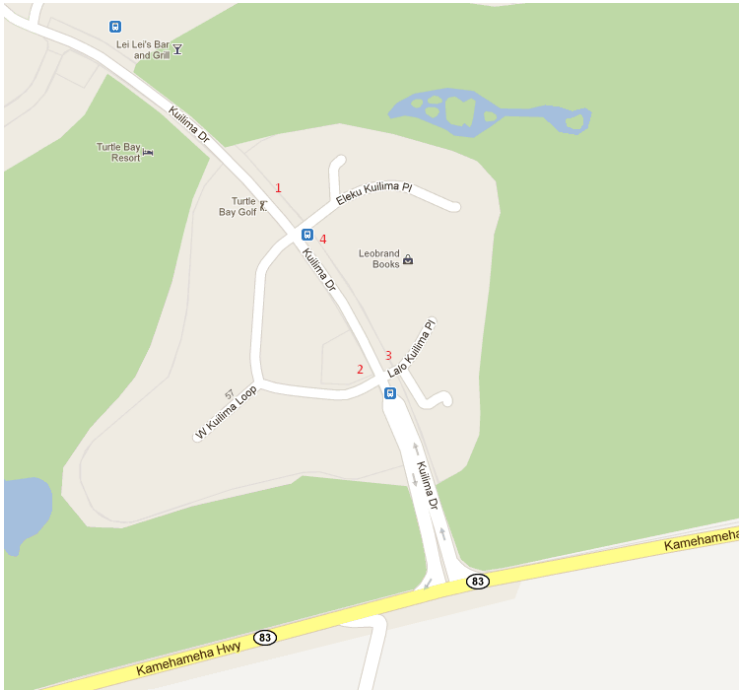
Appendix A: Survey Instrument

	Time Started	Status	Direction from/To		Starting Point	Final Destination	Planned Stops	Time left Origin	Refused	Cars missed
			Haleiwa	Laie						
1			☐	☐					☐	
2			☐	☐					☐	
3			☐	☐					☐	
4			☐	☐					☐	
5			☐	☐					☐	
6			☐	☐					☐	
7			☐	☐					☐	
8			☐	☐					☐	
9			☐	☐					☐	
10			☐	☐					☐	
11			☐	☐					☐	
12			☐	☐					☐	
13			☐	☐					☐	
14			☐	☐					☐	
15			☐	☐					☐	

Appendix B: Map

There was a total of four survey locations (marked in red), but only three locations were being fielded at any given time. Survey station 1 which is the entrance to Turtle Bay Resort guests and golf course was always fielded at, while interviewers rotated every two hours between stations 2, 3, and 4 (entrances to Kuilima Estates).

Figure 1: Turtle Bay fielding location



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