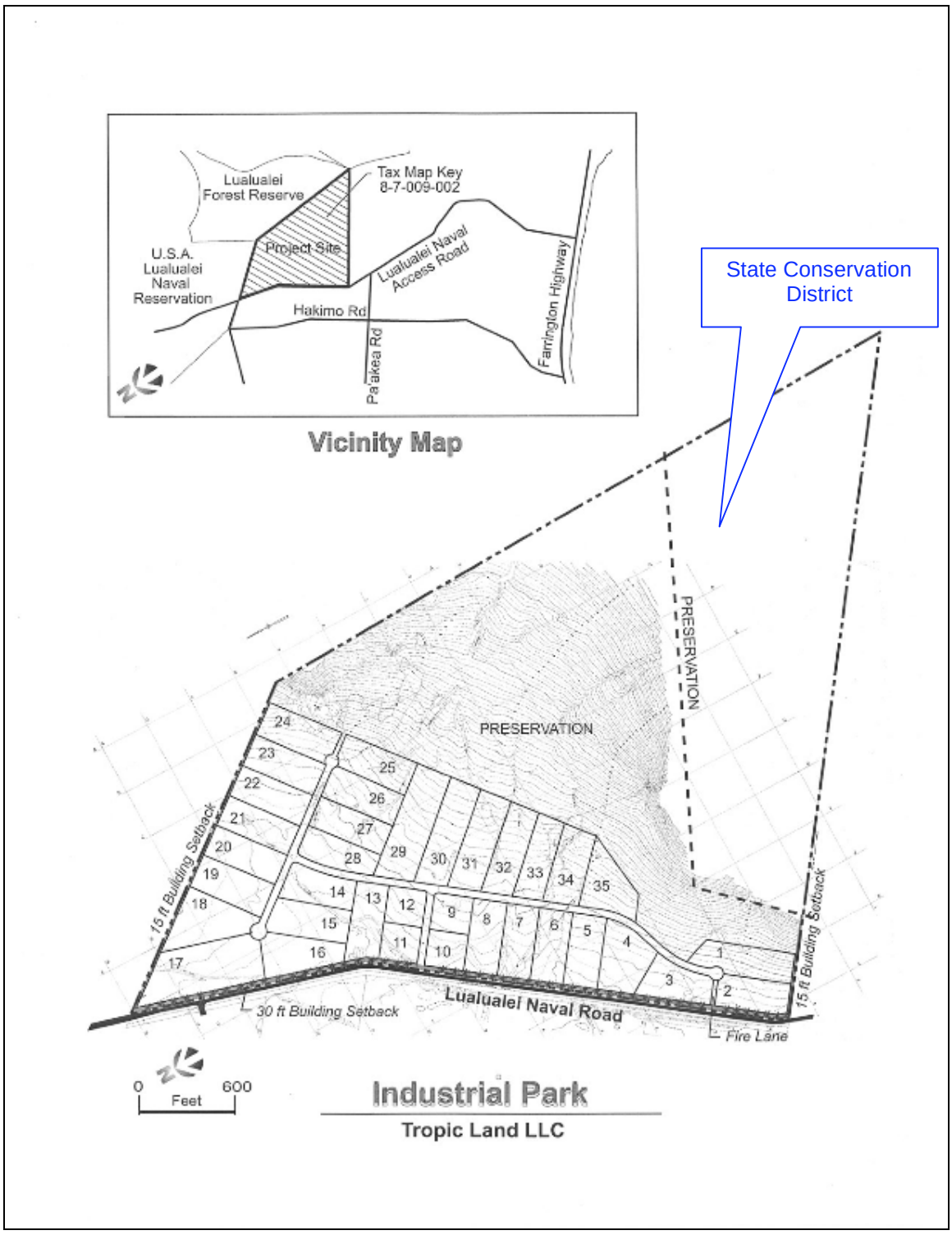
Figure 1


Lualualei Forest Reserve
Tax Map Key 8-7-009-002
Project Site
U.S.A. Lualualei Naval Reservation
Lualualei Naval Access Road
Hakimo Rd
Farrington Highway
Pa'akea Rd
Vicinity Map
State Conservation District
PRESERVATION
PRESERVATION
15 ft Building Setback
15 ft Building Setback
30 ft Building Setback
Lualualei Naval Road
Fire Lane
0
600
Feet
Industrial Park
Tropic Land LLC

fall below the 200 foot (61 meter) elevational contour (Figure 1). Additionally, 67.439-acres of land on the northern face of Puʻuheleakalā is within the State of Hawaiʻi Conservation District and thus will not be developed (Figure 1).

The environment present at the project site is highly disturbed, with abundant signs of fires, bulldozed firebreaks/roads and the like. The vegetation is dominated by buffel grass and Guinea grass (*Cenchrus ciliaris* and *Urochloa maxima*), *kiawe* (*Prosopis pallida*) trees forming a savanna in the upper parts of the parcel (Figure 2) and a somewhat open forest in the lower parts. Both *koa haole* (*Leucaena leucocephala*) and the much smaller virgate mimosa (*Desmanthus pernambucanus*) shrubs are common to abundant across the mostly grassy landscape. Additionally there are numerous alien weedy species present, especially along the various scrapes and unimproved roads within the site. The vegetation is typical of disturbed, xeric areas on the leeward slopes of the island.

Figure 2. Typical aspect of the Tropic Land site with modest, grass-covered slopes and scattered kiawe trees. Puʻu Kaua towers over Lualualei Valley in the background.

Botanical Survey Methods

The botanical survey was undertaken on June 25, 2008 following a wandering transect that traversed all parts of the subject parcel up to about the 200-foot (60-m) elevation. The survey was

conducted early in the dry season and therefore a few plants typical of this site, especially annuals, might have completed their life cycle and been missed or gone dormant. The dominant herbaceous plants (buffel and Guinea grass) were still showing some green leaves, but had completed flowering and fruiting.

Botanical Survey Results

The results of the botanical survey are provided as a table of the flora of the site (Table 1). In this case, the table includes both plant species identified on June 25, 2008 with relative abundances, and species previously reported from the property by Char (1990). In the case of the latter survey, no abundance estimates were made. Species listed in the table without an abundance value were observed by Char and not seen in the more recent survey.

Table 1 - Listing of plants (flora) for the Tropic Land, Light Industrial Park Site

Species listed by family	***Common name***	***Status***	***Relative Abundance***	***Notes***
	FLOWERING PLANTS			
	DICOTYLEDONES			
ACANTHACEAE				
Asystasia gangetica (L.) T. Anderson	Chinese violet	Nat.	U1	(2)
AIZOACEAE				
Trianthema portulacastrum L.	---	Nat.	U2	(1)
AMARANTHACEAE				
Achyranthes aspera L.	---	Nat.	---	(2)
Alternanthera pungens Kunth	khaki weed	Nat.	R	(1,2)
Amaranthus spinosus L.	spiny amaranth	Nat.	O	(1,2)
Amaranthus virdis L.	slender amaranth	Nat.	R	(1)
ASTERACEAE (COMPOSITAE)				
Ageratim conyzoides L.	*maile hohono*	Nat.	---	(2)
Bidens pilosa L.	beggar's tick	Nat.	---	(2)
Conyza bonariensis (L.) Cronq.	hairy horseweed	Nat.	U	(2) †
Eclipta prostrata (L.) L.	---	Nat.	R3	
Emilia fosbergii Nicolson	*pualele*	Nat.	R	(2)
Pluchia carolinensis (Jacq.) G. Don	sourbush	Nat.	R1	(2)
Sonchus oleraceus L.	sow thistle	Nat.	R	(2)
Tridax procumbens L.	coat buttons	Nat.	U2	(2)
Verbesina encelioides (Cav.) Benth.	golden crownbeard	Nat.	---	(2)
Xanthium strumarium var. *canadense* (Mill.) Torr. ex A. Gray	cocklebur	Nat.	---	(2)
BIGNONIACEAE				
Spathodea campanulata P. Beauv.	African tulip tree	Orn.	R2	
BORAGINACEAE				
Heliotropium procumbens Mill.	---	Nat.	R2	
BUDDLEIACEAE				
Buddleia asiatica Lour.	dog tail	Nat.	---	(2)

Table 1 Continued.

Species listed by family	***Common name***	***Status***	***Relative Abundance***	***Notes***
CACTACEAE				
Opuntia ficus-indica (L.) Mill.	prickly pear	Nat.	---	(2)
CHENOPODIACEAE				
Atriplex semibaccata R. Br.	Australian saltbush	Nat.	R2	
Chenopodium murale L.	*ʻaheahea*	Nat.	---	(2)
CONVOLVULACEAE				
Ipomoea indica (J. Burm.) Merr.	*koali ʻawa*	**Ind.**	---	(2)
Ipomoea obscura (L.) Ker-Gawl.	field bindweed	Nat.	U	(2)
Ipomoea triloba L.	little bell	Nat.	U	
Jacquemontia ovalifolia (Choisy) H. Hallier	*pāʻü-o-Hiʻiaka*	**Ind.**	U2	(2)
Merremia aegyptica (L.) Urb.	hairy merremia	Nat.	---	(2)
CUCURBITACEAE				
Cucumis dipsaceus Ehrenb. ex Spach	teasel goard	Nat.	R	
EUPHORBIACEAE				
Chamaesyce hirta (L.) Millsp.	garden spurge	Nat.	R	(2)
Chamaesyce hypericifolia (L.) Millsp.	graceful spurge	Nat.	U2	(2)
Euphorbia lactea Haworth	mottled-candlestick	Orn.	R	
Ricinus communis L.	castor bean	Nat.	U	(2)
FABACEAE				
Acacia farnesiana (L.) Willd.	*klu*	Nat.	O	(2)
Crotalaria incana L.	fuzzy rattlepod	Nat.	O	(2)
Desmanthus pernambucanus (L.) Thellung	virgate mimosa	Nat.	A	(2)
Erythrina sandwicensis Degener	*wili wili*	**End**	---	(2)
Leucaena leucocephala (Lam.) deWit	*koa haole*	Nat.	C	(2)
Indigofera hendecaphylla Jacq.	creeping indigo	Nat.	R2	
Indigofera suffruticosa Mill.	indigo	Nat.	U	(2)
Macroptilium lathyroides (L.) Urb.	cow pea	Nat.	U	(2)
Pithecelobium dulce (Roxb.) Benth.	*ʻopiuma*	Nat.	R	
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	*kiawe*	Nat.	A	(2)
Samanea saman (Jacq.) Merr.	monkeypod	Nat.	R	(2)
LAMIACEAE				
Hyptis pectinata (L.) Poit.	comb hyptis	Nat.	O3	(2)
Leonotis nepetifolia (L.) R. Br.	lion's ear	Nat.	A	(2)
Ocium gratissimum L.	wild basil	Nat.	R	(2)
MALVACEAE				
Abutilon grandifolium (Willd.) Sweet	hairy abutilon	Nat.	---	(2)
Abutilon incanum (Link) Sweet	hoary abutilon	**Ind.**	---	(2)

Table 1 Continued.

Species listed by family	***Common name***	***Status***	***Relative Abundance***	***Notes***
Malvastrum coromandelianum (L.) Garck	false mallow	Nat.	O	(1,2)
Malva parviflora L.	cheeseweed	Nat.	R	(1)
Sida ciliaris L.	---	Nat.	U	(1)
Sida fallax Walp.	*ʻilima*	**Ind.**	O3	(2)
Sida rhombifolia L.	Cuba jute	Nat.	---	(2)
Sida spinosa L.	prickly sida	Nat.	U2	(2)
MORACEAE				
Ficus microcarpa L.	Chinese banyan	Nat.	R	(2)
NYCTAGINACEAE				
Boerhavia coccinea Mill.	false alena	Nat.	---	(2)
PASSIFLORACEAE				
Passiflora foetida L.	love-in-a-mist	Nat.	---	(2)
PORTULACACEAE				
Portulaca oleracea L.	pigweed	Nat.	R	
SOLANACEAE				
Nicandra physalodes (L.) Gaertn.	apple-of-Peru	Nat.	R	(2)
Solanum americanum Mill.	pōpolo	**Ind.**	---	(2)
Solanum lycopersicum var. *cerasiforme* (Dunal) Spooner, G. Anderson, & Jansen	wild cherry tomato	Nat.	U	(2)
STERCULIACEAE				
Waltheria indica L.	*ʻuhaloa*	**Ind.**	U	(2)
VERBENACEAE				
Lantana camara L.	lantana	Nat.	---	(2)
	MONOCOTYLEDONES			
COMMELINACEAE				
Commelina benghalensis L.	hairy *honohono*	Nat.	---	(2)
POACEAE				
Bothriochloa pertusa (L.) A Camus	pitted beardgrass	Nat.	---	(2)
Cenchrus ciliaris L.	buffelgrass	Nat.	AA	(2)
Cenchrus echinatus L.	sand bur	Nat.	R	
Chloris barbata (L.) Sw.	swollen fingergrass	Nat.	O3	(2)
Chloris radiate (L.) Sw.	radiate fingergrass	Nat.	---	(2)
Cynodon dactylon (L.) Pers.	Bermuda grass	Nat.	---	(2)
Digitaria insularis (L.) Mez. ex Ekman	sourgrass	Nat.	---	(2)
Eleusine indica (L.) Gaertn.	wiregrass	Nat.	R	(1,2)
Melinus minutiflora P. Beauv.	molasses grass	Nat.	R	

Table 1 Continued.

Species listed by family	*Common name*	*Status*	*Relative Abundance*	*Notes*
Melinus repens (Willd.) Zizka	Natal redtop	Nat.	---	(2)
Setaria verticillata (L.) P. Beauv.	bristly foxtail	Nat.	U	(2)
Urochloa maxima (Jacq.) Webster	Guinea grass	Nat.	AA	(2)

Legend to Table 1

STATUS = distributional status for the Haaiian Islands:
- **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.

ABUNDANCE = occurrence ratings for plants by area:

R – Rare	seen in only one or perhaps two locations.
U - Uncommon-	seen at most in several locations
O - Occasional	seen with some regularity
C - Common	observed numerous times during the survey
A - Abundant	found in large numbers; may be locally dominant.
AA - Very abundant	abundant and dominant; defining vegetation type.

Numbers following an occurrence rating indicate clusters within the survey area. The ratings above provide an estimate of the likelihood of encountering a species within the specified survey area; numbers modify this where abundance, where encountered, tends to be greater than the occurrence rating:
- 1 – several plants present
- 2 - many plants present
- 3 – locally abundant

NOTES:
- (1) – Generally associated with unimproved roads and other recently disturbed sites.
- (2) – Previously reported by Char () from the property. .
- (3) – Plant lacking key diagnostic characteristics (flower, fruit).
- † -- Seen only as dead plant matter.

A total of 52 species were observed during the survey on June 25. All but 2 species are introduced (not native), putting the percentage of native species at 4%. A total of 76 species have identified from the site when combing the results from Char (1990) with the most recent survey data.

Avian Survey Methods

Eight avian count stations were evenly spaced across the approximately 100-acre proposed development area. Each station was counted once. Field observations were made with the aid of Leitz 10 X 42 binoculars and by listening for vocalizations. Counts were concentrated in the early morning hours, the time of day that bird activity is typically at its peak. Time not spent counting was used to search the site and the surrounding area for species and habitats not detected during count sessions. We took particular care to cover areas upslope of the proposed development area to ensure that no additional habitats or species were present on the owners property upslope of the proposed disturbance area.

Avian Survey Results

A total of 227 individual birds of 17 species, representing 12 separate families, were recorded during station counts (Table 2). All of the 17 species detected are considered to be alien to the

Hawaiian Islands (Table 2). No avian species currently protected, or proposed for protection under either the Federal or State of Hawai‘i endangered species programs were detected during the course of this survey (DLNR 1998, Federal Register 2005, USFWS 2005, 2008).

Avian diversity and densities were in keeping with the location and the depaureate and xeric habitat present on the site. Four species, House Sparrow (*Passer domesticus*), Spotted Dove (*Streptopelia chinesis*), Common Waxbill (*Estrilda astrild*) and Zebra Dove (*Geopelia striata*), accounted for slightly more that 54% of the total number of all birds recorded during station counts. The most commonly recorded species was House Sparrow, which accounted for slightly less than 17% of the total number of individual birds recorded. An average of 28 birds were detected per station count.

Table 2 - Avian Species Detected on the Tropic-Land Light Industrial Park Site

Common Name	***Scientific Name***	***ST***	***RA***
	GALLIFORMES		
	PHASIANIDAE - Pheasants & Partridges		
	Phasianinae - Pheasants & Allies		
Erckel's Francolin	*Francolinus erckelii*	A	1.38
	COLUMBIFORMES		
	COLUMBIDAE - Pigeons & Doves		
Rock Pigeon	*Columba livia*	A	0.13
Spotted Dove	*Streptopelia chinensis*	A	4.13
Zebra Dove	*Geopelia striata*	A	2.88
	STRIGIFORMES		
	TYTONIDAE - Barn Owls		
Barn Owl	*Tyto alba*	A	0.13
	PASSERIFORMES		
	PYCNONOTIDAE - Bulbuls		
Red-vented Bulbul	*Pycnonotus cafer*	A	1.63
	ZOSTEROPIDAE - White-eyes		
Japanese White-eye	*Zosterops japonicus*	A	1.38
	MIMIDAE - Mockingbirds & Thrashers		
Northern Mockingbird	*Mimus polyglottos*	A	1.13
	STURNIDAE - Starlings		
Common Myna	*Acridotheres tristis*	A	0.63
	EMBERIZIDAE - Emberizids		
Red-crested Cardinal	*Paroaria coronata*	A	0.25
	CARDINALIDAE - Cardinals Saltators & Allies		
Northern Cardinal	*Cardinalis cardinalis*	A	1.50
	FRINGILLIDAE - Fringilline and Carduline Finches & Allies		
	Carduelinae - Carduline Finches		
House Finch	*Carpodacus mexicanus*	A	1.63
	PASSERIDAE - Old World Sparrows		
House Sparrow	*Passer domesticus*	A	4.75
	ESTRILDIDAE - Estrildid Finches		

Table 2 Continued.

Common Name	***Scientific Name***	***ST***	***RA***
	Estrildinae - Estrildine Finches		
Common Waxbill	*Estrilda astrild*	A	3.63
Nutmeg Mannikin	*Lonchura punctulata*	A	2.75
Chestnut Munia	*Lonchura atricapilla*	A	0.25
Java Sparrow	*Padda oryzivora*	A	0.25

Key to Table 1.

ST	Status
A	Alien species – introduced to Hawai‘i by humans
RA	Relative Abundance: Number of birds detected divided by the number of count stations (8)

Mammalian Survey Methods

With the exception of the endemic, endangered Hawaiian hoary bat, or *‘ōpe‘ape‘a*, as it is known locally, all terrestrial mammals currently found on the island of O‘ahu are alien species. Most are ubiquitous; no trapping program was proposed or undertaken to quantify the use of the study site by alien mammalian species. The survey of mammals was limited to visual and auditory detection, coupled with observation of scat, tracks, and other animal sign. A running tally was kept of all vertebrate species observed and heard within the project sites.

Mammalian Survey Results

Three mammalian species; domestic dog (*Canis f. familiaris*), small Indian mongoose (*Herpestes a. auropunctatus*), and cat (*Felis catus*), were detected within the study site. There were several pit bulls chained up around the trucks, heavy equipment and sheds immediately *mauka* of the entrance gate. Additionally, one pit bull was running loose on the property. One small Indian mongoose was seen on the west end of the site, and scat, tracks, and sign of both dog and cat was encountered in several locations within the project site.

Discussion

Botanical Resources

A majority of the property to be developed as an industrial park supports a Kiawe-Buffel Grass Association (Char, 1990), although significant areas support Guinea grass as a dominant or co-dominant with buffel grass. From a floristic standpoint, the site below the preservation and conservation zone lacks habitat for valuable native plants. This area has seen various uses and activities over the years (rock quarrying, rangeland, agricultural cropping) and a portion is presently used as a trucking base yard. The property has been subjected to one or more wildfires; Char (1990) reporting the site as partly burned during her survey.

It is unclear from Char’s (Char & Assoc., 1990) description of the site and her survey method as to just how much of the parcel was surveyed in August 1990. The reports notes that land slopes become steep (12 to 30%) above the 200-foot contour and then “rise abruptly and steeply” in the

rear portions of the project site leading to Pu‘uheleakalā ridge. The statement is made that “[n]o golf course construction is planned for these steeply sloping areas,” a generalization that implies the 1990 botanical survey may not have included areas above an unspecified steepness. One significance here is that steeper areas tend to be very rocky with a sparse growth of buffel grass, and therefore are less likely to support devastating wildfires that remove native plants from the environment. In addition, of course, is the fact that direct impacts of the proposed Tropic Land project, would not occur above about 200 feet elevation because the industrial lots will not extend to the slopes above about the 200 foot elevation contour.

Char (1990) developed a longer plant species list (76 species vs. 52 species) than that resulting from the present survey, although the latter included 15 species not reported in 1990. The 24 plants listed as present in 1990 and not observed in 2008 are mostly common weedy species that certainly should be expected on or near the project area. Possibly had our survey extended further upslope or included parcels along Ulehawa Stream as was the case in 1990, many of these species would have been encountered. Seasonal conditions appear not to be a factor, since Char conducted her survey during the typically dry month of August. Char notes that her survey was more intense “[w]here Ulehawa Stream crosses the property” to rule out the presence of the endangered fern, *Marsillea villosa*, known from the nearby Naval Radio Transmitting Facility (Botanical Consultants, 1984; Traverse Group, 1987). Parcels to the west of Lualualei Naval Road were not included in the present survey area.

Figure 3. Unnamed ridge rising over 1800 ft (550 m) to the east above the project site. Note that the steep slopes are still green.

Char noted the native *wiliwili* tree (*Erythrina sandwicensis*) as present in the dry stream bed near the road to an old quarry. The tree was not seen in 2008, either because it is no longer there, was growing above the upper elevation limit of our survey (although a quarry and well site as described was part of our survey area), or missed against the backdrop of the kiawe trees in the gulch—*wiliwili* are deciduous in the dry season and a single tree could be overlooked if absent all of its leaves. Although an endemic species, the *wiliwili* is not listed as threatened or endangered. All of the native plants encountered on the property in 1990 and 2008 are common species in the Hawaiian Islands.

Although no part of the project area is included in the federally designated plant critical habitat Unit 15 encompasses adjacent Pu‘uheleakalā and the ridgeline above the project area extending to the northeast (Figure 3) (Federal Register, 2003). Unit 15 extends all along the Wai‘anae ridge here to the upper end of Lualualei Valley. In the project area, the boundary of this unit descends to around the 500-ft (152-m) elevation on the ridges to the northeast and southwest, rising to the 1000-ft (305-m) contour in the valley behind the proposed industrial park. Within the property boundaries, the area of critical habitat is entirely within the State Conservation District as depicted in Figure 1.

The portion of Unit 15 (Pu‘uheleakalā) closest to the project includes critical habitat for an endangered species of *‘akoko* (*Chamaesyce kuwaleana*; see page 33) and *Lipochaeta lobata* var. *leptophylla* at the top of the ridgeline to the east. The following descriptions from Guinther (2007, p. 33-34) summarize information on these and other listed plant species in the area:

> *Chamaesyce kuwaleana* is a species of *‘akoko* listed as endangered (Federal Register, 1991). Critical habitat for this species has been designated in seven units. Unit 15 encompasses 454 ac (184 ha) of Pu‘u Heleakalā and is thought to presently harbor 300 individual plants (Federal Register, 2003). … The plant is a small shrub between 0.2 and 0.9 m (8 to 35 in) high, known only from “arid volcanic cliffs, 250 m [820 ft high], Wai‘anae Mountains, and also known from one specimen from Mokumanu, Kāne‘ohe, O‘ahu” (Wagner, Herbst, and Sohmer, 1990).
>
> *Schiedea ligustrina* is indicated as having been reported from near the peak (northeast slope) of Pu‘u Heleakalā….
>
> *Nehe* (*Lipochaeta lobata*) is presently considered to be found in the wild as two distinguishable varieties (Wagner, Herbst, and Sohmer, 1990). *Lipochaeta lobata* var. *leptophylla* is a listed variety (Federal Register, 1991); The few remaining plants of *L. l.* var. *leptophylla* are located above Lualualei Valley but the known elevation range of this variety is well above the [proposed industrial park site]…. The lowland or coastal variety, *L. l.* var. *lobata* is not listed and not presently regarded for listing consideration.

Marsilea villosa or *ʻiliʻihi* is a small aquatic or semi-aquatic fern resembling a clover (Fig. [4]). The fern requires periodic flooding and drying of the ground to complete its short life cycle, and thus is confined to shallow basins subjected to brief periods of flooding during the wet season.

The following description is from the Recovery Plan for the *Marsilea villosa* as given by USFWS (undated):

"This fern requires periodic flooding for spore release and fertilization, then a decrease in water levels for the young plants to establish. It typically occurs in shallow depressions in clay soil, or lithified sand dunes overlaid with alluvial clay. All reported populations occur at or below 500 feet (150 meters) elevation. While *M. villosa* can withstand minimal shading, it appears most vigorous growing in open areas."

Figure 4. The fern, *Marsilea villosa* or *ʻiliʻihilauākea*, is an endangered species, here growing among grasses at Naval Transmitting Facility property at Lualualei.

Char (Char & Assoc., 1990) made a special effort to ascertain whether *ʻiliʻihilauākea* was present on the former proposed golf course site, particularly on parcels located across Lualualei Naval Road from the proposed industrial subdivision site that we recently surveyed. She was unable to locate this plant and we did not find either the fern or suitable habitat for this fern.

Avian Resources

The findings of the avian survey are consistent with the findings of a previous study conducted on the subject property (Berger 1990), and with at least three other avian surveys conducted in 2004, 2005 and 2007 on lands immediately adjacent to this site (David 2007), and with at least two other avian studies conducted in the general project vicinity in the recent past (David 2002, 2003). Given the highly disturbed nature of the site and the almost completely alien dominated vegetation present, it is not surprising that all avian species detected were commonly occurring lowland alien species.

The species list generated during the course of this survey is almost identical to that generated during course of the surveys conducted on the property to the immediate south of this site in 2004, 2005 and 2007 which is presented in David (2007).

Although not detected during the course of this survey, the 1990 survey of the site, or the 2004, 2005 and 2007 surveys of the adjacent property, it is likely that the Hawaiian endemic sub-species of the Short-eared Owl (*Asio flammeus sandwichensis*), or *pueʻo* as it is known locally, forages within the project site upon occasion (Berger 1990, David 2007). The Oʻahu population of this species is listed as endangered under State of Hawaiʻi endangered species statutes, it is not so listed under the federal endangered species act.

The habitat on site changes on such a regular basis due to anthropogenic alteration and fire that the site likely does not contain suitable nesting habitat for this species very often, if ever. From a *pueo's* perspective there is nothing unique about the habitat present on the project site. There are large areas of better foraging and nesting habitat within the Lualualei Branch of the Pearl Harbor Naval Ammunition Depot, located in close proximity to this site (David 2002, 2003). Clearing of the project site may temporarily disturb foraging *pueo*, though such activity is unlikely to result in an adverse impact to this species.

Mammalian Resources

The findings of the mammalian survey are consistent with the findings of a previous study conducted on the subject property (Berger 1990), and with at least three other mammalian surveys conducted in 2004, 2005 and 2007 on lands immediately adjacent to this site (David 2007), and with at least two other mammalian studies conducted in the general project vicinity in the recent past (David 2002, 2003).

Although no rodents were detected during the course of this survey, it is likely that the four established alien *muridae* found on Oʻahu, 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 project area. All of these

introduced rodents are deleterious to native ecosystems and the native faunal species that are dependant on them.

Potential Impacts to Critical Habitat

Any human presence is likely to enhance the prospects for fires, and during the dry season, fires arising from activities on this property could be very detrimental to endangered species growing on the high ridgelines forming the surrounding small valley. The following discussion concerning the nearby west-facing slope of Pu‘uheleakalā (from Guinther, 2007, p. 7-8) summarizes the problem:

> "The vegetation of the site is mostly grassland. The dry conditions and occasional fires tend to favor exotic grasses over native grasses, shrubs, and trees. Scrutiny of the satellite image… reveals a complex of fire roads cut into the steeper slopes to control the spread of fires that can occur with unfortunate regularity on leeward O‘ahu between about May and September of most years. Buffel grass dominates, and becomes self-preserving by increasing the intensity of fires that occur, itself capable of regrowing from basal stems when rains return (Hughes, Vitousek, and Tunison, 1991; Tix, undated, Latz, 1991). Native Hawaiian plants are not adapted to fire, and are gradually eliminated from areas subjected to repeated fires (Mueller-Dombois, 1981)."

Conclusions

From a native botanical, avian and mammalian perspective we found nothing precluding the clearing and development of the subject property. It is not expected that the modification of the habitat present on this site will result in any deleterious impacts to native botanical, avian or mammalian species.

Recommendations

The potential for starting a fire that would then spread upslope should be addressed as an issue for the construction contractor and for tenants of the industrial park. In general, this means developing fire breaks at the start of grading and having the ability on-site during construction to quickly address a fire if started.

We recommend that following build-out of the light industrial subdivision that a firebreak be maintained between the subdivision and the undeveloped grassy slopes in the back of the valley and/or that a green belt along the upland border of the development.

Glossary:

Alien – Introduced to Hawai‘i by humans.
Endemic – Native and unique to the Hawaiian Islands.
Indigenous – Native to the Hawaiian Islands, but also found elsewhere naturally.
mauka – Upslope, towards the mountains.
‘ōpe‘ape‘a – Hawaiian hoary bat.
pueo – Hawaiian endemic sub-species of the Short-eared Owl.
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.
Xeric – Extremely dry conditions or habitat.

DLNR – Hawaii State Department of Land & Natural resources.
ESA – Federal Endangered Species Act of 1973, as amended.
USFWS – United States Fish & Wildlife Service.

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APPENDIX E

Traffic Impact Analysis Report for the Proposed Nanakuli Industrial Park. Traffic Management Consultant, January 2010

TRAFFIC IMPACT ANALYSIS REPORT
FOR THE PROPOSED

NANAKULI INDUSTRIAL PARK

NANAKULI, HAWAII

TAX MAP KEY 8-7-09:02

PREPARED FOR

KIMURA INTERNATIONAL, INC.

JANUARY 29, 2010

PREPARED BY

TMC

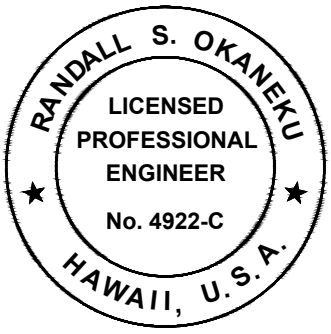
THE TRAFFIC MANAGEMENT CONSULTANT

TRAFFIC IMPACT ANALYSIS REPORT
FOR THE PROPOSED

NANAKULI INDUSTRIAL PARK

NANAKULI, HAWAII

TAX MAP KEY 8-7-09:02



TMC

THE TRAFFIC MANAGEMENT CONSULTANT

RANDALL S. OKANEKU, P.E., PRINCIPAL * 1188 BISHOP STREET, SUITE 1907 * HONOLULU, HI 96813

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TRAFFIC IMPACT ANALYSIS REPORT
FOR THE PROPOSED
NANAKULI INDUSTRIAL PARK
TAX MAP KEY: 8-7-9:02

I. Introduction

A. Project Description

Tropic Land, LLC proposes to develop an industrial park in Nanakuli, Oahu. The 96-acre site is identified as Tax Map Key: 8-7-9:02. The proposed Nanakuli Industrial Park will consist of approximately 33 lots, totaling 75 net acres. Figure 1 depicts the vicinity map and the site plan.

Formal access to the project site is located on Hakimo Road, through a property (TMK 8-7-10: 06), owned Tropic Land, LLC, which is situated between Hakimo Road and Lualualei Naval Access Road; and an easement from the U.S. Navy to cross Lualualei Naval Access Road. Tropic Land, LLC has reached an understanding with the U. S. Navy to use Lualualei Naval Access Road for the access to the proposed Nanakuli Industrial Park. Site access will be provided at a stop-controlled T-intersection with Lualualei Naval Access Road.

The proposed project is expected to be fully built out and occupied by the Year 2020. The Year 2020 is used as the study's planning horizon for the purpose of the traffic impact analysis.

B. Purpose and Scope of the Study

The purpose of this study is to analyze the traffic impacts resulting from the development of the proposed Nanakuli Industrial Park. This report presents the findings and recommendations of the study. The scope of this study includes:

1. Description of the proposed project.
2. Evaluation of existing roadways and traffic conditions.
3. Development of trip generation characteristics of the proposed project.
4. Analysis of the 2020 traffic conditions without the proposed project.

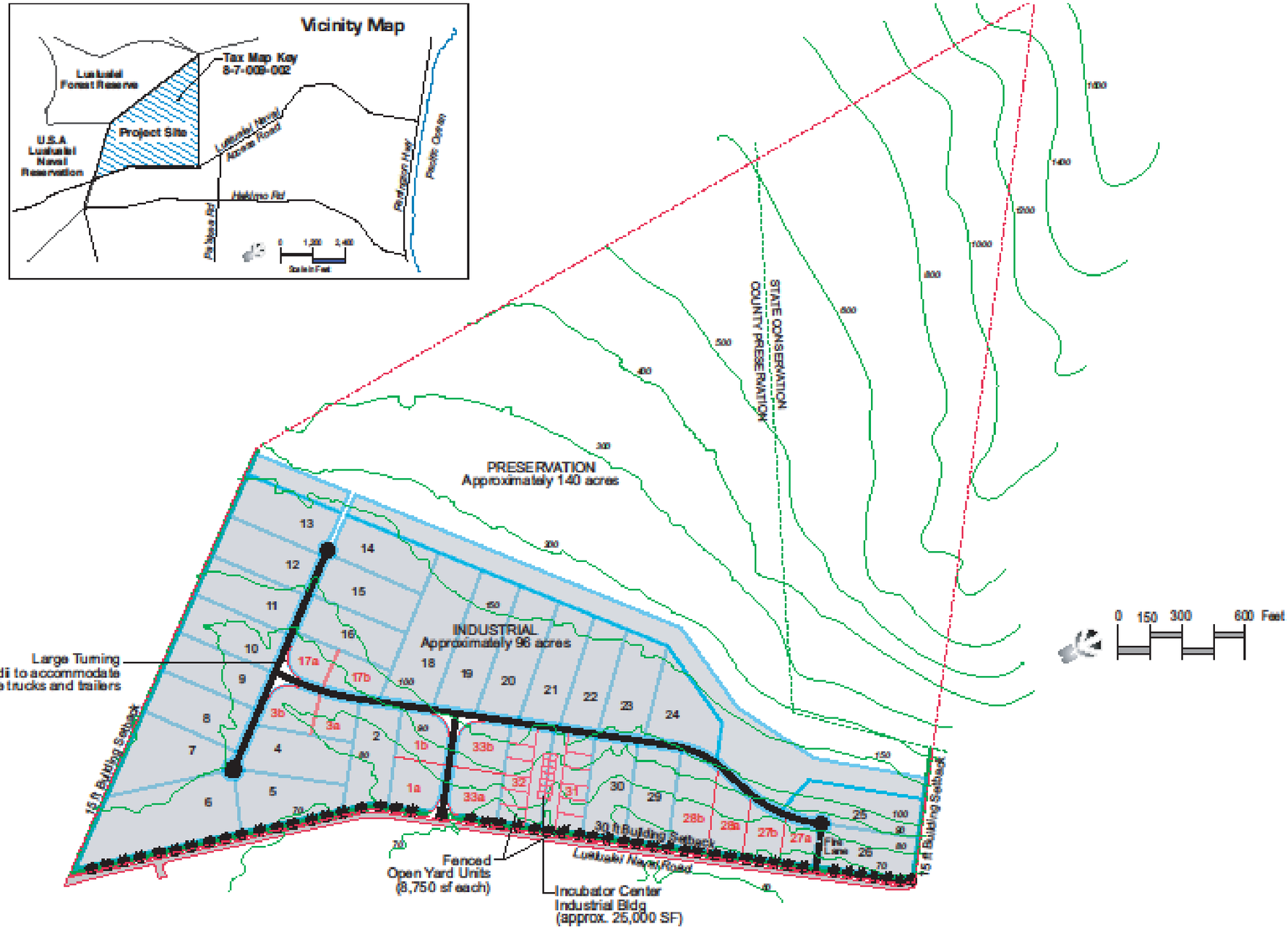

Figure 1. Site Plan and Vicinity Map

5. Identification and analysis of traffic impacts resulting from the development of the full build-out of the proposed project.

6. Recommendations of improvements, as necessary, that 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, 2000. HCM defines Level of Service (LOS) as "a quality measure describing operational conditions within a traffic stream". Several factors may be included 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. Intersection LOS is primarily based upon average delay, which is measured in seconds per vehicle (sec/veh). Table 1 summarizes the LOS criteria.

Table 1. Level of Service Criteria (HCM)

	Signalized Intersections	**Unsignalized Intersections**
LOS	Control Delay (sec/veh)	Control Delay (sec/veh)
A	≤ 10	≤ 10
B	> 10 – 20	> 10 – 15
C	> 20 – 35	> 15 – 25
D	> 35 – 55	> 25 – 35
E	> 55 – 80	> 35 – 50
F	> 80	> 50

"Volume-to-capacity" (v/c) ratio is a measure indicating 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 carrying capacity of the highway facility. Worksheets for the capacity analysis, performed throughout this report, are compiled in the Appendix.

2. Trip Generation Methodology

The trip generation methodology is based upon generally accepted techniques developed by the Institute of Transportation Engineers (ITE) and published in Trip Generation, 7th Edition. ITE trip rates are developed by correlating the total vehicle trip generation data with various activity/land use characteristics, such as the vehicle trips per hour (vph) per acre.

II. Existing Conditions

A. Roadways

Farrington Highway is the primary arterial highway on the Leeward coast of Oahu, which carries over 48,000 vehicles per day, total for both directions. Farrington Highway is a four-lane highway, which is oriented generally in the north-south directions. Farrington Highway is signalized at its intersection with Lualualei Naval Access Road. An exclusive left turn lane is not provided on southbound Farrington Highway at this intersection. The posted speed on Farrington Highway is 35 miles per hour (mph).

Lualualei Naval Access Road is a two-lane, two-way roadway, which provides access to the U. S. Navy Radio Transmitter Facility in Lualualei. The posted speed on Lualualei Naval Access Road varies between 25 mph and 45 mph.

B. Existing Peak Hour Traffic Volumes and Operating Conditions

1. Field Investigation and Data Collection

Manual traffic count surveys were conducted at the intersection of Farrington Highway and Lualualei Naval Access Road on May 1-2, 2008, during the peak periods of traffic – from 5:30 AM to 8:00 AM and from 2:30 PM to 5:00 PM. Additional surveys were conducted on Lualualei Naval Access Road at an existing base yard on the project site on July 21-22, 2008. The peak period traffic data are presented in the Appendix.

2. Existing AM Peak Hour Traffic

The AM peak hour on Farrington Highway selected for this analysis is from 5:45 AM to 6:45 AM, based upon the observed AM peak hour of traffic on Lualualei Naval Access Road. Farrington Highway carried about 2,800 vehicles per hour (vph), total for both directions. Lualualei Naval Access Road carried a total of 430 vph at Farrington Highway, during the existing AM peak hour of traffic. At the project site, the traffic volume on Lualualei Naval Access Road decreased to about 120 vph.

The intersection of Farrington Highway and Lualualei Naval Access Road operated at an overall Level of Service "D" with a v/c ratio of 1.12, during the existing AM peak hour. Southbound Farrington Highway operated at LOS "E". The left-turn movement from Lualualei Naval Access Road on Farrington Highway operated at LOS "F". Figure 2 depicts the existing AM peak hour traffic volumes.

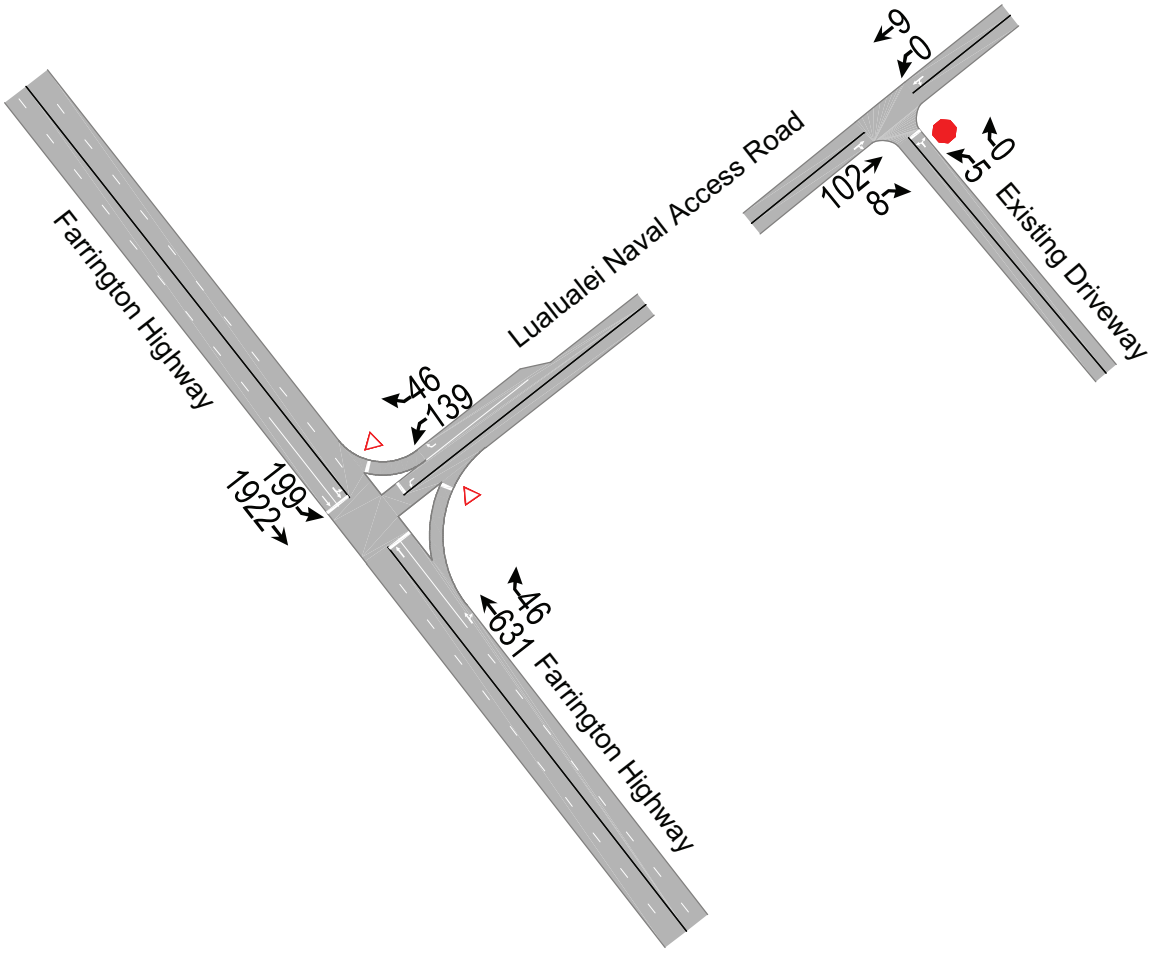

Figure 2. Existing AM Peak Hour Traffic (VPH)

3. Existing PM Peak Hour Traffic

The PM peak hour of traffic generally occurred between 3:15 PM and 4:15 PM. Farrington Highway carried about 3,500 vph, total for both directions. Lualualei Naval Access Road carried a total of over 500 vph, during the existing PM peak hour of traffic. At the project site, the traffic volume on Lualualei Naval Access Road decreased to about 100 vph.

During the existing PM peak hour of traffic, the shared through/left-turn lane on southbound Farrington Highway at Lualualei Naval Access Road operated as a de facto left-turn lane, according the HCM analysis, i.e., the delay on the left-turn movement resulted in the shared through/left-turn lane being used as an exclusive left-turn lane. The intersection of Farrington Highway and Lualualei Naval Access Road operated at an overall LOS "C" with a v/c ratio of 0.94. The left-turn movement from Lualualei Naval Access Road on Farrington Highway operated at LOS "D". The existing PM peak hour traffic volumes are depicted on Figure 3.

III. Future Traffic Conditions

A. Background Growth in Traffic

The Oahu Transportation Regional Plan 2030 (ORTP), was prepared for the Oahu Metropolitan Planning Organization (OMPO) in April 2006, and amended in May 2007. The Year 2030 socio-economic forecasts indicated about a one-half percent annual increase in population and employment on the Waianae coast. Based upon the ORTP socio-economic forecast, an annual growth of 0.55 percent was applied uniformly to the existing peak hour traffic to estimate the Year 2020 peak hour traffic demands without the proposed project.

B. Year 2020 AM Peak Hour Traffic Analysis Without Project

During the AM peak hour of traffic without the proposed project, traffic demands at the intersection of Farrington Highway and Lualualei Naval Access Road are expected to exceed the carrying capacity of the existing intersection, operating at an overall LOS "F" with a v/c ratio of 1.23. The southbound approach of Farrington Highway and the left-turn movement from Lualualei Naval Access Road are expected to operate at LOS "F". Figure 4 depicts the AM peak hour traffic without the proposed project.

C. Year 2020 PM Peak Hour Traffic Analysis Without Project

The PM peak hour of traffic demand without the proposed project is expected to exceed the existing carrying capacity of the intersection of Farrington Highway and Lualualei Naval Access Road, operating at LOS "D" with a v/c ratio of 1.01. Southbound Farrington Highway and the left-turn movement from Lualualei Naval Access Road are expected to operate at LOS "D". The PM peak hour traffic without the proposed project is depicted on Figure 5.

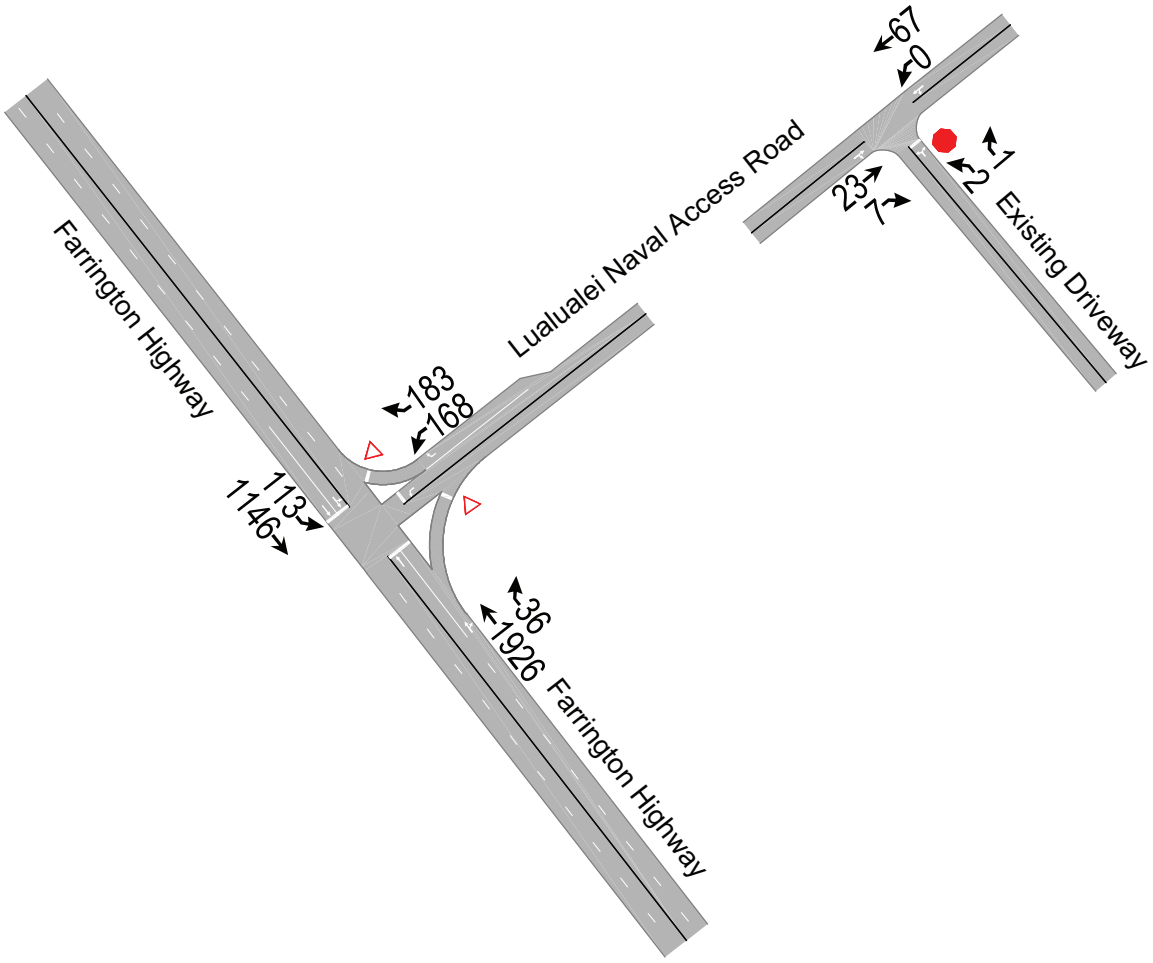

Figure 3. Existing PM Peak Hour Traffic (VPH)

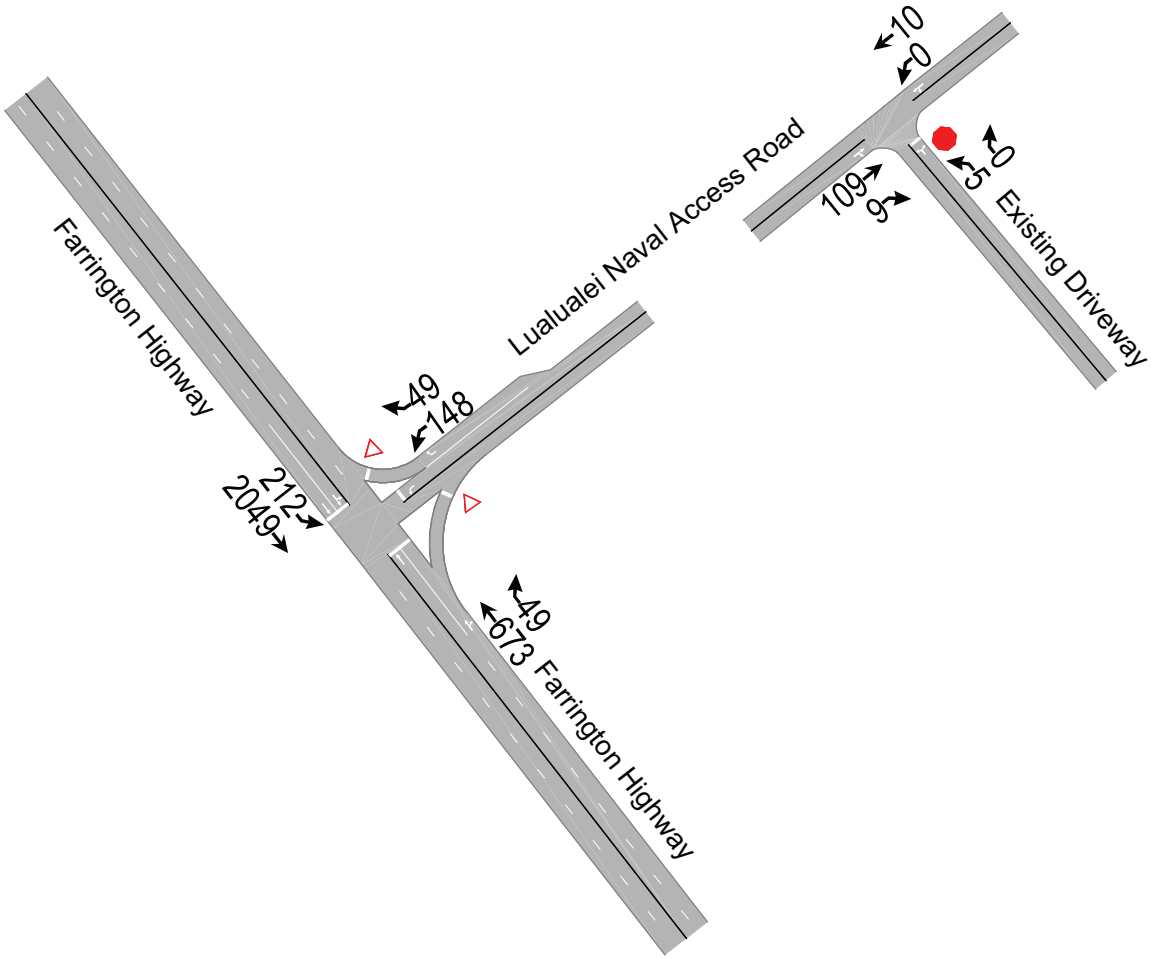

Figure 4. AM Peak Hour Traffic (VPH) Without Project

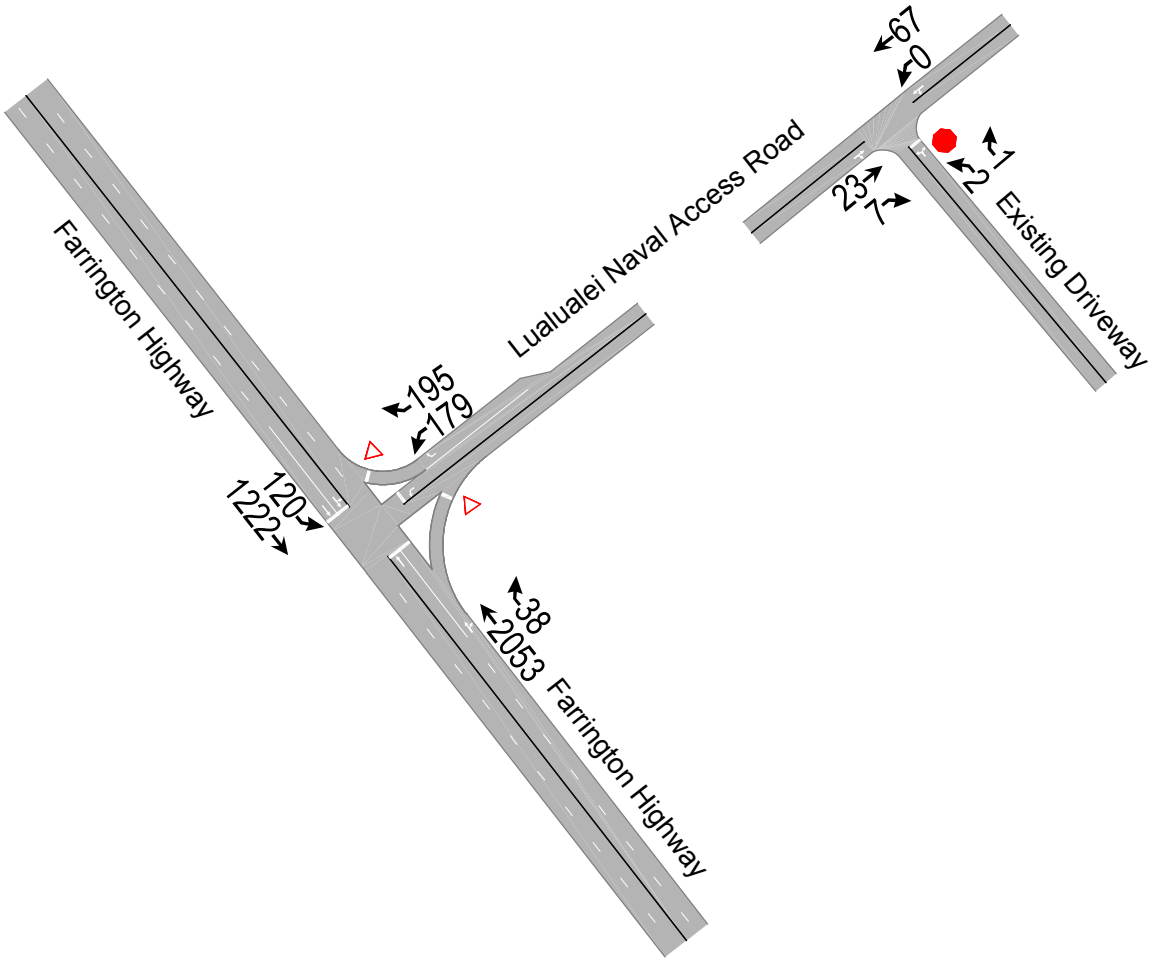

Figure 5. PM Peak Hour Traffic (VPH) Without Project

IV. Traffic Impact Analysis

A. Project Generated Traffic

1. Trip Generation Characteristics

The trip generation for the proposed 75-acre industrial park is based upon the ITE trip rates for an industrial park. During the AM peak hour of traffic, the proposed project is expected to generate a total of 522 vph – 433 vph entering the site and 98 vph exiting the site. The proposed project is expected to generate a total of 518 vph – 109 vph entering the site and 409 vph exiting the site, during the PM peak hour of traffic. Table 2 summarizes the trip generation characteristics.

Table 2. Trip Generation Characteristics

Land Use (ITE Code)	Peak Hour	Direction	Vehicle Trips/Hour
Industrial Park (130)	AM	Enter	433
		Exit	89
		Total	522
	PM	Enter	109
		Exit	409
		Total	518

2. Trip Distribution

The trip distribution is based upon the projected growth in the Ewa and Waianae regions. By the Year 2020, the population of the Ewa region is expected to exceed the Waianae region by a ratio of 3 to 1. Similarly, the employment in the Ewa region is expected to be 6.7 times that of the Waianae coast. Table 3 summarizes the traffic assignment splits during the peak hours of traffic.

Table 3. Traffic Assignment

Peak Hour	Direction	Northbound	Southbound
AM	Enter	75%	25%
	Exit	15%	85%
PM	Enter	85%	15%
	Exit	25%	75%

Figures 6 and 7 depict the AM and PM peak hour project-generated traffic assignments for the proposed project, respectively.

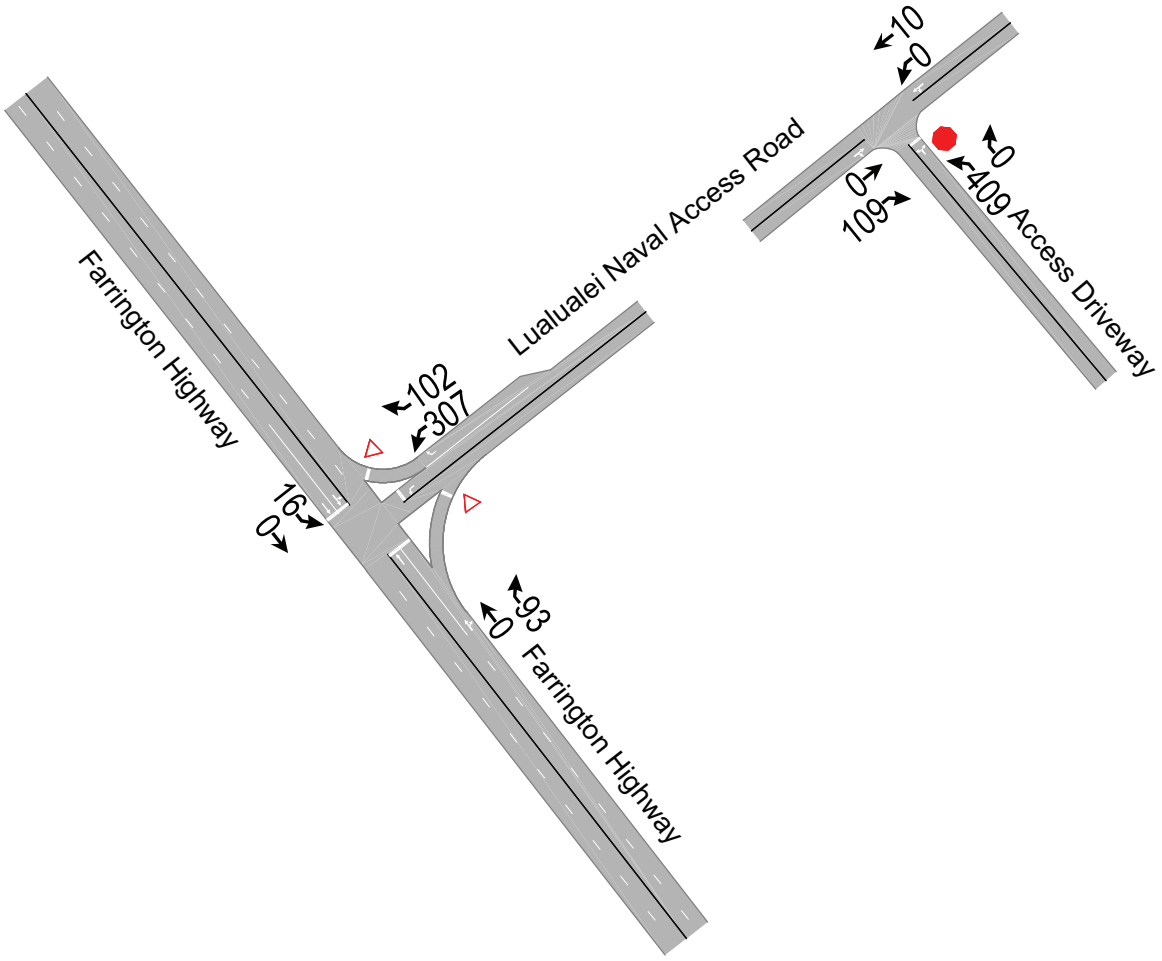

Figure 6. AM Peak Hour Traffic (VPH) Assignment

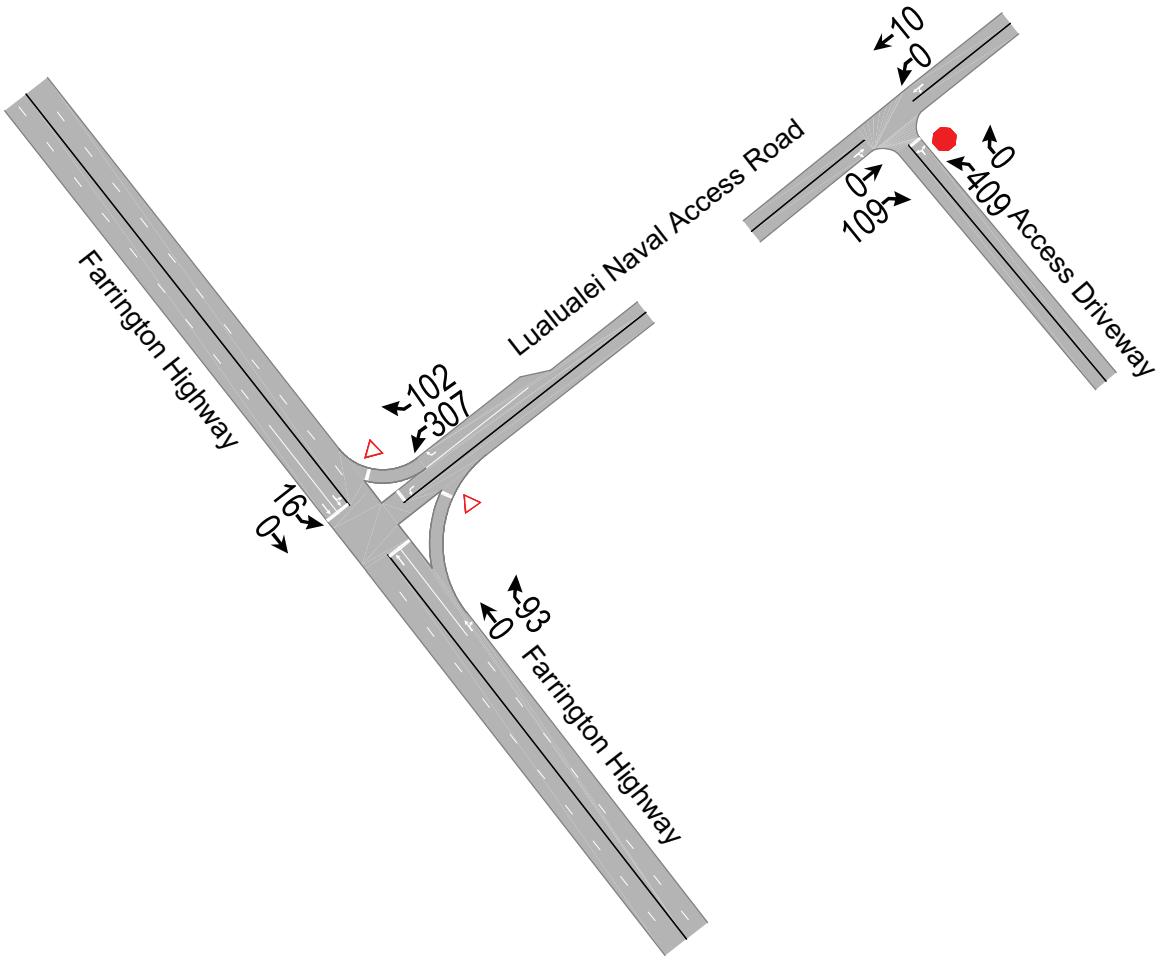

Figure 7. PM Peak Hour Traffic (VPH) Assignment

B. AM Peak Hour Traffic Impact Analysis With Project

Farrington Highway and Lualualei Naval Access Road is expected to operate at an overall LOS "F" and a v/c ratio of 1.86, during the AM peak hour of traffic with the proposed project. Southbound Farrington Highway and Lualualei Naval Access Road approaches are expected to operate at LOS "F". The Project Access Driveway is expected to operate at LOS "C" at Lualualei Naval Access Road. Figure 8 depicts the AM peak hour traffic with the proposed project.

C. PM Peak Hour Traffic Impact Analysis With Project

During the PM peak hour of traffic with the proposed project, the intersection of Farrington Highway and Lualualei Naval Access Road is expected to operate at LOS "F" with a v/c ratio of 1.39. Both Farrington Highway approaches and Lualualei Naval Access Road are expected to operate at LOS "F". The Project Access Driveway is expected to operate at LOS "B" at Lualualei Naval Access Road. The PM peak hour traffic with the proposed project is depicted on Figure 9.

V. Recommendations and Conclusions

A. Recommendations

The following traffic improvements, depicted on Figure 10, are recommended to mitigate the traffic impacts resulting from the proposed project:

1. Widen southbound Farrington Highway at Lualualei Naval Access Road to provide an exclusive left-turn lane (350 feet in length).

2. Widen Lualualei Naval Access Road at Farrington Highway to provide double left-turn lanes (350 feet in length) and an exclusive right-turn lane.

The proposed traffic mitigation would improve peak hour traffic operations at the intersection of Farrington Highway and Lualualei Naval Access Road from LOS "F" to LOS "C" and LOS "D", during the AM and PM peak hours of traffic, respectively.

B. Conclusions

The existing traffic congestion at the intersection of Farrington Highway and Lualualei Naval Access Road is a result of the traffic turning left from the shared through/left-turn lane on southbound Farrington Highway into Lualualei Naval Access Road. The left-turn movement reduces the through capacity of southbound Farrington Highway. During the existing PM peak hour of traffic, the shared left-turn/through lane on southbound Farrington Highway operated as a "default" exclusive left-turn lane, leaving only one through lane in the southbound direction. The traffic improvements, recommended herein, are expected to mitigate the traffic impacts resulting from the development of the proposed Nanakuli Industrial Park. Table 4 summarizes the traffic impact analysis of the project.

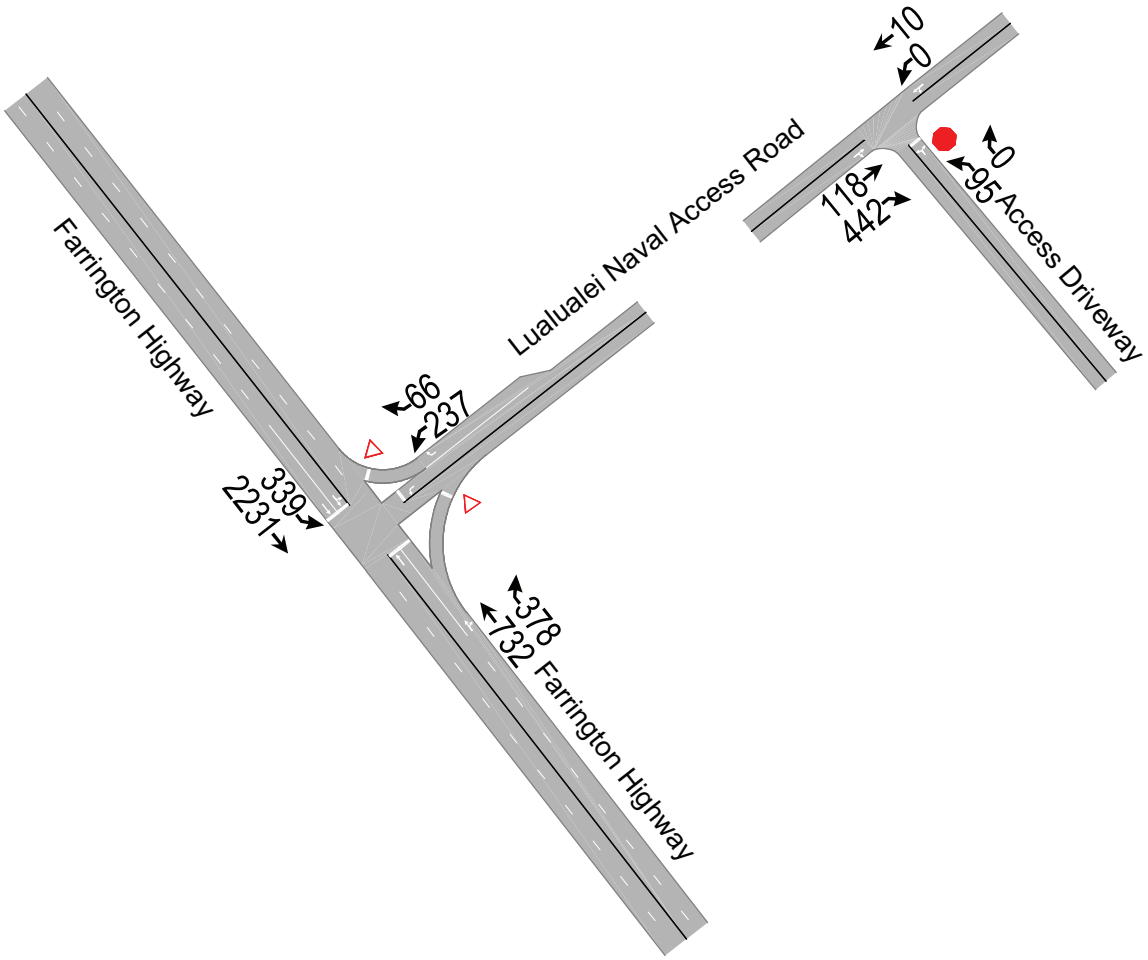

Figure 8. AM Peak Hour Traffic (VPH) With Project

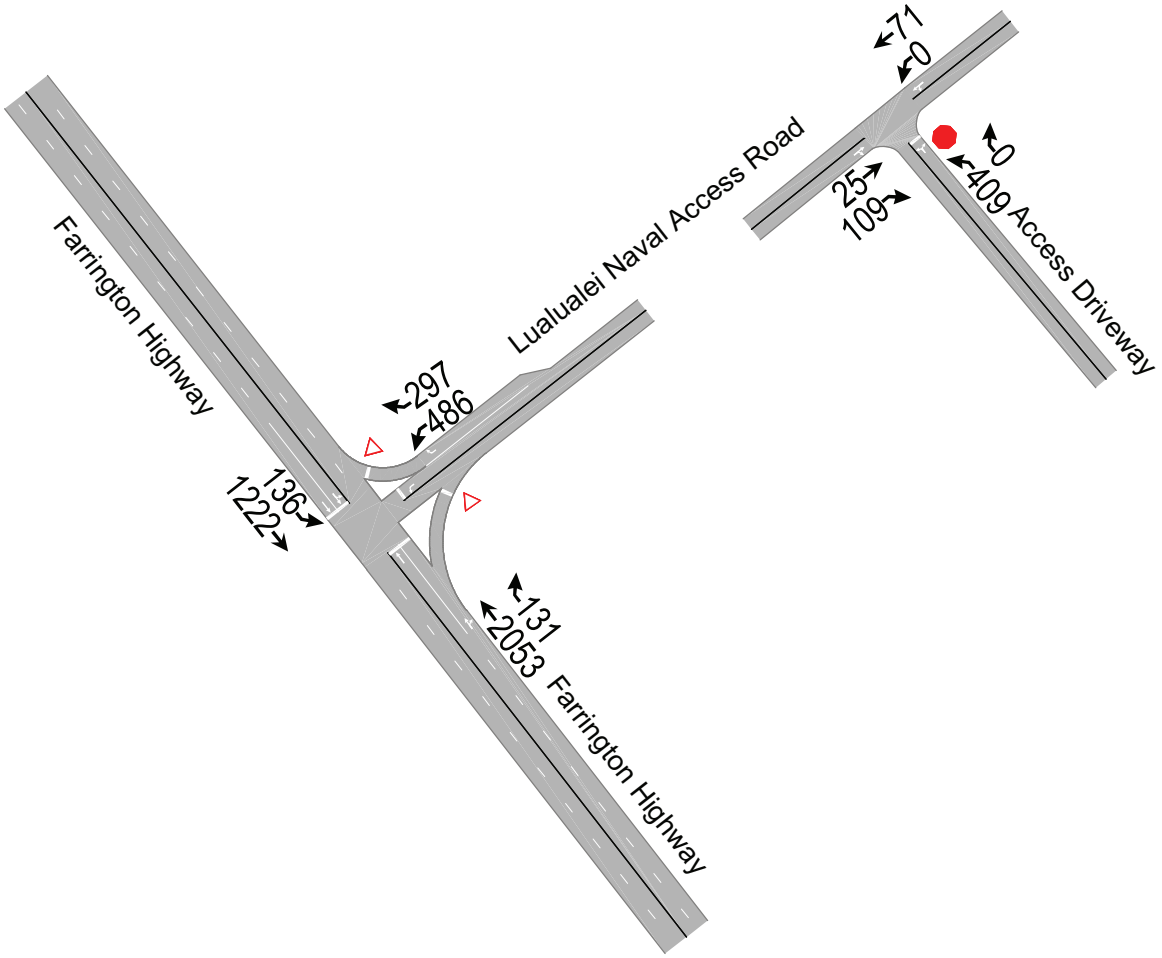

Figure 9. PM Peak Hour Traffic (VPH) With Project

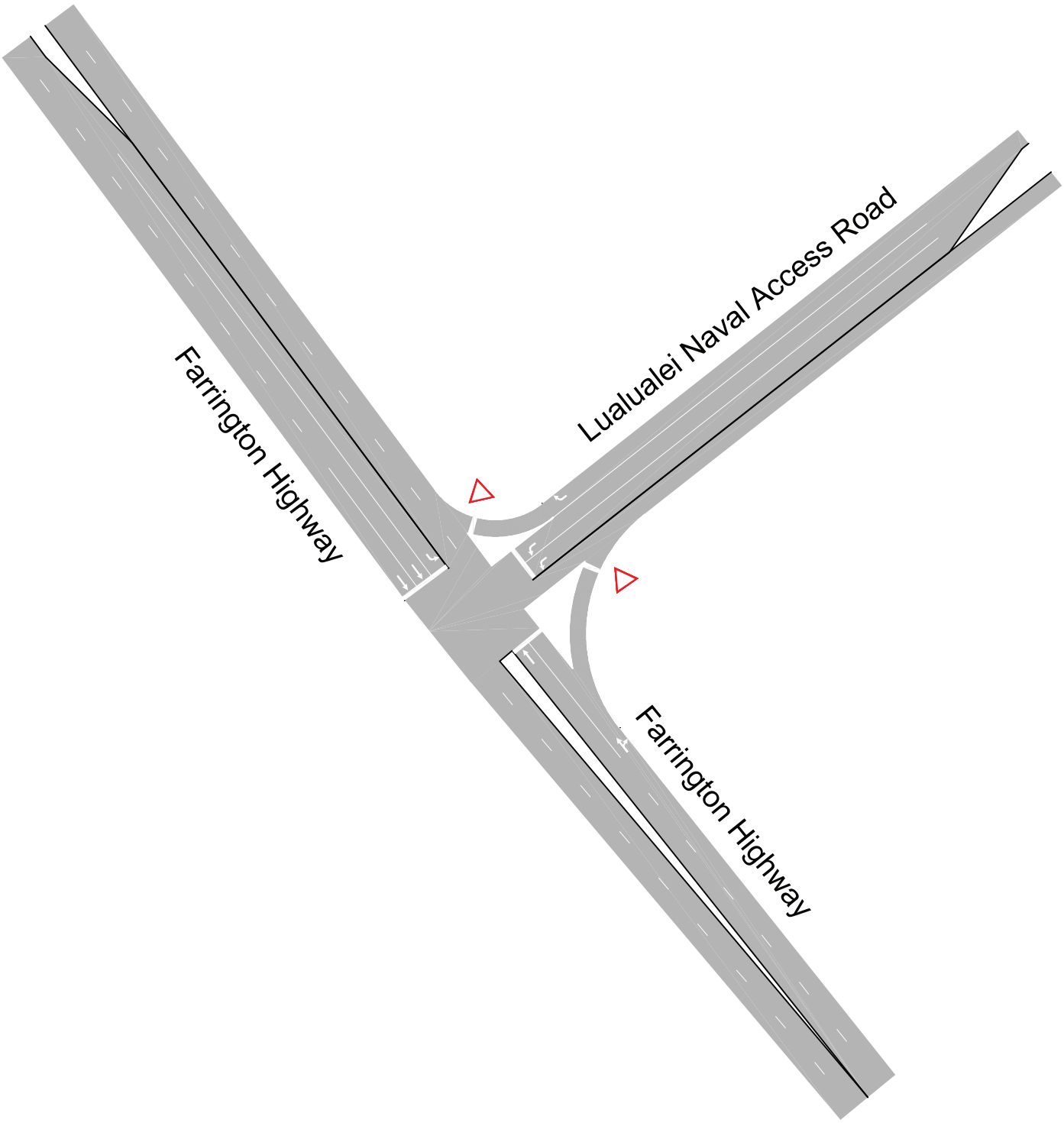

Figure 10. Intersection Improvements

Table 4. Capacity Analysis - Farrington Highway and Lualualei Naval Access Road									
Scenario		**MOE**	**SBT**	**SBL**	**NBT**	**NBR**	**WBL**	**WBR**	**Int.**
Existing AM Peak Hour Traffic		**LOS**	E		A		F	B	D
		v/c	1.12		0.37		0.79	0.23	1.12
		Delay	76.0		3.4		94.6	18.7	52.8
Existing PM Peak Hour Traffic		**LOS**	C	C	C		D	C	C
		v/c	0.67	0.95	0.92		0.73	0.59	0.95
		Delay	29.7	27.3	23.9		50.4	24.5	26.7
AM Peak Hour Traffic Without Project		**LOS**	F		A		F	B	F
		v/c	1.23		0.40		0.82	0.24	1.23
		Delay	125.6		3.6		98.3	18.3	84.0
PM Peak Hour Traffic Without Project		**LOS**	D	D	C		D	C	C
		v/c	0.81	1.01	0.95		0.76	0.66	1.01
		Delay	48.2	41.1	28.1		53.5	31.3	34.7
AM Peak Hour Traffic With Project	**Without Improvements**	**LOS**	F		A		F	C	F
		v/c	1.86		0.63		1.06	0.27	1.86
		Delay	408.1		6.3		136.8	21.9	237.3
	With Improvements	**LOS**	E	A	C		E	A	C
		v/c	0.88	0.71	0.84		0.61	0.10	0.88
		Delay	73.0	7.2	26.1		59.6	6.4	22.0
PM Peak Hour Traffic With Project	**Without Improvements**	**LOS**	F	F	F		F	D	F
		v/c	1.39	1.14	1.09		1.16	0.64	1.39
		Delay	245.7	100.4	82.4		136.6	43.1	97.2
	With Improvements	**LOS**	E	A	D		E	D	D
		v/c	0.82	0.52	1.00		0.95	0.70	1.00
		Delay	60.4	7.9	43.4		75.9	46.6	38.0

TRAFFIC IMPACT ANALYSIS REPORT
FOR THE PROPOSED

NANAKULI INDUSTRIAL PARK

NANAKULI, HAWAII

APPENDIX A

TRAFFIC COUNT DATA

TRAFFIC COUNT DATA **FILE NAME: Farrington Lualualei** Sec 3

PROJECT: Nanakilu Industrial Subdivision PERIOD: AM Peak
LOCATION: Nanakuli, Hawaii NORTH:
E-W STREET Lualualei Naval Access Rd TECHNICIAN: RSO
N-S STREET: Kamehameha Highway DATE: 5/2/08

		Lualualei Naval Access Rd						Kamehameha Highway							
TIME		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	TOTAL	HRLY
5:30	5:45	0	0	0	17	0	6	0	53	7	47	514	0	644	
5:45	6:00	0	0	0	27	0	9	0	88	12	51	516	0	703	
6:00	6:15	0	0	0	49	0	17	0	144	11	62	465	0	748	
6:15	6:30	0	0	0	32	0	11	0	146	6	38	486	0	719	2814
6:30	6:45	0	0	0	31	0	9	0	253	17	48	455	0	813	2983
6:45	7:00	0	0	0	25	0	14	0	218	27	26	477	0	787	3067
7:00	7:15	0	0	0	31	0	16	0	269	21	20	467	0	**824**	3143
7:15	7:30	0	0	0	44	0	17	0	264	3	25	400	0	753	**3177**
7:30	7:45	0	0	0	36	0	14	0	264	18	17	430	0	779	3143
7:45	8:00	0	0	0	42	0	18	0	229	24	28	454	0	795	3151
AM PEAK HOUR															
5:45	**6:45**	**0**	**0**	**0**	**139**	**0**	**46**	**0**	**631**	**46**	**199**	**1922**	**0**	**2983**	**2983**
PHF					**1.12**		**1.28**		**0.62**	**0.68**	**1.04**	**1.06**		**0.92**	**PHF**

TRAFFIC COUNT DATA **FILE NAME: Farrington Lualualei** Sec 3

PROJECT: Nanakilu Industrial Subdivision PERIOD: PM Peak
LOCATION: Nanakuli, Hawaii NORTH:
E-W STREET Lualualei Naval Access Rd TECHNICIAN: RSO
N-S STREET Kamehameha Highway DATE: 5/1/08

		Lualualei Naval Access Rd						Kamehameha Highway						
TIME		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	TOTAL	
14:30	14:45	0	0	0	48	0	44	0	312	18	26	338	0	786	
14:45	15:00	0	0	0	39	0	38	0	356	15	20	286	0	754	
15:00	15:15	0	0	0	38	0	31	0	438	13	31	303	0	854	
15:15	15:30	0	0	0	49	0	35	0	474	14	23	275	0	870	3264
15:30	15:45	0	0	0	51	0	55	0	455	8	33	310	0	**912**	3390
15:45	16:00	0	0	0	40	0	33	0	514	3	30	289	0	909	3545
16:00	16:15	0	0	0	28	0	60	0	483	11	27	272	0	881	**3572**
16:15	16:30	0	0	0	47	0	50	0	452	6	29	250	0	834	3536
16:30	16:45	0	0	0	31	0	59	0	430	5	28	256	0	809	3433
16:45	17:00	0	0	0	47	0	41	0	421	5	32	249	0	795	3319
PM PEAK HOUR															
15:15	**16:15**	**0**	**0**	**0**	**168**	**0**	**183**	**0**	**1926**	**36**	**113**	**1146**	**0**	**3572**	**3572**
PHF					**0.82**		**0.83**		**1.06**	**1.13**	**0.86**	**0.92**		**0.98**	**PHF**

TRAFFIC COUNT DATA **FILE NAME: Farrington Lualualei** Sec 3

PROJECT: Nanakilu Industrial Subdivision
LOCATION: Nanakuli, Hawaii
E-W STREET Lualualei Naval Access Rd
N-S STREET: Site Access

PERIOD: AM Peak
NORTH:
TECHNICIAN: RSO
DATE: 7/22/08

		Lualualei Naval Access Rd						Site Access							
TIME		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	TOTAL	HRLY
6:00	6:15	0	22	4	0	5	0	0	0	0	0	0	0	31	
6:15	6:30	0	21	2	0	1	0	3	0	0	0	0	0	27	
6:30	6:45	0	25	1	0	0	0	1	0	0	0	0	0	27	
6:45	7:00	0	34	1	0	3	0	1	0	0	0	0	0	39	124
7:00	7:15	0	9	1	0	3	0	2	0	0	0	0	0	15	108
7:15	7:30	0	11	0	0	0	0	0	0	0	0	0	0	11	92
6:00	**7:00**	**0**	**102**	**8**	**0**	**9**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**124**	**124**
PHF			**0.75**	**2.00**		**0.75**		**1.25**						**0.79**	**PHF**

TRAFFIC COUNT DATA **FILE NAME: Farrington Lualualei** Sec 3

PROJECT: Nanakilu Industrial Subdivision
LOCATION: Nanakuli, Hawaii
E-W STREET Lualualei Naval Access Rd
N-S STREET Site Access

PERIOD: PM Peak
NORTH:
TECHNICIAN: RSO
DATE: 7/21/08

		Lualualei Naval Access Rd						Site Access							
TIME		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	TOTAL	
15:00	15:15	0	5	1	0	5	0	1	0	0	0	0	0	12	
15:15	15:30	0	8	2	0	7	0	0	0	1	0	0	0	18	
15:30	15:45	0	5	2	0	31	0	2	0	0	0	0	0	40	
15:45	16:00	0	7	3	0	14	0	0	0	0	0	0	0	24	94
16:00	16:15	0	3	0	0	15	0	0	0	0	0	0	0	**18**	100
16:15	16:30	0	3	1	0	10	0	0	0	0	0	0	0	14	96
PM PEAK HOUR															
15:15	**16:15**	**0**	**23**	**7**	**0**	**67**	**0**	**2**	**0**	**1**	**0**	**0**	**0**	**100**	**100**
PHF			**1.15**	**0.88**		**0.54**		**0.25**						**0.63**	**PHF**

TRAFFIC IMPACT ANALYSIS REPORT
FOR THE PROPOSED

NANAKULI INDUSTRIAL PARK

NANAKULI, HAWAII

APPENDIX B

CAPACITY ANALYSIS WORKSHEETS

Lane Group	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations						
Volume (vph)	199	1922	631	46	139	46
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0			0	0	150
Storage Lanes	0			0	1	1
Taper Length (ft)	25			25	25	25
Satd. Flow (prot)	0	3522	3507	0	1770	1583
Flt Permitted		0.644			0.950	
Satd. Flow (perm)	0	2279	3507	0	1770	1583
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)			14			46
Link Speed (mph)		35	35		25	
Link Distance (ft)		592	801		431	
Travel Time (s)		11.5	15.6		11.8	
Peak Hour Factor	1.00	1.00	0.62	0.68	1.00	1.00
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	2121	1086	0	139	46
Turn Type	pm+pt					Perm
Protected Phases	1	6	2		8	
Permitted Phases	6					8
Detector Phase	1	6	2		8	8
Switch Phase						
Minimum Initial (s)	4.0	4.0	4.0		4.0	4.0
Minimum Split (s)	9.0	9.0	21.0		21.0	21.0
Total Split (s)	9.0	129.0	120.0	0.0	21.0	21.0
Total Split (%)	6.0%	86.0%	80.0%	0.0%	14.0%	14.0%
Yellow Time (s)	4.0	4.0	4.0		4.0	4.0
All-Red Time (s)	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	4.0	5.0	5.0
Lead/Lag	Lead		Lag			
Lead-Lag Optimize?						
Recall Mode	None	Max	Max		None	None
Act Effct Green (s)		124.0	124.0		14.8	14.8
Actuated g/C Ratio		0.83	0.83		0.10	0.10
v/c Ratio		1.12	0.37		0.79	0.23
Control Delay		76.0	3.4		94.6	18.7
Queue Delay		0.0	0.0		0.0	0.0
Total Delay		76.0	3.4		94.6	18.7
LOS		E	A		F	B
Approach Delay		76.0	3.4		75.8	
Approach LOS		E	A		E	
Queue Length 50th (ft)		~1258	113		134	0
Queue Length 95th (ft)		#1388	78		#237	41

Lane Group	SEL	SET	NWT	NWR	SWL	SWR
Internal Link Dist (ft)		512	721		351	
Turn Bay Length (ft)						150
Base Capacity (vph)		1899	2925		190	211
Starvation Cap Reductn		0	0		0	0
Spillback Cap Reductn		0	0		0	0
Storage Cap Reductn		0	0		0	0
Reduced v/c Ratio		1.12	0.37		0.73	0.22

Intersection Summary	
Area Type:	Other
Cycle Length: 150	
Actuated Cycle Length: 148.8	
Natural Cycle: 150	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 1.12	
Intersection Signal Delay: 52.8	Intersection LOS: D
Intersection Capacity Utilization 98.0%	ICU Level of Service F
Analysis Period (min) 15	

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Farrington Highway & Lualualei Naval Access Road