# Final Environmental Impact Statement

Prepared in Support of a Consolidated Application for Community Plan Amendment and Change in Zoning

**PROJECT ASSESSMENT APPICATION VOLUME III (Appendix D – Appendix I)**

## Applicant:

Maui R&T Partners, LLC
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## Prepared by:

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## Accepting Authority:

Land Use Commission
Department of Business, Economic Development & Tourism
State of Hawaii

**March 2013**

# MAUI RESEARCH & TECHNOLOGY PARK MASTER PLAN UPDATE

# FINAL ENVIRONMENTAL IMPACT STATEMENT

# FOR
# MAUI RESEARCH & TECHNOLOGY PARK
# MASTER PLAN UPDATE

## PREPARED IN SUPPORT OF A CONSOLIDATED APPLICATION FOR COMMUNITY PLAN AMENDMENT AND CHANGE IN ZONING APPLICATION

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APPENDIX D
Archaeological Inventory Survey

SCS Project Number 985-2

# AN ARCHAEOLOGICAL INVENTORY SURVEY OF MULTIPLE LAND PARCELS LOCATED WITHIN THE MAUI RESEARCH AND TECHNOLOGY PARK, *AHUPUA`A* OF WAIOHULI & KEOKEA, WAILUKU (KULA) DISTRICT, MAUI ISLAND, HAWAI`I [TMK: 2-2-24: 012 por., 014 por., 16 por., 17, and por. 54]


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## ABSTRACT

Scientific Consultant Services, Inc. (SCS) conducted Archaeological Inventory Survey of several undeveloped land parcels and one proposed easement in the "barren zone" of Kihei, Waiohuli and Keokea Ahupua`a, Wailuku District, Maui, Hawai`i at TMK:2-2-24:por. 012, por. 014, por. 16, 17, and por. 54. The total land area encompasses some 338-acres plus a small easement on property primarily owned by the Maui Research and Technology Park. The eastern portion of Parcel 054 (56 acres) is owned by Haleakala Ranch but is in the process of being transferred by sale to the Maui Research and Technology Park. The purpose of the Inventory Survey was to determine the presence/absence of architecture, midden deposits, and/or artifact deposits on the surface of the parcels and to assess the potential for the presence of subsurface cultural deposits.

A total of five sites were identified during the research, three occurring on 2-2-24: 017 por. and two sites occurring on TMK:2-2-24:054 por. The sites have been designated as State Site No. 50-50-10-6239 (modified outcrop; historic), Site No. 50-50-10-6240 (modified outcrop; historic), Site No. 50-50-10-6241 (boundary wall; traditional/historic), Site No. 50-50-10-6587 (L-shape military training feature), and Site No. 50-50-10-6588 (three mounds; traditional location markers). Subsurface testing was not conducted at the three sites on 2-2-24:017 por. due to the extremely shallow soil deposits, particularly within the documented sites themselves which occur over bedrock, and the modesty of cultural remains commonly found in the area. Testing was completed at the two sites identified on TMK:2-2-24:054 por. but no cultural materials were identified. All five sites have been assessed as significant under Criterion D. Save for orange protective fencing to be placed along the northern ridgeline boundary of TMK:2-2-24:017 por. to protect undocumented rockshelters occurring below in Waipuilani Gulch, no further archaeological work is recommended for this project area.

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# INTRODUCTION

Scientific Consultant Services (SCS), Inc. conducted Archaeological Inventory Survey on 338-acres of undeveloped land and one proposed easement in the "Barren Zone" above Kihei in Waiohuli and Keokea Ahupua`a, Wailuku District, Maui Island, Hawai`i [TMK:2-2-24:por. 012, por. 14, por. 16, 17, and por. 54] (Figures 1 through 4). Fieldwork was conducted on land primarily owned by the Maui Research and Technology Park; the eastern portion of TMK:2-2-24:054 por. in the project area (46-acre portion) is currently owned by Haleakala Ranch but in the process of transferring ownership to the Maui Research and Technology Park. The total land area of 338-acres consists of six variable-acreage parcels all associated with TMK:2-2-24:por. 14 (58.288 acres), 2-2-24: por. 16 (116.864), 2-2-24:17 (39 acres), and 2-2-24:por. 54 (124 acres). One easement, measuring 1,400 linear feet by 100 feet wide, was also surveyed per this research and occurs on TMK: 2-2-24:por. 012.

The purpose of Inventory Survey was to determine the presence/absence of surface architecture, midden deposits, and/or artifact deposits on the surface of the parcels through systematic pedestrian survey, to assess site functional and temporal affiliation through recordation and excavation (where possible), and to evaluate the significance of any identified historic properties. Fieldwork for this project was conducted by SCS in three phases over time: September 16-20 and September 23-25, 2006 by Ian Bassford, B.A.; November 19, 2006 and December 5 and 6, 2006 by project P.I. Michael Dega, Ph.D.; and September 18, 19, and 20, 2008 by Randy Ogg, B.A. and Guerin Tome, B.A.

To briefly summarize the results of the Inventory Survey, systematic survey of the "barren zone" project area led to the identification of five archaeological sites, which occurred on two of the six parcels subject to survey. The easement did not contain any sites. No areas thought to contain significant deposits in subsurface contexts were noted on any of the six parcels or the easement. Save for TMK:2-2-24:017 (39 acres) and TMK:2-2-24:054 por. (124 acres) (see Figure 1), all other parcels were void of sites and areas containing potential subsurface deposits. The results of note were gleaned through survey of TMK:2-2-24-:017, TMK: 2-2-24:054 por., and informal survey of Waipuilani Gulch, slightly beyond the southern boundary of TMK:2-2-24: por. 16. The first parcel contained two modified outcrops (historic era) and a wall (traditional/historic period). The second parcel contained an historic period L-shape and three rock mounds (traditional markers). In addition, the southern slope of Waipuilani Gulch was informally surveyed during the recording of Site -6241 and found to contain two

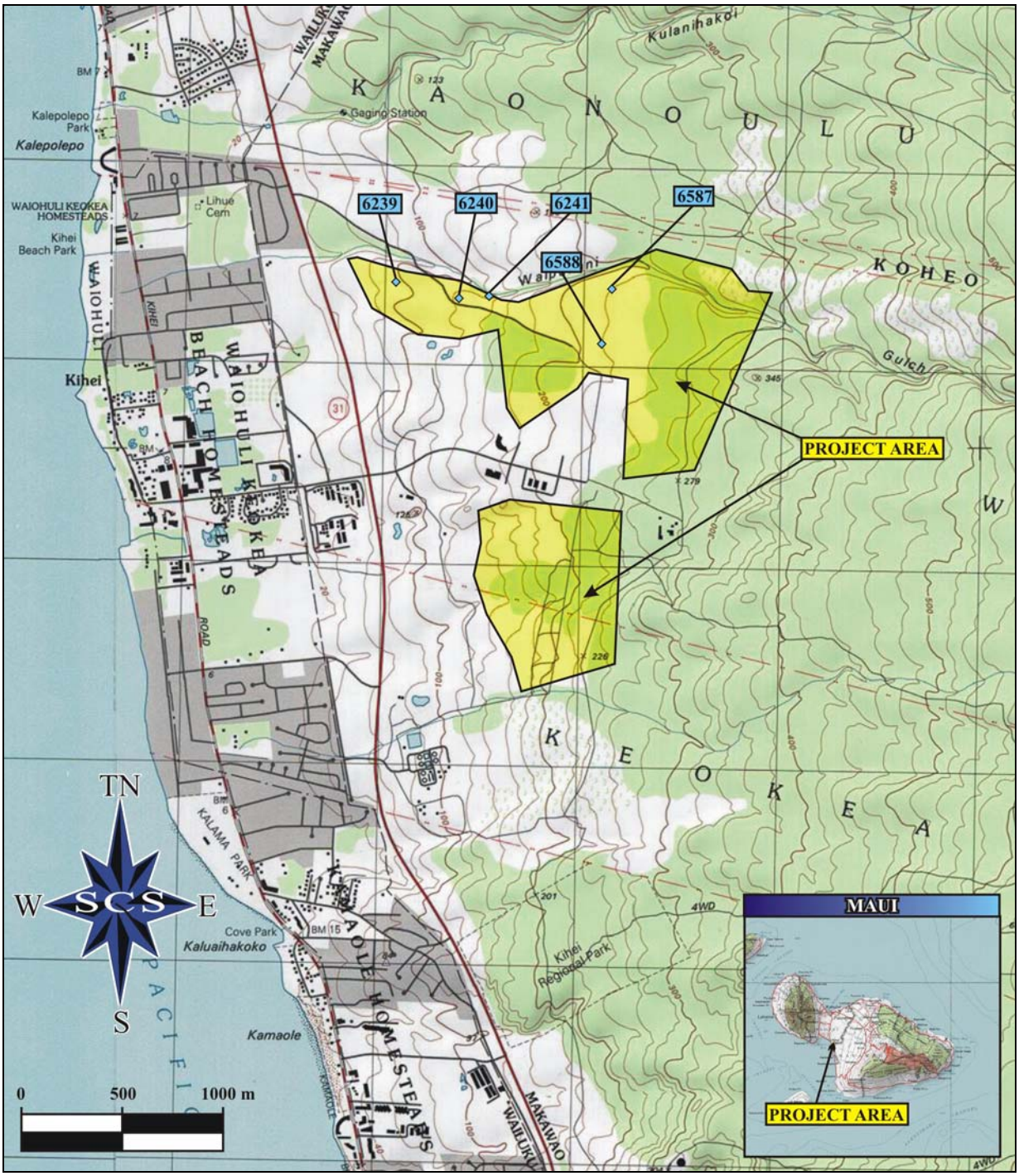


**Figure 1: USGS Map (Pu`u O Kali Quadrangle) Depicting Project Area.**

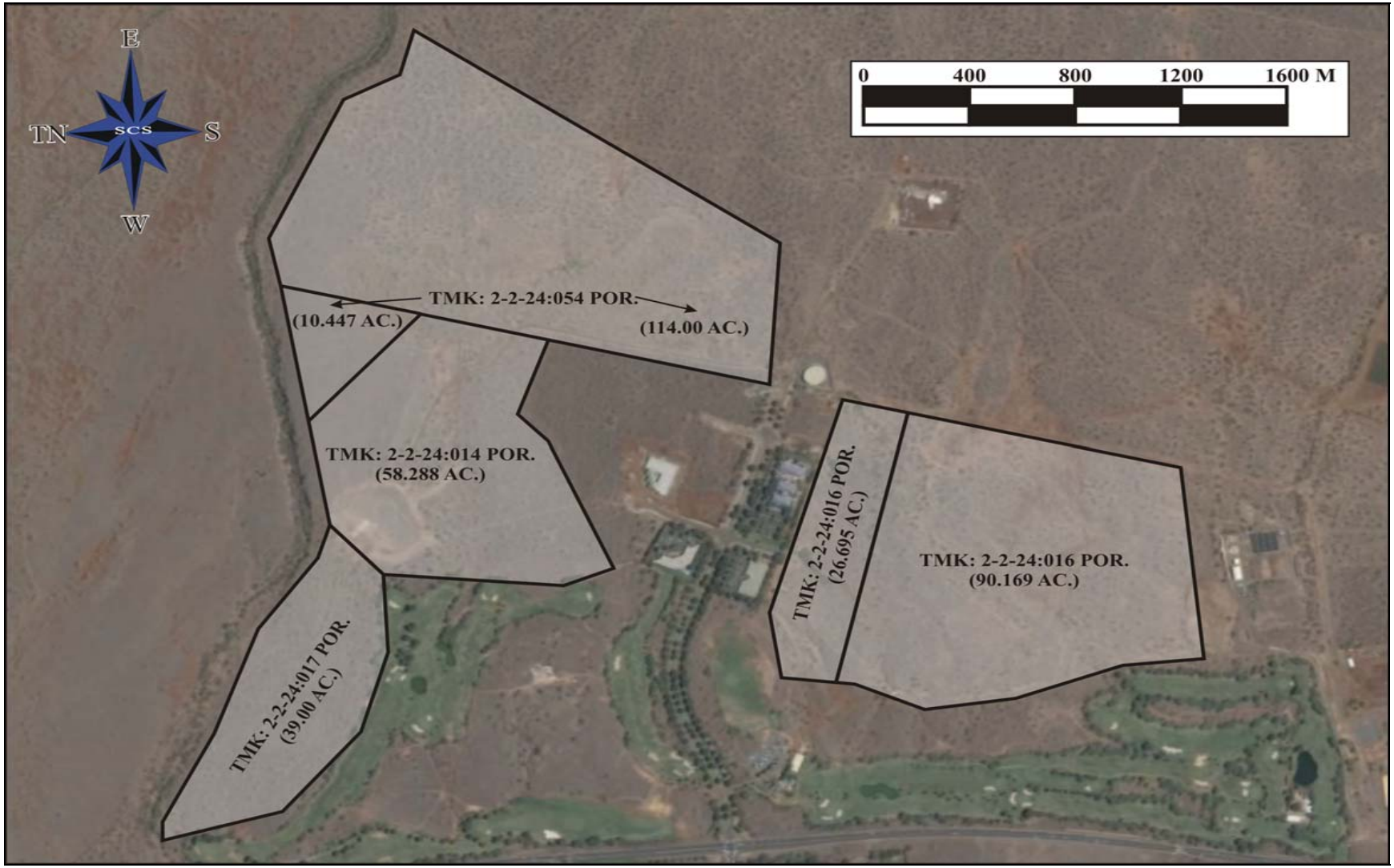


**Figure 2: Tax Map Key [TMK: 2-02-24] Showing Project Area.**

**Figure 3: Photographic Overview, Western Portion of Project Area. View to West.**

**Figure 4: Photographic Overview, Central Portion of Project Area. View to Northeast. Note: Former Borrow Pit Depression Center and Right Side of Frame.**

overhangs with several surface lithics. This site occurs beyond the boundary of the current project area and was not formally recorded. All are discussed in more detail below.

## ENVIRONMENTAL SETTING AND PROJECT AREA DESCRIPTION

The project area is located in Waiohuli and Keokea Ahupua`a, Wailuku District (the traditional district of Kula). The parcels are located approximately 1.5-2 km east (*mauka*) of the coastline at Waiohuli-Keokea Beach Homesteads, Kihei, a variable 40-260 feet above mean sea level (see Figure 1). Piilani Highway, the main thoroughfare in leeward East Maui, is located approximately 0.50 km west (*makai*) of the lowest portion of the project area. The southern flank of Waipuilani Gulch, a major landscape feature in this area, borders the northern portion of the project area. The six variable-sized parcels are generally bounded by Waipuilani Gulch to the north, portions of the Elleair Maui Golf Club to the west, and sections of the Maui Research and Technology Park and undeveloped land to the east (see Figure 2). Both the northern and southern portions of the project area are accessed via Lipoa Parkway.

Several unpaved roads and two-wheel tracks are located across many parts of the project area, particularly in the northern parcels. Grading activities are associated with certain sections of some of these roads and tracks. Multiple 'push piles' of boulders created by bulldozers or other mechanical means are located within many sections of the project area; these all appear to be modern landscape alterations. The 'push piles,' which are typically 1 to 2 meters high and 2 to 3 meters in diameter, often incorporate several large tree limbs and smaller trunks, clear evidence of their being 'push piles.' Small scatters of recent garbage and some concrete barricades are located throughout the parcels as well. Construction debris, junked cars, and other recently deposited debris are also common.

Geologically, the project area is located on the lowermost portion of the Kula Dissected Uplands, the vast network of leeward (western) slopes of the dormant Haleakala volcano that comprises East Maui. The Kula District is situated in the rain shadow of Haleakala. This general area of the current project is a gently sloping transitional landscape between the steeper volcanic highlands to the east and the narrow coastal strip to the west. The local topography is relatively flat with slight undulations, this presumably caused by uneven distribution of bedrock below shallow sediment sequences. There is a slight increase in slope to the east as the project area proceeds to more upland extents. More specific to the project area, low, rounded mounds and hillocks—the remnants of weathered basalt outcrops—are interspersed with shallow, ephemeral drainages and depressions.

Soils in the project area, defined as "extremely stony silty clay loam," are part of the Waiakoa Series of the central Maui uplands (Foote *et al*. 1972). These soils form on smooth, low uplands, and stones cover 3 to 15 percent of the ground surface. In most areas where this soil is present, approximately 50 percent of the surface layer has been eroded. Runoff levels are average and the erosion hazard is severe (Foote *et al*. 1972). For these reasons, soils in the project area are generally only utilized as pastureland and for wildlife habitat. Low bedrock outcrops are commonly associated with these soils, and cultivation is usually impractical unless the stones are removed. Importantly, soil profiles are extremely limited, typically to 20-30 centimeters or so below the surface, overlying bedrock. Testing during the current project confirmed the shallow matrices. Cultural deposits within these thin layers are typically only very modest, both quantitatively and qualitatively.

Annual rainfall in the project area—between 10 and 15 inches annually—is the lowest on Maui, making this region one of the driest in the Hawaiian Islands archipelago (Armstrong 1983). Daytime maximum temperatures, confirmed during fieldwork, range between 80 and 90 degrees Fahrenheit. At the time of the present survey, the subject parcel was exceptionally dry and dusty, consistent with a period of prolonged drought in the area. In fact, because of this combination of low rainfall and fairly unproductive soils, the general area in which the subject parcel is located has been labeled the "barren zone" (Cordy 1977), a characterization that has been supported by numerous archaeological surveys in the area (see below).

Vegetation is dominated by xerophytic flora including *kiaw*e, lowland shrubs, and grasses (see Figures 3 and 4). Plant species documented in the project area include: *kiawe* (*Prosopis pallida*), *haole koa* (*Leucaena leucocephala*), *'uhaloa* (*Waltheria americana*), balloon plant (*Asclepias physocarpa*), *pa`aila* (*Ricinus communis*), Golden crown-beard (*Verbesina encelioides*), and *ilima* (*Sida fallax*). Various grasses, small (unidentified) weedy plants, and decorative flowers near current buildings and the golf course complete the floral inventory.

## HISTORICAL BACKGROUND OF THE PROJECT AREA

While Kula is an arid region, a considerable population existed along its seashore—where fishing was excellent—and on the lower slopes of Haleakala at elevations high enough (at least 1,000 feet above mean annual sea level) to support dryland cultivation and sustainable habitation. There is no evidence, oral or written, of taro farming in this dry "barren zone" area; the sweet potato, or *`uala*, "was the staple of life here" (Handy and Handy 1972:511).

In the uplands of the Kula district, at elevations higher than *c.* 1,000 feet above mean annual sea level, traditional agriculture was based on dryland field systems. Handy and Handy (1972:488) write:

> The great bulk and altitude of Haleakala makes its southern flank practically a water less desert, and the southeast and west flanksrelatively dry, so that there were no *lo`i* (pond fields) cultivation at all. The arid country below the west and south slopes of Haleakala, including Kula, Honua`ula, Kahikinui, and Kaupo, were dependent on sweet potato.

Handy and Handy (1972:131) also describe the planting methods in the drier sections of Kula:

> Where potatoes are planted in crumbling lava with humus, as on eastern Maui and in Kona, Hawaii, the soil is softened and heaped carelessly in little pockets and patches using favorable spots on slopes the crumbling porous lava gives ample aeration without much mounding.

At lower, drier elevations, in the so-called barren zone, agriculture was a relatively minor component of the traditional subsistence economy. The modest range of the subsistence economy also reflected occupation in the area: temporary, on a recurrent basis through time. As is discussed below, it is only within more recent times that permanent occupation was been sustained within the barren zone.

The fact that few references to Kula district are found in traditional sources is likely an accurate reflection of its relative importance compared to the often-cited and better-known districts of Hana, Lahaina, Wailuku, and other population centers on Maui. Most references to Kula are minimal even when describing important battles and their participants. Other references allude to the difficulties of living in the fairly harsh environment of the lower Kula region. During a drought in the time of Kihaa Pi`ilani (*c.* A.D. 1500–1600s), people in this area were forced to subsist on weeds such as *laulele*, *pualele*, and *popolo* (Kamakau 1961). They could restore their crops only by obtaining potato slips from neighboring districts. However, sustained settlement did occur on the Kula slopes over time. By the 15$^{th}$ century, for example, large settlements were appearing in upcountry Kula and the building of religious temples flourished (Kolb *et al*. 1997; Dega *et al*. 2007).

Early historical accounts and archaeological evidence suggest that the barren zone, in which the subject parcel is situated, was a transitional area in which people moved resources between the coast and the uplands to heights of over 1,000 feet (above mean annual sea level). Large, permanent settlements—with clusters of habitations, *heiau,* petroglyphs, and large agricultural terraces and garden enclosures—have been documented in the uplands of Kula, above the 30-inch annual rainfall line (Kolb *et al.* 1997; Dega *et al*. 2007). Fishponds (three at Kalepolepo) and coastal *heiau* indicate a relatively sizable coastal population relying on marine resources. Both the uplands and the coast were settled or utilized by at least A.D. 1200, if not earlier, and trails linking these areas, and crossing through the barren zone, have been identified in Waiohuli and Keokea (Kolb *et al.* 1997). This intermediate zone, the barren zone, was not subject to the population growth seen in more upland or near coastal reaches; the barren zone has a unique character.

Although relatively general and of varying quality, early accounts of explorers, travelers, and missionaries can shed some light on traditional land use and lifestyles in the project area. Eight years after Captain James Cook's initial arrival, La Perouse sailed up the western coast of East Maui and stopped at Keone`o`io. La Perouse was greeted by 120 Native Hawaiians, who offered "…hogs, potatoes, bananas…taro, with cloth and some other curiosities…" (La Perouse 1798:345). He also noted that this part of the island was hot, dry, and rough, with soil "…wholly composed of lava and other volcanic matter" (La Perouse 1798). Water was scarce and the villagers drank from a shallow, brackish well.

Vancouver recorded his impressions of the southern and western coasts of Maui during his second visit in 1793:

> …the part we were abreast of [east of Pohakueaea Point] at day-light in the morning, though terminating very abruptly in the ocean, and though its surface was very uneven, had yet a verdant and fertile appearance, and was seemingly in an advanced state of cultivation. From the number of villages and distinct houses, we were let to consider it as tolerably well inhabited [Vancouver 1884:850].

Cultivation of Irish potatoes in the Kula district began shortly before 1840, after which time Kula became known as "the potato district" because of its great success in their cultivation. During Kula's peak potato producing period of the 19$^{th}$ century, dryland gardens in the uplands extended all the way from Kula to Kaupo. Corn was also planted in large upland concentrations, albeit during more recent times (A. Chun, Personal Communication). The resulting deforestation

adversely affected the amount of rainfall in the district and periods of drought became more common (Kolb *et al.* 1997). The *Honolulu Advertiser* describes the changes to Kula and the Kihei area:

> Before 1850 Kula was supplied with moisture naturally through the existence of a large forest. That forest was cut down when land was cleared in Kula to open farm plots in 1850. This was in answer to the demand for food in California during the gold rush… [and] by ranchers clearing for pasture. A secondary result of clearing forests was destruction of existing fresh water ponds in Kihei on the Maalaea Bay coast below Kula. When forest was cleared, water was free to rush down the mountains carrying soil from Kula and filling with mud the ponds for which Kihei was once famous [1962: A15].

Ranching was also present in Kula prior to the 1840s (Land Court Awards, State Archives). Large sections of Crown Land were leased for grazing cattle, and, by the 1880s, lower Kula consisted primarily of pasture land for ranching. Archaeological evidence of ranching is present near the subject parcel (see below). In 1888, Edwin H. Baily, Lorrin A. Thurston, W.H. Baily, and Henry P. Baldwin met in Honolulu and purchased Maui ranch lands owned by Charles Alexander for $50,000. The resulting ranch included 33,817 acres with 400 to 500 acres set aside for corn cultivation. The land in and around the project area was historically used for ranching activities by Haleakala Ranch Company.

The current study area does not contain Land Commission Awards (LCA), which typically implies that the land was not formally settled at the time of the *Great Māhele* (1848). Again, this aligns with the 'barren zone' model of settlement in that it was not a primary habitation area due to the dearth of natural resources (water, soil, etc.). Part of the subject parcel was, however, a portion (*apana* 1) of Royal Grant 9325 to Haleakala Ranch Company, Waiohuli-Keokea, Kula (Kihei), Maui.

Twentieth century activities in the Kula District included a significant World War II military presence along the beach of Ma`alaea Bay, a combat demolition training station at Kama`ole, two naval air stations at Pu`unene and Kahalui, and Army camps and hospitals in the Kula and Makawao areas. In particular, small, low walls and C-shaped rock formations—used as fighting positions by gunners—are documented as occurring near the project area (see McGerty *et al*. 2000).

## PREVIOUS ARCHAEOLOGICAL RESEARCH AND SETTLEMENT PATTERN

Multiple studies have been conducted adjacent to the current project area in association with development of the Maui Research and Technology Park and the Elleair Maui Golf Club (Hibbard 1994; Chaffee *et al.* 1997; McGerty *et al.* 2000; Sinoto *et al.* 2001; Tome and Dega 2002; Dega 2003; Monahan 2004). Before describing these studies, it is first necessary to present a general picture of the landscape in which these studies were conducted.

### THE "BARREN ZONE"

Decoding what is meant by the term "barren zone" is an important for assessing site predictability and survey results. By knowing the characteristics of the term, explanation as to the presence/absence of archaeological sites and site types is more evident in previous studies.

In geographical and physiographical terms, the barren zone is an intermediary zone between direct coastline and backbeach areas to upland forests. This medial zone appears to have been almost exclusively transitory, or at best, intermittently occupied. Intermittent habitation loci, as defined by surface midden scatters or small architectural features (i.e., C-shapes, alignments) dominate the few documented site types in the area through time. Divisive within an inland-coastal dichotomy, the barren zone was a necessary area to access more productive upland regions and the coastline. Apparently, agricultural endeavors were practically non-existent in the barren zone and tool procurement materials (basalt, wood) were selected from other locales as well. Sediment regimes in the area are shallow, most often overlying bedrock, and perennial water sources are virtually non-existent.

Cordy (1977) has taken the dichotomous model a bit further, particularly for this region, and has divided the Kihei (inclusive of Kama`ole) area into three environmental zones (or subzones when one considers the entire *ahupua`a*): coastal, transitional/barren, and inland. The current project area would occur in the transitional or barren zone: the slopes back of the coast with less than 30" annual rainfall (Cordy 1977:4). This barren zone is perceived as dry and antagonistic to permanent habitation. Use of the area would primarily have been intermittent or transitory, particularly as the zone could have contained coastal-inland trails and would have marked an intermediary point between the two more profitable ecozones. The region remains hostile to permanent habitation, only having been "conquered" in recent times through much modern adaptation (air conditioning, water feed systems, etc.).

Based on general archaeological and historic research, the barren zone was not subject to permanent or expansive population (until recently). This intimates that population pressure

along the coast was minimal or non-existent in the Kihei coastal area through time. As such, architectural structures associated with permanent habitation sites and/or ceremonial sites are not often identified in the area. The prevailing model that temporary habitation-temporary use sites predominate in the barren zone has been authenticated further by recent research.

As interestingly noted by Hammatt and Shideler (1992:10), "what is particularly striking in the many archaeological reports on Kihei is the general paucity of sites within the transitional or barren zone." Cordy (1977), Walton (1972), and Cox (1976) all conducted large-scale survey in this zone that led to the recordation of only small, temporary habitation or temporary use sites. Several other studies in this zone of Kama`ole Ahupua`a, including those conducted by Mayberry and Haun (1988) and Hammatt and Shideler (1990), also only revealed the presence of temporary habitation/temporary use loci.

McDermott (2001:100) states that site densities are typically quite low within the "barren zone" with multiple studies having been conducted on large parcels (Kennedy 1986, Watanabe 1987, Hammatt and Shideler 2000, Kikiloi *et al*. 2000) that did not lead to the identification *any* prehistoric sites. However, military sites related to WWII training exercises have been previously in the area (McGerty *et al*. 2000), these sites often consisting of low, short alignments or walls. The few radiocarbon dates acquired from the area indicate definitive use of the landscape in later prehistory c. A.D. 150-1600+.

As may be gleaned from this praxis of the barren zone, site expectation and site density is low for the area. Even large-scale surveys at times have failed to document sites of any time period in this dry area. Coupled with forms of modern land use (construction, infrastructure, and bulldozing activities), the sites identified in this zone become much more significant.

## PERTINENT RESEARCH WITHIN AND NEAR THE MAUI RESEARCH AND TECHNOLOGY PARK—CURRENT PROJECT AREA

SCS and others have more recently conducted numerous projects in the immediate area of the present project area parcels. The location of this work is noted in Figure 5 (below, following project descriptions) and summarized below.

As noted above, several studies have been conducted nearby, in association with development of the Maui Research and Technology Park and the Elleair Maui Golf Club (Kennedy 1986; Hibbard 1994; Chaffee *et al.* 1997; McGerty *et al.* 2000; Sinoto *et al.* 2001; Tome and Dega 2002; Dega 2003; Monahan 2003) (see Figure 5).

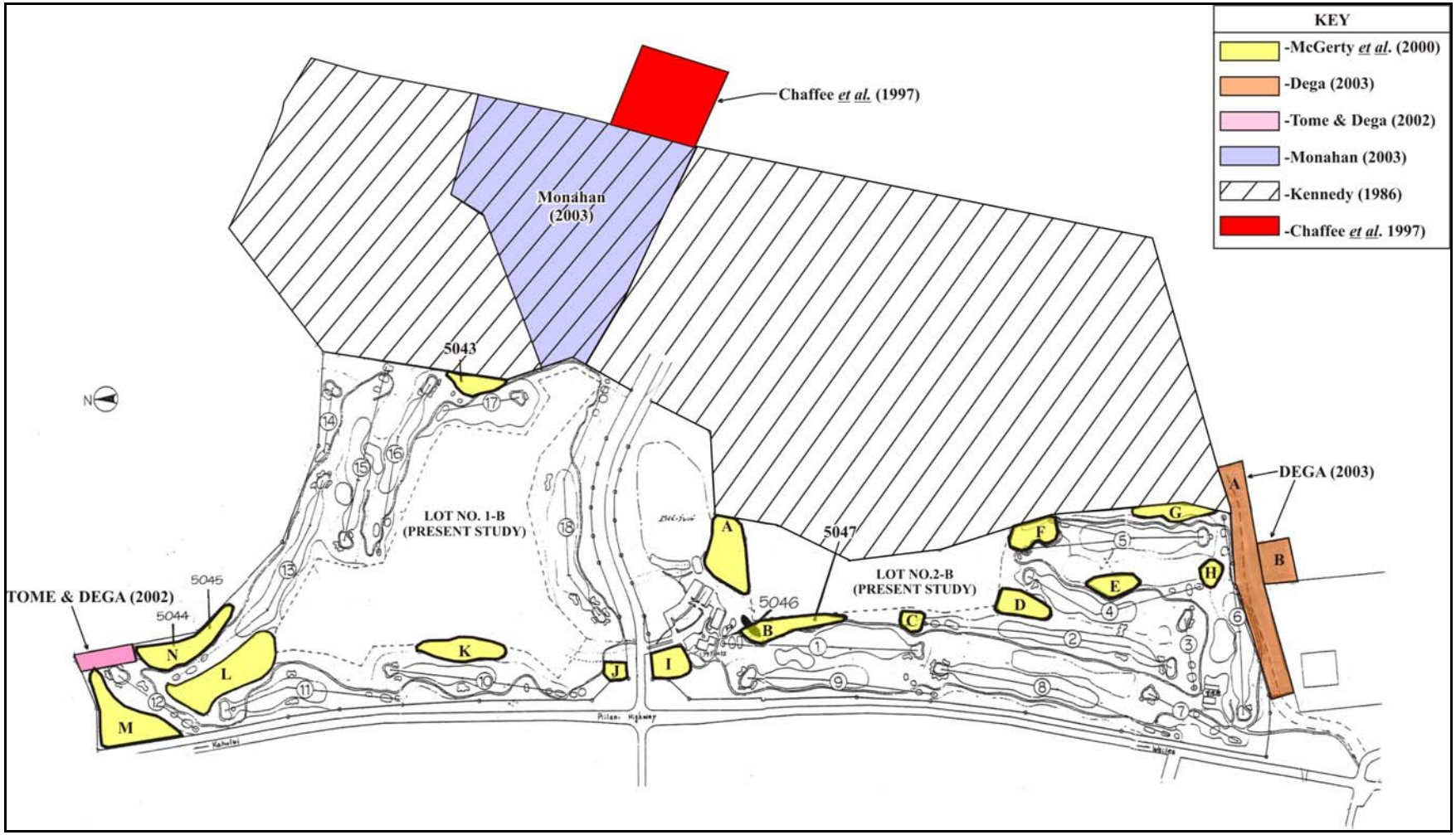


**Figure 5: Previous Archaeological Studies Conducted in the Immediate Vicinity of the Project Area.**

Kennedy (1986) conducted an archaeological reconnaissance of the entire 150.032 acres of the then-proposed Maui Research and Technology Park (TMK:2-2-02, since changed to 2-2-24) (see Figure 5). Kennedy's study, which did not include subsurface testing (excavation), concluded that no archaeological sites or features were located within the proposed site. The study area corresponds with much of the landscape studied herein.

Chaffee *et al*. (1997) conducted Archaeological Inventory Survey, inclusive of subsurface testing (excavation), in a portion of the Maui Research and Technology Park formerly investigated by Kennedy (1986). Three sites consisting of ten archaeological features were identified. The features included remnant terraces, stone alignments, a mound, and a modified outcrop. All of the sites were interpreted as agricultural in function with the exception of a rock mound that may have functioned as a religious feature.

Monahan (2003) conducted an Archaeological Inventory Survey, including subsurface testing (excavation), of a 28.737-acre portion of the Maui Research and Technology Park, within the area investigated by Kennedy (1986), situated immediately upslope (*mauka*) of Lot No. 1-B (present project area). Other than one surface feature—a small arrangement of stacked boulders interpreted as a 'push pile,' this survey yielded no evidence of historic or prehistoric significance.

Theresa Donham conducted an archaeological reconnaissance of the Haleakala Greens Subdivision area (Hibbard 1994). She identified a low, circular rock mound, a historical site with multiple features on the crest of a prominent ridge, a linear rock mound or wall remnant, a rock-filled terrace outlined with a low, rock wall, and other modifications along a rock outcrop. Shell midden was observed on the surface inside an enclosure.

McGerty *et al.* (2000) surveyed fifteen selected areas within the Elleair Maui Golf Club, and identified five archaeological sites (State Site Nos. 50-50-10-5043, -5044, -5045, -5046, and -5047) containing a total of seven surface features. The surface features were interpreted as agricultural terraces, perhaps dating from the pre-Contact period, and C-shaped rock formations (fighting positions) built during World War II training. Ten excavation units placed within these features yielded no cultural material.

Sinoto *et al*. (2001) conducted an Archaeological Inventory Survey of a parcel adjacent to the subject property. No archaeological or historical sites or features were identified.

Tome and Dega (2002) conducted an Archaeological Inventory Survey along the northeastern flank of the Elleair Maui Golf Club property. This survey occurred just to the west of the current project area. They identified a historical ranching corral and a short agricultural wall, collectively designated State Site No. 50-50-10-5233. No other structures or subsurface deposits were identified. No traditional Native Hawaiian sites or features were identified. Another Inventory Survey along the southern flank of the Elleair Maui Golf Course (Dega 2003) failed to yield any archaeological or historical site or features.

Finally, Scientific Consultant Services (SCS), Inc. conducted an Archaeological Inventory Survey (Monahan 2004) on two undeveloped lots totaling approximately 56.647 acres near the Elleair Golf Course in Kihei, Waiohuli and Keokea Ahupua`a, Wailuku (Kula) District, Kihei, Maui Island, Hawai`i [TMK: 2-2-24: Portion 12 and 13]. The project area immediately borders several parcels under the concern of this Inventory Survey. Pedestrian survey and subsurface testing (hand excavation) were performed in advance of a proposed residential project near the Elleair Golf Course by Betsill Brothers Construction, Inc. Four surface features—consisting of stacked basalt stones—were located within the project area, and each of these was assigned a separate State Site Number.

Test excavations yielded buried cultural material consistent with traditional Native Hawaiian activities at three of the four sites (Sites 50-50-10-5506, -5507, and -5509). Excavation at the fourth site (-5508)—a C-shaped rock pile consistent with a World War II military training feature—did not yield any subsurface evidence. The discovery of three traditional Native Hawaiian sites in this area is significant, as previous studies have generally failed to document any such activity. One of these sites (-5509) yielded a modern radiocarbon date (0$\pm$50 BP), but its context is questionable and it may not refer to the (probably older) buried artifacts. Two other sites (-5506 and -5507) failed to yield datable material, although both contained buried traditional artifacts and midden. No additional archaeological work was recommended in the project area (Monahan 2004).

In summary, previous archaeological research has documented a fairly limited degree of human settlement in the Kihei barren zone, of which the subject parcel is a part. Archaeological Inventory Surveys in and around the subject parcel, some of which included subsurface testing, have yielded a modest amount of evidence of both historical and traditional human activities. These include: agricultural terraces, possibly dating to the pre-Contact period, C-shaped rock formations interpreted as World War II-era training features, and a historical ranching corral and a short agricultural wall. It is noteworthy to add that no formal survey has been completed

within the Waipuilani Gulch drainage, which would presumably yield additional pre-Contact, temporary habitation sites beyond those noted herein.

## EXPECTED FINDINGS

Given several factors—previous archaeological findings in the area, geographic location and known natural resources, and historical land use patterns in the area—expected findings of this Inventory Survey were as follows:

(1) There was a relatively low probability of finding pre-Contact evidence of traditional Native Hawaiian habitation loci (permanent settlement). Short-term or temporary camps might be discovered, perhaps associated with natural rock outcrops that occur throughout the area.

(2) Traditional agricultural features, such as rock-stacked terraces used to level the gentle slope, might also be found, especially in association with the natural rock outcrops.

(3) There was a relatively low probability of finding traditional Native Hawaiian burials due to the extremely stony and shallow soils in the area.

(4) There was a good chance of finding historical structures, such as rock walls, ranching corrals, or World War II-era rock formations.

## METHODOLOGY

The entire c. 338-acre project area composed of the six separate parcels was subject to systematic pedestrian survey at various times by SCS field crew members I. Bassford, B.A., M. Dega, Ph.D., Guerin Tome, B.A., and Randy Ogg, B.A. Pedestrian survey of the parcels was conducted by crew members walking north-south transects at 10-15 m intervals. Ground surface visibility was generally excellent through the project area which allowed for greater interval spacing of transects. Surface grasses were slightly higher in the northwestern portion of the project area (see Figure 3). Survey was conducted in October through December, 2006 and in September, 2008. The purpose of survey was to identify and document all historical and/or archaeological features across the landscape. All identified surface features were identified, described, and mapped in accordance with standard archaeological procedures. Photographs were taken of each phase of fieldwork as well as project area overviews and identified features. Two sites were manually tested (-6587, -6588) as part of the research. The other three identified sites were not tested due to perceived lack of associated soil matrix (they were constructed primarily on bedrock) and known function.

Laboratory work, conducted at SCS facilities in Honolulu, consisted of digitally drafting maps and sketches, and digitizing of all photographs and maps for archival purposes. All documentation pertaining to this project is curated at SCS facilities in Honolulu.

## RESULTS

Full pedestrian survey of all six parcels and one easement lead to the identification of five archaeological sites which have been formally designated as State Site No. 50-50-10-6239, 50-50-10-6240, 50-50-10-6241, 50-50-10-6587, and 50-50-10-6588. All first three sites were identified on the peninsula-shaped, 39-acre parcel [TMK:2-2-24:017] while the latter two sites were identified on the 124-acre parcel [TMK:2-2-24:054 por.] (see Figures 1 and 2). No traditional structures, scatters, or deposits were identified on four of the other six survey areas or in the easement. In addition, on the four parcels and easement which did not yield surface architecture or midden/artifact scatters, no areas thought to potentially yield cultural materials in subterranean contexts were identified. Features that most often have survived this barren landscape are related to WWII training exercises, once ubiquitous in the area. Three of the sites (-6239, -6240, -6587) have been interpreted to relate to such training. A brief listing of the descriptions and results for each of the six variable acreage survey areas and the easement follows.

**TMK:2-2-24:016 (90.169 ACRES)**

One modern rock alignment was identified on this parcel, amidst numerous examples of modern landscape modification. The combination of landscape work and dry conditions allowed for excellent ground visibility. The alignment was composed of a single-course and extended 4 m long on a north-south axis. The field investigator (I. Bassford) assessed alignment construction, the lack of soil around the alignment, and adjacent landscape work and suggested this remnant to have been caused by mechanical blade push, the latter creating the aligned nature of the rocks. The alignment was deemed modern in origin. No other features were identified on this parcel. As noted above, landscape modification in the form of mechanical clearing lines (through blade and backhoe) was prevalent across the parcel, a symptom of neighboring infrastructure and fire clearance work in this dry zone locale. Typical for the “barren zone”, sedimentation was minimal and there were no areas thought to yield cultural deposits through testing.

**TMK:2-2-24:016 (26.695 ACRES)**

No surface architecture nor midden or artifact deposits were identified on this parcel. Ground visibility was good. No areas readily amenable to testing in hopes of recovering cultural deposits were identified. Contemporary landscape modifications were also common on this parcel.

**TMK:2-2-24:054 (10.447 ACRES)**

No surface architecture nor midden or artifact deposits were identified on this smaller parcel (Note: This 10-acre portion was divided out of the larger 054 parcel for administrative purposes by the client). Ground visibility was also good. No areas that could have potentially contained subterranean cultural deposits were identified. Landscape modifications were common on this parcel, as they were across most of the project area.

**TMK:2-2-24:014 (58.288 ACRES)**

No surface architecture nor midden or artifact deposits were identified on this parcel. Ground visibility was fair-good. No areas plausibly containing subsurface cultural deposits were identified. Landscape modifications in the form of mechanical blading, dirt road work, and digging several small borrow pits were present on the parcel.

**TMK:2-2-24:054 (114.00 ACRES)**

The largest of the parcel's surveyed for this project, the 114-acres forms the easternmost boundary of the project area. While recent landscape modifications were common and took the form of mechanized work (dirt roads and such), several intact sites were identified in the western portion of the parcel. Ground visibility was good in this survey area, with some ground surface covered by thin grasses. Over-story was sparse in this area.

A total of two sites were identified on this parcel: an L-shape and three rock mounds appearing in fairly linear fashion (see Figure 1). Both of the sites were present in the western portion of the parcel, and most of the component features were constructed over outcrops. As exhibited during testing of these two sites, soil matrices were very shallow, extending to a maximum 0.22 meters below the surface (mbs).

**SITE 50-50-10-6587**

This site was identified in the western portion of the parcel at c. 95 feet above mean sea level. Occurring on a small knoll (5 feet high) over exposed bedrock, the site consisted of one feature, an L-shaped structure (Figures 6 and 7). The site measures 2.9 m long, 1.6 m wide, and rises to a variable 0.18-0.58 m above the slightly undulating outcrop surface. Oriented on a

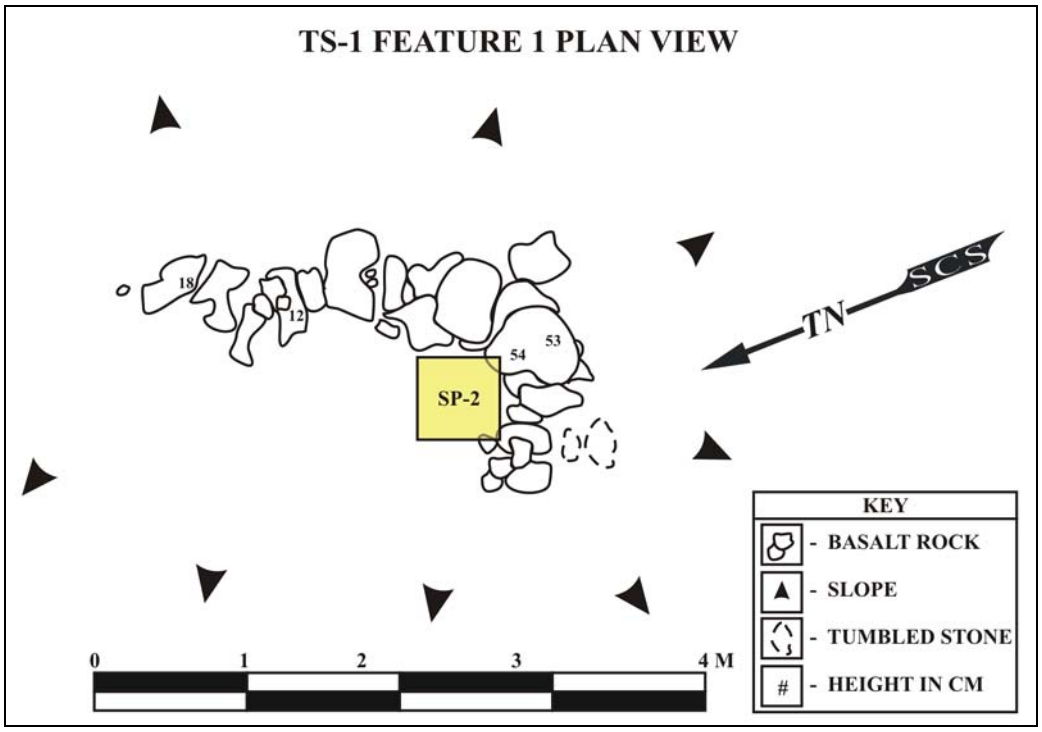


**Figure 6: Plan overhangs with several surface lithics. This site occurs beyond the boundary of the current project area and was not formally recorded. All are discussed in more detail below.iew Map of Site -6587.**

**Figure 7: Photograph of Site -6587. View to Southeast.**

northeast/southwest axis at 20º/200º, the site was comprised of underlying outcrop with three courses of roughly stacked cobbles and few boulders. The slight L-shape occurred in the southwestern portion of the small feature.

No artifacts or midden deposits were identified on the site's surface and no standing or faced areas were present on the structure. The site was interpreted as an L-shaped feature constructed during WWII times when training was conducted in the area. The site location could have served as a gun placement or observation area during training exercises. One unit was excavated in the feature to further explore its temporal and functional roots. The unit, however, did not yield a excess of information.

Test Unit 2 (TU-2)

TU-2, a 0.50 by 0.50 m unit, was placed on the interior of the feature at the crux of the L-shape arm and remainder of the feature, against architecture (Figure 8). Excavation revealed one sedimentary layer, occurring above bedrock (Figure 9). The unit also revealed that the feature was solely constructed on the surface, no portions of the L-shape protruding into subsurface contexts. Layer I (0-20 mbs) was composed of dark yellowish brown (10YR 3/4) silt with moderate structure. Abundant micro roots and some macro roots were present, as well as common small cobbles (non-modified). No cultural materials were identified in the test unit. Excavation terminated on bedrock.

**SITE 50-50-10-6588**

This site was identified to the south-southwest of Site 6587, also in the western portion of the parcel at c. 90 feet above mean sea level. Occurring on a slightly larger knoll (15-20 feet high) over exposed bedrock, the site consisted of three features: three semi-rounded rock mounds (Figures 10, 11, and 12). The overall site measures 11.0 m long by 1.8 m wide, with each feature rising to a variable 0.12-0.60 m above the slightly undulating surface terrain. The site is oriented on a northwest/southeast axis at 152º/332º, with the three similar rock mounds occurring in a fairly linear fashion about the knoll. The Feature 1 mound is present at the apex of the knoll, with the Features 2 and 3 mounds occurring only several feet away, at a lower elevation, down the knoll. All features were constructed primarily on exposed bedrock. The linear fashion of the arranged features is suggestive of their function being related to direction-location markers. Surface materials included the recovery of aluminum cans appearing to have been recently deposited (past 10 years).

**Figure 8: Photograph of Site -6587, TU-2. View to East.**

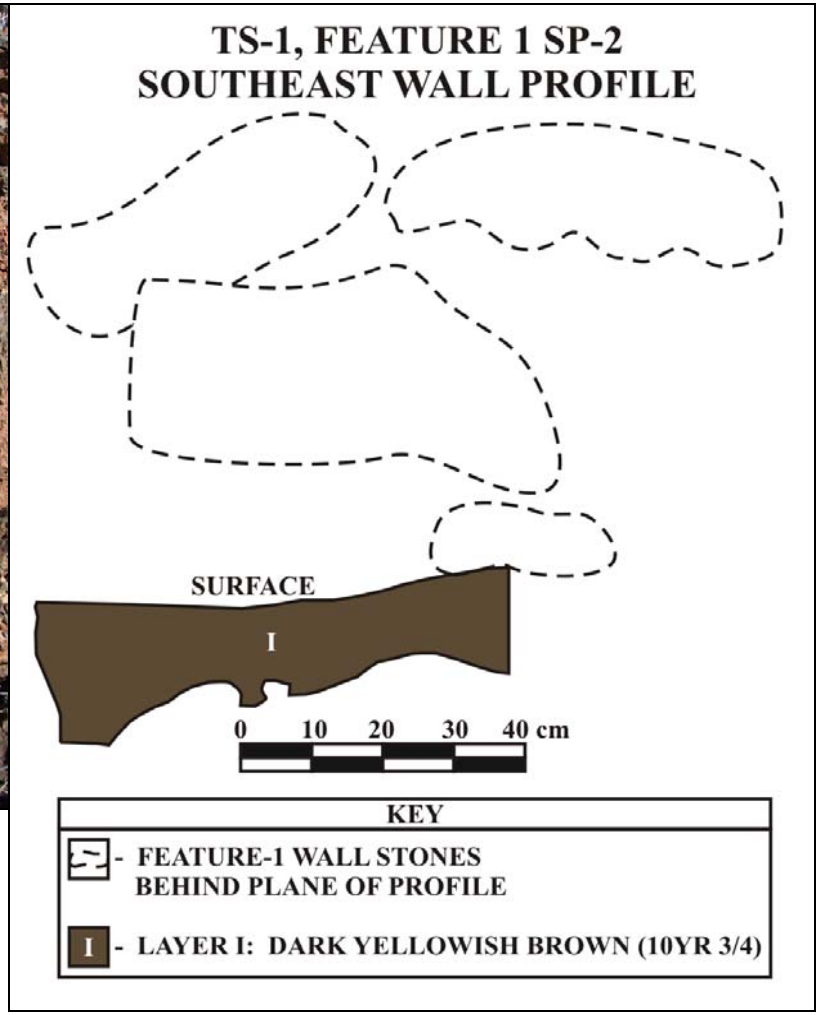


**Figure 9: Stratigraphic Profile of Site -6587, TU-2. Southeast Wall Profile.**

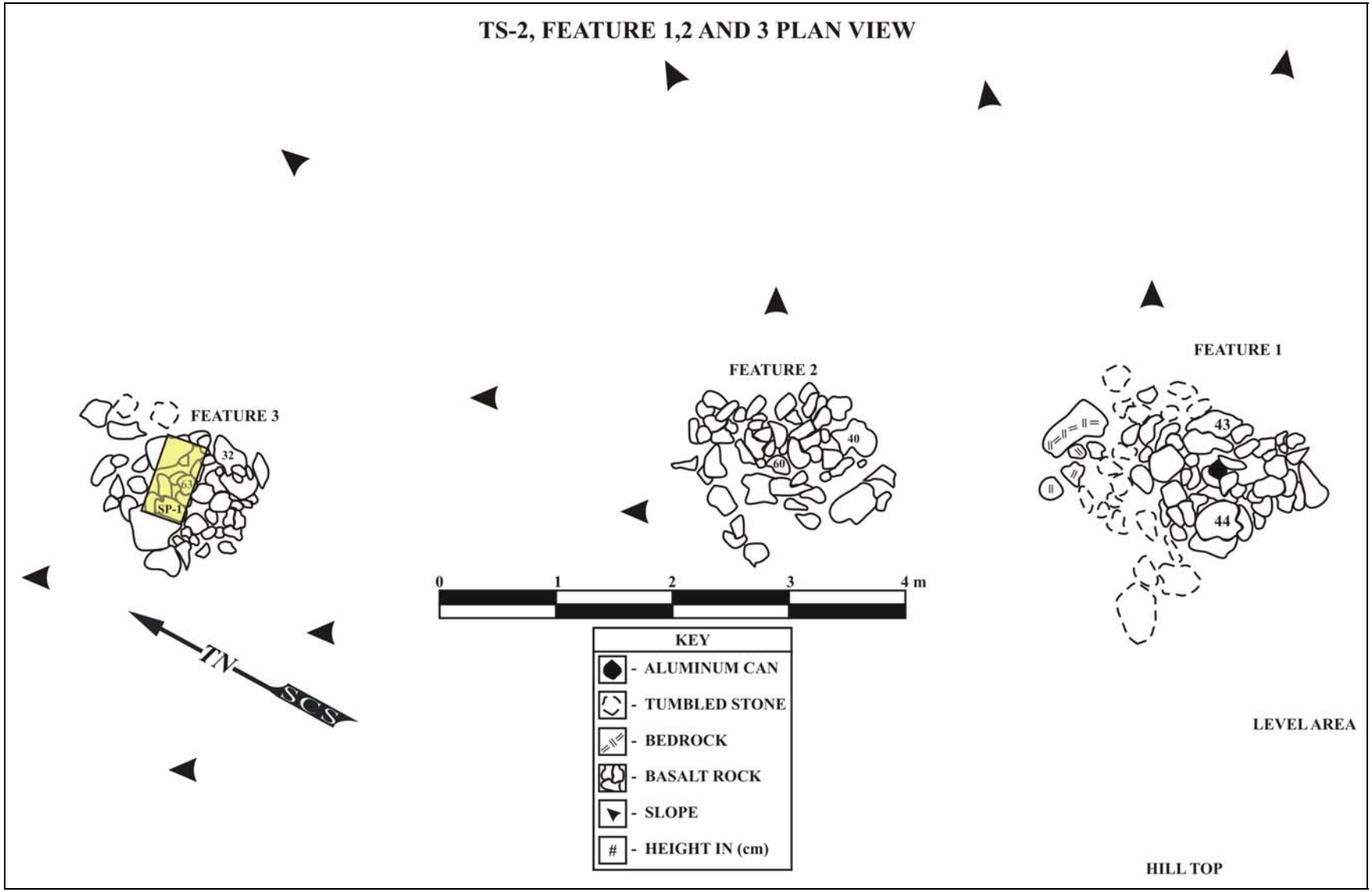


**Figure 10: Plan View Map of Site -6588.**

**Figure 11: Photograph of Site -6588, Features 2 and 3. View to East.**

**Figure 12: Photograph of Site -6588, Feature 1. View to East.**

**Feature 1**

Occurring at the apex of a small knoll, the Feature 1 mound measures 1.2 m long, 1.0 m wide, and rises to 0.44 m above the sloped surface (see Figure 10). Oriented on a northwest/southeast axis at 130º/310º, the feature consists of piled, semi-rounded and angular basalt cobbles. The feature is rounded in plan view and does not contain facing or any formalizing elements. Surface materials include only a single metal, bottle cap. This no-descript feature is similar in size and morphology to the other two mound features occurring several feet away, down the small knoll's slope. Feature 1 was not tested.

**Feature 2**

Occurring below Feature 1 and 1 m to the north, the Feature 2 mound measures 1.6 m long, 0.9 m wide, and rises to a maximum 0.60 m above the sloped surface of the knoll (see Figure 10). Oriented on a northwest/southeast axis at 152º/332º, the feature also consists of piled, semi-rounded and angular basalt cobbles. Feature 2 is rounded in plan view and does not contain facing or any formalizing elements. No surface materials were identified within or around this feature. Feature 2 was not tested.

**Feature 3**

Feature 3 occurs 3.5 m to the northwest of the Feature 2 mound and is slightly lower in elevation (two feet lower on a c. 10º slope). The Feature 3 mound measures 1.27 m long, 1.2 m wide, and rises to a maximum 0.44 m above the sloped surface (see Figures 10 and 12). Oriented on a northwest/southeast axis at 152º/332º, the feature consists of piled, semi-rounded and angular basalt cobbles. The feature is rounded in plan view and does not contain facing or any other formalizing elements. No surface materials were recovered during recording. This feature was tested, having been bisected to assess internal construction and the presence/absence of associated cultural materials in subsurface contexts.

<u>Test Unit 1 (TU-1)</u>

TU-1, a 0.70 by 0.50 m unit, was placed through the center of the feature and oriented on an east-west axis (see Figure 10; Figure 13). Excavation revealed one sedimentary layer, occurring above bedrock (Figure 14). This unit also revealed that the feature was solely constructed on the surface, no portions of the feature protruded into subsurface contexts. Layer I (0-20 mbs) was comprised of olive brown (2.5Y 4/4) silt with weak structure. Few micro roots were present and saprolitic gravels (decomposing bedrock) were common. No cultural materials were identified in the test unit. Excavation terminated on bedrock.

**Figure 13: Photograph of Site -6588, TU-1, Feature 3. View to Southeast.**

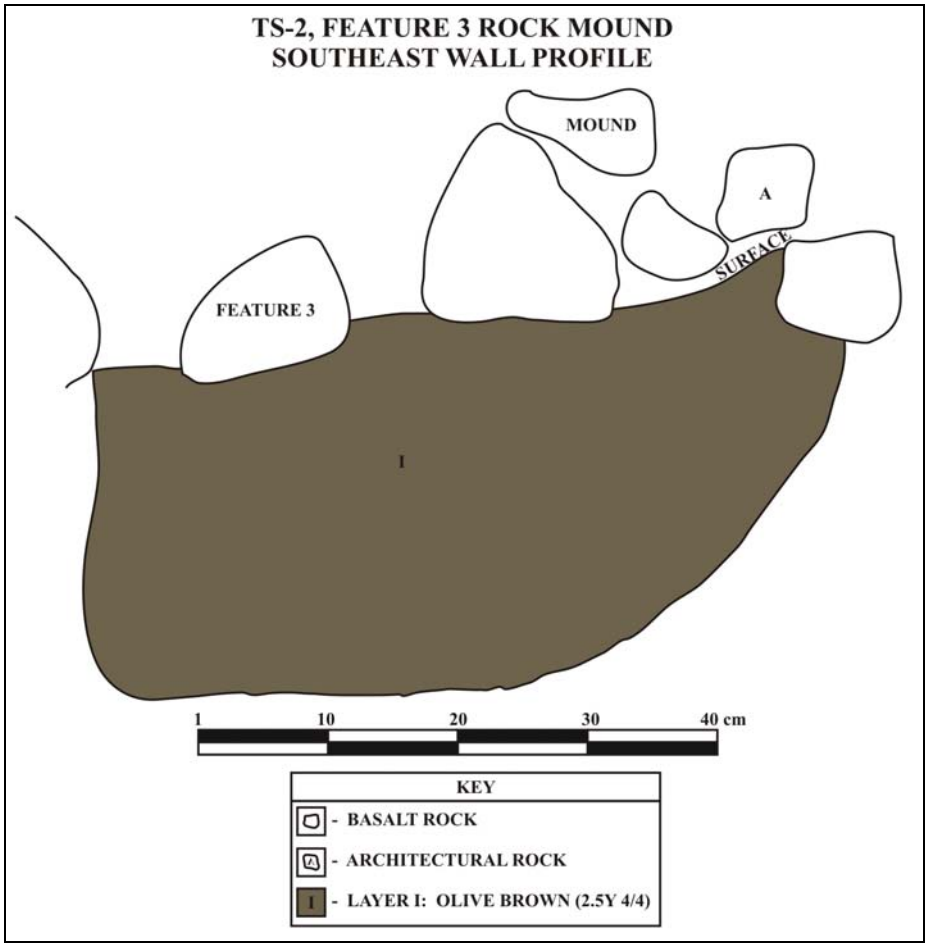


**Figure 14: Stratigraphic Profile of Site -6588, TU-1, Feature 3. Southeast Wall Profile.**

**TMK:2-2-24:017 (39.00 ACRES)**

Framed as a "peninsula"-shaped parcel of land to the south of a large drainage (Waipuilani Gulch), three sites were identified on the parcel. In addition, several previously identified sites (Tome and Dega 2002; see Figure 5) were re-located to the west of this parcel. Waipuilani Gluch did not occur within the parcel's boundaries and was only informally surveyed. Ground visibility was fairly good in this survey area, with some ground surface covered by thin grasses. Landscape modifications were also common on this parcel and took the form of mechanized work associated with informal access road construction and adjacent golf course work. A large borrow pit with concrete reinforcements was present just to the east of this parcel's eastern boundary.

A total of three sites were identified on this parcel: two modified outcrops and one free-standing wall (see Figure 1). All three single-feature sites were present in the northwestern portion of the parcel, with the modified outcrops occurring on small knolls above shallow swales and the wall occurring at the top, southern flank edge of the gulch.

**SITE 50-50-10-6239**

This site was identified in the northwestern-most portion of the parcel at c. 90 feet above mean sea level. Occurring on a small knoll with shallow swales to the north and western flanks, the site consisted of a linear-shaped modified outcrop (Figures 15, 16, and 17). The site measures 7.10 m long, 3.30 m wide and rises to a maximum 0.65 m above slightly undulating terrain. Oriented on a northwest/southeast axis at 120º/300º, the site was mainly comprised of outcrop with minimal stacking (1-2 courses maximum) of small basalt cobbles and boulders along its southwestern flank. The site consisted of an oval-shaped morphology and followed the outcropping itself.

Few pockets of sediment were evident within this site. No artifacts or midden deposits were identified on the site's surface and no standing or faced areas were present. No excavation was conducted due to the dearth of sediment and the low integrity of the single feature. The feature was not considered a push pile as no mechanical marks were observed on the rock segment surfaces. The site was interpreted as a modified outcrop presumably constructed during WWII times when training was conducted in the area. The site location could have served as a gun placement or observation area during the training exercises.

**SITE 50-50-10-6240**

This site was similar to Site -6239 yet slightly more formalized. Located near the northern terminus of the parcel at c. 100 ft above mean sea level, this single feature site consists

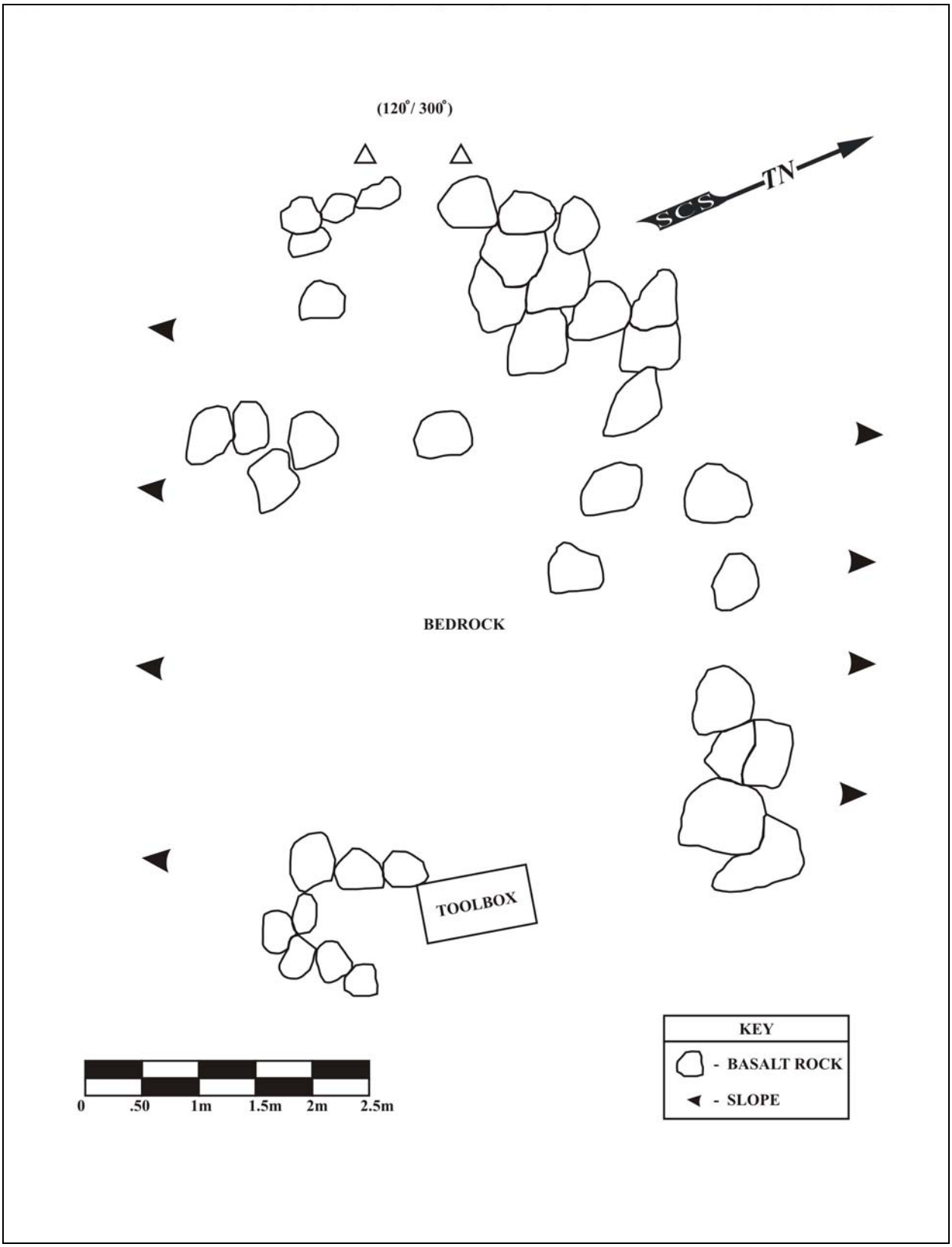


**Figure 15: Planview Map of Site -6239.**

**Figure 16: Photographic Overview of Site –6239. View to East.**

**Figure 17: Photograph of Site –6239 Southwestern Profile. View to Northeast.**

of a small modified outcrop (Figures 18, 19, and 20). The site measures 4.3 m long, 2.55 m wide, and to 0.70 above the ground surface. Oriented on a northeast-southwest axis at 40º/220º, the site consists of exposed bedrock with modifications in the form of 1-2 courses of small cobbles. These modifications occur on the northern flank of the site, overlooking Waipuilani Gulch. Somewhat oval in morphology, all the composite cobbles and boulders utilized in construction were not modified. Soil deposits within the site were minimal, with outcrop dominating the feature surface. No excavations were conducted at Site -6240.

The highest part of outcrop modifications occurs to the north, which provided a slight barricade overlooking the gulch. This site was interpreted as a modified outcrop associated with historic times. Like Site -6239, this single feature site was presumably constructed during WWII times when military training was conducted in the area. The site could have served as a gun placement or observation area during the training exercises and is currently is in poor-good condition.

**SITE 50-50-10-6241**

The single-feature site consists of a linear wall running roughly east-west along the upper, southern flank of Waipuilani Gulch from the c. 120 foot above mean sea level mark. The wall essentially demarcates the northern border of the survey area and runs along the top of the gulch, with steep sides declining to the north into the gulch base itself (Figure 21). The site measures some 120 m long, 0.60 m wide, and rises to a variable 0.35-1.20 m above the undulating ground surface. The northern, interior flank of the wall is generally higher than the southern exterior of the wall, this due to placing the wall into the slope angle. Composed of a variable 2-7 courses of fitted basalt cobbles, the site is in good condition (Figure 22). Well-preserved sections of the wall reveal 2-3 cobbles width and chinking evident along much of the higher sections. Oriented on a rough east-west axis at 70º/250º, the free-standing wall parallels the contours of the gulch ridgeline. Site -6241 was interpreted as a boundary wall that could have been utilized during ranching times to keep domesticated animals from tumbling down the sleep Waipuilani Gulch slope. That the wall follows almost exactly the upper contour of the southern gulch ridgeline leads to the inference that this is a boundary wall with some time depth. The feature is being assessed herein as a traditional-historic period wall, serving as a boundary (traditional times) or barrier (historic times).

**EASEMENT SURVEY (TMK:2-2-24: POR. 012)**

The final area surveyed for this Inventory Survey consisted of a corridor measuring 100 feet wide (east-west axis) by 1,400 feet (north-south axis). The easement commenced at the westernmost flank of surveyed parcel TMK:2-2-24:017 (Figure 23). This easement will

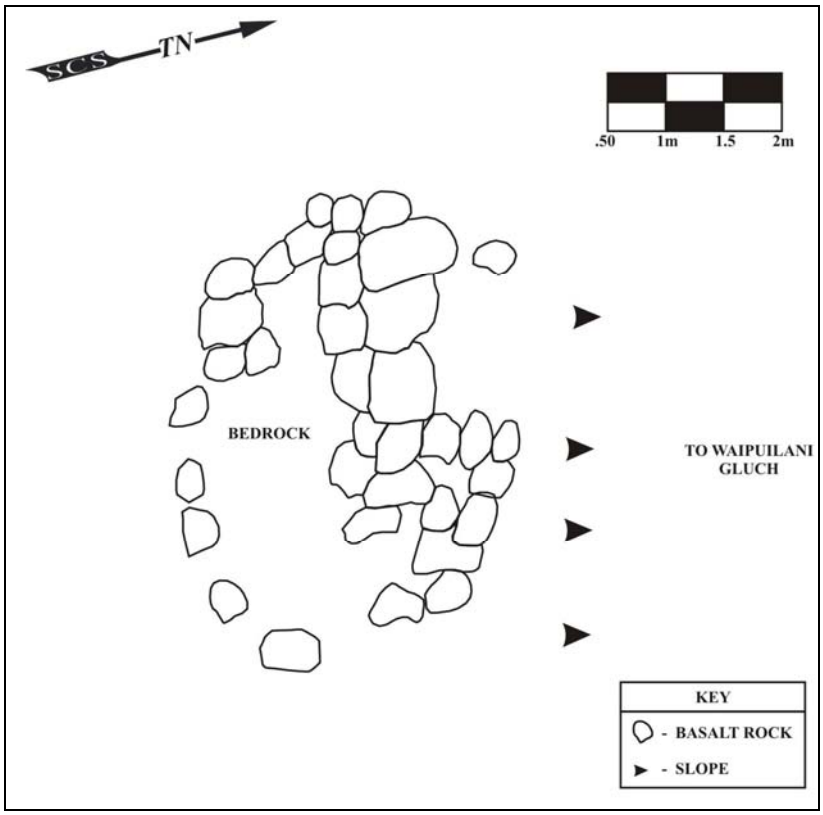


**Figure 18: Planview Map of Site –6240.**

**Figure 19: Photographic Overview of Site –6240. View to West.**

**Figure 20: Photographic Overview of Site -6240. View to West.**

**Figure 21: Photograph of Site –6241, Top of Wall Overview. View to West.**

**Figure 22: Photographic of Site –6241 Wall Profile. View to East.**

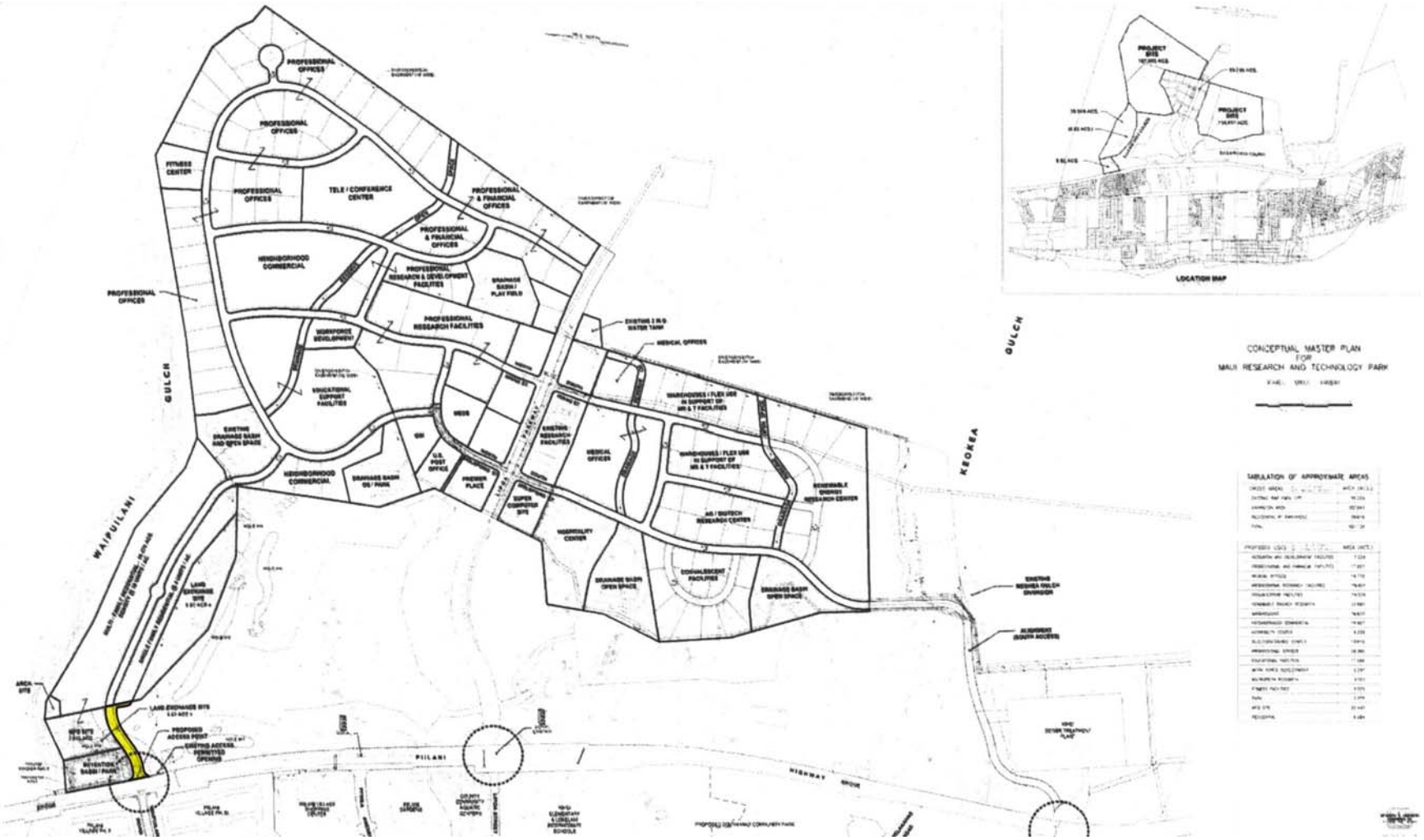


**Figure 23: Planview Map Illustrating Location of Easement.**

eventually consist of a neighborhood road connecting the development to Pi`ilani Highway. Full survey of the easement failed to yield any evidence of surface architecture, midden or artifact scatters, or locations potentially containing subsurface deposits. The easement area has been heavily modified due to its close proximity to the existing golf course, as well as its terminal point near the heavily used highway.

**NOTABLE FEATURES OUTSIDE THE PROJECT AREA**

The upper, southern ridgeline of Waipuilani Gulch essentially defines the northern boundary to the current parcel. During investigations of the Feature 3 wall, and when recording the feature from the gulch side, two rockshelters were identified on the slope of the gulch itself. These features are clearly outside the current project area but could be impacted during any work on the current parcel above (debris rolling into the gulch, over and through the rock shelters). A search of previous archaeological work in the area revealed that these features have never been recorded; they are simply noted herein. There is a recognized cultural element to the rockshelters as several basalt flakes were identified on the surface of each shelter, over a soil deposit which could yield additional cultural materials. No other archaeological features were identified along the southern slope of Waipuilani Gulch near the Site –6241 wall.

## DISCUSSION AND CONCLUSION

Consistent with the "barren zone" model for pre-Contact human settlement in the Kihei area, the present Inventory Survey of some 338-acres (and one easement) in Waiohuli and Keokea Ahupua`a, Wailuku District yielded only a modest number of small sites: two modified outcrops and one free-standing wall (State Site No's –6239, -6240, and –6241 respectively) on one parcel and one L-shaped feature and three rock mounds (State Site No's. –6587 and –6588) on a second parcel. Save for TMK:2-2-24:017 (39 acres) and TMK:2-2-24:054 por. (124 acres), the four other parcels and one easement were void of sites, this presumably being the result of limited activity through time in the area, the nature of the "barren zone" itself, and landscape modification through time, particularly in recent times. Few archaeological signatures are present in this zone as a whole, particularly in subsurface contexts. While ranching activities and such may have altered the landscape of the overall zone, ranching related structures were primarily also absent in the project area (the Site -6241 wall being a possible exception). The only results of note were gleaned through survey of TMK:2-2-24-:017 and TMK:2-2-24:054 por. and informal survey of Waipuilani Gulch, beyond the southern boundary of TMK:2-2-24:por. 16 wherein two overhangs with several surface lithics were identified.

Site density in this area is minimal and often empirical evidence for the limited prehistoric activity is negligible. Features that most often have survived on this landscape are related to WWII training exercises, which were ubiquitous in the area. Three sites of the current study (-6239, -6240, -6587) have been interpreted to relate to such training. Site 6241, the free-standing wall, is also of interest. That the feature follows the contours of the upper ridgeline may allow for its interpretation as a prehistoric boundary wall. As the feature runs along the top of a steep slope also allows for re-use of the wall during ranching times as a barrier. Both interpretations appear valid at this juncture. Site -6588 is also worthy of additional discussion. The empirical record of the site is scant, but based on the nature of the features (non-descript rock mounds) having been arranged in a linear fashion, the mounds may represent location-direction markers associated with traditional times. Certainly multiple trails accessed these "barren zone" areas which connected the uplands-lowlands. Temporary habitation sites are other hallmarks of these areas containing such long distance trails (see Tome and Dega 2002a).

Finally, the paucity of features and/or cultural materials within the large project area must be addressed. The lack of prehistoric features (c-shapes and such) and historical features related to ranching or military training activities—as preserved in other, nearby parcels—may be a result of grading, bulldozing, and/or other earth-moving operations. Clear evidence of such activities is evident through multiple small roads and two-wheel tracks within the project area. There are a few relatively large push piles of boulders with large tree limbs and smaller tree trunks incorporated into these piles within each TMK of the project area and smaller rock piles also abound. Most of the latter where mechanically manufactured either through adjacent construction or during fire fighting operations.

Overall, the "barren zone" yielded expectations similar to what was originally hypothesized: several small features related to historic times (military usage), an alignment of rock mounds (prehistoric), and much landscape alteration during modern times. Certainly there is a prehistoric aspect to the landscape (see Previous Archaeology section above), herein represented by the Site -6241 wall, Site -6588 rock mounds, and the rockshelters noted outside the project area within Waipuilani Gulch. The prevailing model that temporary habitation-temporary use sites and WWII training structures predominate in the "barren zone" has not been disproved by the current research.

## SIGNIFICANCE ASSESSMENTS

The following table (Table 1) present significance assessments and recommendations for the five sites identified during the current research. Mitigation recommendations are presented below.

**Table 1: Site Designations, Significance Assessments, and Recommendations**

| State Site No. 50-50-10- | Temporary Number | # Features | Form | Function | Temporal Assessment; Significance; Recommendation |
|---|---|---|---|---|---|
| 6239 | TS-1 | 1 | Modified Outcrop (linear) | Military Training (barricade or gun placement) | WW II; Criterion D; No Further Work. |
| 6240 | TS-2 | 1 | Modified Outcrop (irregular) | Military Training (gun placement or observation area) | WW II; Criterion D; No Further Work |
| 6241 | TS-3 | 1 | Wall (linear) | Boundary Wall | Traditional-Historic; Criterion D; No Further Work |
| 6587 | ----- | 1 | L-Shape | Military Training (barricade or gun placement) | WW II; Criterion D; No Further Work. |
| 6588 | ----- | 3 | Mound | Markers-Locators | Traditional; Criterion D; No Further Work |

## RECOMMENDATIONS

Based on the results of the present Inventory Survey, as well as the overall settlement pattern of the general "barren zone" area, no further work is recommended for five of the parcels or the easement: TMK:2-2-24:por 12, por. 14, por. 16, and por. 54. No further work is recommended for Sites -6239 and -6240 on TMK:2-2-24:017. No further work is recommended as well for Sites -6587 and 6588 on TMK:2-2-24:054 por. However, we encourage the landowner(s) to informally preserve the entirety of Site -6241 wall or portions thereof if given the opportunity. It is recommended that the wall nonetheless be bordered by orange construction fencing during construction on the parcel due to the potential for adversely impacting the two rock shelters noted on the side of the slope below, within Waipuilani Gulch. The fencing will serve to keep soil and other debris that may be mechanically moved from disturbing the unrecorded features below.

In the unlikely event that contractors or machine operators identify sites (artifacts, architecture) during initial work on these parcels in the future, they are to cease activity in that area and contact either SHPD or SCS to evaluate any finds. At this writing, there are very limited expectations for identifying any additional sites across the parcels. Finally, due to the shallow nature of project area sediment matrices, coupled with the very modest yields of subsurface testing in barren zone areas, Archaeological Monitoring is not recommended for any of the six parcels or the easement.

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APPENDIX E
Cultural Impact Assessment

# CULTURAL IMPACT ASSESSMENT
# For the
# PROPOSED
# Maui Research and Technology Park
# Master Plan Update

December 2006

Revised: December 2011

Hana Pono, LLC - PO Box 2039 Wailuku, HI 96793 – hanapono@gmail.com

# CULTURAL IMPACT ASSESSMENT
For the

PROPOSED
# Maui Research and Technology Park Master Plan Update

**TMK: 2-2-24-1, 2, 3, 4, 5, 6, 7, 8, 9, 14, 15, 16, 17, 54 (por.)**

Prepared for:
**Maui R&T Partners, LLC**
**Kihei, Hawaii**

Prepared by:
**Hana Pono, LLC**
**PO Box 2039**
**Wailuku, Maui, Hawai'i 96793**

December 2006
Revised: December 2011

# Management Summary

| | |
|---|---|
| **Report** | Cultural Impact Assessment for the proposed Maui Research & Technology Park Master Plan Update. |
| **Date** | December 2006; Revised December 2011 |
| **Project Location** | County of Maui; Kihei Ahupuaʻa/District (modern), Kula Moku. TMK: 2-2-24-1, 2, 3, 4, 5, 6, 7, 8, 9, 14, 15, 16, 17, 54 por. |
| **Acreage** | Approx. 400 acres |
| **Ownership** | Maui R&T Partners, LLC |
| **Developer/Applicant** | Maui R&T Partners, LLC |
| **Project Description** | Update Maui Research & Technology Park Master Plan to include opportunities for employment expansion and diversification as well as neighborhood serving retail and residential areas. |
| **Region of Influence** | Kula Moku, Waiohuli Ahupua'a, Kihei Town, Maui |
| **Agencies Involved** | SHPD/DLNR, Maui County Council, Maui County Planning Department, State Land Use Commission |
| **Environmental Regulatory Context** | The undertaking is subject to both State and County zoning regulations, and other environmental regulations |
| **Results of Consultation** | No known cultural resources located directly on project parcel, interviewees recall the area as being used for kiawe and ranching. |
| **Recommendations** | • Cultural advice when necessary and for related activities |

## Cultural Summary

The project parcel sits in the Waiohuli ahupua'a; the makai (lowland) portion of this ahupuaʻa is best known for its post-contact use for Cattle Ranching and the Kiawe forest. Due to its dry and barren nature the chances of iwi kupuna (burial sites) are lower than in other areas, but the possibility should not be ruled out. To our knowledge, there have been no traditional agricultural or religious practices exercised in the parcel in recent years. The area sits as an open space in Central Kihei, mauka (upland) of the Honoapiʻilani Highway, South Kihei Road, and the retail complexes and residential homes of Kihei.

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## Scope

The scope of this project will basically be to compile various historical, cultural and topographical accounts and facts of the ahupua'as Waiohuli and Wailuku/Kula District where our project for Maui Research and Technology Park (MR&TP) sits. Presently, Lipoa Parkway is the roadway off the main Honoapi'ilani Highway which leads mauka (upland) towards the MR&TP.

In the introductory section of this report, we will briefly explore the possible reasons for the native Hawaiians to limit their settlement in these two ahupua'as. Several archaeological surveys have been done for these two areas and the reporting is consistent that this barren zone, in which the subject parcel is situated, was definitely a transitional area. Looking at the accompanying map, it shows that the existing gulches did not start directly from the top of Haleakalā. The path the water carved to reach the ocean was relatively shallow compared to other gulches indicating limited water flow through the targeted ahupua'a. Although the land was relatively flat and readily accessible, the lack of water was the most important reason the land area did not attract large group of residents to build expansive communities like the other four districts on Maui. In later years, the topography of this land area served very well for farming even with limited water and especially ranching.

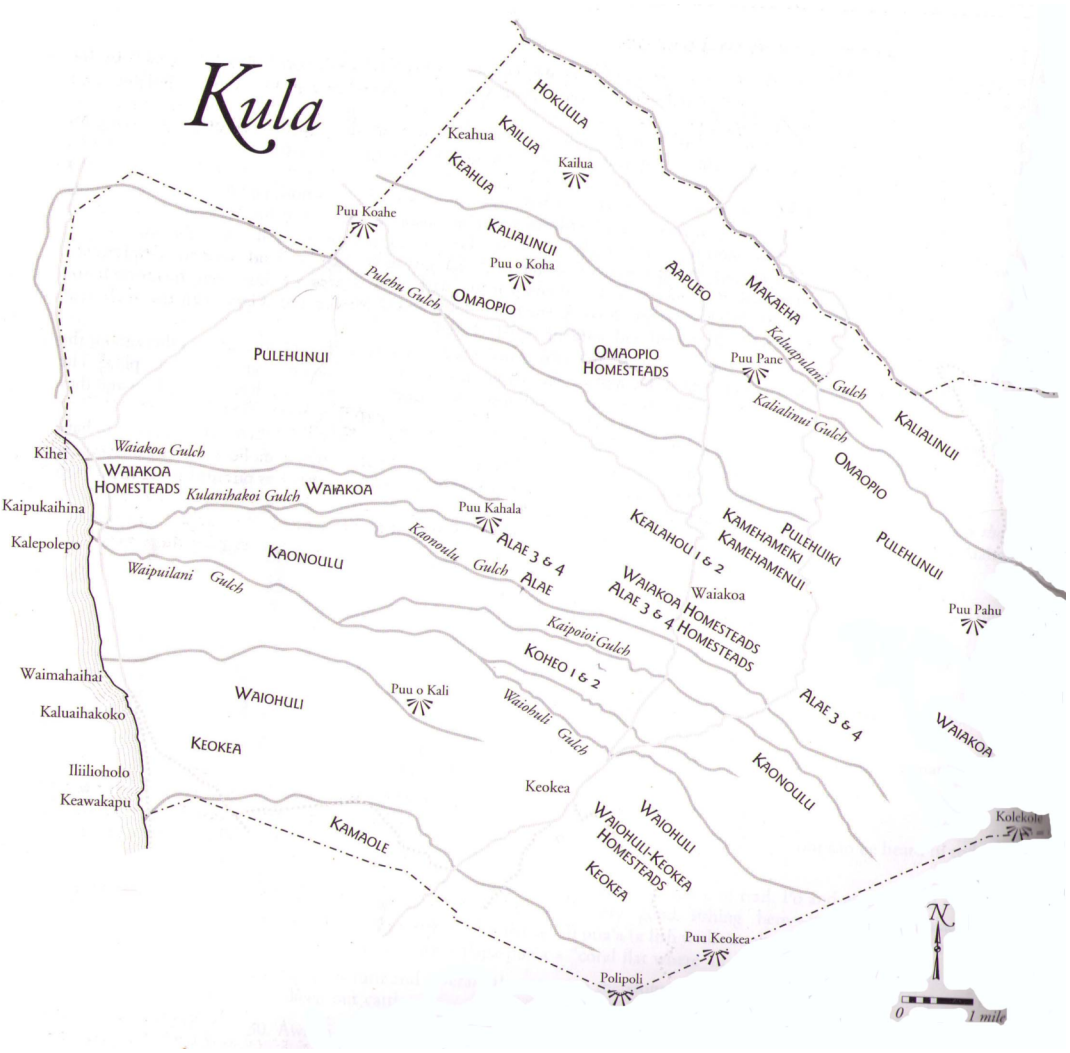


**Figure 1: Gulches of Kula**

By looking on the map in the area of our research, Waipu'ilani Gulch is one of the few gulches that have subsidiary streams flowing into one main stream by the time it reaches the ocean taking much of its loose lepo (top soil) and 'opala (rubbish) to wash out into the ocean. This might be one of the reasons that the fishpond at the ocean tip of Kihei was called Kalepolepo (Much dirt). As a guideline in ancient times, no water meant no permanent settlement. Those who tried to settle faced harsh living conditions in windy, hot and dry conditions.

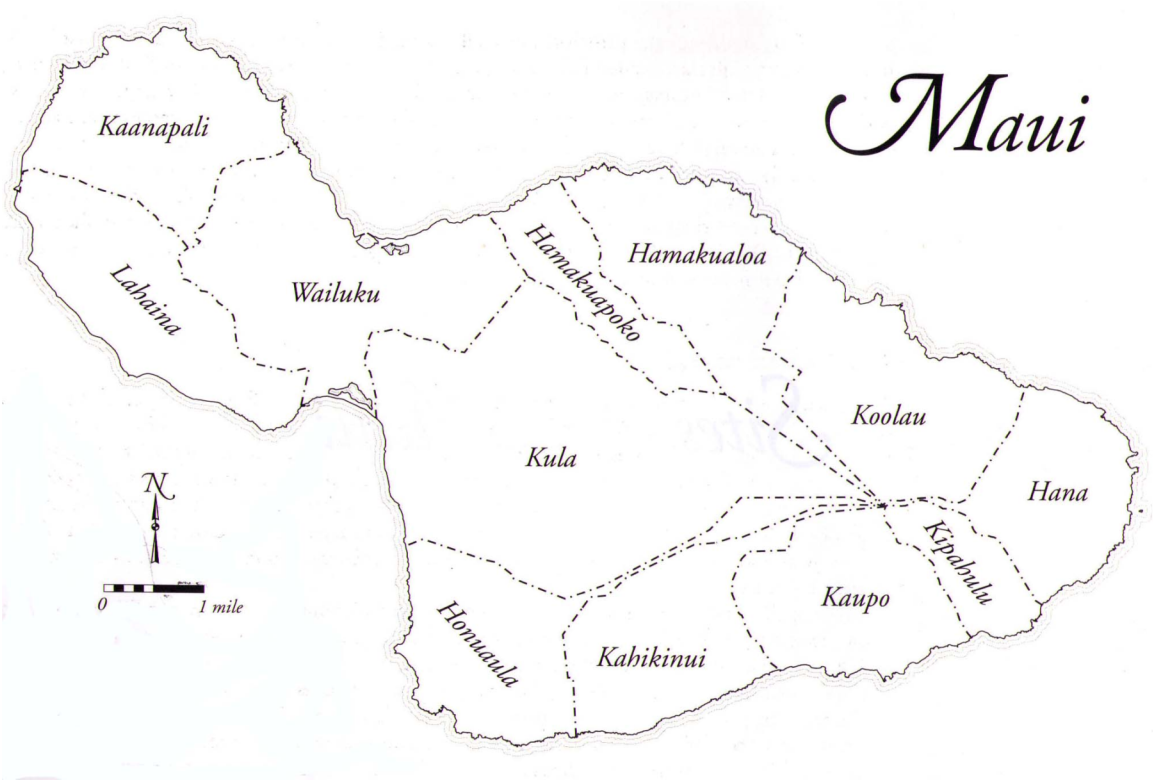


**Figure 2: The 12 Mokus of Maui**

# Introduction

Hana Pono under contract to Maui R&T Partners, LLC has conducted a Cultural Impact Assessment (CIA) for (MDA) proposed project for the lands of MR&TP spreading out from the ahupua'a of Waiohuli to the ahupua'a of Wailuku/Kula. The closest road access presently to this project area is through Lipoa Parkway in Kihei, Maui.

The CIA was conducted according with the State of Hawai'i Office of Environmental Quality Control (OEQC) Guidelines for Assessing Cultural Impacts {1997} and includes oral interviews with knowledgeable consultants of Kihei, Wailea and Makena and its surrounding areas as well as archival research.

The location of our study, MR&TP, is in the kona (hot, dry) area of Maui along the trail of the Northeast trade winds kicking up regularly from distant North Maliko to Kahului gaining momentum as it winds through the funnel embankment of Ka Mauna Kahalawai and Haleakalā until it touched all the significant landmarks south passing through the 'āina (land) on its way to visit the other side of the Pacific Ocean. An extended amount of cultural background will be provided to explain the low density of people occupying this area on the island of Maui especially in the proposed area of development.

## Maui's Five Centers of Population

### *Kahakuloa and Nā Wai Ehā*

Maui entertained five centers of population starting with Kahakuloa, an isolated valley on the northwest coast of West Maui deeply rooted in the staple lo'i kalo (wet taro plant). The next location was at the southeast and east part of West Maui, known in present day as Wailuku and Kahului. The area housed four deep valley streams which watered four areas of taro land spreading fanwise to seaward: Nā Wai 'Ehā (The Four Waters) were famed in song and story—Waikapu, Wailuku, Waiehu and Waihe'e. Eventually as we move to the modern era, sugar cane took over the former taro lands and the same waterways that were once used to irrigate the taro. The name song for the area is provided below.

SONG: **'INIKI MĀLIE –Gentle Pinches**

The winds & waters of Nā-wai-'ehā

| | |
|---|---|
| **Wai-kapü** makani kokololio | Skin-stinging wind |
| Makani houhou 'ili | Waikapü, wind in gusts |
| 'Iinikiniki mālie | Gently pinching |
| **Wai-luku** makani lawe mālie | Wai-luku, wind becoming gentle |
| Makani houhou 'ili | |
| 'Inikiniki mālie | |
| **Wai-ehu** makani hō'eha 'ili | Wai-ehu, wind paining skin |
| Makani houhou 'ili | |
| 'Inikiniki mālie | |
| **Wai-he'e** makani kili'o'opu | Wai-he'e, wind graceful |
| Makani houhou 'ili | |
| 'Inikiniki mālie | |
| Ha'ina mai ana kapuana | Thus ends the story |
| Makani houhou 'ili | Skin-stinging wind |
| 'Inikiniki mālie | Gently pinching |

(Elbert and Mahoe, 56)

In the middle of Nā Wai 'Ehā is the sacred valley of 'Ïao where chiefs and chiefess's, after living their earthly lives, requested that they be secretly laid to rest. This area funnels moisture-laden clouds onto Pu'u Kukui which sits above Mauna Kahalawai (West Maui Mountains) making it the second wettest spot in the Hawaiian Islands with 400 inches of rain a year falling on the peak. (Roelofs, 12)

### *Olowalu through Lahaina*

Another populated area was at the southwest coast of west Maui beginning at Olowalu and continuing through Launiupoko, Laupakanui, Waine'e and Lahaina and on to the small terraced valleys of Honokowai and Honokohau where taro lands were irrigated from streams out of the West Maui mountains. Lahaina, flanked by excellent fishing grounds, was the primary seat of the chiefs of West Maui.

## *Ke'anae through Hana*

The northeast flank of the great dome of Haleakalā roughly opposite the more sheltered shore line of Mākena are the two adjacent areas of Ke'anae and Wailuanui which comprise the next chief center on the rugged east coast. It supported intensive and extensive wet-taro cultivation. Further eastward down the coastline is the isolated but popular town of Hana. It is a region famous in legend and history although it was supported chiefly by fields of mulched (dry) taro cultivation and sweet potato, the small steep-valley called Wailua being almost the only area of wet taro nearby. The popularity of this district was based upon the relationship of neighboring Hawai'i island and its close proximity.

## *Kula to 'Ulupalakua*

The last major district on the south coast of East Maui, from Kula to 'Ulupalakua, was a consistently dry and lava-strewn country. Included in this area was the now popular Mākena and Ke'oneo'io which is noted for good fishing, calm sandy shores and pleasingly warm weather and sunshine. These favorable conditions attracted temporary settlers to live next to the shorelines and close inland. There were some patches of dry land taro but there was a notable area for 'uala (sweet potato) which combined with the fishing, must have supported a sizable but transient population.

The explanation of the last district is about the same with the land area of our report on Waiohuli and Wailuku/Kula since it is in close proximity north of Mākena. Clearly the arid country below the west and south slopes of Haleakalā, including Kula, Honua'ula, Kahikinui, and Kaupo were dependent on sweet potato. In Fornander, Volume 6, he describes the planting of sweet potato in the dryer sections of Kula:

> *Planting in rocky places was called makaili. There was very little soil proper, the greater portions {of the field] being gravel, with rocks all around. There were also large holes resembling banana holes. Upon the sprouting of the potato vines gravel and stones are piled up and around then, and by the time the hole was covered thick with leaves, the potatoes were large and grooved. (pg. 164)*

**Figure 3: Sweet-potato field, 1934. (Handy and Handy, 509)**

Hawaiian sweet-potato field, Honua'ula, Maui, in 1934.

The nature of the common Hawaiian was a bit kolohe (rascal) as demonstrated in the following Hawaiian saying of sweet potato in Kula and a beautiful young lady of Keanae.

> *O ka wai kau no ia o Keanae; o ka 'ulei ho'owali 'uala ia o Kula.*
>
> *"It is the 'ulei digging stick for the potato [patch] of Kula." A*

*handsome young man of Kula and a beautiful young woman of Ke'anae, on Maui, were attracted to each other. She boasted of her own womanly perfection by referring to her body as the pool on heights of Ke'anae. Not to be outdone, he looked down and boasted of his manhood as the digging stick of Kula. (Pukui 2447)*

By the brief explanation of the five large settlement districts of Maui, the reader of this report can draw their own conclusions that the ancient settlers were attracted to the lands that could provide their wet taro crops with a constant flow of water. Although the area of research carries the prefix "wai" meaning water as in Waiohuli (Water that turns) and Wailuku/Kula, (Water that destroys - in Kula), the flow of water in this area has never made any significant impact to create a fertile land base. These dry conditions left this section of land with a few settlers in the middle section of the ahupua'a in ancient times.

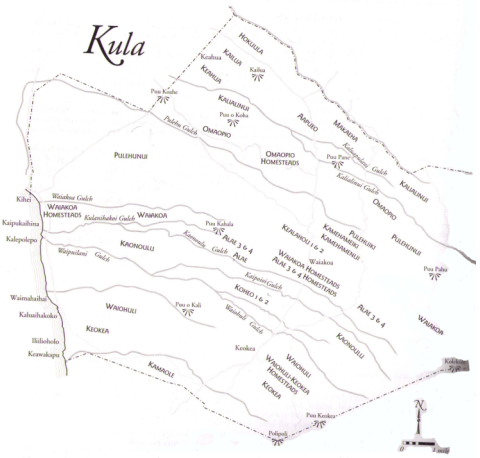

**Figure 4: Map of Kula Gulches**

To follow the evolution of the islands, its people, and the land area we are researching, Hana Pono, LLC will now provide an overview of Hawai'i from pre-contact Migration to chiefly rule of the ahupua'a (1600 -1778) leading to the changing tide from Captain Cook's discovery to current times. Periodic historical data of Maui will be included when it deems appropriate and relevant to our report. By understanding the different significant time periods in Hawaiian history, you, the reader, will be better equipped to make a personal decision regarding our findings.

## Eras 1 & 2: Pre-contact Migration – 0 to 1100AD

After the mythical creation of the islands was completed, pre-contact migratory periods in five distinct eras started in the year 0 to 600 A.D. Migrations from Polynesia, particularly the Marquesas, continued through the second era. Between 600 and 1100 A.D. the population in the Hawaiian islands primarily expanded from natural internal growth on all of the islands. Through the course of this period the inhabitants of the Hawaiian islands grew to share common ancestors and a common heritage. More significantly, the separation from their home base allowed the early arrivals to develop a Hawaiian culture and language uniquely adapted to the islands of Hawai'i which was distinct from that of other Polynesian peoples. (Fornander, 222).

During these periods, the social system was communal and organized around subsistence production to sustain 'ohana (large extended families). Hawaiian spiritual beliefs and customs focused on maintaining harmonious and nurturing relationships to the various life forces, elements and beings of nature. Ancestral spirits were honored as deities known more commonly as 'aumakua. Land and natural resources were not privately owned; rather, the Hawaiian people maintained a communal stewardship over

the land, ocean and other natural resources of the islands. The kupuna (elders) provided leadership and guidance to the makua (adults) who performed most of the daily productive work of fishing, cultivation, and gathering. Between the islands of Hawai'i there was some variation of language dialect and names for plants, animals, rains and winds. As an example, the residents of Ni'ihau used T's in place of K's in their language and still do today. There were also variations in physical structures, subsistence techniques and art forms. Origin myths varied according to the particular migration and genealogical line from which families descended. The prominence of akua (gods) and kupuna (elders) also varied by island. For example the volcanic deity Pele was more prominent in Puna and Ka'u. Many of Pele's followers believed her to have been a mortal person and her family believes that she still lives on today especially on the island of Hawai'i. Qualitatively, the language, culture, social system and spiritual beliefs and customs were common among all the inhabitants of the islands. Oral traditions indicate frequent transmigration and even intermarriage among families from the different islands in the Hawaiian Chain. During this era, there was continuous peace as described in this chant. (Bishop Museum)

**Mālie Maui ke Waiho Mai la** from the Bishop Museum Library

| | |
|---|---|
| Mālie o Maui | Maui is peaceful |
| Ke waiho mai la Kaihuakala | Situated next to rough seas |
| 'O Kaihuakala Mokuhano kai uka | Kaihalulu is inland |
| Kaihalulu i ke alo Kauiki | And Kaihalulu on the face of Kauiki |
| Hii Kauiki ia Mokuhano | Kauiki guards over Mokuhano |
| Hii Mokuhano ia Keanini | Mokuhano attends to Keanini |
| Hii Waikoloa i ka ili'ili | Waikoloa cares for the pebbled beach |
| Hone ana ia Kapueokahi | Which softly embraces Kapueokahi |
| O Honua'ula mauka | Honua'ula is inland |
| O Kauliuli makai | Kauliuli is seaward |
| Pau Pe'ape'a i Keahi | Pe'ape'a is destroyed by fire (The border ends at keahi) |
| No ka hee-palaha | Because it's slipping away |
| Moku i ka ohe la ea la e | Severed by the sacred knife |

The above chant describes the gentle calmness of the early settlers to these islands especially Maui. The title of the chant, "Mālie o Maui" means "the peacefulness of Maui." I can recall growing up in the bottom edge of Kula where we could look down to Kahului as well as Kihei, Kaho'olawe and Makena. As I woke up daily with my dad at sunrise, he would look makai (towards the ocean) and if it was so, he would automatically say, "Mālie i ke kai (The sea is calm)." As in the tradition, dad passed on to me and I passed on to my son Hōküloa.

## Era 3: Early Tahitian Migration – 1100 to 1400AD

This third period, between 1100 and 1400 A.D., marks the era of the long voyages between Hawai'i and Tahiti and the introduction of major changes in the social system of the Hawaiian people's nation. The chants, myths and legends record the voyages of great

Polynesian chiefs and priests, such as the high priest Pa'ao, the ali'inui (Head Chief) Mo'ikeha and his sons Kiha and La'amaikahiki, and high chief Hawai'iloa. Traditional chants and myths describe how these new Polynesian chiefs and their sons and daughters gradually appropriated the rule over the land from the original inhabitants through intermarriage, battles and ritual sacrifices. The high priest Pa'ao introduced a new religious system that used human sacrifices, feathered images, and enclosed heiau to facilitate their sacred religious practices among the priests. The migration coincided also with a period of rapid internal population growth. Remnant structures and artifacts dating to this time suggest that previously uninhabited leeward areas were settled during this period.

Honua'ula is an ancient name that was introduced to Hawai'i by Chief Mō'ikeha of Tahiti. The reason Chief Mō'ikeha decided to depart from Tahiti was to separate himself from his lover Lu'ukia who originally came from Hawai'i with her husband Olopana. Lu'ukia had created turmoil in Mō'ikeha's life and therefore the Chief felt that his separation from her would heal his wounds.
(Sterling, 214)

Chief Mō'ikeha's departure was not simply moving to another section of his island and beloved home of Lanikeha. Instead, he ordered Mo'okini, his kahuna nui (influential priest) to prepare their large wa'a kaulua (double-hull canoe) to set sail to the distant land of Hawai'i. On this voyage, he would take his foster son Kamahualele to help him on this voyage. Mō'ikeha also took his sisters Makapu'u and Makaaoa, and his two younger brothers, Kumukahi and Ha'eha'e. At this time, Kamahualele was inspired to provide a definition of the character of a kanaka maoli (indigenous Hawaiian) in the following chant.

From David Malo's "Hawaiian Antiquities" (p. 222) we can see that Hawaiians of ancient times were equally connected to their genealogical lines and the islands they called home.

| | |
|---|---|
| Eia Hawai'i | Here is Hawai'i |
| He moku | An island |
| He kanaka | A man |
| He kanaka Hawai'i e | A Hawaiian man |
| He kanaka Hawai'i | A man of Hawai'i |
| He kama na Kahiki | A child of Kahiki |
| He pua ali'i mai Kapa'ahu | A favorite chief from Kapa'ahu |
| Mai Moa'ulanui'ākea Kanaloa | From Moa'ulanui'ākea Kanaloa |
| He mo'opuna nā Kahiko lāua o Kapulanakehau e | A grandchild for Kahiko and Kapulanakehau |

The translation of this chant describes a Hawaiian person as Hawai'i, an island, a man, a Hawaiian man, a man of Hawai'i and a child of Kahiki. This information is important in as much as Polynesians of ancient times identified themselves with their protocol genealogical chant in their first meeting.

On his inaugural sail, Chief Mō'ikeha stops at the first landfall at South Point, Hawai'i. There, the Kalae family on Mō'ikeha's first migratory journey asks the Chief if they could

reside there. He grants them permission and today, one of South Point's community names is the town of Kalae.

After Kalae, the remaining families on the wa'a kaulua (double-hull vessel) followed in line by requesting to get off as they came to a place in the Hawaiian Islands that attracted them. The Chief sailed north to drop the Hilo family at the town of Hilo. He took kahuna nui (powerful priest) Mo'okini up along the North-western part of the island to Kawaihae where the famous Mo'okini Heiau was eventually built after his popular priest.

From north Kohala, Hawai'i, Chief Mō'ikeha could clearly see the beauty of Haleakalā which enticed him to set sail and island hop from Kawaihae onto the deep rough channel of 'Alenuihāhā to Hana, Maui. There, the Hana family asked and were granted permission to reside at Hana. After, he sailed around the Kaupo coastline until he arrived at Honua'ula.

The Honua'ula family was granted permission to take up residence there. Still to this day Maui is the home for some of Honua'ula and Mō'ikeha descendants. The rest of the voyagers along with the Chief Mō'ikeha sailed on to Lahaina, then Moloka'i, O'ahu and eventually Kaua'i where he decided to take up permanent residency. It is not clearly known how widespread the Honua'ula 'ohana (family) infiltrated on the island of Maui since he continued his sail North, but till this day the Mō'ikeha family, descendants of the Chief still reside in Kihei just below the MR & TP.

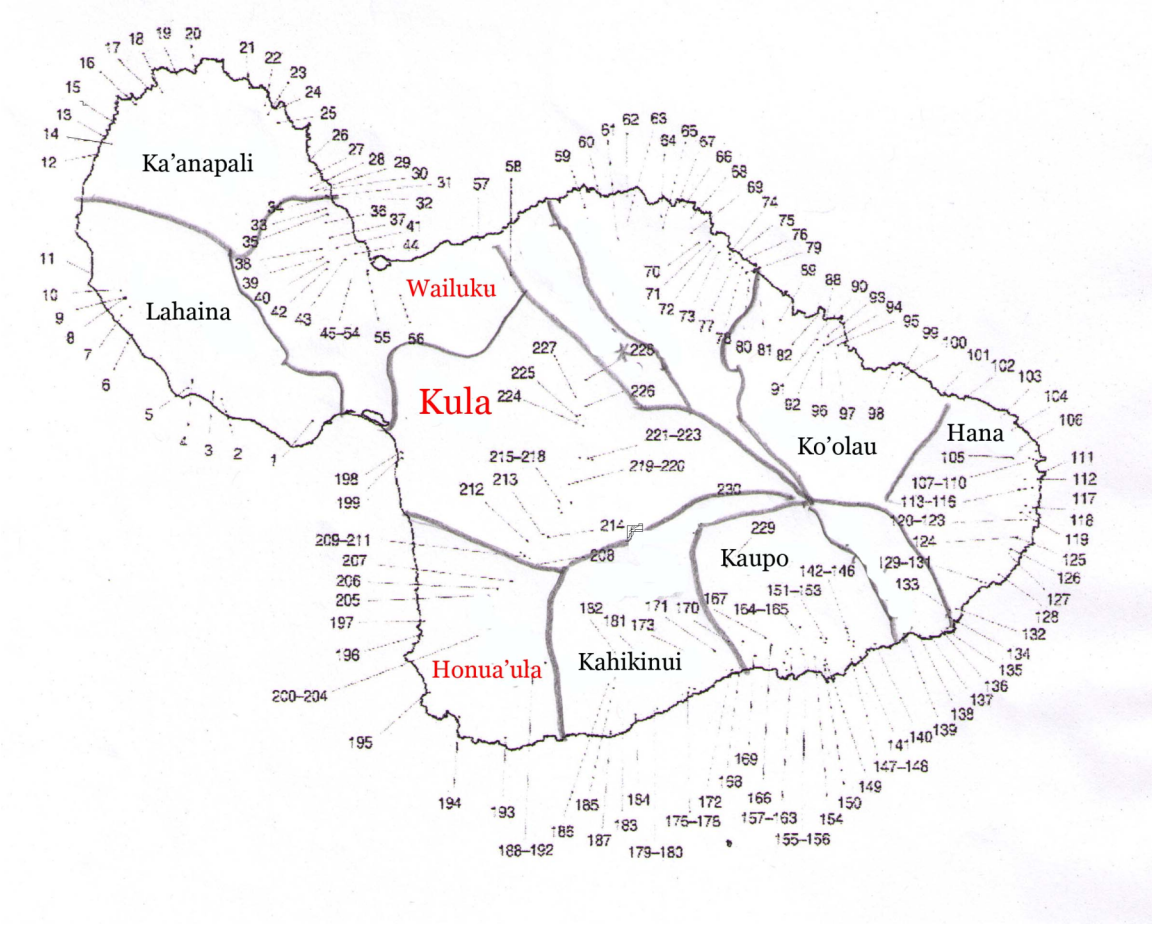


**Figure 5: Map of Heiaus in Maui**

Returning to Pa'ao and looking at the heiau map, we see that he changes the entire nature of the Hawaiian people with his religion and practices. Rock formations start to surface around the islands in different configurations to serve as heiau (temples) for the priests in the community. Some heiau were very elaborate stone structures while others were simple earth terraces. The wooden and feather-like images along with the pohaku (stone) images sometimes found on the heiau spring up island-wide representing Pa'ao's religious beliefs and war like attitude which contributed to a new ruling class and a working class found in the Hawaiian feudal society.

Fortunately, the land of Waiohuli and Wailuku, Kula did not attract the ali'i with the same mind-set such as Pa'ao. As shown on the heiau map, very few heiau were built on our designated ahupua'a study especially of the luakini (sacrificial) type. Several large and elaborate heiau were built on Maui at the five centers such as Pihana and Haleki'i at Wai'ehu and Pi'ilanihale heiau in Hana. The Haleki'i heiau was used for the sacrificing of the females and Pihana for the male chiefs of the enemies. Here, Kamehameha the Great after the victorious Battle of Kepaniwai in 'Ïao conducted the last sacrificial ceremony of the Maui Chiefess Poloahilani in 1790 (Roelofs, 16). The number of heiau found in the different districts was a good indicator of the size of a community that lived in the area.

## Era 4: The fourth period dates from 1400 through 1600 AD.

Voyaging between Hawai'i and Tahiti ended. The external influences of the migrating Polynesian chiefs along with internal developments within the culture resulted in sophisticated innovations in cultivation, irrigation, aquaculture, and fishing. These innovations were applied in the construction of major fishponds, irrigation systems, and field cultivation systems. Such advances resulted in the production of a food surplus which sustained the developing stratification of Hawaiian society into three basic classes, ali'i (the chiefs), kahuna (the priests), and maka'ainana (the commoners). Oral traditions relate stories of warring chiefs, battles, and conquest resulting in the emergence of the great ruling chiefs who controlled entire islands, rather than portions of islands. These ruling chiefs organized great public work projects which are still evident today. For example, 'Umi-A-Liloa constructed taro terraces, irrigation systems, and heiau throughout Hawai'i island, including the Pu'uhonua at Kealakekua. King Pi'ilani on the other hand was the only island king inspired to construct the King's Highway that passed through Waiohuli and Wailuku, Kula as it encircled the entire island of Maui.

The first builders of the famous Maui fishpond Ko'ie'ie were the legendary menehunes who built it overnight. Later, in the 1500's, king 'Umi-A-Liloa had the wall rebuilt. The Ko'ie'ie fishpond in Kihei was eventually renamed Kalepolepo either because of the kicking up of the dirt by all the people and/or the afternoon winds that blew the dust through the area.

**Figure 6: Picture of current day Ko'ie'ie Fish Pond**

Another popular mo'olelo (story) that touches Kihei and Kula through chant in this era has to do with a father/son connection whose names are Paka'a and Kua Paka'a. Kua Paka'a received the gift of learning all the wind chants for the archipelago of Hawai'i nei. Below is the wind chant that describes the wind originating from the island of Hawai'i traveling through the southern coastline of Maui until it passes Honua'ula then moves mauka (upward) towards Wailuku, Kula and Waiohuli:

**Ka Mele Makani a Kua-Paka'a (Upcountry winds of Maui),** (Fornander, 97-100)**.**

| | |
|---|---|
| Aia la, aia la, ke kau mai la ke ao makani, | There! There they are! The wind blown clouds are appearing |
| O Kapali ale ko Hilo makani, | Hilo's wind is Kapali ale |
| He Pakiele o Waiakea, | Waiakea's is Pakiele |
| He makani ko Hana he Ai-maunu, | Hana's wind is 'Ai-Maunu(bait eating) |
| He Kaomi, he Kapae. | Kaomi, Kapae |
| He Ho'olua, he Lau'awa'awa, | Ho'olua, Lau'awa'awa |
| He Apiolopaowa, he Halemau'u, | Apiolopaowa, Halemau'u |
| He Ku, he Kona, | Ku and Kona |
| He Kohola-pehu ko Kipahulu, | Kipahulu's wind is Kohola-pehu |
| Kohala-lele iho no ilaila, | Kohola-lele blows there also |
| **Ai loli** ko Kaupo, | 'Ai-loli wind belongs to Kaupo |
| He **Moa'e** ko Kahikinui, | Kahikinui possesses Moa'e |
| He **Papa** ko Honua'ula, | Honua'ula proudly hails the low blowing wind, Papa |
| He **Nā'ulu** a'e i Kanaloa, | Towards Kanaloa blows the showery sea breeze, Nā'ulu |
| Hina ka **hau** i ka uka o Kula, | Hau blows steadily in the **Kula** uplands. |
| Ko laila makani no ia, | This wind blows there |
| Ke noke ami la i ke pili, | Persistently whirls the pili grass |
| **Ulalena** i Pi'iholo, | Ulalena is at Pi'iholo |
| **'Ūkiu** ko Makawao, | The 'Ūkiu wind belongs to Makawao |
| Ka Ua Pu'ukoa i Kokomo, | The Pu'ukoa rain is at Kokomo |

Although the common people provided food, bark cloth, and household implements to the chiefs, Hawaiian society remained predominantly a subsistence agricultural economy. There is no evidence of a money system or commodity production. A system of barter in essential goods between fishermen, mountain dwellers, and taro cultivators existed within the framework of the extended family unit called 'ohana. In general, this exchange within the 'ohana functioned primarily to facilitate the sharing of what had been produced upon the 'ili (extensive land grant) that the 'ohana held and worked upon in common.

Within the 'ohana unit there was constant sharing and exchange of foods, utilitarian articles and services. It was not an organized barter system but a voluntary (though decidedly obligatory) giving. 'Ohana living inland raised taro, bananas, wauke (for tapa, or bark cloth making) and olona (for its fiber). The inlanders had need of gourds, coconuts and marine foods; they would take a gift to some 'ohana living near the shore and in return would receive fish or whatever was needed. When the fishermen needed poi or 'awa they took fish, squid or lobster upland to a household known to have taro, and would return with his kalo (taro) or pa'i'ai (hard poi, the steamed and pounded taro corm)…. In other words, it was the 'ohana that constituted the community within which the economic life moved.

Cultivation of taro and fishing were the centerpieces of the material culture. The system of irrigation, fishing and aquaculture was highly developed and produced a surplus that sustained a relatively developed and unified social structure that was embraced throughout the whole archipelago. All the basic necessities came from plants. Even fishing relied on plants; the canoe was made from a hardwood tree; the net was woven out of olona or some other vine; spears were carved out of a hardwood tree; ropes were woven from the coconut husk or a vine; the sails were usually made of lauhala (pandanus leaves). Hawaiians could not have survived without plants, and Hawaiians were expert planters and cultivators.

Sam Po was one of the major native consultants for the book "Sites of Maui" authored by Elspeth P. Sterling. Throughout the "Site of Maui", Kupuna Po shared ideas relating to Hawaiian mauka-makai use of the ahupua'a in Wailuku, Kula and Honua'ula of south east Maui. He said that the planting cycle was dependent upon the variations in rainfall according to elevation and seasons. He went on to say that planting in the uplands were done year round since there was rain daily. However, in the lowlands, planting was done when the rains came. Kupuna Po said that he had seen entire families with lauhala baskets carry lepo (dirt) from mauka (upland) to makai (lowland) one month before the rains came to put in the lava holes. Hawaiian watermelon, ipu oloolo, ipu nuhou-lani, pumpkin, and Poha or Ipu 'ala matured in about six months and were consumed while the families enjoyed the lowland plantings and fresh fishes from the sea.

## Era 5: Chiefly rule of the Ahupua'a – 1600 to 1778

In the fifth period, during the century preceding the opening of Hawai'i to European contact in 1778, the Hawaiian economy expanded to support a population between 400,000 and 800,000 people. The social system consisted of the 'ohana who lived and worked upon communally held portions of land called 'ili within the ahupua'a natural resource system. These families-- the building blocks of the Hawaiian social system-- were ruled over by the stewards of the land, the chiefs along with their retainers and

priests. The history books are filled with tales of battles among the chiefs from all islands.

In Honua'ula, high chief Kahekili gave permission to a chief named Ku-Keawe to run pigs in the upland. This chief abused his power and was killed with his body placed propped up facing the sea as an example to others who might consider abusing their powers.

Even during this period of chiefly rule, land in Hawai'i was still not privately owned. The chiefly class which provided stewardship over the land divided and re-divided control over the districts of the islands among themselves through war and succession. A single chief could control a major section of an island, a whole island or several islands depending upon his military power. Up until the time of Kamehameha I, however, no one chief was ever paramount over all the islands.

During the time of Captain Cook's first visit, King Kalaniopu'u and uncle of Kamehameha the Great ruled Hawai'i island and King Kahekili of the Valley Isle controlled Maui as well as Moloka'i, Lāna'i, Kaho'olawe, Kaua'i and Ni'ihau.

The chief divided his landholdings among lesser ranking chiefs who were called konohiki. The konohiki functioned as supervisors on behalf of the chief over the people that lived on the lands and cultivated them. The tenure of a konohiki was dependent upon his benefactor, the chief. Konohiki were often related to the chief and were allocated land in recognition of loyal or outstanding service to him. However, unlike elsewhere in Polynesia, the konohiki were rarely related to the maka'ainana or commoners on the land under his supervision. Thus, the konohiki represented the collective interest of the ali'i class over the maka'ainana as well as the individual interest of his patron chief.

The lands allocated to the konohiki were called ahupua'a. Ahupua'a boundaries coincided with the geographic features of a valley. They usually ran from the mountain to the ocean, were watered by a stream, and were bounded on both sides by mountain ridges. It afforded the 'ohana who lived in the ahupua'a access to the basic necessities of life-- marine foods from ocean reefs and streams, low lying wetlands for taro, fresh water, timber, and medicinal plants from the forest. The use rights of the konohiki included fishing rights over shoreline fishponds and reefs.

The konohiki supervised all productive communal labor within the ahupua'a month-to-month and season-to-season. He collected the annual tribute and determined if it was sufficient in relation to the productivity of the land. He regulated the use of land and ocean resources, administering the kānāwai (law) applying to the use of irrigated water as well as to fishing rights in the ocean. The konohiki was responsible for organizing communal labor for public works projects such as roads, fishponds, and irrigation systems.

The ahupua'a of the konohiki was further divided into strips of land called 'ili which were allocated to the maka'ainana (commoner Hawaiians). These land grants were given to specific extended family units of maka'ainana called 'ohana. The 'ili either extended continuously from the mountain to the ocean or was comprised of separate plots of land located in each of the distinct resource zones of the ahupua'a. In this way an 'ohana was provided access to all of the resources necessary for survival (Handy, Handy & Pukui, 49).

In Sterling's "Sites of Maui", he introduces the guardian shark Ka'ala-miki-hau of South Maui in this short chant: (p. 10)

| | |
|---|---|
| 'O Hi'u noho i Keanae | Hi'u resided in Keanae |
| Keli'i hue wa'a noho i Hana | Keli'i hue wa'a lived in Hana |
| Puhi noho i Kipahulu | Puhi was stationed at Kipahulu |
| Ka'ala noho i Honua'ula | Ka'ala-miki-hau guarded Honua'ula |
| Kamohoali'i ke ali'i nui a puni o Maui | King Kamohoali'i watched over all Maui |

Included in the guardianship of Maui is the mele inoa (name) chant for Ka'ala-miki-hau who served the people of South Maui as their aumakua (ancestral god).

| | |
|---|---|
| Eia ka 'ai | Here is the food |
| Eia ka i'a | Here is the fish |
| Eia ke kapa | Here is the kapa |
| Nou e Ka'ala-miki-hau | For you Ka'ala-miki-hau |
| Nana ia'u kau pulapula | Look upon me your devotee |
| I mahi'ai | That I can cultivate the ground |
| I lawai'a | That I may fish |
| Kuku kapa | And beat the kapa |
| A e ola ia'u, Kanui | Grant life to me, Kanui. |

## Kamehameha III (Kauikea'ōuli) & the Great Mahele

Up until the rule of King Kamehameha III (Kauikea'ōuli) 1848, the Hawaiian people's fundamental conception of property and law was based on water rights rather than land use and possession. Actually there was no conception of ownership of water and land, but only the <u>use</u> of water and land.

These fundamental concepts made drastic changes by King Kamehameha III with the implementation of the Great Mahele (division of land) between the king and the ali'i (chiefs) and konohiki (headman of an ahupua'a) and the kuleana 'aina (owned land) to the hoa'aina (tenants) of the ahupua'a. The King came under pressure from foreigners who were used to owning land in fee simple title in their homelands, and he desired to free his lands from the burden of being considered public domain, and as such, subjected to the danger of confiscation in the event of the Hawaiian Islands were to be seized by a foreign power. He also wanted to enjoy complete control of his property.

## Wai and Waiwai

"Uwe ka lani, ola ka honua – When it rains, the earth lives." The popular 'ōlelo no'eau (Hawaiian saying) did not have major impact in the targeted area of our research but when it did rain, it flooded the lower areas of Kihei, Wailea, Honua'ula and Makena leaving many wetland areas still existing today. Kupuna Mary Cravalho has had many life stories living in the lowlands of Kihei next to the fishponds of Kalepolepo. She tells of an incident when it rained throughout the night while she and her husband quietly

slept. She turned to her husband and said, " 'I smell mountain ferns.' then went back to sleep." When they awoke the next day, they found the water up to the front door with all the Kula vegetables surrounding their water filled yard decorated with mountain ferns.

**Figure 7: Lono Ki'i (Lono image) Water Goddess**

Wai (water) duplicates to waiwai (wealth). The thinking behind this is that when a person has a lot of water, they are truly wealthy. In real life, we are continuously brought to the realization that water is the key element in developing new communities while sustaining the old. In 1869, Samuel Alexander and Henry Baldwin formed (A & B) Alexander and Baldwin to grow sugar and East Maui Irrigation Company (EMI) to irrigate the crops. The partners in 1876 first formed the Hāmākua Ditch Company and completed the construction in 1878. During the ensuing decade Alexander and Baldwin's plantation was incorporated as the Pā'ia Plantation and included Hāli'imaile Plantation (Grove Ranch), East Maui Plantation, and Seaside Farm. The two partners gained control of Hawaiian Commercial and Sugar Company (HC&S) in October 1898 and immediately started building the Lowrie Ditch also known as the Lowrie Canal which started in the rain forest of Kailua in the Makawao District. The ditches two main sources were a reservoir at Pāpa'a'ea and the Kailua Stream.

Maui Agricultural Company was formed in 1921 by the merging of seven small East Maui plantations: Ha'ikü Sugar Company, Pā'ia Plantation, Kailua Plantation, Kula Plantation, Makawao Plantation, Pülehu Plantation, and Kālialinui Plantation. HC&S, anchored in Pu'unënë, and Maui Agricultural Company based in Pā'ia merged in 1948, at which time Alexander & Baldwin owned about 35 percent of the stock of each of the companies. This merger consolidated all of A&B's sugar plantations on Maui under HC&S. In 1962, HC&S merged with and became a division of Alexander & Baldwin, and EMI became a subsidiary of A&B.

It is said that EMI is the largest water company in the United States perhaps in the world. Luckily for Maui county residents, EMI supplies between 850 million and 1 billion gallons of water per year for domestic purposes.

Our research area did not entertain the two commercial crops, sugar cane and pineapple but it provided open grazing territory for an entire new industry called cattle ranching. It covered all the open arid lands from the tip of Makawao into Kula, Ulupalakua, Kanaio, Kahikinui, Nu'u, Kaupo and Hana. The industry brought a new lifestyle to the island people but in some areas it devastated the lands because the horses and cattle ate the existing vegetation all the way to the ground.

## The Hawaiian Paniolo

Captain Cook's arrival as well as Captain Vancouver with the animals that they brought changed the complexity of the Hawaiian Islands and how the land would be used.

Kamehameha the Great was given two pua'a pepeiao hao (pigs with iron ears- cows) by Captain George Vancouver in 1793 at Kawaihae, Hawai'i. Captain Vancouver's first visit had been with Captain Cook in 1778, he returned in 1793 and again in 1794 where he had decided that Waimea, Hawai'i was an excellent area for the propagation of the pipi (cattle) he had left on the island. Kamehameha the Great put a ten year kapu (taboo) on the pipi to let them breed and increase. As we have found out, thousands of cattle later swarmed over the valleys, slopes

and dale in this region bearing testimony to the land's rich natural pasturage. The pleasant cool climate and rich pastureland suited the pipi (cows) very well to the point that it became a very lucrative business for those who were interested in raising cattle.

The cattle increased rapidly growing wild and causing havoc to the islanders tearing up their banana and taro patches, eating the leaves and branches of the valuable koa trees, running and ransacking villages, and overall causing major damage. Many visitors to the islands were attacked and many hurt.

**Figure 9: Picture of hand-braided ropes**

One notorious instance concerned the world renowned botanist, David Douglas, for whom the Douglas fir was named. The wild cattle were so hazardous to approach that the hunters turned to digging deep pits to trap the beasts. David Douglas' mutilated body was found in such a pit in the Waimea area of Hawai'i in 1834.

Although there were lio (horses) in the islands during that time, no one here had any idea on how to herd cattle. Captain Cleveland in 1803 brought several lio over and let them loose in the islands. The Spanish-Mexican vaqueros were imported from California for the specific purpose of working with the Hawaiians and teaching them how to handle the great herds of wild cattle and horses that roamed the 'āina (land) of Hawai'i nei.

From this humble beginnings came the paniolo (Hawaiian cowboy) learning the art of horsemanship since a successful cattle person needed to catch, brake-in and train his horse and move on to the task of roping a cow, branding, herding and even building enclosed stone wall and barbed wire fences to keep the pipi contained.

On August 22, 1908, the paniolos took their cowboyship on the road to Cheyenne, Wyoming entering the National Frontier Day events rodeo competition. There, Ikua Purdy after roping his steer in fifty-six seconds flat captured the World's Championship steer-roping contest. What made Paniolo Purdy's feat particularly outstanding was the fact that he performed it aboard an unfamiliar horse; the mount had been supplied by the mainland's rodeo association. Thus, Ulupalakua, Maui became well-known with the Purdy name hanging on the wall till today.

Archie Ka'aua, too, scintillated for Hawai'i by coming in second in time to Purdy, and Jack Low placed sixth. All this competition had been against the best in the United States and it brought more than a little repute to Hawai'i. Before the Championships, people on the mainland hadn't even known there were any cowboys or cattle herds in the

isle of the sea or even the existence and location of Hawai'i. It was a great feat for the island paniolo as they returned with their trophies and justifiable pride.

This mele (song) found in Nā Mele o Hawai'i Nei entitled "Hawaiian Rough Riders" honors Ikua Purdy & Archie Ka'aua along with Jack Low. The term "Rough Riders" referred to President Theodore Roosevelt's cavalry regiment in the Spanish-American War.

**Rough Riders**

| | |
|---|---|
| Kilakila nā rough riders | Magnificent rough riders |
| Me ka ua Kīpu'upu'u | and Waimea's cold rain |
| Me ka nani a'o Pu'u-o-ka-lani | with its beauty of Pu'u-o-ka-lani |
| Me ka hae o ka lanakila | and the flag of victory |
| | |
| Hui | Chorus |
| Hu'i e, hu'i 'eha | Aches, aches and pains |
| Hu'i konikoni i ka pu'uwai | Aches throbbing the heart |
| Hu'i e, hu'i 'eha | Aches, aches and pains |
| Hu'i konikoni i ka pu'uwai | Aches throbbing the heart |
| | |
| 'Akahi ho'i au a 'ike maka | Never have I seen |
| Na rough riders helu 'ekahi | Such champion rough riders |
| Inu ana i ka wai aniani | Drinking sparkling waters |
| E ma'ü i ka pu'u ke moni | To wet the throat when swallowed |
| | |
| Hanohano wale nā cowboy, | Wonderful cowboys, |
| He maku'u noho i ka lio, | Pommel saddle on the horses |
| Hālena pono 'oe i ke kaula 'ili | Pulling taut the lasso |
| I ka lawe o ka pipi 'āhiu | Bringing in the wild cattle |
| | |
| Kaulana Ikuwā me Ka'aua | Famous are Ikuwā and Ka'aua |
| Nā 'eu'eu kīpuka 'ili | Spirited lassoers |
| Eia mai nā paniolo pipi | Here come the cowboys |
| Me ka nani o ku'u home | The glory of my home. |

(Elbert and Mahoe, 42-43)

The victory and pride that these paniolo brought back to the islands still linger among the old as well as the new. After returning, the Purdy family moved to Ulupalakua Ranch on Maui where he brought the paniolo skills, experience and excitement and continued the legacy he established as the best paniolo in the whole world.

> *"Evidence of cattle on Maui is noted as far back as 1806 when Amasa Delano, in his Narrative of Voyages and Travels (Boston, 1817) told of his sailing to Lahaina. He reported: 'They had recently brought to this island, one of the bulls that Captain Vancouver landed at Owhyee*

*(Hawaii). He had made very great destruction amongst their sugar canes and gardens, breaking into them and their cane patches and tearing them to pieces with his horns and digging them up with his feet. He would run after and frighten the natives and appeared to have disposition to do all the mischief he could, so much so that he was a pretty unwelcome guest among them.' "(Brennan, 97)*

There are no larger or more famous ranches on Maui than Haleakalā Ranch and Ulupalakua Ranch. Many tales have been told about the trails and pastureland of these territories. Carved in its legacy is this popular song composed by John Pi'ilani Watkins that is sung and danced regularly by the kama'āina (old timers) and mālihini (newcomers) describing Ulupalakua, Maui's home of the Paniolo.

**Ulupalakua**

| | |
|---|---|
| Kaulana mai nei, a o Ulupalakua<br>He iniki niki ahiahi,<br>Ka home a o Paniolo | Famous is Ulupalakua<br>With its chilling evening breeze<br>The home of the Paniolo |
| He wehi e ku'u lei, a o Ulupalakua<br>Onaona me ka awapuhi<br>He beauty ma'oli nō | Adorned with my lei @ Ulupalakua<br>embraced with the fragrance of ginger<br>with much beauty |
| Hā'ina mai kapuana a o Ulupalakua<br>He iniki niki ahiahi,<br>Ka home a o Paniolo | Thus ends my story<br>with its chilling evening breeze<br>The home of the Paniolo |

(John Pi'ilani Watkins)

*Maui's Haleakalā Ranch, the Ulupalakua Ranch, and several others have, over the years, been great spawning ground for top paniolos who ride their ranges the way the original ones rode theirs on the Big Isle. Like the Lindsey and Purdy men who have ridden the plains and mountains of Hawaii for well over a century, the Maui paniolos, too, have worked their huge acreages with the selfsame dedication, and have absorbed the Polynesian environment into their blood streams. (Brennan, 98)*

*Over on the small island of Lanai, too, is a cattle operation; nothing, of course, comparable with that found on either the Big Isle or on Maui. Today Lanai is owned by the Dole Pineapple Corporation, but before the days of pineapple take-over, the whole island amounted to one single cattle ranch, operated by lone white man and his Hawaiian cowboys. (Brennan, 100)*

Hawaii's paniolo of the past created and molded a routine that became a one-of-a-kind lifestyle. Long and hard days and cold and wet nights with only pipi kaula (Hawaiian dried salt meat) to eat were the activities of a dedicated paniolo. As the torch-driven sun nestled down along the western sky and the mahealani (full moon) began its rise to the pinnacle of Haleakalā, the evening makani (breeze) blew in the soothing sounds of the paniolo's kï ho'alu (Hawaiian style) guitar playing calming him and his pipi down for the night.

**Figure 11: Picture of cattle skull on rocks**

## Quiet Ka-Ono-Ulu Ranch

While the bigger ranches of Haleakalā and Ulupalakua were stealing the thunder, the Ka-ono-ulu Ranch quietly carried on raising their cattle on their ahupua'a stretching from upper Kula down to the popular ocean-side of Kalepolepo in Kihei. After years of raising cattle, the Rice family, owners of the cattle ranch, diversified into pig farming down in Kihei at the Maui Lu Hotel area. Also, farming became another area of diversification with a lavender farm, a hydroponics lettuce farm and a section filled with crops such as corn, strawberries, zucchinis and onions. Our informant and CEO of the ranch, Henry F. Rice, spoke of the lifestyle as he grew up on the ranch riding on his horse from Kula all the way to Kalepolepo Fish Pond. While riding up and down, he recognized old stone walls, holding pens for their animals and old camp sites. Research from other sources such as the Archaeology of Kula, Maui along with the Archaeological Inventory Survey of Waiohuli and Wailuku/Kula point out other findings such as ahu(s) (boundary markers or temporary worshipping sites) and cave dwellings. That would be the same or similar description of the area of our study since Ulupalakua Ranch stretched out from Kula all the way down to the ocean and the ahupua'a was deep in cattle ranching like Ka-ono-ulu Ranch.

## Use of the 'Āina

Consultant Hamby Kahawai described her father to have had many occupations but one term new to our ears was that he was a logger. Upon questioning her about what her father logged anticipating that it would be koa (acacia) or ili'ahi (sandalwood), to our surprise she mentioned kiawe (algaroba). Why not I ask myself? Waiohuli and Wailuku/Kula have been literally overrun by the kiawe forest replacing the Hawaiian forest trees such as the koa, sandalwood, kukui, Hala, Wiliwili, 'ākia, 'āla'a and many others.

Mr. John Akina logged these trees to sell to ranchers for poles to build their barbed wire fences. The wood was logged to make charcoal. I have overheard locals say they would never barbeque their food on any other charcoal except kiawe. Youngsters would spend after school and summer time hours to collect the seeds which were sold to pig farmers and others who cooked the seed to feed their animals. During times of famine, the locals have also eaten the seeds, a legume which is sweet to the taste.

**Figure 12: Picture of surrounding area around present day Maui Research and Technology Park.**

The kiawe, a legume, was imported from Peru in 1828 to Hawai'i by missionaries who first planted it in downtown Honolulu next to the Catholic Church. The conditions in Hawai'i are so attractive to this tree that it presently grows on every island especially in hot and dry areas of the islands like our designated area of study. Above the project area all the way up to Kula, Ulupalakua and Kanaio, the kiawe grows so profusely on these lands that one could call the area the kiawe forest.

**Figure 13: Picture of Kiawe**

**Figure 14: Land area around proposed project site**

## Planting Brings Makani, Ua, Ānuenue

**Figure 15: Picture Ua and Ānuenue**

In ancient times, kupuna said, "Ke kanu nei au, aia ia 'oe ka ulu meaning simply, I plant and the growth is yours". This saying by our wise ancestors point out that they knew the effects of planting upon the makani (wind), ua (rain), and the blessings of the ānuenue (rainbow).

In Kamakau's "Ruling Chiefs of Hawai'i", he tells of the of humble beginning of Maui's famous and legendary chief Kiha-a-Pi'ilani and wife who lived on the charity of others in the boundaries of Honua'ula with the papa winds and Kula winds at a place named Ke'eke'e. Later, they depart from Honua'ula with the inviting kehau winds of Kula and met the 'Ūkiukiu winds of Makawao along with the Ualena winds of Pi'iholo. During the time of their visit the area was addressing a serious famine so they resorted to living on the laulele, pualele, popolo and other weeds.

One night, Kiha-a-Pi'ilani went to clear a patch of ferns to plant sweet potatoes from slips he had collected from Hāmākuapoko and Hāli'imaile. As he traveled through these areas, the sunshine beat down on his back and intense heat reflected from the 'ulei vines. Meanwhile, one kupuna (elder) remarked to another, "There must be a chief near by for this is the first time that a rainbow is spread before the trees" (Kamakau, 24). Even today, we are regularly blessed by the rainbow of Kiha-a-Pi'ilani spreading over the skyline of Makawao pouring bucketfuls of rain from ka lani (the heaven).

The kupuna had discovered the chief's secret identity. He now felt prompted to rush back to Kula so he could plant his huli (sweet potato shoots). As soon as he had completed the planting, a rain shower fell, blessing the land that was once in draught. The lines in Hawaiian below speak of the people of Kula being a highly unusual people.

| | |
|---|---|
| He 'āina o Kula ua kaulana | Kula is a land that is famous |
| mai nā ali'i Kahiko | from the days of the ancient chiefs |
| he 'āina i piha ka e'epa | a land full of peculiarities |
| kau na nahi i ka pikopiko i ka he'e | for the scaling of the suckers of the octopus. |

Sterling p. 243

## 'Āina Momona

The people of old referred to ahupua'a with fishponds as fat lands known as 'āina momona. The idea of calling land fat alluded to the ahupua'a being rich with fish that could conveniently serve the ruling chief and his people with necessary protein from his personal ancient ice box.

This idea can continue into the fact that Hawai'i as a whole is truly paradise and Maui can accept the adage that it is "No ka 'oi" meaning the best, as proclaimed by people of old. The round-a-bout way of describing our report on Wailuku, Kula and Waiohuli is a device to showcase the entire island of Maui providing a glimpse of our

precious island while leading to this following summary which is based on the principles taught to me by my elders. The one principle that stands out when I think of the land we are reporting on is that it has the foundation of beauty, grace and charm and the time of its recognition will surface as time goes on. It already hosts many quality organizations. Maui has always attracted newcomers from all over the world and the different ahupua'a has had its strong attractive points.

## Synthesis of Archival, Literary, & Oral Accountings

Project area is located in what was a barren and transitional area of land. There are no signs of pre-contact settlement directly located in the project area due to lack of water. However, in the post-contact era, the project land was used heavily for Ranching and Kiawe. Interviewees do not directly identify any known cultural sites or cultural uses of the project area.

## Potential Effects of Development & Proposed Recommendations

Development of this parcel brings with it the hardening of more ground in the Kihei region, an area already pored over with concrete. Also, there is the cumulative effect of losing more open space in the area. Care should be taken with any grading, grubbing or other work that involves digging or moving earth due to the possible, though unlikely, presence of cultural features underground.

### *Cultural Advice*

In order to assure the cultural integrity of the project, a qualified cultural specialist should participate in various cultural-related activities. Activities would include the development and implementation of the cultural orientation for construction personnel, advice concerning inadvertent finds and related protocol, and any other cultural concerns during the length of the project.

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# Appendix A: Hawaiian Name Places for project Ahupua'a

| **Makai-(Ocean)** | **From Kihei to Keawekapu** |
|---|---|
| Kihei- | Shawl |
| Ka-ipu-kai-hina | Hina's meat dish |
| Kalepolepo | The dirt |
| Wai-māha'iha'i | Broken water |
| Ka-lua-i-hākōkō | The pit for wrestling; name of a chief |
| 'Ili'ili-o-holo | Traveling pebbles |
| Keawakapu | Sacred harbor |
| **Mawaena-** | **(In-between)** |
| Pulehunui | Large Pulehu;broil |
| Wai-a-koa | Water used by warrior |
| Waiakoa Gulch | |
| Waiakoa Homesteads | |
| Kü-lani-hāko'i Gulch | Agitated heaven that stands |
| Ka-'ono-'ulu | Desire for breadfruit |
| Waipu'ilani Gulch | Watersprout |
| Pu'u-o-Kali | Hill of waiting |
| Wai-o-huli | Water of change |
| Kë-ō-kea | The white sand |
| Kama'ole | Childless |
| **Mauka-** | **Uplands** |
| Pu'u Kahala | The pandanus hill |
| 'Alae 3 & 4 | |
| 'Alae | Mudhen |
| Ka-'ono-'ulu Gulch | The breadfruit Gulch |
| Kaipoioi Gulch | |
| Kōheo | To show off or to twirl |
| Wai-o-huli Gulch | Water of change |
| Kë-ō-kea | The white sand |
| Polipoli | Rounded |
| Kolekole | Raw |

## Consultant Interviews

### *Interview: Douglas Wayne "Butch" Akina*

**By Keli'i Tau'ā/ Kimokeo Kapahulehua**

### KT- Keli'i Tau'ā
### C- Consultant
### W- Wife of consultant (Mrs. Sandy Akina)

KT- So, mahalo for allowing me to come talk story, your full name.
C- Douglas Wayne Akina.
KT- No more Hawaiian name?
C- No more, Butch. My nickname Butch, everybody know me like that.
KT-Yeah, and when were you Grand Marshall? What was that? Kamehameha Day Parade?
C- No, Kihei.
KT- For what event?
C- For Kihei Community.
KT- Community, wow. So, Butch how old are you now?
C- Sixty three. Just made sixty three.
KT- And we're feeling the pains yeah of sixty three.

C- Yeah.
KT- But congratulations I heard you got some wonderful contracts, your business is expanding.
C- Yeah.
KT- More headaches but of course.
C- More headaches and the people not like, the workers not like they used to be. Today everybody is..
KT- Not committed.
C- No, they not committed.
KT- Yeah, money first and even then sometimes they don't show up.
C- The more money you pay, same thing. Doesn't matter it seems like only people want to work for money, not for the enjoyment of the job.
KT- The joy of working.
C- Joy of working is changing, the world is changing.
KT- Yup. Um, I don't know if your wife showed you the article I wrote about your father. I delivered, you remember when I used to come visit you guys? Um, but he, as you know was born on Kahoolawe.
C- My grandfather was foreman over there.
KT- On Kahoolawe?
C- Yeah, that's why they was there.
KT- Foreman for what?
C- The ranch.
KT- Ah, so how much do you remember of that?
C- I wasn't born there.
KT- I know but dad or mom them.
C- Well, my dad used to tell me.
KT- Yeah, what did he tell you?
C- How my grandfather was outlaw.
KT- Outlaw?
C- He was a smart little pake.
KT- So when you speak of Chinatown, which Chinatown?
C- In Kula.
KT- Wow, all the way up there! How they got em up there?
C- The Chinese like the opium so we used to take 'em up there for the Chinese. Us boys call
that was the reason.
KT- Yeah, um how did they get 'em up there though?
C- Kaluhi, he bring 'em up and he get good horses.
KT- Ok, rode horses all the way up.
C- Yeah, and then the cop trying to catch 'em but his horses faster than the cop! (laughter)
KT- So the cops.
C- That's what my dad told me, I'm just repeating.
KT- So the cops um, were riding on….just like cops and robbers on horses.
C- Yeah and then he jump on his canoe, they cannot catch him. He was a gambler too.
KT- So you think your father picked up some characteristics from tutu man?

C- Oh yeah, you always get that little lean.
KT- How many in your father's family?
C- There was only three brothers that I know.
KT- And you were the youngest?
C- No, his side, our side.
KT- So was John, your father's name was Alex.
C- Alex and Frank.
KT- Frank yeah, and then your father's children was. Where were you in the….
C- I was the last.
KT- You're the last.
C- I just lost my last brother.
KT- How old was he?
C- Sixty seven. All my brother's died, I'm the only one left. I still got four sisters left.
KT- So, is that to say the females….
C- Now, now all the females going like overrun me I have no chance.
KT- But dad left the business over to you.
C- I bought that school bus business over there. The tourist one I made. I went build that one up. I had to fight Robert's, Grayline. Took me six years about three hundred thousand dollars to get the license.
KT- But now you're the biggest.
C- No, in Maui maybe. For one small, in the price like me, them all around. But in Maui…..
KT- You got the most people.
C- Well...up and down. But my class is the better class. You know I cater to people; I don't herd them like cattles.
KT- Ok.
C- You know, then school buses. We was thinking about the school buses. That's why I came home for to run the school bus. Then Robert's went under beat us way the hell down to nothing just to throw us out to their control. Then Kamehameha School called if want to go back in and get into school bus they want me to run this school bus system. So I tried it, I did and then Robert's came in and under bid me. Well, they lasted one year and Kamehameha School threw them out because their service was terrible. They just want to cut you down and boss all the small guys around. That's how I started school bus again. State they can have 'em and sell 'em. They all bunch of hypocrites.
KT- You're the one working with them so you know.
C- Oh yeah like before they, you only allowed to own fifty percent in one island. When Robert's took over they was ninety percent! How the hell that happened. Right? How that happened? Politics all that bullshit. Paying, paying, paying. And then now it's coming to the point where Robert's under bid they losing money so bad. So now they going get the State. I know they going get 'em. Now the State going suffer. Instead they leave how things was, you know, everybody takes their districts and do your thing. But you know money talks bullshit walks right.
KT- So, you said you came back. Where were you before?
C- California. I was working for this company. I was the foreman up there.
KT- Doing what?

C- Spices. Making black pepper, making spices for Kentucky Fried Chicken and right, I busted lot of records into making spices.
KT- So, you already had your family up there? Sandy and….
C- No, this is my second wife, Sandy. I had another wife up there.
KT- So what made you go up there? Work?
C- Well, there was no job when I graduated in sixty-two.
KT- From where?
C- Hawaii.
KT- What school?
C- Um, Saint Anthony. I went to a private school. Then I had a job actually after I graduated I went to the post office in Honolulu into maintenance. Then I waited, waited about two weeks, nothing happened. I had my sister and brother up the mainland, oh come up. So I sold my car, bought a ticket, just then here comes the government, "you got the job." I look at the ticket and I look at that going to the mainland I said, "ah hell I'm young the hell with it. I'm going." Take the chance. That's how I went up the mainland. I wasn't planning on the mainland, I see how different nationality operated you know. After I saw that they ain't no better than me because I didn't know any better. That's how I started.
KT- For how many years?
C- I stayed up there about…. Sixty three I left here I came back 1970. But I learned plenty you know.
KT- What State were you in?
C- California, Anaheim. It was nice those days up there but not anymore.
KT- So, coming back to Hawaii you can remember your childhood days? What did you do for fun?
C- Fun, you had to create you own.
KT- Like what?
C- Well, I had a lot of nieces and nephews, I was the boss. Since I was the youngest of the whole family and they was almost same age like me. We made cowboy games and I was the boss. If I go smoke or do anything you gotta have one cigarette or whatever they give you so they can tell on me.
KT- So dad was really into fishing.
C- Yeah, he was. That's when I was young. And he always had school buses, but you know just for Kihei was small. I guess he saw in the future that it would be the future. So he kept that and run, run, run. Get bigger and bigger and I had my two brothers over here and they didn't want to run 'em so he call me up in the mainland. In fact before that I went up he went call me in the mainland he going buy buses in Chicago if I can help him go bring the buses home. What the hell, I never did drive one school bus in my life. So I went down the motor vehicle and I went try get a license. They told me you can't get a license you need a bus and everything. The guy told me what the hell just drive 'em go for it. And I never drive a school bus I chance 'em and I went. But I knew the mainland, I knew how to travel 'cause I been up there long enough and I knew it. You knew I knew the maps so my dad would depend on me to navigate how they going get back to California or Chicago. That's how I did.
KT- Wow, you had guts just to do that.
C- I did anything, I wasn't scared of nothing.

KT- So, um.
C- I started my own business up there too. After I quit the spice company I run my own business.
KT- What kind?
C- Ah, mobile home. Wipe 'em, wash 'em. Do all maintenance everything I had my own.
KT- So where did you pick up those skills?
C- I find people and people tell me, friends, "eh, why don't you quit this company and go with me." "Doing what?" "We go clean over here." "Oh yeah, let's go." I never even tell my wife, I went. I'm the type that would do anything. I not scared of nothing. You gotta chance 'em in life, right?
KT- So was dad a philosopher? Did he spend time with you guys to kind of…
C- I was, when I was young I was always with my father. I mean to me he was my idol. But I watch him what he do and everything I watch, I watching all his mistake. But those days when you young you cannot tell your father you wrong.
KT- As an example.
C- Like you know when we saw that some methods can do 'em faster this way. Why you do 'em this way? You don't know what you're talking about you young punk you get outta here. So, but you watch and you learn so I don't say nothing. One day I went end up with em on the fishing thing. In fact I never want to. My oldest brother died and my second brother took over, then my second brother told me, "You gotta take over because this is my last day. I never going come back." We was my house we was partying, singing songs all night long and singing, "I ain't coming back no more." Fine over there playing over my house. I was supposed to go fishing with them I told them I not going fishing. By that afternoon I had the bad news the crash and I didn't want to. Then my other brother came from the mainland said, "Who the heck going run this business again? Gotta keep up the name." I said, "I don't wanna." No, no, no. So, ok. "You sure you going stay work, now don't lie to me." You know he come from the mainland he been up the mainland all his life mostly. Yeah, we started all right. I learned I had to go learn how to fly. I was a pilot, learn how to patch net, I knew how to do the rest but I didn't know how to patch net. I had to learn how to do all that. And my dad was still living so he kinda teaching me, you know. And my dad wanted me to get back because he wanted the name, he didn't wanna quit fishing. To me it was a hard job. But I went notarize them and I saw too much laws of the State came. You can't come down the beach, all this blah. You can't do this, you can't do that. I was arrested in Lanai for throwing in the place. I don't see no signs over there. They arrest me I said, "You no think I really…" I take 'em I fight em in court and won. But you know, just trying to make a living. Why cannot fish over there? Why, you tell me why? Because why? Resort coming, you want only haole boys, you don't want no locals around here? What the hell. So I went and went and I see they close out more place and more place and more place I say I quit. That's not the first time they arrest me down there. But I don't stop it. But, when you throw out the current can move your nets into the zone they're not supposed to be. I can't help it the current moves there. I lost about 20 thousand dollars, I gotta pull my nets out. And then I say, I think it's time to quit. I ain't going fight the government. Why should I fight the government. I mean they just going beat you, they get more money than me. More better I just quit. And I sold my fish only to the public, never to the market. The

market never like give me my price. So if they not going give me my price, why should I sell them to you? I might as well give ‘em to the people for cheap, dollar pound and that’s it! Right? I did good for the people. Except you know, the market want to control the price. But you no take ‘em all and you going control. What I going do with the rest? What I going do with the rest. I might as well take out all the twenty thousand tons I catch, ten tons whatever. Why not give ‘em to the people for a good price and I still make money. That’s why when I see all that coming up, politics, closing here, closing there, can’t go here, can’t go there. Time to quit, right? Can’t fight City Hall. Right, can you fight City Hall? Just like right now they like close all the lay nets. Just like right now they like close all the lay nets why they don’t make say lay nets, home use only and don’t give this bull where, one hour, half an hour you gotta go check your net. You going jump in the water every night check your net? Something wrong with your head, right? And you don’t lay net in the day, you lay net in the night. You going jump in the water? Are you going jump in the water? What the hell wrong with this people? What’s wrong, where’s our culture? I can say they stop commercial on laying too much nets. Home use, never. If you get two piece net you want to go catch some fish for your family, don’t give me this law you gotta jump in the water every half an hour. And that damn turtle, the turtle all getting sick. They better stop that. They gotta control. And these damn haoles come over here they tell you, “You know Hawaiians used to control nature.” What the hell the damn turtle all get lumps on the head because before get a lot of food, limu, that’s what the turtle eat. There’s no more already. That’s why all the sharks coming in, you know that? That’s their favorite food. Because the turtle hungry and it’s so much they cannot handle already. They wonder why everybody get bitten by the shark. Oh that right the damn turtle, who making might of the turtle? The damn tour boats. That, we go turtle land all this pollution. And what’s happening? You’re disturbing the nature of the whole system. Not controlling ‘em, home use right? The Hawaiian’s like eat one turtle why not they go get one turtle. I not going commercial. We used to commercial turtle when we was by the by the government. My father used to catch that, I see ‘em. Today that turtle around, ok go ahead let em go. And all the sharks come in and you go swim, they going get you. You know what I mean? Close the beach, close everything. They let nature alone, they be better off. You gotta control things. I can say a lot of things, yeah. Commercial ok, fine. But you cannot be stupid. Still, but where the culture? I get net and maybe I like go out there catch some fish, I never jump in the water every half an hour check my damn net, that’s stupid. Right? That’s not one fisherman, these guys don’t know anything about fishing. If anybody fishing to protect the ocean it’s me. I know how to conserve them. You know what I mean? Akule, if you like salmon it’s spawn, it come big school you can never get rid of ‘em. And I can see the net can hurt the grounds and all that. If it’s done too much. But the Hawaiian’s never did do that. They just go catch what they want to eat, right? That’s conservative, but you get this other nets that come in filipino’s other’s start learning. They go out there and start catching for sell. Hawaiians go catch for the family. Now if you could stop that. Bad enough they’re already homeless. Now you starving everything right? Why you gotta do that for, right? Stop the commercial. Akule, no worry because it’s like a salmon. They spawn summer then they going come, there’s so much out there. And Akule is not a shallow water fish, it’s not. It’s a deep water fish. But they gotta come in

for spawn. And when they spawn they make millions and millions, you know what I mean, so you cannot hurt that one. That's like a salmon, right.
KT- So, when you used to go catch them it was almost like a cycle then?
C- It is a cycle. It's Salmon, same principle. We know its summertime is the best time. Wintertime come they gone because they spawn. Summertime all the babies come in they grow up big, fat. Now they come in to schools getting ready for spawn.
KT- So, when you're not fishing before? What did you go and do?
C- You gotta do, you know, whatever side job you can. You know what I mean?
KT- Oh, so ok. So you add.
C- Or you go lay net for go feed the family. You know you just for you go kaukau fish. That's why the went stop lay net, a fishermen need this, he need this, he need this. He not a cattle so you take your fish you exchange with the rancher and he give you meat and you give him fish. That's how the system works, right?
KT- Yep.
C- Right, it's no money. Nobody get money, you exchange, you exchange right? Or maybe I need carpenter job at my house, well you give the carpenter fish. He don't know to fish, so you give him fish, he help you fix your house. See, it's an exchange. But the haole boys come around here or who the hell that damn stupid state, or DLNR, whatever making all this law. Can't catch the turtle, or you can't do this. What you going do with the turtle, let em… there's no food, there's no food, there's no seaweeds out there. They went wipe 'em out, because too damn much, no control. Right? That's what the haoles say, 'endangered species.' You tell me there's when the damn thing sticking their head all around in the ocean. You told me that's endangered? You know what is endangered? The Hawaiians are endanger. If they don't have food, they don't have what they get, they all going die. That is endangered. What about all the Hawaiian's let 'em all die so they can steal all the land. In fact they like steal the ocean now. Let's put it this way. How come I no can fish over there but the haole can go there, can go snorkeling and make money. How come the Hawaiian's no can go fish over there? And you get some Hawaiian place down Makena only certain Hawaiians can go fish. What the hell that kind law? I don't understand that.
KT- So you guys used to, what kind of airplanes you used to fly?
C- I had two airplanes. And hangers everything, it was a big business.
KT- Where did you fly out of?
C- Only Maui.
KT- No, but…..
C-Oh, Kahului. Before we used to land over here you know the old way that. They just built that army place.
KT- Mokulele Highway.
C- They just built that arm place, used to be a big hanger over there. That's where we used to park our plane, my brother's side. My brother was the main pilot he went school and then I had to go school.
KT- So, during the fishing season, you guys, if the Akule schools was Kahului side you guys go that side.
C- We go, yeah.
KT- You just run your boats, launch out there.

C- All on trailers see we put them all on trailers yeah. Everything was on trailer. Trailer we had big, my brother had a sanpan, was alright but a lot of high maintenance yeah. I had everything. I had plenty skips. Six boats and well equip, plenty equipment. I don't see anybody was built the way I was built today. I was better than my brother, better than my father, I was more modern. But I just couldn't take the, 'closing over here, closing over there.' That's where the breeds go every year certain spots they were spawning, always ate. We knew every spot, the fish don't go anyplace they only go to certain spot. What the hell you close 'em for? And then they close 'em but everybody snorkel! And who's making money out of that? Oh you can't fish there but they allow snorkeling the tour boats can go but nobody can go, only haole boys make money. Just pull the Hawaiians ah, "no, no, no, no. Close, close, close, close." That's not right that's so bull. That's why I quit fishing. Over in Lanai they arrest me with the gun, on the boat! On my skiff now, I no even have one damn ID. On the skiff and they knew I was coming, somebody went go squeal. I gotta admit I knew was closed. I knew couldn't be there, but I don't see no sign in the ocean so what the hell I go for it. I tell you the truth I knew, but that's not the point. The point is why should you bring a gun to me on the….and they was watching me surround when my plane, my pilot was over there in Lanai waiting for go up. The cops was there everybody was there, why he never stop me now. Why he waited till I throw my net, right? Why, why you wanted to excite me with guns to our head?! And jump on my boat? You have no right to jump on my boat. That's communist. Why they never stop me? I fought them in court!
KT- What year was that?
C- In the eighties. In the eighties, in the eighties. When I was strong, I had a big boat take me over there, I knew. But that's not the point. There's no sign there's nothing. The sign is on the land, but we're not on the land right? But the police department was there, everybody knew the D&L was there. Why you never stop me and tell me if you throw your net I'm gonna arrest you? They let me do everything, they all sit there. I saw the damn skiff out there, I saw 'em. So I went they like confiscate everything, with the gun! From that day on I say I think this is the end of my era, as if, right? We took 'em court. But they only fight me little bit because after they was wrong because they knew. Why you never stop me, right? I no see sign in the ocean. They supposed to put sign in the ocean. I mean they made this damn laws, Hawaiians is pau already. Might as well give the damn nation go bury themselves and forget about it. It's true, that's why I'm tired of doing this, I'm tired of this bull. Damn Lingle like take this damn man away. And Lingle fighting me in court, because this is a residential. Since we were here there was no law, there was no damn code when we built over here and we run all this business here. We live Kihei all our damn life. All of a sudden, they come over here, "oh, you no can do this."
And he get free land everything, not free land, we paid for this damn thing. We build every damn thing. There was no code on what this land is. There was nobody. When we lived Kihei there was nothing! Nothing! And when I was young, Kihei was only Akina's. That's all had. We used to own almost the whole damn Kihei. Now all that and then that damn Lingle I tell her shove it. Tell her I said what the hell give the money back to the people. Don't give the money back. Fix the schools! Help the Hawaiians, do something! Tired of this bull. You know what I mean? I'm tired! I'm a business man, I'm not stupid. I mean if everybody listen to her the only reason she get one Hawaiian

next to her is because you need the damn Hawaiian votes, that's all she needs. That's true. We've been here all our life, even when I went to the planning committee stating should've put this automatic to commercial. How come they changed this they go make this no zoning, right. All our life we live here. All of a sudden, oh this all residential now. What I supposed to do? Right? Oh, you gotta get out of here, we changed the law. Who is the people? Who is the government tell you get the hell. Eh, cost me, how much that went cost me? Shoot cost about 200 thousand to fight the case! At least 30 thousand I know to fight the case. Or else I gotta get out of here, and where the hell I'm going? There's another Hawaiian down to the grave again. What happened? Eh, I've been through a lot of courts and everything. Just to get one license. Bum bye make two of us, cost me 300 thousand dollars to fight Robert's and all these guys. Where's the poor Hawaiians? I thought the Hawaiian's, I thought the Hawaiians, you know get some rights. We have no rights, shoot we no belong here. I get more work in the damn California, I think.
KT- So when your dad was living you guys used to go all the way down Makena pick up kids? Or did they have to walk in somewhere over here?
C- Oh, Makena hardly anyone. Mostly we pick up the whole Kihei.
KT- Just Kihei?
C- Well, way back you know you talking about banana wagons. You're talking way the hell back. Actually if you talk school buses from my dad's time to me continue, looking pretty close to ninety years. Eighty eight is guaranteed!
W- Nineteen twenty eight.
C- Yeah, till me still running. And then you get these jackasses that on island that never did do transportation school bus. And they come here just to throw you out so they can control 'em, just beat through them cheap, it's impossible to make money. Now they suffering.
W- Yeah, nineteen seventy there were forty one contractors in the seventies. Now there's only ten.
KT- Forty one…
W- Contractors within the State of Hawaii. On Maui, Maui had um I think about thirteen or fourteen.
C- No, more that much.
W- No had, had. Now it's only three.
C- Not our area, our area was only about four.
W- When we bought it, yeah.
C- Was only about four.
W- But when your dad was….
C- See the law was in Hawaii a contractor can own only work fifty percent of one island.
W- But we took over, yeah.
C- No, that was the law from when I was in. When my dad was in a contractor can only own fifty percent of one island, one county. Like Lanai, and Lanai and Maui all same company. You can only own fifty percent. When Robert came in he end up ninety percent. I ask him how come is that? Well, well, well, well, well….. (laughing) Forget it, they all bunch of crooks. You can tell 'em I say too, I don't care.
KT- So Sandy, you're not from this island but.
W- No I am from this island. I'm from Waihe'e. Waihe'e valley.

KT- Oh you are?
C- Taro patch country.
KT- So when you look at getting involved with Butch you knew that his family was literally the family of South Maui?
W- Oh yeah, when we grew up um…
C- Everybody thought we owned the whole Kihei.
W- Yeah, um when we used to come down to the beach on weekends I always thought that beach, Kamaole I was Akina's beach. Because I always saw all their skiffs, the nets all laid out there. So we never went swimming there we always went down further. But I always thought that that was Akina beach. I was surprised to find out it was Kamaole I.
KT- Is that where your father built, he had a bar 'eh?
C- Yeah.
KT- Right there?
C- No we had what you call Seaside Tavern. There was a war, during the war, we had a camp right next to us. Ten thousand troops right around us. Nobody could come in, we could come in, we owned it.
KT- So during the war your dad's fishing business was still going on?
C- Oh strong boy he had to go catch turtle for the government for feed 'em. Big kind turtles, three hundred pounds you know that.
KT- And you went out with them?
C- I was young so my dad tell me.
KT- You had any idea on how they prepared it to eat?
C- Oh that's good meat boy that's steak.
KT- Steaks? Like how we eat?
C- Oh yeah! That's better than the cow. Or make good hekka, soup and you know the oil from the turtle we used to boil and save the oil. If you get burned, put that on you, never get scar.
KT- Really yeah.
C- Never scar. We had 'em by the gallon, somebody stole 'em all. Like it would never scar, you get a burn you put that turtle oil on you, you never scar. Sting like hell!
KT- Our people learn a lot on survival.
C- Yeah, but he wasn't, my dad that's all he did was fisherman really. He brought all of us up all eight kids. Of course he had a bar and all this but tt's like a Seaside Tavern. I was young boy. I was born in forty three after war, but my dad used to tell me, you know. I remember money, you know in the closet like, you know like we never know what was the value of money. We just go grab 'em put 'em in our pocket, what's that we going do with 'em, everything free. Stole there, candy there you know everything's free right? So value we never know, I was young though. But after the was then times came hard because the government not around.
KT- So what kind of families, you remember, used to live in Kihei when you were growing up?
C- Umm, never have too much really.
KT- Was the Plunkett's here? Was the Moikeha's here?
C- Yeah But the Plunkett's was here when had the, the plantation time. You know when? You know I go Suda Store, this used to be A&B and in the back over there is the camp, the sugar camp. And had a theater, open air theater you gotta…

KT- Drive in?
C- No you walked in but it's open air. You know ten cent and certain times you take canned goods it's all free. That's all, I remember that. And you sit next to the Filipino's they smoke Tascani no more the mosquito. (laughter) You sit next to them, they no understand what you talking about that's alright. Open air theater, yeah, in the back of Suda Store. Used to be not Suda Store, plenty people owned that before Suda but A&B used to own that used to be like a two story bedroom. In fact you know how Hali'imaile, the General Store that's how used to look like. If you look at that, look like that. I remember, I was young kid you know. But I remember a lot of stuff cause I was kinda always nosy looking around what else to do. You gotta remember you know, I'm the youngest of all. The whole family so I just remember things but I remember.
KT- Of the boys, who was the teacher in the family?
C- My oldest brother used to be just like my father.
KT- John.
C- No, oh the oldest boy Frank. He was the contractor. In fact he was one of the biggest contractor in Maui. Heavy equipment.
KT- What was his company name?
C- I don't know, I guess maybe Akina Contractor's, I don't know. And my other uncle he was kinda fishing and doing odds and ends job. My old man was strictly fishing and school bus. But my uncle Frank was actually the top man. He was big in construction.
W- But your dad was doing the fishing and he was doing the wood.
C- Wood, you know those days, survival right. For the government, he used to fly for the government everything right, that was those days but my uncle Frank actually was heavy equipment contractor. In fact when I was fourteen years old I used to drive the truck, construction. Big truck, no need any kind license no matter.
W- You folks owned Seaside Tavern before you sold it to Aunty Becky.
C- Yeah during the war, during the war. We lease 'em, we owned all the land, when we sold the land, everything gone. We leased 'em
KT- So when you said you owned all the land, can you give me an idea from where to where?
C- Oh Kamaole I we owned eleven acres then we owned all the way up eleven more acres.
W- Fourteen acres.
C- We owned the land all around the place.
W- Twenty eight acres my father-in-law had in that area.
C- We owned plenty land, you. Way up there, way up here.
W- By St. Theresa's somewhere they had property over there too.
C- My uncle them owned more land, they owned plenty.
W- And where Billy lives too, right? Your father bought that place right?
C- We owned land all around Akina's used to own 'em all. Nobody want to live Kihei, hardly any people. There was no sign, street name; you gotta know all the green house, the white house, that's all you know.
W- In fact when we grew up we used to call the Kihei people kiawe beans.
C- Cause we eat kiawe beans too! You ever eat kiawe beans? You gotta get the one in the sun, just like jelly beans we call them, go eat.
KT- Dry?

C- Yeah, good eats. Yeah the one in the sun you pick, sweet. The cow can eat 'em, you can eat 'em. Those days was starvation. (laughing) Was hard days but was good days, good days. We had no white man around telling on you. In fact white man was all Wailuku, Kahului, Makawao, Kula and all of that. Everybody scared. Till I went mainland and said this damn white man ain't better than me son of a bitch still in the sewer too I say to 'em right. And I learn right. They wasn't any better than me, in fact I was better where I was, we had a better life, cleaner life. Today, forget it.
KT- So, you never spent any time on Kaho'olawe with dad?
C- Oh I used to roam, I used to roam that island when it was illegal I was on the whole island. I know every part of that island, I know everything. We used to go hunting, fishing, I got caught lot's of times there.
KT- Before they started bombing it.
C- Yeah, we was on there when they was bombing. (laughing) No, when they was bombing we was there, but during the weekdays they don't bomb they let you know they not bombing. We used to go there no bother the government, the federal never bother. It's when the damn State took it over. No can go over there, what the hell's the difference, right? Now open days you can go, same federal, why the hell can't do any day. Then the Hawaiians come, oh preserving the fish. What preserving the fish? Not preserving the fish.
KT- What kind of fishes you used to catch over there?
C- Whoa, there's a lot of fish. Any kind you like. Anything you know.
W- Like what?
C- Holehole, moi, marlin, anything. Anything you want. Ulua's rubbish, that's a rubbish fish. Anything you name it. Opihi, you sit on the rock, you don't go da kine struggle looking under the hole. You sit on the stone and you eat. But we only go over there and get what we need for our luau's and that's it, we go home. The Hawaiian, they know how to preserve you know, they don't wipe 'em out. We don't sell that kind stuff, we just go for the..our own use. I'm a commercial fisherman. I don't go out there kill the ocean, I know how to preserve.
KT- Did dad talk to you guys about taking care of the land?
C- Oh yeah. He would always say, why go kill 'em.
KT- Never used to have as many goats when you were growing up, I mean deer.
C- No, that deer never come till later.
W- That was introduced by our neighbor…….
C- No way, no way. It was introduced by the State. He was only one game warden that's all. He ain't never introduce. They brought only four I think, yeah. Actually, it was involved with the ranch. The ranch was looking for the future. That's why you got, one day the deer comes you get one on the land you going charge for hunting. It's all tricky they ain't stupid. You think the ranch like the damn thing on their land going eat all the grass? But they was thinking, what is the future, right? What the sense, you no can hunt on the land. Nobody own the land, who own the land? The ranch, where was the damn deer? On the ranch, right? So maybe one day we go make money we go charge people come hunting in my land. You ever thought of that? Who own the land? The Hawaiians own nothing, who owns us. They went buy the ranch how long, the ranch get cattle the deer going eat all his grass. So why the hell you all that? No, that's what it is. Eh, you think I was born yesterday? You think I stupid? That's why you gotta think

right? What you think, what the Hawaiians went go put 'em over there? No way, correct. The ranch went go put this. So one day they can charge people for go on their land. Today, same thing; you like go on my land, oh you going get permission, maybe I charge you. You look today, all the ranch no more cattle over there, you see any cattle? But their land, they still paying the cheap tax, right? The same as us. The sugar cane, now they selling all their damn land, making big money. Why they no get rat for all that taxes, the back tax like. They selling all the land, Hawaiian's lose all their land because the government come in and "oh, you get our land, we charge you all tax." The Hawaiian's no can afford the tax, all gone!
W- That was my father's situation. He couldn't afford the tax so they was gonna change.
C- Too much land we own, so they push you right. They force you in the back door. The haole's from the mainland or whoever like the land raising the tax. No can afford, he no work for nobody he had nothing. Gotta sell land over there because my father was sick, he had cancer. Couldn't afford the doctor's so we had to sell the land for pay the bill. What you going do? What you going do? No more insurance.
W- So he sold it to…..
C- Was bought by the Canadian. My father no work for nobody, I mean there was nothing in Maui, right? Really there was nothing. In the sixties, nothing. There was no job that's why everybody had to leave. You know the part of the problem is the taxes got to him. They don't give you because you live there all your life and then they tell you, "oh no need worry about the tax." No you pay your taxes or you going lose your land. And who the hell, who's the big boss? All the haoles in the back, they like grab all this. They see the future, so that's why the Hawaiian's lose every damn thing, and it's still going on today just like this land. Same principle what went happen to us. Oh, we change the zoning, you don't belong here because that's not a business zone. This is residential, how the, I was here before that damn residential came up. So I had to fight 'em in court now it costs me money. Lucky I had a little bit money. But that's why no can make money because every time I fight 'em in court, fighting in court. I getting tired of fighting, next time I'm out of money shot everybody be a renegade like Ben That's true, right? You only can push one Hawaiian in one corner so long. That's true, you want to know the truth, how I feel I tell you how I feel. I mean I help, I do this I help out a lot of families this damn jobs. And teach 'em not only you know. I teach 'em culture, I teach every damn thing. You know what I mean, haole's come in run the damn business now these boats own all these tours coming in these big boats came in, they own 'em all. They the owners. Not local people no more own tour companies. I think the last is, Robert's the last but he's going down the drain too. It's all these mainland people coming in taking all this damn bull. What you going do? You can't do nothing, right?
KT- We gotta educate our people.
C- How can they all….
KT- Fight 'em in the court.
C- If only the Hawaiian's get together and stick to one nation. Not one group here, one group there, one group here. No can. I'll tell you a good one. I was on the board Kahoolawe, right? When they first started. I went in the…. So we was sitting on this table, all us guys. So they ask everybody what we going do with Kahoolawe? Everybody come, well…we go and only Hawaiian's can go over there. Fine with me. So they came ask me. I said you know what we should do? We go put one gambling casino

on Kahoolawe and then that's where the Hawiian's going get some money, right? Make more sense right? Cause how the Hawaiian's going get over there? They don't own no boats, you going swim? Canoe? I don't think so. They fired my ass off the board. Never did call me back, fine with me. I don't care because I hate meetings anyways. What would you decide? I mean if you get a something, somehow you gotta create money right? Right? And if the Hawaiian's can make the gambling like the Indians you can create enough money so the Hawaiian's get power. Money talks, bulls** walks I going guarantee that, right? They fired me off the board. Never even tell me nothing, never call me back. Ever since then. Lot of them don't even know my father was born over there that's what they knew about Kahoolawe. And they never been on the island. I've been on the island before they was born. Ask my wife, I used to take her over there pitch dark I used to take her over there, two o'clock in the morning. "Where you going?" "I going Kahoolawe. I going go pitch 'em. I going park in there go sleep. Then tomorrow I going bag up fish I going home." They think I crazy! I go right in the bay, pitch dark you no can see nothing I know where to go because I've been there lot of times. And we would go over there just fish enough to go home, then we go home. Opihi, anything, but those days are gone. Forget it. Whose running that? The Hawaiian's or the State? That island right now? Who own it? I thought the Hawaiians own it but the Hawaiians' got no say. Forget about it. I tell you Hawaiian's if they don't shape up now, no can. Kihei, forget it you don't see one Hawaiian walk on the road no more. If you do they all dope up or some damn thing wrong with 'em or they homeless. Why? They did it themselves, they fight each other. Forget it, right? They don't get together, be organized right. Tell you right. Tell you straight I don't care, jeez!
KT- You know like the high top out there that didn't bring it back.
C- I don't care, tell Mr. X that I said too, I no care.
KT- Nah, we don't need to say that.
C- No, one time he asked for help I gave 'em all free. Then my mother in law all them wanted to go see, they had all the Hawaiian performance. I short ticket, two tickets. My father in law just like go hear music, they old people. Oh, no I no can give you that. I said, "what do you mean Mr. X? That's for your da kine, your ohana. You mean they gotta pay? And I give you everything free, go pick up all the musicians, send all my buses down there." Cannot? I don't think so. You think that's right? You know Mr. X he passed all the land you no his big mouth oh the Hawaiian's no can here. But you give him one piece of property ah, he go pass.
KT- Sandy what is this?
W- Oh I wrote the script for that when we had our family reunion. It's about the family.
KT- So, can I look and?
W- That's for you to, yeah. To, you can have, you can have it and make copies.
KT- Mahalo.
W- I had a professional come in and do the editing and taking the…I wrote the script out and he went to different places as I wrote it and he read off my script and put it together for me.
KT- Great. You got a hard copy of that script?
W- Volumes and volumes. We went through, it's binders and binders it took me a long time to write it and it's down below.
KT- Excited to look at it.

C- I don't know. I feel sorry for the Hawaiian's and how they fighting and all this kind. I don't know. Like, what I no can understand too, get the Hawaiian homeland. This Hawaiian go inside there he get one, then pretty soon where the hell he went? He went go sell 'em to somebody. That's not things to be sold. If you don't want to do nothing with 'em give 'em to the next guy and he buy it. Ha? That's not right that. That whole system's getting screwed up. You know what I mean? You cannot go start selling or trading. And if the guy get big land all around get house everything give the first guy no more nothing. He get the first choice, right? Give him one chance. Not the kind guy get everything already. I mean they get the system wrong, they gotta check background or look at this. No, no. The next guy get 'em. And this guy get a land over here, Hawaiian land, he still get his house over here, right? Now he go rent house. What about the guy no more nothing? How come he no more the first choice? That's what I don't like about this system. I don't think that's right. And you cannot tell 'em if you don't tell you gotta tell 'em go right back into the pot. No more such a thing as selling, right?
KT- I was surprised when I heard that that's what they were doing.
W- We know people that had three properties.
C- I know a guy don't even get Hawaiian blood get 'em!
W- They sell it. They sold the first.
C- I know guys no more Hawaiian blood. See how crocked coming. The Hawaiian's their way, I mean. That's why sometimes I like nothing to do with it, you know. I get 67 percent Hawaiian but I just don't agree with that. Give the guy that need it first. If you got a home everything fine. But don't go keep your home and then go Hawaiian land and still own over here, right? Or if you get one, give 'em for your kids, now that's different, right? Blood line, right? But that's not right that. That's getting greedy that's what you call that right. Playing politics inside that system. That's what it is.
W- And then you have the old people that still on the list quite a way back and never get there yet.
C- That's wrong that. That's why I stay away from the Hawaiians. They call me. No, no, I don't want nothing to do with it. I no bother no more. You know what I mean? I was kine arrested but I pau. I don't think that's right what they're doing.
KT- On the maps I saw what they call this side Waiakoa Homestead. Are you familiar with that?
C- I don't know.
W- Kula one.
C- Oh, Kula one that's the place yeah, nice over there. In fact my grandmother, my grandfather is Thompson. My grandmother the one own all the land from, after you pass Kula, all the way down to Wailea, she own all that, my grandmother. Thompson, was German but my grandmother went own all the land from the King. From the, all the way up there all the way down to Kihei. You know Thompson Ranch? That's my grandfather. But in order to get the land you gotta be my grandmother right? Had the Hawaiian blood.
KT- Still in the family.
C- All gone.
KT- All gone.
C- All gone.
W- She was um, what did she do for the king? The queen.

C- That side I don't know too much. I know my grandmother, how you going get the land those days with the king? You gotta be the Hawaiian, my grandmother the one own all that. See, the Thompson get five wives. We come from the first one. The first generation I come from. My mother was a first generation, Thompson side. Dunno all the history. What going do? Right, we're sorry, me I getting old already. Just gotta do what I gotta do, survive my family and that's all I can do.
KT- So what he just said is in here? The Thompson connection.
W- This is the Akina side.
C- Thompson is my side. That's my mother's side.
KT- So you got all the pictures of his brother's and uncles?
W- As much as, some of it. I don't really remember it was I did that in 1997.
C- That was our first…
W- Our first reunion.
C- We were going mostly all lost already. We just lost my brother about a month ago.
KT- Natural causes of death or?
C- Heart attack.
KT- Heart attack.
C- My oldest brother died in the car. My other brother died in the airplane. Terrible kine accidents.
W- Your dad died of diabetes.
KT- Really?
C- He was eighty two. He was good shape, I don't know why never catch diabetes long time ago.
W- Well, they knew he had diabetes but he had cancer of the colon so they did the chemo they had to stop the diabetic medication.
C- Came worse.
W- So then when he was cured of the cancer then the diabetes came. And they were supposed to amputate his leg but then…
C- I think that was better because I don't think my father like be in one wheelchair, he was too hyper.
W- He was a strong man. Very proud man.
C- Brain strong till the day he died. My mother died when I was young. I was only like about sixteen. Was hard on me.
KT- So dad brought you guys up then, yeah?
C- Not really. Only me and him left. Everybody was gone already. I had my oldest brother around too he was just like my father, my oldest brother. And when I get mad with my parents I run too. They all come up there, if not my oldest brother come. I was the rascal one, I always moving. Like when my father them fight, you know how brother's fight right? Me I go over there ah, it's like nothing. I didn't care, that's not even my problem. I go my uncle's house, I visit 'em all, I no care. Right? That's the way I was, right?
KT- So you were saying there were family feuds?
C- Oh yeah, always one. Three brothers.
W- There were three brother, yeah. Was Frank, the oldest was Frank then John then Alec.
KT- So there were feuds?

C- Yeah but little while, then pau, come back. I remember like New Year's everybody get around and all the fun, party make one. The party last for weeks. One family going make, that's one week. The other one make one week. The other one make, one week and never end. But I was youngest but I always observe things. I watch, even today in life. They tell me how come you know? I say you gotta look then you see things. Always look then you learn, right? Never close your eyes, right? Till you go sleep.
W- What was that incident at Suda Store, Akina's fight and the feuding?
C- Yeah, my brother losing. My oldest brother losing, this guy like bust up my brother, the other one come around. My father come, I was young though, that was before my time. Family always fight each other but they forget about it. One thing with this family, they'll fight but they'll forget about it. Never last forever. Those days no more nothing for do anyway what else you do? No more TV, right? What else for do, right? You gotta think it's that way right? No more TV, you know how bad boys right? Yeah that was their enjoyment, what the hell. Nothing else for do, it's all family anyways they not bothering nobody else. But nobody better come in Kihei and play with us. Oh boy, that's it. Everybody join, they join. Ha? Cannot come you know like Makawao, Lahaina or whatever. You no come Kihei, you don't ever enter. That's how those days used to be. Then they joined back again. You know we fight each other but the one's outside come that's haole's for you. Those was old days right? What the hell there's no TV no more nothing, that's something. You can't be happy forever, right? Big families, my house had kids sixteen kids. Two sides, we was the smallest only eight! The other side sixteen. Right? And they all big, you know? It was a hard life, I mean it was a fun life but it was hard. The old man's icebox never very much food or get fish, you can only eat fish so long, right? But we survive 'em right? I think was, sometimes I look back it was better days. You thought it was hard but survival. I was young boy. I'm the youngest in the whole Akina family, I'm the youngest. I mean all my uncle's all their kids, everybody I'm the youngest. My father the youngest, I'm the youngest. You know out of the whole clan, you know the whole family, I'm the youngest. Still surviving and I'm the only one still doing business with the name. That's why I picked the name to keep the name going, right? If I go, I don't know who going take over.
KT- You no more sons?
C- I get one but….my daughter maybe. My son is too playboy.
KT- He married?
C- No. Playboy you know.
KT- How old is he?
C- Twenty eight.
KT- And your daughter how old is she?
C- Thirty. That one work hard.
KT- She come and work with the.
C- She's the General Manager. She asked me one day, "Dad, why can't I be the General Manager?" "You want to be the General Manager, take 'em!" She's doing a good job, hell of a good job. I kinda semi retired because I let her run 'em. Give her a chance. I'm in the back, she asks me questions do 'em this way. I kinda stay away.
KT- What's her name?
C- Cassie.
KT- and what's your son's name?

C- Douglas, same as me. Douglas. He still playboy, never grow up yet. I get one other girl but she's in some foreign country someplace I don't know. I get the grandkids, my grandkids I take care one.
KT- The girl?
C- Yeah.
KT- That's Hawaiian way, yeah?
C- What you going do, throw 'em around? Get two. But one my other nephew took 'em. They adopted 'em. This one I found the father, not bad he call every time check. He cannot handle so she stay with me.
KT- Well, Butch I appreciate your time for talk story. Can I take your picture before I go? Just right here. OK.
C- Yeah. I had a hard life.
KT- Sounds exciting.
C- I love to invent things. I'm the type that I gotta do better than the next guy. In fact I was the one really made the tour company shape up. When they came in I bought tour buses that nobody had in Hawaii. They thought I was stupid cause the buses get video inside, TV, karaoke. They thought I was nuts. Today what? Everybody gotta do that, right? Yeah you ask my wife. When I first started tour, I came in with the best equipment ever had in Hawaii.
W- Right, right.
C- Big shows in Honolulu, the best everything had. They thought I was nuts, today what, everybody gotta do?
KT- So your husband had a vision.
W- Yeah, he's a visionary. That's what he is; he's always ahead of his time.
C- I gotta tell you one thing. My wife went help me plenty. She learned plenty and she did help out. Only true love stuff, yeah. She's a good woman.
KT- I'm glad to hear you say it.
C- I hardly say it anymore. It's true though, my wife is good. She thought I was nuts sometimes but not really.

C- Pick up and let go the rest.
W- So what we did was we called, um….Ulupalakua.
C- They all came help us, they always come help us.
W- We told them bring whatever you have.
C- People came from Hana. I give away over three tons to them, they don't know what to do with it.
W- Whatever they could load in their truck, they brought.
C- Then I let 'em go the rest. Give 'em back, you know give 'em back. I never kill 'em, make sure my bag is, I let 'em go. I let 'em go. I get enough fish already and what I going tell. Day and a half was sold.
W- Then we came home, by the time we got home was like four o'clock in the morning. And that's from all day and all night and then coming home. And I thought oh my goodness I gotta go teach because I was a teacher. I didn't have substitute plans so I had to go teach, so what am I going to go do with all this fish? I gotta sell the fish. I had peddlers, my bus drivers that would want extra money. Frank them would want extra

money. And I would have them buy it form me and then they could sell it. No more than dollar, whatever price I set they had to stay there.
C- Dollar quarter you go, if I sell dollar you sell dollar quarter.
W- Yeah, if I sell seventy five cents, you can charge dollar. You cannot make too high because it's not right for the people right? And so I'm sitting in the, full of scales, in the bathtub I said what am I going to do with all this fish? So I called the three stations, I used to always advertise with the Filipino's yeah because they love the fish. Three stations and then I said ok I gotta go to school so Iwent to get my kids ready to go to school And he drove bus and then in the afternoon I went running down I said oh you pick up the kids and I'm going to go into town because that's where we had the whole thing situated in town at one of our bus driver's property. And I said I'm going to go help her and he said help her? Help her what? I said sell all that fish because we had tons we had about 10 thousand pounds we brought out. And so he says, "there's no fish left." And I said, "Are you kidding?" No, people had like, it was like a circus they said. It was around that Mokapu, Mokuahu, I forget what street. But anyway um people were lined up. Even the mayor's wife was there.
KT- Who was the mayor then?
W- Hannibal Tavares. And lined up.
KT- Japanese?
W- Yeah Japanese and Filipino's.
KT- No but the mayor's wife was Japanese right?
W- Was Japanese yeah, loved that fish. And they just, it was all gone by the time school ended at two o'clock.
KT- What year around was that?
W- Had to be in the eighties. Yeah, had to be in the eighties, late seventies, early eighties.
KT- So you guys were really busy yeah?
W- Oh yeah. You know at one time we ran five businesses.
KT- What were they?
W- We had um, rooter service. He was the first one to have to do rooter service on Maui, before Roto Rooter even came. And then we had um cesspool pumping. And the bus business we ran for my father- in-law. And he used to blow wells, he had um these wells that he had to blow for people when they would get clogged.
C- Oh yeah I never tell you how many businesses I used to own too yeah?
W- I said five, right.
C- And that was all same time.
W- Yeah, and the fishing and then I was doing real estate on weekends. And I was teaching.
C- I was the first guy brought Roto Rooter in, in Hawaii. Maui, I mean.
W- It wasn't Roto Rooter, it was Maui Roto Rooter.
C- But same principle but I name 'em different. In fact Roto Rooter like sue me because my name was too close to them. So I had to name 'em, what I went name 'em, Maui Rooter? I had to change the name, they tell me that or I going sue you so I change the name.
W- We had to change the advertisement too because the….
C- Change advertisement, what I had? Pumping.

W- You had pumping, you had cesspool, you had Rotor service, you had the blowing the well and the fishing. And we were running the business for dad, school buses. And then I was doing real estate on weekends and on top of that I was teaching! (laughing)
KT- So what made you guys do this?
C- At that time I had nothing to do.
W- Survival. We just had that energy before, you know. We were very young, we were young and we knew we had to make it.
C- I was in my thirties. I'm the type that will go for it. Nobody teach me, they teach me little bit. After that I do it my own.
KT- So after how many years, you retired from school teaching?
W- Um, I started in '69 and then I went to the mainland and then I came back in'71, no '70 and then I started teaching again, yeah. I retired actually after vice principal at Maui High School and that was in '95 I retired with enough years of service and you can, I have 22 years accredited of full service. But that's because I took like part time work. You know I do part time teaching so I could run the business, the businesses with him so I could help him.
C- The reason why I went into pumping, I tell you why. This one guy, he did all the pumping. So I told him one day, "Eh, give me your card. I got a lot of jobs for you." To drain, I know the cesspool whatever need 'em. He look at me and he walk away. Eh! Ok, come home tell my wife I'm going to be a pump business. And I did it! He take one week, I took one day and finish the job. That's how. I threw him out of that business. I ask him I get a lot of jobs give him customers I can tell 'em call you, he walked away! Oh no! After all that I going into pumping. (laughing) And I went go see this guy he get building this, he get big tanker, I like 4000 gallons. I like this I like that. "Eh, you sure?" "No worry." Ok no more afraid. And what he do throw 'em water everything. I didn't want 'em all I ask him I just get job for you. That's all I said and he just walk away!
W- We even sold fishing nets, we went to town.
C- Oh yeah, plus I had, I build nets, I build everything. I sell 'em. I had a big business going on, on the cart everybody.
W- We could get free yeah? Our nets, we brought extra and then we put the….
C- Back then was too expensive so I went Taiwan buy all my nets for all my fishing. I tell, eh I going buy 'em might as well build all the net, build everything.
W- And then we would sell it to the people.
C- And then I tell people I sell regular net and I had longer net and better price. Geez, I made a killing. Pretty soon I get tired you know. I get tired of business, ah I give this up.
KT- Bored.
C- Bored! I had everybody come over here all these guys, you like drink? Yeah come over here drink maybe. Oh, we go make lead. Eh, they like that they had fun. Of course I teach 'em right? I teach 'em how to make net, they all learn. I think my wife did.
W- It was, yeah he taught us. All my kids, we make um the nets and he would tell us, ok.
KT- You had a system.
W- He would say I pay you at the end of the summer so you have money for school clothes. Crazy we would have to whistle, we never got our money. That ok we all had fun.
C- What they learned?

W- It's like the fishing too, was like a family thing because this kitchen was built for that. For their fishing.
C- That's how this kitchen was built.
W- Because I had to cook and I have huge pots. I had to cook pots and pots and pots of food and I had to take all the beer and all the fish you know in the back of my, my I had a station wagon that was like should be for a taxi.
C- I bought her that station wagon because we had a Mustang. That damn Mustang ain't worth shoot, I go turn 'em in brand new. I said I should've keep 'em worth a lot of money. Ah, turn 'em in go buy the station wagon so we can make use of all that. (laughing)
W- So I would see the kids out of the tuna boat, yeah? So we pack up. I couldn't go down to the beach with less than seven cases of beer. And all this food and all the fishermen.
C- That's all my kids always with us on the beach.
W- Yeah, who would all come with their family, and they knew they he was going to be there.
C- All his family and his kids all come. We would stay overnight, two days, three days. Sometimes one week and all the family come and everybody, right?
W-They're families were there.
C- And you know all those kids small and then but all taken care of right?
W- And everybody had to work when you get there because you had to haul fish, you know.
Everybody had to work, we had to haul the tadai's hundred pounds we have to carry. And those days, you had to lift it up and give it to the guys and dump it into the big containers with ice yeah.
C- And all my equiptment was A-1 shape. I had mechanics take care of everything. Painting, all nice, we not going on the beach look like one junk. Everything was look nice. Painted all scrape up.
W- And then we would come home and then it was up to me, what I going do with this fish right? And these guys all too much you know and everything so I had to call for ice. And I would have to drive the truck. I tell him, "you take home the kids." I just take my oldest daughter, that was his oldest daughter from his first marriage.
C- Was steel covered.
W- Yeah, I would take my oldest daughter and we'd go, we would drive up to Wailuku and they would open the plant for me. The ice, for the ice, block ice. They load it for me in the back of the truck, come back here my daughter and I, two o'clock in the morning we were loading ice into the big truck to save the fish because these guys were all…
C-What do you mean? Had the Bank of Hawaii manager deliver ice for me.
W- Yeah, he was our ice man. We used to have all kinds of people come.
C- The bankers deliver ice to me that's his job. Sleen my car was.
W- Alvin, Alvin Nishihara.
C- And he go on the boat too! His job.
W- And he loved that! He enjoyed it you know it's so different from what he had, the pressure of the bank, right? Come out and do physical labor.
C- Had all these business guys used to come, run with me. All business guys come help me.

W- And everybody get paid with fish. Take home fish.
C- Well, that's better than money, no tax. And when I give fish, I give fish. People would come help on the beach if I see one old people over there on the beach, I tell 'em take this and go give to that old people. If I see old people at the beach, you know Hawaiian's like that sitting around, go take this fish and go give them. Because they get too much pride I know that. Take 'em, give 'em.
W- I couldn't sell. If we caught less I couldn't sell. That we would have to give.
C- I would give away.
W- All of that give away. That was my father, my father in law always told me that Akule, Akule, that kind of fish you have to take care.
C- It has ears.
W- Yeah it has ears to hear and you must take care and you always give, you always give you don't just keep you know. And we learned that and we did well.
C- Lot of old people I see them around. I know they hungry they like eat fish but get too much pride. And whoever working with me, eh go over there take this fish, maybe take twenty pounds, go give that to the lady over there. I think maybe that's Pele or something. Go give 'em anyways.
KT- Clear that up with me again. If you don't keep, catch a thousand pounds.
W- No if we, if we.
C- One ton.
W- Yeah, we had to catch, for me to sell it has to be over two thousand pound before he would allow me to sell. If less than it's all give away.
C- Cause I get all my fisherman, I get all my friends. That's all give away. I won't sell anything. If I catch two thousand pounds to us that's bad, bad, bad. I rather give 'em away. I lost anyways so what's the difference, might as well give 'em away. If you going lose might as well lose all the way. I give 'em all away.
W- Well, it's always taught, his dad said you gotta give.
C- No, I always give. No matter I catch 30 tons or whatever, but it doesn't matter it's. I already lost money on two thousand pounds so not going help me anymore, might as well give 'em all away so people still come back and help me.
KT- So, um dad said that's the Hawaiian principle or just an Akina principle?
C- No that's my principle.
W- Oh no for the…..
C- No, no this one. You give away this one ton it's my principle, I was the one say.
W- I don't know where dad got that from but he always told us….
C- No but give 'em one ton not from my father. My principle is if we catch less than one ton, it's all giveaway. I don't care what. Because I already lost money, I know that. So what the hell, it ain't going help me, give 'em away. But I get more in return than I could sell 'em, right. Because I cannot make money on dollar a pound on two thousand pounds. That's only two dollars out. Everytime go out cost me four five thousand. The best way you give 'em away, when you catch big that's how you come out make 'em. So, better to give 'em away.
KT- Most of the time you used to catch big though.
C- Oh yeah, I catch twenty, thirty, forty tons. Ten tons, our average. I make my own. Those days everything cheap, yeah? I had mechanics for my plane, wash my plane

everything. Pop the plane yeah they take care our mechanics car, they wash the car. They all fish with me. Everybody had their own job, everybody had their own job.
KT- So, dad never used to go fly to see the fish.
C- No, no, no.
KT- Who went train you, your brother?
C- I went school.
KT- To see the fish from the….
C- Oh, I would just go with my brother. I knew already. I just go with my brother. When I was young everyday I go with my brother. I was young, sick. I come down puke and ew sh**, I don't want this sh**. (laughing) But when I took over he said, "Well who going fly the plane?" I guess I'll do it and then I went learned how to fly, buy my own plane, buy everything.
KT- You guys are the last Hawaiian entrepreneurs. I mean the volume of business….
C- I get a lot more ideas I like do but I too old already. See my son was up to grade I would do it. I get lotta more years, I don't think so. I tell you what I going come, you like know? Hmm? One professional gambler (laughing) That is my dream and I can do it.
KT- Yes, if you can make the money.
C- No, not greedy just make enough to make a living, not to come millionaire. That's impossible but to make a good living and have a good time that's my dream.
KT- You gotta take care health first, though.
C- Oh yeah, I take care my health. Either one doesn't matter, you know what I mean? I no kid you. Just because I say gambling you know not out there but I know slot machines. That's where the money is. No, you don't get greedy, you not going come rich. No way! But, you going have fun, win and you going to make enough. Like you make enough I talking about six thousand a month, that's good enough. Right?
W- He studies it like everything else.
C- I study and I study everything and read, I read books. Any book, I read 'em. Anything I want to do with my life, I going to study and I'm going to read about it and I'm going to do. That's my dream, that's my last dream. No hard work right, it's only brains. I'm gonna beat the damn system that's my dream. And then I going write a book.
W- So he has a computer and plays, you know the disk and he plays it. Two o'clock in the morning he's up.
C- Practice it.
W- Practicing. He finds a method, a system that he tries and he flies off to Vegas or Reno and tries his system. Oh, didn't work, back to the drawing board.
C- Back to the drawing board. But I get fun with it anyway.
W- So it's not just gambling just to gamble.
C- No, gambling it's not the gambling.
W- No it's to beat the system.
C- It's not the gambling. The gambling, I hate gambling, but I'm a challenger, let's put it that way. I'm a challenger. Any human thing made, it can be beat. Hmm, if you're smart enough. You know you just gotta be spunky enough to beat 'em right? Right? Anything human beings make they think they can't figure out but, you know if you think about it anything human makes can be beat. Hmm, true 'eh? So that's my challenge in

life, I mean that's a hard one but that's the kind I like. But one good thing about it is it's not hard work. You just using up here and doing things; practicing, practicing, practicing. But it keeps my mind going right?
W- I told him it's fine with me as long as you don't the company money, you use your own money.
C- No I don't touch that. I don't touch no company money, right?
W- Yep.
C- I don't take money. I never touch company money to gamble, hmm. I not greedy, I just go in there. All I want is to hit, make six thousand or break even or make money. That's all I want. I don't want the guys go, I don't want the twenty million. You keep the damn thing. I don't even want the jackpot on the damn machine. All I want is the two hundred, hundred dollar, fifty dollar, that's where you're making money, right? And you're having fun, right? Why be greedy. Just like when I used to sell fish. I could've sell 'em for two dollars a pound, make big bucks. For what? What I going do it for? I want to help the people, I want to do this, I want to do that right? When I made enough money for me to experience and enjoy my life I didn't care. I made lot of people happy, right? Then I'm happy.
W- Even when he did his Rooter service. My sister in law Mele was his accountant, right? She'd say, "ok when you come home empty your pockets." Ok. "What? You don't have any money?" "Oh no, I did." This was when it first started out, people really didn't know about it. And he would go to these home and would had poor Hawaiian's.
C- I sit on the porch, like this sitting there. They get the money here, plenty kids around, ah sh**. I look at the money, I take enough for one six pack, here that's enough. (laughing)
W- Yeah, that's what he would do because he would feel sorry, yeah. And his sister said, "how you expect to make money in this business you just getting enough for a six pack of beer? Gotta pay for the bills."
C-I survived. Somehow God bless me, right. I never was greedy. I seen too much people you know poor and the rich, that's the worst one! Whoa I see poor people, I look you know and their kids. I walk in the house I can see everything. I see on the table they get the money ready. Not the rich, oh they going try to chew you down. The poor always get the money. I can see they get hard time already. I looking around, I tell 'em, ah only need one six pack enough to go store buy beer and the rest is for them. No worry about it. (laughing) I can't help it. I just can't help it. I'm not selfish but I work late but what I going do? Can't help it. I used to go a lot of people. If fact when I went quit, people was still calling me. I wish you was back in. We getting ripped off.
W- We didn't quit, we sold the business.
C- Yeah, but they getting rip off, same thing.
W- And we told the guy, see I was flying back and forth with my teaching profession. I met these, at a party, I overheard these people talking about Rotor Rooter wanting to come to Maui. But they couldn't come to Maui.
C- They had 'em in the phone book!
W- Because they couldn't come to Maui because there was one company there, I didn't say was my husband's and my company, that were the prices were so inexpensive that they couldn't make money if they came here. So when we sold the business to his friend

we told him, he told him don't raise your prices too much because you'll volume in the whole island.
C- You going invite 'em in. I had 'em controlled the whole island.
W- You'll get volume but if you raise your price, Rotor Rooter is trying to come in. They're in the phone book already but they haven't been able to come in because the prices were at a point where they weren't going to make money. No, he didn't listen. They raised his prices and they came right in and then everybody came in and then he closed up. He ended up, he ended closing up.
C- I used to go all the way Hana help 'em.
W- Yes, we'd go all the way to Hana.
C- Had this one guy I went go do. Twenty years he suffer on this one line so the plumber's going do 'em. Going cost him 20 thousand dollars, twenty grand. So he call me up he just happened to see in the paper or whatever, he was this teacher from Baldwin High School. Forge his name already. So I went over there he ask how much going cost to clean this drain, I mean twenty years and.
W- Les Skillings…..
C- No was one Hawaiian, Kamai….
W- Oh, Kamahiwa.
KT- Oh, Hinano.
W- Hinano.
C- Yeah him! He call me, how much cost me? I said, "twenty nine dollars." I look 'em right. So I went in there, five minutes he was done, open. He was so happy tell me, "you stay over here, don't go, don't go no place." "Where you going?" "No you stay here." I sit down write the bill. He went down the store, he bought pupu, beer. Eh, lucky I never have one other job I got so drunk over there. (laughing) He was so happy! Cost him 20 thousand dollars, the plumber wanted to charge him to fix that one line. And he suffered for 20 years. I did it in five minutes, twenty nine dollars. I said how many people I help like that.
W- That was Mrs. Kamehiwa's husband. Yeah, the principle at Kihei School.
C- Yeah? He was so happy I never seen one somebody so.
W- What's her name? Andre…
KT- Yeah, Andrea.
C- I did it in less than five minutes and was going cost him twenty grand. You know how much people I went help rotor rooter and save their life. How many people I went help in Maui. When I went quit, man, people was still calling me. They can't beat you. I was honest, ha? I was there I finish the damn job, I no care how much went cost me. Because I really wanted to find out what's wrong, the more you learn right? It wasn't the money, it was the knowledge right? The more I learn the more I come better, right. Money wasn't everything to me but knowledge, right. Just like I tell all these young kids today what, when you go school, the school pay you or you pay the school? (laughing) Right? Listen, but not only listen pick up things and learn, learn, learn, right. Do your own experiment, right? Do 'em because this guy taught me….no, no, no he only giving you one fundamental, right. The rest is up to you boy. Right, you have to, you have to. You cannot, if somebody teach you that no mean that's all you going learn. You gotta learn by yourself too.

W- All your family members were entrepreneurs right? Your father, your uncles and then your sisters.
C- Everybody run their own business.
W- All of them.
C- Only me the one, the youngest and went come up this big. That's why when I named my company I wanted to keep 'em for all my family. My uncle's and the whole Akina, that's why it's named Akina. I wanted that name, I'm the youngest so I keep up that time, right? And I'm the last one doing it.
KT- So how many buses you guys have with education, school buses?
C- Oh we get school buses, all the equipment there's about fifty or sixty.
W- Fifty, about fifty increment we have.
C- Had more and I kinda going down, I don't want too much because I getting too old.
W- Hard to find drivers.
KT- Really.
W- We're looking for an accountant if you know anybody who's an accountant. Someone to work in our office here.
KT- Question so is it certified kind?

***Interview: Michael J. Boteilho***

**By Keli'i Tau'a and Kimokeo Kapahulehua**

# January 7, 2006

Interviewers= KT/KK and Consultant=C

C: Whatever I know is more Chinese than Hawaiian.
KK: We going to show you some Chinese things.
KT: So you get the background on what we're doing.
C: Had this other boy before, Keoni Fairbanks, he had to come. What happened to Keoni?
KT: He's still at Hawaiian Homes.
KK: He's the one used to be at Kaho'olawe? Yeah, he moved to Hawaiian Homes.
KT: So, this is Pulehu right here, yeah? So when we look at land we look at what's on there. So I'm shooting from across the valley. Here's all the stone wall. Right here are gullies, so I ask myself what were they thinking they make all up here, but no can get down inside. In fact the picture. So we look at the picture and it looks like the Garden of Eden and we look at this and we encourage people to beautify. Again here's all the petroglyphs along the wall yeah. So, we walked up the street that's Pulehu stream the one we went. Here's more petroglyphs not the same that one is just over there. But fast forward we ran across this guy here.
KK: Talking about more Chinese.
C: Right.
KT: This one of a kind find. In the whole state of Hawaii, because everyplace I went that had petroglyphs, Big Island, you know they get choke pictures. No more this. This is Japanese.
C: Japanese? Whoa.
KT: Chinese characters but Japanese because what this reads is this character here is Dai nihon, and over here is ito. So my students still haven't been able to translate so I might have to walk an older person up there. But what they interpreted was, and when I saw this and he and I were up in a river bed. They used to bring the Iliahi, the sandalwood, down through the riverbed get them down Makena to ship to China, right?

C: And then the thing is, they going stop write their names. Same like today.
KT: Right! Yeah.
C: They going stop. I was here. They going carve in the table.
KT: Right, no difference, because that's all they had.
KT: You're full name please.
C: Michael J. Boteilho.
KT: Where were you raised?
C: Up Kula, born and raised up here.
KT: Where you went school?
C: Kealahou.
KT: And then?
C: Kula Elementary.
KT: And then?
C: Maui High. Then in the Navy.
KT: And then when you came back, what did you see for the future for you?
C: Livestock, raising cattle, that's about all.
KT: Which is what you're doing now.
C: Not now, it's not feasible now.
KT: Ok, talk about that feasibility.
C: You cannot find land to raise cattle.
KT: Ok.
C: All the land we used to run cattle get houses on top.
KT: Which was where?
C: Like Kula 200, Kula Glen.
KT: So you guys were leasing the land. When you say you guys that's your dad.
C: My dad, my dad. And then you know feed gets expensive. Everybody rather eat mainland meat than local meat. All the local markets shut down. We used to supply like Azeka's, AhFook's, Ooka's. We supply them lot of local beef but they all closed down. Then you get all the mainland chains coming in they bring in all their beef.
KT: So, I see all this fun stuff hanging over here.
C: That's tools that we used to use before on the ranch. Go help a few friends that run cattle nowadays that's about all. But before three days a week we were on horseback working cattle.
KT: So today what are you doing?
C: Working for the water dept.
KT: As we sit here I have something in mind. I just going throw it out, not relative to this, but Kimokeo can you see my teaching students getting paid to have them have exposure to all of this. Every one of these things that I see here has a story.
C: Everything has a story but today's cowboy is they read one book two days, they one cowboy.
KT: Like everything.
C: Yeah, you know before most cowboys was like cattle, born on the ranch. So that's how you follow everybody. Now today, look all the ranchers today. They bring managers all with degrees. No common sense about the 'aina, how the land drought's. Then they try bring in mainland ways of running animals here. Mainland run their way,

we run our way. Two different type. You can come from Makawao to Kula there's a big difference on the type of grass that you have.
KT: So talk about that grass, what is the difference?
C: Food runs on the grass, but you get down Haiku you get more rain there so your grass not as strong. Mostly your minerals run down to the ground. Where up here you don't have as much rain the grass is more potent. I used to put ten in there I butcher them and they probably go about 450 pounds, 500. Ten same steers same breed ate Makena. Butcher same time those go about 700 pounds, they're much different.
KK: The protein, the enrichment.
C: Right. From Pukalani up this way is way better country. If we had the rainfall this would be an ideal place for raise cattle. Look right now the drought we have.
KK: When the last rainfall we had over here?
C: I forget. Probably a couple months ago. But the thing is you get one rain you need the follow up, yeah.
KK: No come back yet. Get one rain never help, one rain is like no rain.
C: Yep, one rain come up get everything started.
KK: And then make yet.
C: So you need the follow up one more rain and one more rain. Then now even if we do get the rain, days short cold, the grass no grow like it really should.
KK: The cattle you guys used to have over here, what kind cattle was that?
C: We used to use a lot of cross cattle. They were more hearty cattle they could handle droughts, more tough. Today everything is certified Angus.
KK: Yeah, the fashion now.
C: Yeah but you know certified Angus is a name of a brand of beef. No mean it's Angus, only Angus cattle. Lot of people think it's only Angus, which is not only Angus.
KK: Well, they change that now because they're not only looking at the real way. They just looking at what is cheaper and more marketable since the public knows more Angus they going buy more Angus.
C: Just ways of selling. You know it's a way of selling your beef.
KK: This cross bread you talking about where did you guys get it from?
C: We bought it from the mainland, lot of ranches had lots at one time because they could handle droughts. And they were more tough cattle, but then the market changed you know. They like their nice steaks so they start bringing in different like Angus was good beef cattle. Was a tougher animal where they could handle the drought.
KK: More tolerant.
C: More tolerant to the area.
KT: Mike this does not have any relevance but what is you ethnicity?
C: Pure Portugese.
KT: Pure Portugese. So the Boteliho line is pure.
C: Pretty much. I have probably about 3rd or 4th generation, pure. But then my kids already all mix.
KT: So you can trace back to where, where did they come from?
C: From what I hear Portugal. And then my grandparents was born here then my parents and then me.
KT: So why did your great-great grandparents come?

C: I have no idea. I guess everybody wanted to see the other side of the world or something.
KT: Well, coming to Hawaii in that early age was either for working or being luna. Portugese used to be luna, Portugese-German. You don't have trace back to anyplace?
C: Never did.
KT: I'll talk to Antone about helping you out. So, fast forward here Mike. As we showed you the pictures, if we go across where is the Ag park compared to here?
C: Pretty much same elevation.
KT: In alignment.
C: Straight across, below here.
KT: We have the key to go onto this property.
C: Haleakala, right below here. Cause you can go down here and come back to that park get one road. You know when you come up the Ag park get the road right before you turn into the Ag park. Right below that on the right get one corral.
KT: Right that's where we went.
C: Ok, if you go in there you come over you can come up this road. That's what they call Waihono that area, small Waihono. You come inside there, you cross you come over then going get one corral here. If you turn right going below the corral you can come up Kihei Heights.
KT: Remember that.
C: If you turn left you going come back up to this road right here.
KT: So, you familiar with the area that we're talking about?
C: Yeah, I used to hunt in there. Wasn't that pineapple something at one time.
KT: That's what I'm trying- it's still pineapple but not as full.
C: But I think we used to come way this side too?
KT: Yeah!
C: Cause if you look the trees no more that real big trees. But as far as when I was one kid till now Haleakala always run cattle in there.
KT: Right, ok. Now, I interviewed Kauai yesterday.
C: What Kauai is that?
KT: Thomas.
C: Oh, Thomas, yeah.
KT: His whole family line was cowboys, right?
C: Right, like us.
KT: So, he said they used to herd the cattle down to Makena landing and some others yeah.
C: Right.
KT: Now as a cowboy where would you herd if you were raising over here during the old days? All the way down to Ma'alaea, or Kihei? Kihei had one ramp right that they used to..
C: Well depends how far back you looking. Because probably in the…
KT: Let's go as far back as you can think that had cattle.
C: Now when you say as far back, as far as what I seen or what I heard.
KT: What you heard.
C: Well, if you look the movies they take the cattle Makena landing and ship out. But did you know at one time this island had over 36 slaughter houses for butcher cattle?

KT: No, give me some locations.
C: Right Oma'opio. On top Boteliho had one. Go more down Costa had one. You go further down had one. Rubello had one. And I think one more Sakagawa had one. Five.
KT: That's David?
C: Right by David's house get one slaughter house.
KK: Down there where he was talking about that's the original slaughter house.
C: Ok, right there that is five. Now you come up going down Kula, Pulehu the old road right on the right, one more there. That's six. Then Pukalani, Makawao, what's that Maha road where the chicken farm stay? Ok as soon as you turn up Makawao you go there.
KT: Makani Road.
C: Makani, ok. Go down little ways turn left, right inside the slaughter house there. Go more over Perriera had slaughter houses. Everybody had slaughter houses. Makena had slaughter house. Kihei had 2 slaughter house. Right across Kale Makai had slaughter house right there.
KT: But that's for the convenience of the guys raising the cattle right.
KK: Not so much convenience they must have had the acreage for the land.
C: Well, that was, had everybody up Kula. Right now this island lucky if we have 25% of cattle that used to have on this island. We no more cattle. Everybody in Kula had cow, milk and cow always few head of cattle. Even the farmers used to raise cows. Feed them all the opala grass like that. But today you don't have that kind of stuff. But the inspector told me we had 36 slaughter houses at one time in operation on this island. But me I know was the fancy kind, I never have ice box. We butcher you take down. You no hear anybody get E-coli and all that kind.
KK: Right around this area we're looking at about 8-10 yeah?
C: What slaughter house?
KK: Yeah.
C: From Oma'opio I would say 5 then you come up the camps get six. Had one right here, then seven. Ulupalakua Ranch had one, eight.
KT: Right here.
C: The next one Pulehu road, eight. On top there when you go China town on the right. Jane had one for kill chickens. You know had lot of slaughter houses here. And lot of oh, Makani road, where the chicken farm stay. The green one that one was a big slaughter house from Likoi. Was one big slaughter house.
KK: Now they have their own up by Makawao.
C: Right now only get DeCoite and Nakasone that's the only two on the island. Haiku had McGrath used to kill rabbits or the cannery. Had a lot of slaughter house. Hana ranch had slaughter house, pretty much everywhere had.
KK: You know you call this Waiakoa gulch? When you guys come through here what do you guys call it? Waiakoa gulch?
C: Over here? No one different name um Kulaloa gulch I think.
KT: So we went down here, going back, and we saw a heiau but you know any other Hawaiian stuff on the land?
KK: That's the corner, on the top going on the side get all this black rock going up. It's not like a flat heiau, it's just pile of rocks.
C: But what is the, how can you identify one heiau? Just by how the rocks pile up?

KT: Well, one of them is passed down the stories, word of mouth. Family to family.
KK: Obvious one would be having a stack really nice, neatly like a certain height. Most of them have a height of about 5-6 feet.
C: And every one at Iao, that's a grave.
KK: Not necessarily, it can be like an altar like a church and it serves like a purpose of a person or the purpose of a God, serve the purpose of an area.
KT: Let me clarify that. Heiau's were not connected to burials see, misconception. Heiau's were place of worship but the reason why you can find graves close to it is because in ancient times they weren't designated graves. Where you die that's where they put you in. That's why today some people, "oh my gosh, what is this over here?" They never take the bodies to a designated place they would call it graves.
KK: Just before the missionary times yeah. When the missionaries came, like my grandma she's Portugese so the Catholic they all had their graveyard by one church.
C: But as far as way back that one tape that they brought out that had pretty much tell us a lot of stories of the old cowboys.
KT: What tape was that?
C: Paniolo.
KT: It's entitled "Paniolo?"
C: You ever seen that tape?
KT: No.
C: I might have it, I'll try go get it later on. But that gave us the whole break down.
KT: Historically.
C: That was a real good tape. Lot of old timers and a lot of old timers around and when you know that wasn't on the tape. But from what I see around here, mostly I find Chinese stuff.
KT: Ok, as an example.
C: For example couple days I was up the ranch I find this spurs. And you know this not from no big bugga.
KK: Oh, it's a small guy.
C: You know this wasn't no Hawaiian or no Podagee, no, but that's one old spur.
KK: Where you find this?
C: Up above the pasture I just was walking down.
KK: Now they get more mercy on the animal so they no make the spike so long yeah.
C: I get some with spike. Depends on the animals. Spur's you not gonna abuse it you just kinda wake up call. You know like anything people abuse some stuff, but this person not one abuser.
KT: You mentioning a lot of in the cattle people. Was there any connotation among different owners, different workers?
C: No, pretty much.
KT: They all got along.
C: We had less people on the island and more beef and everybody could sell their beef.
KT: So the main thing was that you could take to market and make everybody happy.
C: Was pretty stable because you never have an abundance or surplus of beef. Everybody got rid their beef. But now it's a different ball game that this Maui cattle man started up. But that's only a few ranchers it's not everybody involved.
KK: Oh for their meat?

C: Yeah, I don't know. Those things that we did they're trying to do. You had Sakagawa, Nobriga, ourself we used to supply local market. Willie Jacinto, Joe Santos. They all used to supply local markets and what not.
KT: Willie Jacinto was always a cattle man.
C: Yep, Willie taught cattlemen.
KT: And he's still doing it.
C: Still doing it and he's probably 70 something still going. Another good cattleman Bill Evey
KK: Oh, yeah Bill Evey, where is he now?
C: Somewhere Haiku I think Bill lives. But you know had plenty other good ones. Jacinto, my dad you know they raise cattle they supply them, market.
KK: You know when we go through here, look like had one big fire.
C: Down here? Early or lately?
KT: Recently you know all the Kiawe down and stuff.
KK: No stay all charcoal.
C: Every now and then would get fire close to the power line sometimes box like that.
KK: Oh, but it never come up this far?
C: No, no come this far.
KK: And look like they had a water line going through this area where that water came from?
C: Where is this now? Haleakala take their own water down for the cattle. They have to get their own water. Their water go down to Kihei.
KT: So, they drill their own?
C: No, no county water. But their pipes went down that's why you see lot of water tanks down there what not.
KT: So before I forget, so what is your attitude about where Maui is going?
C: I think Maui is "Goodbye, Hawaii!" You know how they say. Right now I think we're the minority. What I predicted 10 years ago it's Maui going to pay a big result, and it's coming to that real fast. Real, real fast. Us local guys what ours kids going get? If we don't have nothing they sure not going to get nothing. Look affordable housing, what costs today. It's not going to get any better. Look our land tax they trying to squeeze us out. We live here we have to pay high taxes. This other guy come buy next to us he pay high price, let him pay the high tax. Why should? When we sell then the next guy pay the high tax. We never buy our land high so why should we pay the high tax?
KK: Yeah I agree with that.
KT: It's something that we got to do politically to move it so we don't get screwed.
C: But we're outnumbered put it that way. We're outnumbered.
KK: How long you been on this land?
C: Over here. This land right across here was from my grand-dad from my mom's side. This one we had to buy to get right of way to get into that land. So to get to that land we had to buy this for get that right of way. Okay, after we buy this then all these haole guys build up here. All of a sudden there's a right of way up here. Thirty-fifth in the back access. But when we wanted couldn't. But this other people come, they find em. The state don't want to own it, the county don't want to own it but on the map shows that the right of way is there.
KK: How many kids you get now?

C: One boy one girl.
KK: And where are they at now?
C: They living up Kula.
KK: They got their own place?
C: Yeah, they live up Kula. My son about 30 my daughter 20 something. She's going to MCC.
KT: So, you're brother's they were all desirous to continue being cowboys.
C: No, I guess by the time, I figure my grandpa cowboy, my dad cowboy. My dad had 5 boys I guess all would be cowboys but never have cowboy job so I pretty much the only one that kinda stayed in there. The rest turn to truck driving that kind of stuff yeah. So I'm the only still cowboy on a part time base.
KK: So you know on the property we seen a lot of panini yeah. Not so much cattle so look like all the panini growing wild like one grass you know. Before the panini get people they would be using them, yeah.
C: Before had two types of cactus. Had the red and the white. The red from Pukalani to Kaupo, you couldn't see nothing. And animals strive on that. Never need water, get fat. I guess these people couldn't catch all that cattle, missionary type guys the big ranchers so they brought this bug. So the bug ate all the good panini. That's all food. And now get nothing else for eat so the bug eating the white one. So pretty soon no more panini. But panini had trees you could ride the horse underneath.
KK: Wow.
C: It wasn't like what you see now. Was big things. Just past Kula glen there was all cactus when we had all that. And had cattle inside there, big trees, cut trail with the paiola. That's what you do, you cut you do underneath with the horse.
KT: Paiola is.. this is paiola.
KK: That's one old one they don't make this anymore.
C: You make this. Sometimes you get rough cattle you like cut the horn you use this side.
KK: Oh, you saw them.
C: Yeah, and then this side for cut trails. That cactus was a real good feed for animals. Pig, Kamaole how much pig had, Tavares ranch like that. Used to have pig drives, not only cattle drive, pig drive. Take down to the pier. Before my wife's grandfather he used to tell me he was small boy used to go with the meal and one horn he blow and feed corn to the pigs. And then when come more huge they make one heard then take them down to the beach. But you never see that anymore.
KT: Goats.
KK: You raising the goat?
C: Yeah, that's the only one you can afford to raise.
KK: But they sell yeah?
C: Yeah, goat is one pretty hot item right now. Thank god we get Filipino's who buy the goat.
KK: They come up here buy them?
C: Yeah and then I raise them and I have one middle man, George, come and then he re-sell it.
KK: Which George Tam is that the one that used to have the boat?

C: Yeah, Dolly. So he come get them from me and then he re-sell. I just raise them. So around about 60-70 nannies.
KT: Yesterday, Thomas told me that in different areas that you're familiar with there used to be different places where water used to collect. Where it used to create natural pools.
KK: For the Hawaiians?
C: Around here no more. But you know if you go- that's why I keep coming back to Chinese you find a lot of cisterns where have Chinese houses up here.
KT: Oh, they made it.
C: So, that's the only ones I know of, old cisterns run off on the house, yeah. In fact a lot of the old houses all had cisterns before. So that shows we had better rainfall before too. Then another place get dams in the gulches, but that is all man made get cement. Like dams to hold back the water, that is all man made. As far as natural kind you know depends on the year. You know if get plenty rain get few ponds water.
KT: So, VonTempsky exactly where is that?
C: That's from Bill Leavy right up to the mountain. Yeah, but then they keep selling yeah. Start from down here by the post office. Makai that then go right back up past the petting zoo, above there go way up you can see one big patch pine trees, it goes above that too. It's one long strip yeah. Think get about 3000 acres above the road and downside maybe 1500. But VonTempsky used to lease a lot of his land the farmers was using all that makai land, that was all farm land. And then what the farmers wouldn't use, Haleakala ranch was using. But now they have some kind hunting deals down there.
KK: With the hunting?
C: I guess one of the daughters married some guy that turned a lot of the land for hunting now. Private hunting.
KT: For what kind of game?
C: I think deer and he bring in different stuff and guys pay to go shoot. And then if get too much grass then somebody put cattle in.
KT: So as far as you know the use of this property we are talking about. Back in the old days Hawaiian only used to put little kind. There really wasn't any kind of settlement right there. Only in the riverbeds like the petroglyphs indicate and was kind of ongoing yeah, moving through. So there wasn't really any kind of settlement type of vegetation of plants, right?
C: I would think so.
KT: So the first….did plantation come before cattle? Cause right now get pineapple.
C: Right.
KT: Not everything, you know get pineapple. So that was, did sugar cane come on the land? How far up sugar cane came?
C: I cannot tell you that. I would think pretty high up.
KT: How close from here?
C: I don't know if it was sugar cane or pineapple but this land I think was farmed before it was ranched. Because you look the size of the Kiawe trees.
KK: Small.
C: So that shows you had some kind of farm up there either sugar cane or pineapple. I would think more pineapple. But then you look the white country, Kipahulu, had sugar cane. Hana had sugar cane but they had enough rainfall.

KT: But sugar cane was a staple product of ancient time.
C: Right.
KT: The difference is they commercialize it so that now you plant to harvest. So, what I'm trying to find is the history of the usage of the land. Some of the things that you guys did yeah, were just for cattlemen that us guys who no raise cattle who are not around cattle. What are some of the unique things that you can recall. You know fond memories.
C: Well, before every time one ranch would have branding everybody go help. Always help each other. Maybe this week we go Haiku help Jacinta's. Next week Jacinto come up help us, following week we go do somebody else's job. Always weekends we, families would go.
KT: Ok, when you would go outside of the work that you did what else is expected when you go. The whole families come, you bring food.
C: Yeah, pretty much one big potluck. Or the ranch that's hosting the brand, he make the food then next time the other guys doing it, he make the food.
KT: So Mike, in other words was work but was play. Was fun.
C: To a point.
KT: HA! Work is never play but you love the work so.
C: The thing is everybody think cowboy is only ride horse. Cowboy is everything. You gotta do everything from carpenter, mechanic, you know plumber. It's not only ride horses. You gotta know how to pick one sick animal, how to doctor that sick animal, you know. But everybody think ah, they buy cowboy boots cowboy hat they one cowboy. No. It' something you learn.
KK: So, did you guys use any of the plants on the land for the animals to cure the sickness. Or was it purely medication that you would learn already where you would get it.
C: Well, was more commercial medicine. But then one good medicine we used to help cattle plenty was Koa, haole Koa. Haole Koa is high in vitamin A, which was good for their eyes.
KT: So what, you would use the seeds?
C: No the animals eat that.
KT: The leaves.
C: Yup. But then you but haole Koa horses eat too much haole Koa they spilling the beans they come like us, all the tail fall down! It comes short because high in protein. But that was good feed for cattle. Even for fattening cattle, very good. Except the fat comes yellow and people no like the yellow fat. Before people like yellow fat.
KK: Oh yeah, they fry 'em.
C: Today they tell you no eat fat. Before you like fat. But without fat the meat no more taste. But the Koa would make the fat kinda yellow like that. Now everything they want grain fed.
KK: The pineapple brand, molasses, corn.
C: Yeah, but right now we don't have even that so even the pineapple we cannot get for them so they're feeding different feeds that they bring from the mainland but cost money for bring it all in. Cost a lot of money. Everything cost money.
KK: Never used to be though.

C: Well, for example in the 70's we were selling beef probably was getting $5 a pound, carcass. Gas was 55 cents a gallon. To butcher that steer was 27 bucks. Feed was a lot cheaper. Today we pay $80 to butcher a steer. Gas is what $2 a gallon and they still getting the dollar something little over a pound.
KK: The rancher.
C: So, does that make sense?
KT: Yeah.
C: When you can sell that same calf today, get $400 they keeping them up to a certain age for get the same $400. Probably 7-8 month old calf you can get $400 today. They keeping em up to 18 months to get the $400. Cause there's a lot of buyers here that are buying cattle. Like right from the cows they buy the calves.
KT: Mike, what are some things that you guys used to do that you don't se happening anymore? Unique things to the paniolo.
C: Oh, family parties. Before always had after Thanksgiving every weekend you had one party to go. Not today. Gatherings go down the beach once and a while all the families. Go down the beach, stuff like that.
KT: What about rodeos?
C: I was never into rodeos. My brother's was into rodeos I was never because your rodeo cowboy and you regular cowboy is two different cowboys.
KT: One is show and one is work.
C: And I guess they only get on limit for where they're at. We work different, we had to yeah. They going for fun. But that's pretty much two different cowboys. Rodeo cowboy and regular cowboy.
KK: You know on this land look like the Kiawe tree young so they never have too much Kiawe around. I know that my dad when he was a cowboy he used to use the Kiawe beans for feed the animals.
C: Real good feed.
KK: So where would you guys get your Kiawe beans then?
C: Before when our increment first came up after dream season. We used to buy lot of Kiawe beans from the Filipino's. Was maybe couple cents a pound. But in those days was big money. We used to feed cattle with that, horses, rabbit. Everything eat Kiawe beans. Kiawe beans was real good feed.
KK: Where do they put them, in the huluhulu bag?
C: Yeah we used to take the bag, active feed bags we would give to them and they would pick and then we would buy the feed back, the Kiawe. That was real good feed. Even we used to chew them. Sweet! Try get one real nice Kiawe bean and chew on it, it's sweet. Plenty people used to use Kiawe bean to feed. But today everybody lazy.
KK: So you were talking about the family the cowboys so would you guys ever cross each other's land. Would you take you horse 6-7 hours that way to Makena side and they would come this side or round up. How would you guys go? You guys trail them or you ride to the round up?
C: Some places we ride on the road. We even used to drive on the road by Kula 200 we used to ride up.
KK: So most of these roads were already cattle driven.
C: Even Hana we used to drive cattle from Hamoa to Makalai.

KK: Yeah, I see the guys in Kaupo they still using the road about 6-9 months ago I see guys driving cattle on the road.
C: But like before the big ranchers- Ulupalakua, Haleakala, they were to themselves they were never involved. We were the small potato ranchers next to them. So they never bother too much with us. So we never enter their property. We ranch around them or like I say we would go through the road but never through their property.
KK: Was there at one time on this land when you guys cowboys big pilikea amongst each other or everybody knew their territory and knew the rules and understanding?
C: I guess they had honor among each other.
KK: Honor yeah?
C: They never was fighting people. They had respect before. That's one of the things nobody get respect.
KK: But there was one thing that everybody had to go to. They didn't do it on their own. So, who shoe your horse? Did you shoe your own horse or did you go to a horseshoe man?
C: I had different guys used to come shoe horse had like this guy Tony Spange to shoe our horses. Henry Silva used to shoe horses. Plenty cowboys used to come shoe horses. Side money, to shoe a horse was like $4.
KK: $4.00 a horse?
C: Yeah, today I think it's $50-60 to shoe a horse. Then some ranchers do their own.
C: Get Carly Chung. Carly's a good shoer Henry's still shoeing but he's getting old like the rest of us.
KK: Henry???
C: Henry Silva. He long time horseman, cowboy. Get lot of horseshoer's today.
KK: You know any of the guys used to work on Koomoa ranch, was this Koomoa ranch originally?
C: This side. That was when had Earnest Martin he was like the manager before. He was there a long time. Henry Kikiwi. Jimmy Miguel. Wilford Souza worked there for a while.
KK: These guys are sill around. Kikiwi around though yeah?
C: No. Wilford Souza still around. He's a old time cowboy too. Wilford Souza.
KT: Martin Kikiwi passed away?
C: No Henry Kikiwi. Yeah, no make me scared, I just was talking to Martin.
KT: He around 50-60's.
C: Martin? Yeah, Martin was Ulupalakua Ranch. This is Ka'ono'ulu ranch. And had a lot of cowboys there.
KK: So the big ranches was like, Haleakala, Ka'ono'ulu, Ulupalakua, Rice.
C: That's about it. Hana. And way back we had like Gold Ranch. That was HC&S had their own ranch, Gold Ranch. That was big ranch. Lahaina had Pioneer Mill, had their own ranch. But those ranches all shut down yeah. But the big ranchers were pretty much to themselves and the other ranchers, like I said we used to go work with each other's animals. Help out.
KK: So, Kumu asked you the question, what year were you born.
C: 1951.
KT: Lot of accumulated knowledge through experience.

C: That's why I say cowboy was through experience not through book. You know today is degree's no common sense, no experience.
KT: What would you advise young people if they said they're interested in getting into this area, learn about it.
C: Learn is fine, just to get the feel. But as far as to be, I wouldn't recommend it. There's no future.
KK: All the ranchers now using motorbikes for round up. Like Ulupalakua I see them use their big tire motorbikes.
C: The motorbikes are good. But there's still places you need horses, the motorbikes cannot go.
KK: They're never going to go where the horse can go.
C: Yeah, and the motorbike cannot hold one calf when you branding. Lot of people finding that out.
KK: I think when they change their styles, finding out what you say. A lot of them don't have the feel and the common sense. The big thing for me with my dad was the spirit being high in the cowboy. Feed em, clothe em. You cannot overwork them because you have long ways for go. A lot of things about going from Mauka to Makai people don't realize that once you hook up the horse we going be going for couple days not 2 hours. Just to go Makena going take 6-7 hours.
C: Yeah, but you know before the animals were tough. Your horses could handle. Today's horses cannot handle.
KK: Their blood change like our blood. From your father to you to you to your kids. We talk about our kids. But the environment change and the type of lifestyle change so it's not applicable anymore.
C: That's why you look today, the horses, the men before uses all dogs. Top working animals. Wasn't the best looking but they knew their job. But today you have to have this kind dog for work cattle, this kind horse for work cattle. Before you ride anything the job is what made the animal or the man. Doing it that's what made everything.
KK: My dad is from Niihau so I'm on my way to go there in June. But I can relay to my friends about you about a real cowboy. When I went to Niihau they know that I was the haole Hawaiian. Because my hands was all smooth and those guys over there like you with all the dirty jacket. They not going to wash their clothes everyday.
C: Once you ruin the jacket you kill the feel from the jacket.
KK: So they keep the mana in the lepo and they just use their jacket and they use the same jacket.
C: You know this jacket was like canvas. Every time wash come soft,
KK: We appreciate your time Michael. I think the important part about people like you who still around maybe not so much people to apply what you did, but at least they can learn what was before. It's up to them to carry on the important things. Like you like us open space is always a deal so we're hoping that they're going to do that here.
C: I hope so too. I think I'm the only person who has 11-13 acres here. Everybody is 2 acre lots.
KK: Small yeah.
C: But sooner or later they're going to grumble my goats making noise, my chicken making noise.
KK: You seen this morning in the newspaper, yeah?

C: I never see yet.
KK: Front page that the next time they meet they are going to talk about the peacocks and the chickens. No can be in residential area.
C: But like all these people come to Kula for country. What is country?
KK: Yeah, animal.
C: Animals.
KK: They don't hear this dog barking or the chicken coo in any country anymore. Better you have dogs animal and chicken crowing and goats running around. Whether they're tame or wild it's a healthy life.
C: What they rather have one goat next to them making noise or one house next to them making noise?
KK: Yeah, especially with a jukebox.
C: One of my crimes is to sell em all. You know, pack 'em, pack 'em, pack 'em. They cut like bologna and eat that. But today poi no make the skin.
KT & KK: No.
C: Even for find sour poi today hard. No more sour poi.
KK: No, they make em too watery.
C: Before the poi you eat, you come back the can full again. Now no more that kind poi.
KT: Mike, we really appreciate you taking time out.
C: I don't know if I'm helping any or what.
KT: Of course, tremendous.
C: You know like over here. (walking ) From this branch go down see that's why the bottom get one small hog wire go way down go over I think you met that other guy across the big gulch raise cattle. Come up. Before this was all panini. And from what I heard the old man Rice you to raise pigs inside here. And then he come get the babies and leave all the mother's down here. They used to raise our pigs in here.
KK: Oski Rice?
C: The father.
KK: Oski's father?
C: Yeah, used to run all pigs in here. This here was all cactus way back.
KK: So you're saying that one of the roads come right up here.
C: This one right here you go right down you going hit that road. You stay on that road you keep going down, going down. You going come to one corral. By that corral you turn right get one gate you open, you going come out that side corral.
C: Like the guy Oma'opio he raising for milk, different kind goat.
KK: The one all stringy yeah?
C: That can be all right, but more slow growing yeah.
KT: Describe the horses again.
C: We're talking about the Hawaiian horse, which to me kinda resembles some of the Mustangs. They're small but they can handle, they're tough. But today everybody looking for tapered horses. Quarter horses, thoroughbred, registered horses.
KK: Get more value yeah?
KT: And they work the ranch.
C: Actually for cowboy horse you need one more with heart than with breed. The thing work. Same like one man, you need one with the heart more than muscles or anything else.

KK: I see right here you get, is that a lungong tree, or lychee?
C: Lychee.
KK: So the Chinese people went put that?
C: I put that.
KK: Oh, you put that. But up here did you see these trees before on the land.
C: No. But they say this house had, but I think it's too dry up here.
KK: Right, but look like this one growing healthy.
C: Yeah but never going get one lychee. They say you gotta lick 'em yeah?
KK: Oh, I see over there get the milk can over there. So that's the milk can from the…
C: That's old kind they make them like that more round. But nowadays they make em ugly they paint them yeah.
C: I like how natural the frost is like that.
KT: How far back they used to use that?
C: Oh, up to probably.
KK: Sixties, seventies. Sixties we used to have the milk wagon. Haleakala still had the milk wagon carrying that.
C: Before they used to deliver milk house to house.
KT: How come you get all these cows here? You collect them?
C: Whenever I go pasture I come home and put them around. Then once and a while guys come they like they take them home.
KK: Well, that's good memories of the past yeah? You not going find plenty of them anymore.
C: Like I said, now I stay with the water works not with so much cows.
KK: You still with the county water works?
C: Yeah, I just started. No more job home so, keep me out of trouble.
KT: So who owns all of this?
C: That's all my stuff.
KK: For working animals.
C: My trailer stay down my mom's place for our cattle like that.
KK: You gotta come with the land or else you cannot get to the place. When I was with my dad, nobody get on the truck unless it's a working day. We never used to jump on the truck for ride around.
C: You know that's the thing with new trucks today the price on the truck. Before truck was strictly for working. Today they buy one four wheel drive Dooley for go down store for go buy one loaf bread, huh? And they pay fifty thousand for the truck.
KK: Everything is a work animal.
C: But truck was strictly for work, not for da kine, holoholo.
KK: Solar panel over there?
C: Get lights come on by the statue at night time.
C: Yeah.
KK: Was you went put em in.
C: Yeah was not too long it's only about little over a month, just coming out.
KK: Where's it from, Waikamoi?
C: Yeah. Was on the side. Small kine though.
KT: The hybrid kind cactus.
C: Makuli kind cactus. Thing old.

KK: Old that thing. They used to have this in the land. This the one that cut the water inside?
C: No that one cactus. I forget the name of this one.
KK: They used to get the one that cut water.
C: Yeah they take the water outside
KK: Even the kids not going know that stuff cause no more already.
C: See over there is my smoke house, we went smoke meat like that.
KK: This one Kupuna ti leaf yeah?
C: Supposed to cut 'em, too tall. No can reach.
KK: Eat laulau.
C: Every time come night the wind over here. Too tall.
KK: So the wind you know the wind that comes over here. You know the Hawaiians had a special name.
KT: Is that for milk?
C: That's for cream that, cream kind.
KK: The thick one Kumu.
C: The makai one is the milk.
KK: They also had the cheese one yeah?
C: Yeah they get different kind.
KK: Who's house that, that your guys one?
C: That's my house but I rent em out yeah when I need help.
KK: That's your family in there?
C: Our friends. And then I get one bunk house that's what I live in.
KT: So Mike, what I'm going to do is transcribe what we talked about. Bring 'em to you, show you what we going submit. Those who trust us they just sign off on it and you'll get it.
C: This what, not going be on TV.
KK: This not going be public.
C: Bum by they, you know the friend how come you no tell my name and all that.

## *Interview: Mary Carvalho*

**By Keli'i Tau'a/ Kimokeo Kapahulehua**
**October 5, 2006**

***KT- Keli'i Tau'a***
***C- Consultant***

KT- So once more, your name is?
C- Mary Cabral Carvalho
KT- And you were born in?
C- Nahiku, Maui.
KT- Nahiku?
C- Nahiku, upper Nahiku.
KT- So you went to school in Hana?
C- Hana School, Kaeleku School and then Hana School.
KT- So when did you move in the area of Kihei?
C- In 1949.
KT- 1949, what made you move there?
C- In 1949 we moved to Kihei.
KT- Why did you move there?
C- Well, because at the time the plantation, they formed the Union and where I formally lived in Puunene Plantation (my husband worked for the company) and then they started charging us house rent so we decided we might as well buy our own home rather then pay them rent. So we moved to Kihei. Land was real cheap at the time. (laughing)
KT- How much did it cost?
C- It cost us a thousand dollars for half an acre and it was close to the beach.
KT- Exactly where was it?
C- On, where, next to where Maui Sunset is now.
KT- So the house is not there anymore?
C- It is, oh yeah! We lived in it for twenty years and my parents lived with me. Then my father had a stroke but our house was off the ground so it was hard for him. So then we

moved to Uilani Street and we built a home on the ground, you know level ground, because of my father. And we lived there on Uilani Street since 1969 and still there, my house is still there. But the other home is still there, yeah we sold that.
KT- So you and your husband moved from Puunene to buy cheap land but you just mentioned mom and dad; what were they doing?
C- They were retired. My mom and dad…
KT- What did they do?
C- My father was a forest ranger for Hana district and Marian Cabral. And when he retired he wasn't well so they moved (they used to live out in Hana) and then they moved in with us. My father was 80 years old when he had a stroke and it was hard for him to get around and all. We had a ramp but still it was hard. And they used to have tidal wave-1960 all those tidal waves. So we had to evacuate because we were close to the beach so we decided we better get something else. We moved to; Francis Akina opened up a subdivision.
KT- Where was that?
C- On Uilani Street, close to his home Francis Akina used to live. Uilani Street is between the Baptist Church and Kalama Park.
KT- Okay.
C- The fire station, I would say. So we built our home there and- but before we built our home my mother died so only my father moved with us.
KT- So how old was mom when she died?
C- My mother was eighty-two.
KT- So your family-well before I continue; How old are you?
C- Oh, I'm 88 years old.
KT- So your family is known to live a long life.
C- Yeah, my father was 90 close to 91 when he passed away.
KT- Wow.
C- And now I have a sister that lives up Iao, she's 97. And one here is Kahului she's 94.
KT- And did they all live in Kihei for a while?
C- No, they never did, no. The one up Iao lived Waiehu and then she moved to Iao and then the one in-Ali lives here in Kahului and she used to live in Kahului; her husband was Bill Helm, the old timers, the Helm family.
KT- So, Mary living in-so how old were you when you were in Kihei in 1949 that would be?
C- I wasn't even fifty then, so yeah I've been in Kihei for most of my life in Kihei, really.
KT- So you've seen a lot of changes.
C- Oh yes. When we moved to Kihei the road was only until Kalama Park.
KT- But people were living in Makena?
C- Yeah, was a dirt road, yeah.
KT- So there was access but it was only dirt road. What was there in Kihei that you can remember? What kind of stores?
C- They had only the A&B Store, afterwards was Suda Store.
KT- So where Suda is, is where A&B was?
C- Yes. And then they had the little post office next to it. Johnny Ventura was the manager of the store at the time and he opened up- the little post office right next to the

store. And he was Post Master and manager of the store and I used to work out of that post office. I would deliver mail; I was the first mail carrier.
KT- Really? Can you remember how many houses you would deliver to?
C- Well we, actually Johhny I remember going with Johnny begging people to have rural route; home delivery and we had thirty five people on the route at the time.
KT- Okay.
C- Yeah and I used to deliver mail; we get through real early and all. And then my daughter worked there, Jeri Serrao she worked in the post office. Then afterwards they moved to the big one where she is. She worked there and she retired out of the Kihei Post Office.
KT- Oh, wow. So what vehicle did you ride to deliver?
C- We had to use our own car. In those days we used our own car.
KT- So what kind of car were you driving?
C- I had my husband, we had a 1951 Chevrolet and we had to… And then afterwards when they first started Maui Meadows up and down those hills. Oh, he had to- good thing my husband was a mechanic he used to fix brakes almost every, at least every other week he had to fix the brakes, yeah.
KT- So was it dirt road going up Maui Meadows?
C- No part, it was already partly paved; yeah most of it was paved. That was way, years afterwards of course.
KT- So the time that they built Maui Meadows, that was really the first kind of development of Kihei.
C- Yeah, well, the first development I would say was Maui Lu.
KT- Oh, that's right.
C- Yeah, Maui Lu was the first that started condominiums, yeah and uh. Yeah, when Maui Lu first started they um…
KT- So, um there was only South Kihei Road for you to drive on to deliver your mail.
C- Yeah, um hmm..
KT- So, was there a Lipoa Street?
C- Yes, they had Lipoa.
KT- Was there a Honoapiilani Highway then?
C- No. The Honoapiilani was, no.
KT- The up mauka.
C- Yeah, the Piilani Highway, yeah what they call the Piilani Highway. No, no, there was no such, even when I gave up delivering mail; No there wasn't Piilani Highway.
KT- When did you retire?
C- Uh, I was age fifty-six. I didn't exactly retire because afterwards I became only a sub carrier because the route grew too much and it was too much for me.
KT- But by then they hired some other people right? Paula said she used to go too.
C- Oh yeah, Paula yeah and Paula used to go and then afterwards then they had two carriers. Two different carriers and I used to substitute like Christmas time when they needed extra help. Yeah, and then when other carriers would go on vacation I used to work- take their place because I was no, I was never a regular carrier.
KT- So, Mary since the post office was located on South Kihei right at Suda Store as we know it; you had to travel all the way and your farthest route out was Maui Meadows.
C- Maui Meadows, yeah.

KT- So the area that we are researching is in between your route which is presently Maui Tech where they are interested in putting in a full hospital in South Maui. Can you recall what happened during rainy season? Talk story about that.
C- Well, one experience I had when we were still living still on Ewa Road near Maui Sunset, one experience I had, it had happened we were flooded and my father was with me and he had another slight stroke and I couldn't get him out, out of Kihei; and luckily there was a woman that was a nurse and she came, she was able to get to my house to tend to him. Yeah, and several times we were just stranded in Kihei. Even now, in case we have heavy rains, right there the junction by Suda Store you wouldn't be able to because I saw where cars were washed into the ocean there. Right there by that junction there. So, of course we could, like now with Piilani Highway we could if you could get up to Piilani Highway. Like where I live now they didn't have opening to get up to Piilani Highway we had to down the South Kihei Road in order to get out of south Kihei.
KT- So one more time, I'm not really sure so I want you to say it one more time. Your house is exactly where in Kihei?
C- It's um, between the Baptist Church of South Kihei Baptist Church and the Fire Station where the library is.
KT-So right now that's Kalama Street?
C- No, I live on….As you're going toward Kalama Park I live on the left of- yeah you have to make a left turn on Uilani Street toward Welakahao, you know where? Okay, now if in case we, they just opened up the road from where I am, I have to go up and get across Welakahao in order to get up on Piilani Highway.
KT- So, down there….
C- I live just four houses off Kihei- South Kihei Road and sometimes before they didn't have the traffic light and now that; it used to take sometimes I get out to get to the main South Kihei Road and it would take me 20-25 minutes before I was able to get out of, to get on the highway but now at least they have the traffic light so that gives me a little more leeway. That's why I usually go south- I mean go north instead of South. Yeah like I go shopping more that way and good thing they have the Kaiser Clinic, you know, north of my way because it's easier to get that way then, you know.
KT- So, the area that you're describing where you live, you were surrounded by what they call wetlands.
C- Yes, uh huh, Azeka's- close to Azeka's Shopping Mall.
KT- All wetlands.
C- Yeah, uh huh and the Miranda's property was considered wetlands, yeah.
KT- So you've seen a lot of change?
C- Oh yes. (laughing)
KT- In your opinion, is it a good or bad change?
C- It's hard to say. Well, my children were brought up, you know, there and they didn't like the changes because the beaches were all freed. They'd go camping whenever they felt like it and, yeah, there was… so my children don't like it. (laughing) They all moved away and I still have one son in Kihei and uh, as far as he is concerned (he's 51 years old) and as far as he's concerned he doesn't like the change. But, it's created jobs it did a lot of, you know, you have to look at those things. It created jobs for our kids and so…
KT- So your husband was associated with the plantation?
C- Yes, he worked for HC&S.

KT- So, he started with them from Hana or he came here?
C- No, my husband was from Kula. He's a Kula- his nephew is Elmer Carvalho. He worked for HC&S and we lived in Puunene the first 10 years.
KT- So, where did you folks meet?
C- Um, through his nephew (laughing) and we met at the party, yeah I was still out in Hana, living out in Nahiku.
KT- So when you folks first got married you folks lived in Puunene.
C- Yeah because my sister and then Bill Helm, my sisters husband's worked for the Sugar Company so.
KT- Can you describe Puunene?
C- I didn't like it because up in Nahiku the homes were far apart. You know it rained, it was so clean there and when I first moved they still had the train tracks and they used to haul the cane by train and the dust- oh it was! I just didn't like it, and then the homes, you know everybody- the homes were so close to each other and; no I didn't really like it.
KT- Plantation homes?
C- Yeah, plantation homes but we had a lot of benefits though because we had free housing, free lights and free doctors. Everything was there, when the Union organized in '46 they did start charging us house rent and lights and, you know so it was a different world to live in after that.
KT- So how far did the train tracks run?
C- All the way down to Kihei because they had sugar cane down, yeah, Kihei.
KT- Maui Tech Park, did it go that far?
C- No, I don't think so; I'm not too sure. I think it only went as far because there was a camp- camp four I think they called it…
KT- Mokulele Highway.
C- Right above where the Suda Store, around that area I would say the train tracks were because the Pires used to live, Victor Pires used to live over there near the store and he; yeah I think the train tracks ran until there. And they used to haul cane form there and we lived close to the train tracks.
KT- So you didn't work for the plantation but did you have an opportunity to ride the train?
C- I did ask- well, no. Not the sugar train, I rode the train that used to go to Maui High School.
KT- Passenger train.
C- Yeah, uh huh. I rode that after they- just before they closed up. The train used to take people up to Maui High School and my sister used to go to Maui High but I rode it after, after- just before they closed the whole thing, yeah. They gave up that, but I didn't.
KT- What was your husband's responsibility with the plantation?
C- He was a tractor operator and when the war broke out they took him as a worker to build the airport. At the airport as a tractor operator he plowed up all the area to build that bunker's because they closed the road, in fact, to go to Kihei. But we were still living in Puunene at the time but he was, went to work as a tractor operator at the…
KT- So he's responsible for building the bunkers?
C- Bunker's yeah! Well, he actually helped build the airfield.
KT- Which is on Mokulele Highway? Yeah, nobody can remember that because they all who lived then passed away.

C- Oh no, no. I got on a plane ride from there to Honolulu after there, was still during the war.
KT- What airlines was flying out of there, can you remember?
C- I think it was Hawaiian and I'm quite sure it was Hawaiian. Yeah because I remember; anyways I'm sure was Hawaiian Airlines, I'm sure it was.
KT- When I was a child I can remember flying out of there too. So, it was a great life?
C- Yeah, oh yeah. Yeah we went to Honlulu because one of my sister's lived in Honolulu. In fact, she lived- her back yard was Hickham Air Force Base and when they attacked Pearl Harbor she was right there. I mean she saw the whole thing. In fact her husband still lives here in Puunene too- I mean in Hale Mahaolu. Yeah, he's 95.
KT- By the way, what nationality are you?
C- Portugese.
KT- And your husband was?
C- Portugese.
KT- Pure?
C- Pure, yep.
KT- So Elmer Carvalho is pure Portugese?
C- Yes.
KT- Who was his- what was his mother's maiden name?
C- His mother's maiden name was Pierres. She was Pierres.
KT- Do you folks keep in contact at all?
C-Oh yeah, um hmm, we do. Well, they're all gone now.
KT- But, do you periodically talk to Elmer?
C- Yeah, I do.
KT- How old is he now?
C- I think 80- he's in his early eighties because he was, you know. I'm quite sure he's about 82, I would say.
KT- Would you consider calling him and telling him I want to interview him?
C- I would.
KT- Okay, I'll leave you my number later but let's get back to you. So, did you go- did you folks go down to the ocean?
C- Oh yes. Right there in front of my first house the children used to play on that; because they had a reef outside, the one they're trying to rebuild, and we used to go when low tide we'd go right out to the reef and get shells and all kinds of things.
KT- Did you folks eat things from the ocean?
C- Oh, yeah. Squid and I had a friend, Ludy Perreira, he used to live next door to us and he used to go squidding and he taught my oldest boy how to squid, how to pop the squid. Oh yeah, I love squid and then we used to always get ogo (limu) yeah, a lot of ogo, I love ogo.
KT- Yeah, so the area that you lived in was really wealthy with ocean things?
C- Oh yes. The reef had a lot of shells. I still have some of the shells, those coral shells. Yeah we still have.
KT- Down close to your area, one of the fishpond names is Kalepolepo.
C- Yeah, I lived right there. In fact our area is considered Kalepolepo, yeah.

KT- Now, do you, do you think and it's possible I was just writing some stuff last night and I said-Can you remember during the rainy season that all of the top soil from Kula come down and change all the water?
C- Well, when we first moved to Kihei in January of '49, was rainy season. I remember we were there- maybe about 2 weeks in about the middle of January I would say. I remember one night it rained in Kihei, wasn't that bad, but toward morning I told my husband, I said, "I hear water running through our yard." And he said, "never mind and go to sleep." And I remember I kept saying I said, "I hear water running." I told him, "I smell mountain fern." 'Cause being brought up, you know in Nahiku, I said, "I smell mountain fern." He said, "You crazy!" And finally I got the flashlight and I went out (I couldn't stand it) I went out and sure enough water was running. Good thing our house was; well the old lady, Alec Akina told us that to make sure build our house off the ground. And sure enough was good thing, our house was about 2 feet off the ground. And sure enough water was running right through our yard and the next day we went out and there was panini's and vegetables from Omaopio (laughing) in our yard and yeah, I experienced that. And then another time; and then before my mother died (she died in '76) yeah, that time too that we had heavy rain and we had, they said was 7 inches up in Kula and that rain, all that our whole yard was all flooded again. Then after that I know we were in our new house now and I'm not sure what year that was but we had flood in. And my brother was living on; he had a Quonset hut where McDonald's is right now. He lived in a Quonset hut and the thing- and they had to, the army had to go rescue him and the children and they came to stay with me out of that. But we've had a lot of other experiences, a lot of flooding. I think in 1980 they had one. I know my son-in-law was in the police department and he got flooded. He got called and he couldn't even get out of Kihei. He couldn't even go to work that day.
KT- One of the causes was because it was all wetlands.
C- Yeah and they didn't have the outlets like they do now. Even now, you know right next to St. Theresa's Church they have all those lilies growing there? That is a bad place. I don't see why they don't take out all those lilies because if in case we have any heavy rains, those homes along the, you know-South Kihei Road, they used to get all flooded. And now they'll get all flooded again.
KT- So all the years you were there, it still hasn't changed?
C- No as far as the lowlands; No, I don't think so. They said they detoured the water. There used to be a ditch along Miranda's property and then would go into the ocean to that area near St. Theresa's Church and but they've covered that ditch so I don't know where that water will be going.
KT- So the bridges that they built to go under the road is not sufficient?
C- No I don't think so. I don't think it is you know. I know when I was delivering mail up by, um…what was that place called now; I know they have a ditch or just before Keonekai we used to go there. The road, they didn't even have Keonekai at the time, but we would go up there and we would go down low (they have culverts now there) but one time I couldn't deliver the mail because that place was flooded. But still they have the culverts but if we have heavy, heavy rain I don't think they'll be able to. And then I saw by Hale Kai; no Kihei Akahi where they built- Henry Miranda was there and they had just, they built housing in there and they just built the housing and the road. They just raised the road but the whole road was washed out completely. You couldn't get beyond;

this is where the police substation is, it's on Kamaole, by Kamaole II, yeah. They, you couldn't get across there, the whole road was washed out and that's why I say…. And then now they built that place by Kanani, Kanani. They built some homes down in that hollow. I don't know how they allowed them to build that because that area always flooded. That's right by Charlie Young's bridge, yeah beyond Charlie because that….
KT- You know that's interesting; My associate Bully Kapahulehua, I don't know if you know him but we just went and took some pictures of some petroglyph's (you know those writings on the wall).
C- Yeah petroglyph's, uh huh.
KT- Right in that area and as you were living in Kihei, were there any Hawaiian stories or any Hawaiian things that you can recall that was there where we're talking about where the hospital will be built?
C- Where are they planning? It's on Piilani, yeah?
KT- Yeah, right by the Maui Computer Tech; Mauka over there.
C- Yeah well, that's up high.
KT- Yeah but the water, the road comes out through Lipoa so while I was saying yeah that all of the school flooded on big rains and so…
C- Oh yeah Lipoa used to be really flooded because the church, the Catholic Church, they were just building the second Catholic Church, the one that they use as a hall now.
KT- Right.
C- And the water went right into that church. That's why the present one they built it high up on a hill but that area was awful. Lipoa used to flood really bad.
KT- So can you recall anything up there?
C- Up that side, no.
KT- Any Hawaiian temples that somebody told you about?
C- I don't know too much about up there really; I wouldn't uh…
KT- Of course, like you said, cars never passed so unless you cowboy you wouldn't be riding around there.
C- Yeah, uh huh. Like now, I belong to the Kihei Senior Citizens, of course the bus goes because even Maui Meadows has- has really grown. But, no.
KT- When does the Senior Citizen's meet down here?
C- On Tuesday's and Friday's.
KT- Where do they meet?
C- They meet at the Community Center.
KT- What time?
C- From 9am to 11am.
KT- Community Center.
C- Yeah up by where the swimming pool is.
KT- So, since you live here you don't go to the meetings anymore?
C- No, well I don't. I'm just temporary. I'm anxious to go back because I had a fall and Dr. just don't want me to be left alone. So, my son is in San Jose California and he came and then, well he's old enough to retire and so he's going to claim his Social Security and he's coming back to live with me so I'll go back to my house. Oh, yeah.
KT- No place like home, right? Anything else you want to say?
C- You know who you could, if you want to interview anybody else that lives- is Eleanor but she was Xavier but she is Gomes. She lives on Ewa Place in Kihei.

KT- How old is she?
C- Oh, in her eighties, yeah and they actually moved to Kihei before I did. Yeah, Joe Xavier
KT- Is she healthy?
C- Oh, yeah. Oh, yeah.
KT- Do you keep in contact with her? So if you don't mind contacting her, I'll leave you my number and then let me know what, you know.
C- Yeah, because she and her husband still lives there and then her father. Because they moved to- they're the one's who moved to Kihei after because he used to work for HC&S too.
KT- And her father was there before they moved there?
C-Before, yes; Joe Xavier moved.
KT- And how's the father's health, good?
C- Oh, no he passed away; only Eleanor and Val-Val's home.
KT- If you don't mind if you can call her and call Elmer Carvalho, I would love to interview them.
C- Okay, sure. Yeah Eleanor lives right in Kihei.
KT- Okay well, let me end this here.

***Interview: Papa Chang***

**By Keli'i Tau'ā/ Kimokeo Kapahulehua**

**KT- Keli'i Tau'ā**
**KK- Kimokeo Kapahulehua**
**C- Consultant**
**W- Wife of consultant (Mama Chang)**

KK- Papapauka…There's Mala Wharf, right there we was over there.
C- It was by Maui Prince Hotel, yeah?
KK- Mmhmm.
C- But from this map, smaller maps come. If you read over here that's two one yeah?
KK-Yeah. There's the edge of the lava flow.
C- And it doesn't clearly say Honua'ula but Honua'ula comprises most of this area. Yeah, but then you look at the like area seven. Map seven, right here. This map just to give you an idea. So you take map 2 one which gives you the names, that's one of the few maps that has all the old Hawaiian names yet, you know. And some of the old Hawaiian, you see this that's all Mahele's property that. A lot of it's been erased and changed..
KK- But you know these these guys they had um they in Hawaiian. The bureau conveyance they never transfer em because they was too lazy and they get 'em in records.
C- Sometimes they better off to leave it that way. Somebody translate it, they change the meaning yeah?
KK- Yeah they do.
C- Cause no more Hawaiian meaning. Hawaiian words are so clean by itself, yeah. They don't have legal terminology for so many stuffs.
KK- No more. No it's pretty much a spiritual culture terminology. And it's for the people over there, yeah. It wasn't given for the people everywhere. That's why everybody was indifferent in the ahupua'a. Then they can tell you who you are, what you are because they know your ano(nature)already.

C- Ok, you look at this map this is the old Ulupalakua Road that used to come to Makena. Makena landing is over here, yeah? We're over here, you see that lot right there, that's our place.
KK- Like this kind lots, Keauhou.
C- Yeah, but there's two Keauhou. There's this one and I guess this is the ahupua'a. But anyway then if you want to look at tax key seven, this area, that's what this map is. Just to give you an idea of what references you might be using, or we might be talking about. So this is map seven. See this is my lot right here.
KK- Wow. What's that in the front? The State?
C- In front here? It's now State. Ulupalakua was claiming it.
KK- Oh, multiple claim.
C- This is one long darn story. You know, Ulupalakua sold this property and sold Makena Landing which is all this stuff over here they sold it to my great grandfather. Kukahiko. John Kukahiko that's the one buried down here by the Kukahiko house. You know the big grave? This was John and Kamaka.
KK- By the beach?
C- Yeah, on the beach. He was the one that bought this place in 1883. This place and this place. And then later on he bought some stuff back here. But then this lot and that lot he bought from McKee's daughter.
KK- Oh, the original people.
C- Yeah but the story with McKee's daughter, McKee had a daughter and son. He passes away, he gives the property to daughter and son. The daughter, one of the daughters, well the daughter marries a Raymond who eventually buys Ulupalakua. Raymond passes away, she becomes the owner of Ulupalakua Ranch by herself.
KK- McKee.
C- McKee. And then later on it's transferred to uh, I think Baldwin at that time. The Baldwin's wasn't the original owners. And when you start looking at who owned Ulupalakua Ranch before McKee, now before McKee is before Mahele, you know. Cause Mahele's start in 1840's yeah? We bought this in 1883 had passed away before that.
KK- Forty three years later.
C- Yeah.
KK- Wow, that's not too far away, forty three years. From Mahele to….
C- The story goes that much of the land that McKee bought, now we talking about approximately 20 plus thousand acres to 30 thousand acres. Much of that land that he bought was leased to McKee, not sold to him.
KK- By the Hawaiian's.
C- Uh, no from Kalākaua. This is before Mahele now. Oh, ok Kalākaua's the one that give to Mahele.(correction-Mahele from King Kamehameha III) So he leases 'em when you go start tracing records it's hard to find how all property all got transferred to this one man. But somewhere along the line you'll hear of Talbert Wilcox. Yeah, Talbort and Wilcox were people that bought property to farm. The original farmer down here was one haole named Nolan. And then he joined Wilcox. Wilcox or Talbert I'm not sure which I forgot. I used to know.
KK- This Wilcox is the one same….

C- But Nolan sells his interest so now Talbert joins Wilcox. So when you look at a lot of these maps, these maps were done by Talbert and Wilcox to claim the property that they thought they bought, or they thought they lease, and etc.
KK- They make their own map.
C- Yeah, you gotta realize that a lot of this stuff that you see over here that's all been subdivided at one time by Mahele. And now comes one guy and he buys the majority of this property under one name. But he gotta go and keep these titles clear yeah? And back in the old days during my father's time you pay the tax for seven years, you're the owner. You no need put notice in the newspaper.
KK- Automatic. They take away.
C- Yeah, yeah. You can become the claim owner. The quiet title process is changed. Anyway, come back to this story we were talking about when my father, my great grandfather buys this piece and this piece in Makena landing which is. Which, when you look at the map, it's this piece and that piece. And you question is, who own this? When we go try trace the owners. See what happened was my father thought, he always thought that Baldwin never own next door. This was way back after WWII. You know from Keawakapu all the way till this lot they went subdivide it and so had half acre lots all that stuff was sold long time ago. Had owner's already. So they took this land along the beach, and at that point in time Ulupalakua came through and they went stake this property, our property. What they sold to us they come through one stake to sell, to make a long story short. But this used to be the old Makena Road that came through here.
KK- Through the Prince Hotel?
C- That's all part of it down there.
KK- Down by the beach yeah?
C-Yeah.
KK- Right over there come down through you?
C- Yeah.
KK- That one come through, you know that Angus lot?
C- By the hill yeah, yeah.
KK- The road come through there, that paved part?
C- Yeah, that's the old road, this is the old road, a part of it down there. You see Uncle Charlie's place over there? That's the old road. Now that old road we call is, is not the old government road. It's the World War II road.
KK- Oh the military road.
C- Yeah. Because if you read, you read some other stuff about this the old government road was in here. You gotta remember that Maui had a road completely circling the island.
KK- On the ocean side. The Kahakai Trail.
C- That's right. That's the one we call the government road but it was built by uh, well they named the road now.
KK- Well you know it's funny because when we stay Kipahulu, this um this guy Teddy his mother's mother they had this property on the road. They show the road and the lighthouse, and Hana Ranch took 'em. Like Ulupalakua you know they call like how you state it.

C- Well, you hear the story about the road in front of Prince Hotel, the one go past the church and dead end then circles around. And what's now an old road that they kept as a walkway, etc. That's part of the old King's Hwy, the old road, ok.
KK- Yeah.
C- When the urbanized Makena area, the County and I guess in conjunction with the State, went take that road and swap for the new road. Now comes Dana Hall and Leslie Kuloloio and my father and George Perreira claiming that they don't own the road. It's the old King's highway and nobody owns it except you know from the old days. It's a traditional road, leave it alone. You don't have the right to change.
KK- Hui O Makena.
C- Yeah, Hui Ala Nui Makena.
KK- Wow.
KT- So, what came from that? They won the claim?
KK- No they never win.
C- They settled it by leaving that area open but not for commercial traffic. But that road is still, it's a walk path, it's a pathway now and it dead ends on both sides. And then that George Ferriera got a big settlement. Hui Ala Nui O Makena got I think, two or four acres, above the golf course. Three acres. George Ferriera.
KK- Because we went to see Hui Ala Nui O Makena when we were starting up, they said was supposed to be for cultural yeah? And we like go over there with the canoe's, they said no, not for you guys. And the we went go see Roy Figueroa and he said, "oh I cannot discuss that." So, was me and Jimmy Ross because we wanted to go for the keiki.
C- Yeah I think Hui Ala Nui O Makena has the place of what it is to be used for and how it is to be used which is according to what I understand is a cultural thing. But, I don't think 500 thousand is enough money to do what they had intended to do twenty years ago. You know, dollars have changed yeah?
KK- Well, they're doing the same thing as Olowalu now, taking on King's trail. The County taking on King's trail and surrendering that for something with them so. Aunty Patty just called me yesterday and I said I dunno you gotta get.
W- On the King's trail?
KK- I don't know some road that belongs to the Hawaiian or city land and then the county went swap with them or something just recently. They still doing that today. They doing the same thing down at Haiku on Holokai Road. Holokai Road was a King's trail along the ocean and they kinda gave it to the subdivision, the county. You know what I mean? And people fighting over there because the owner's stopping the fishermen from going inside. And they been using that trail for years.
KT- So the Ku'ula next door, by the hotel.
C- Yeah.
KT- You guys ever relate to that?
C- Which one?
KT- When you walking down the path to the ocean.
W- Kukahiko, you mean by the graveside?
KT- It's just sitting over there by itself, going through the hotel, what is that hotel.
C- The Prince Hotel?
KT- No, no, no.
KK- Makena Surf.

KT- Makena Surf.
W- Oh, the little cove there.
KT- Get the Ku'ula right there. Any of the family ever use that over there? It a fishing shrine, they got it locked down.
C- Yeah, yeah. We used several things. One they got a canoe hale the other is the fishing shrine. I not sure what the proper Hawaiian terminology was, but back in the old days when they, before they start closing that area it had stone wall built around it. It wasn't very large maybe it was you know.
KK- This hale's over here it's all separate hales for your brothers and your sisters. Kukahiko one is everybody?
C- No. It's not everybody. This place my father bought from the Kukahiko's. The place that's down there that we had built, that I had built for the Kukahiko's. I was the President at that time for the Kukahiko Corp., the remaining heirs in the Kukahiko Estate that still had Kukahiko property. See most of the Kukahiko property owner's sold their shares. They sold their share to Jimmy Campbell, and the houses that you see up above Makena Landing and all those houses that you see before the Kukahiko house, except for the Lu'uwai house, was all sold to Jimmy Campbell. Kukahiko got two lots out of that place. Two of which we sold and we built this place down here. But the remaining owners incorporated it because they didn't have a large enough share to have one legal lot. And there was some sixty owners at the point this property was finally awarded to the Kukahiko Corp. There was sixty owners. Now there's a lot more because there's more keiki's yeah. Cause that stuff was awarded back in 1974. Well this one here, this was my father's property that he had trusted to his kids. And what we intend to do is to have a family subdivision here.
KK- That's nice, probably going be only the local family left around here.
C- Yeah. But one of the blessings that we had is my father, the State changed his taxes. Excuse me, changed the zoning, this place was all ag. The State came through and they said, "on the water side it's rural. On this side it's agriculture." And then his taxes went up as a result of the change makai side of the road to be rural. Of the old road, this road here. So, he went to court, at first he went challenge the taxes, they wouldn't allow it so he went to court. The court gave him ag dedication, which I still use. So I pay for where the house sets but all the rest of the stuff is ag. So I hardly pay any taxes, I don't pay the taxes like the Kukahiko's pay.
KK- Awesome!
C- So as long as I do some kind of nursery and some kind of ag, which we intend to do, our family subdivision going be, we'll build on the ocean side and the side mauka on the road will remain ag.
KK- What's the ag right here with all the trees?
C- Yeah.
KK-Those trees was always there long time I remember now bigger the trees.
C- Yeah, well had papaya here before. Before that my dad raised alfalfa. there's a well down there. Built by one of my dad's brother's in 1920.
KT- Still get water.
C- Oh yeah, yeah. The water's not as good anymore, they dug too many wells above us and I , no what I think what happened was if you dig a well too deep you hit the fresh water and then you think you going dig a little more and you going hit more fresh water.

Sometime you hit the salt water. And once that salt water mixes with the fresh water everything down below gets mixed. And I think that's what happened. The water used to be colder, not as salty.
KK- Too many guys digging. They splitting 'em up maybe.
KT- For the record can you give me your full name.
C- Edward Quai Ying Chang Jr.
KK-Quai Ying Chang?
C- My father's name father was Quai Ying Chang.
KT- Try spell.
C- YING CHANG.
KT- I don't know if Kimokeo told you, our kuleana is um, we're going to have this transcribed come back to you have you look it over make sure everything ok and submit it as part of our work. I'm going to make sure we got everything.
KK- Oh that's Stan Garcia's place? They going subdivide? They doing it already?
C- They're in the process.
KK- I seen 'em at the church. Because this place over here stay…..
C- I mean you got, you got a heiau in there yeah.
KK- Yeah get, eh? Right in front the house?
C- Behind. Well, next to him, next to him the Garcia's is David Lono's place, yeah. Old David Lono. And had one old house with the swings in there long time ago you remember? It's torn down now.
KK- Had all ducks and animals all running through there?
C- Yeah, that was George Ferriera's place that he got from one of his aunt's, or our aunt's, Mary. So there were two plots in there in front which Farrington them bought already.
KK- They went subdivide already.
C- No they bought. And now they're going to put, uh I don't know 4 houses or was it 2 houses. Four houses wasn't it. And then Sam Garcia's bought the church from that, yeah?
KK- That one they went go get the meter before the lot to divide it because you can do that. So they got their meter before get the lot subdivided. They get all the meter. Then the question was brought up how come you guys get the meter you know you never even sub.
C- Who is this, Sam? Or Farrington?
KK- No, Farrington. Going get all the water meter for that lot.
C- Yeah because what Farrington does is he builds individual houses but he condominumized the area so that by condominumizes the area he can get lots to supply each building. Not lots, meters, to supply each building. It's a State process.
KK- It maximizes the lot.
C- Yeah, yeah. This Makena place over here you look all individual houses but they condominumize. The house owner owns the property the building sits on but everything else is condominumized.
KK- But the one next to Kukahiko they only going build one house, eh, those people. They went make one lot on there.
KT- So how old are you now?
C- I'm seventy four.

KK- Whoa, young man. And you, mama?
C- Yeah.
W- I'll be seventy three this month.
KT- And you lived here all your life?
C- Uh, no. No, I moved here about age four or five I'm not sure. I can't even remember that young.
KT- Where were you born?
C- I was born in Wailuku. My dad, my dad worked for Kahului Railroad way back then. Then he got tired of working till somebody else came back and started farming. That's about 1937, I think. All my brother's and sister's were raised down here from kid time but I wasn't raised here till about four or five years old.
KK- But Norma Lei went go Kentucky.
KT- Who were your neighbors?
C- Mostly family, the neighbors uh, we came down Ulupalakua Road yeah.
KT- So give us some names.
C- Uh, well there's my great-great grandmother which was a Haihai and then her sister Moloa, who lived down Makena landing. And later on the World War II came they throw all those houses down and then John Lu'uwai came down. John is Boogie Lu'uwai's father. And then across the bay there was Piho's, the Piho's lives now where Dogul lives, you know where Dogul Milney just before the church.
KK- Oh yeah on the top the hill.
C- Yeah and then where Eardmen lives now, Eardmen's house is, that's the place they call Apuakehau where the Hau tree is. And that, that island out there that I don't know it's referred to as my father them referred to Dickson island but I think at one time it was owned by a guy named Pikanela. Pikanela was the Chiefs down here, the Ali'i Chiefs down here Makena area for that Hau.
KT- Doesn't sound Hawaiian but.
C- That's a funny kind Hawaiian name and he's recorded as Pikanela, yeah. And Boogie said you know that word means something but we forgot already yeah.
KK- In front there get one fish pond?
C- Between that island and Erdman's road or Eardman's house there's a fish pond, yeah.
KK- Get one fish pond yeah over there. Cause get on the map all the fish ponds, yeah.
C- This is that island I'm talking about, this is where Eardman is right. No, no wrong side, wrong side, this is the church yeah? Uh, the fish pond is right in here, right in here, right in this general area. If you look it's got all kinds of rocks, low tide.
KK- This is where we went with the canoe for the funeral?
W- That's right.
KK- That's why I asked you about that, because that day I seen all the rocks in here. Was so clear the bay, you know. It goes round and round you know everytime I go around looking oh what is this.
C- Small kid we used to go down there you know with the kind bag pole has uh, net has two poles. Throw stone make lot of noise. Everyday get Weke inside, sometime get Pananuu inside.
KT- Even today?
C- Yeah!
KK- But the State own that.

C- But it's not as good because the inlet has been ruined, yeah. You said the State owns that?
KK- Who owns this?
C- I think it's all privately owned.
KK- They should redo that wall.
C- Yeah.
KK- Get one nice fish pond by the church.
W-Used to have clams through here, I know we used to see clam shells.
C- Still get clams down there.
KT- So where did you go to school.
C-I went to school at Ulupalakua.
KT- Wow.
C- Yeah, up the hill. My father and mother used to drive, see they had a bus contract from the County and drove all the kids that lived down here up to Ulupalakua then went up to Kanai pick up those kids and brought 'em to Ulupalakua. And then the afternoon they took 'em home.
KK- Where is the school over there?
C- Ulupalakua, uh before the Catholic Church, next to the old Congregational Church. Uh, you know where the baseball park is?
KT- Yeah.
C- Uh, you go and then there's a baseball park go down and then there's a bunch of houses and then you see one, is that church still or just the site there? But there used to be a camp retreat. It's all overgrown you can't even tell there was anything there. That camp retreat is right next to where the church used to be. And then you go further past it's all empty grounds, yeah. You go further past it's where the Catholic Church is.
KT- From kindergarten through eighth grade?
C- Uh yeah but only three rooms. Was first grade to eighth grade; never had kindergarten when I was young.
KT- How many kids were going?
C- Let me make a guess. My graduating class was six people.
KT- Who was the teacher?
C- So, uh the teacher I had was the principle who was Furokawa. My mother was a teacher for a while, and Furokawa's wife.
KT- Was she a college graduate, you mother?
C- Uh, no my mother was not.
KT- Just high school.
C- But the other two teacher's were college graduates.
KK- Had one school by Keokea too, yeah?
C- Yeah.
KK- Right here by the gas station below.
C- Yeah, yeah.
KT- So you guys had that bus service going that way and Akina's going that way because Akina's serviced Maui High and Baldwin.
C- But you gotta remember we never had road between here and Kihei, you know.
KT- Right, right.
KK- All separated.

KT- Never came through.
C- This road over here was built during World War II by the army.
KK- So you guys only can go up you guys no could go this way through the trail?
C- Yeah.
KT- So if you came to end of Kihei Road you guys had to walk in over here? Or you never did come this way?
C- We very seldom went that way, there was no need to. You know, over here when we were kid time if we went that way was probably to go fishing or to go store. During my father's kid time, see my father, my grandfather had a store in Makena.
KT- What was the name of the store?
C- Uh, Chang Store.
KT- What was the merchandise?
C- Was a General Store, yeah mostly food stuff, yeah.
KK- And how you guys went get your guys stuff? You guys go up this road?
C- Ulupalakua, order from wherever.
KK- But no more boat come inside deliver nothing?
C- Back then they did, yeah, there was some delivery yeah. You gotta remember that this harbor was in before Kahului Harbor was.
KK- This was after this.
C- Makena, yeah. Makena actually had two harbors, they had one by the church. And then later on when Talbot and Wilcox built Makena landing, Makena landing was known as Talbot's Bay. Talbot's Wharf, that's where they shipped all their stuff from, you probably heard some history where they were raising sweet potatoes down here and selling it to the gold rush days. That was part of the Talbot and Wilcox thing.
KK- Oh, out of here?
C- Out of here. They brought in animals and shipped animals from here. Ulupalakua used to be sugar cane.
KT- Wow.
C- Way back, you know, way before I was born.
KK- Because they used to store the sweet potato underneath the ground yeah, before the ship come? Or in the like, Makena Golf Course they show like all the little imu like that look like they store things before.
C- There's plenty, there's plenty stone wall that's closed off you notice? No more opening like some walls had? And then look like one plot where the stone is loose that they keep stacking 'em up to, uh somebody claimed that that was used to store potatoes.
KK- To keep 'em cool.
C- Yeah, you know, rock wall and I think they probably had something on top to shade it, you know.
KK- The sweet potato was a Hawaiian sweet potato or something else?
C- Not sure.
KK- They talk a lot about the sweet potato up here.
C- But the success was probably with the Hawaiian sweet potato. You can't come down here and experiment with that success.
KT- So how did the people survive around here? Your father was an entrepreneur building a store?

C- Other than my farm and a few other people that, most of the people had back yard stuff, chickens and pigs. My father little bit more serious, he had plenty pigs. At one point in time before World War II he had over a thousand pigs. Then World War II came we had to cut back because we couldn't get commercial feed. We cut back to about 400. But the rest of the people, a lot of them lived off the land and fished. This place had plenty fish before. Was easy to fish.
KK- I remember coming down here in the sixties hunting down here somewhere with the truck. Like passing stone walls, all dirt road.
W- Right down here.
KK- There we go night dive.
W- The road was right here in front this house.
C- I remember kid time we used to see schools of Manini and big Uhu traveling with them in this kind of water. And you see 'em outside all you gotta do is wait a couple days at the right tide, they come right inside. And you could reach 'em with the throw net.
KK- Manini was big.
C- And we go hukilau, we gotta let some fish go 'cause no more place for put 'em.
KK- I seen the Manini when I first came down here was like this big. You hit 'em though spear would fall down with 'em.
C- Yeah, yeah.
KK- When we came down here before, night dive, yeah daytime too we see the queen all the time. Now I never see the queen, the golden Manini. Never ever see 'em.
C- Yeah. We used to go fish once and a while in the evening when we get plenty company, we just paipai maybe the paipai net is only like forty feet.
KK- What about the Opelu? Pleny Opleu out here.
C- Opelu was more on Molokini.
KK- Nobody go with the canoe out there?
C- Uh, one of my, one of my great grand uncle's did.
KK- He went go with the canoe?
C- Yeah, Kawakani. He was the one that went out there.
KK- Koa canoe?
C- No. I think was the, was the, when I was born they had plenty red wood type canoes, yeah.
KK- Because the one guy we talked to, the podagee, what his name?
KT- Mike. Mike Boteilho.
KK- We talk about a cowboy up here, they talk about finding canoes up there.
C- Hmm.
KK- Because I know Keala went find one canoe someplace around this, around the Pimoe, Pimoe area in one cave the found one remnant and how the thing was lashed. So they took the picture and try to recopy the lashing. Was able to do that.
KT- So what inspired you guys to build such a big house at a later part of your life?
C- We had planned to build that house sixteen years ago but I got side tracked with a lot of other stuffs.
W- Clearing off this land the title……
C- One is if you remember Angus used to live down there, right? And I wanted to make sure we had clear title to what we owned before my father passed away. My father

owned 95 percent of this place. The other five percent which is about an acre of land was owned by 51 people, Angus was one of 'em. So, it's not only Angus that we had problems with other people would say, "if Angus can do that, where can I go?" So we went to court, we partitioned our share from everybody else.
KK- You partitioned your share, what is that? You take 'em away.
C- No. We own 95 percent of this lot but we don't know where so we went to the court and made claims of where we think we should be, ok? And what, what the fortunate thing Angus had already built, bigger than a quarter acre place over here. So we said let them have that, we'll take the rest. So that's how we partitioned the 51 people from us. And the fifty one people, majority of them wanted to sell. They didn't want to incorporate, they didn't want to do nothing, they just wanted the money so.
KK- They sold.
C- They sold.
W- Took us 13 years in court.
KK- To partition?
W- That's why we're late in building this. And at the end of the 13 years the Kukahiko's had the land issue.
C- It's not that simple. You don't just go to court because it's the land issue, you go through all the rightful owner kind stuff and how you arrive at that we did it basically by genealogy. We all came from the same family. Old man Kukahiko bought this place, he had ten children. And he deeded it to ten children and one grandson.
KK- Who was the grandson?
C- Uh, John Kukahiko. He used to live Kihei, was the daughter of, son of Kukahiko's daughter.
KK- So Earl Kukahiko fought for Earl, not down this side…
C- But he's from this guy. Earl Kukahiko is from Mahele, John Kukahiko had a son named Mahele. Earl Kukahiko's father went by Mahele more than Kukahiko when he was younger. That was the style in the old days, yeah? You Lu'uwai, you Mahele, you Mooloa, hardly ever carry the last name.
KK- Yeah, parts of the thing.
C- Yeah. And wasn't until we started had to do birth certificate and everything we start putting a real name. My mother's uh, my mother's father bought the Mahele land in Molokai. The only thing the deed said is Kamai. And I'm sitting here wondering, how I going prove that Kamai is my grandfather? (laughing) That's true story, I mean when he signed it only Kamai! But the family knows Kamai to be Able Kamai Laumanu, which is my mother's father. And then his brother buys same thing, an adjoining piece of land, Kumahele, they call 'em Waiweia, that's it. That's the only name on top the deed. Waiweia. And then there's a book, you know the Indye?. Have you folks seen the book the Indice? The Indice has all the breakdown is a like a Reader's Digest version a shortcut version of all the breakdown of all the land awarded during the Mahele. And most of them are first names. The one's that no more first name happens to be haoles that were given lanyed from chief's or kings. Because they used to use first name, last name, etc. Us, we not used to. My father, my father's father comes here and he marries one Hawaiian. Tutu Aihai's daughter right, which is the Kukahiko. They call him A'ana, they give him one pake, one Hawaiian name right away. He's not known as Ying Chang. We know him as Ying Chang, but the Hawaiian's all call him A'ana.

KK- Oh they give ‘em, they talk to him Hawaiian, yeah.
KT- Were you raised here too?
W- I was raised here. I was raised in Wailuku, Omaopio and um during the War years in Waiakoa.
W- Yes, went to Waiakoa because my parents felt it was the safest place instead of Wailuku in case they came they would be up in the mountain. So went up in the mountain, my parent’s was farmers so we went up there.
KK- Where’s that Waiakoa? The ahupua’a Waiakoa, Kula.
W- Right below the Elementary School, where the Post Office is, in that area?
KT- Now Haleakala Waldorf.
W- Yeah, that’s Waiakoa.
KK- Oh, the old man was telling us used to get slaughter house up there. Pig house, rabbit house, chicken house, cattle you know. Slaughter house.
C- Ulupalakua had a big slaughter house. In fact slaughter house used to be down here, Makena Landing. First it was in Kana'ena . Then he moved out to someplace in between, uh, what the hell’s the name of that place. Uh, Kana'ena. Kana'ena is just before the lava flow stops where all those people go snorkel diving, that small bay is called Kana'ena, yeah. And then it moved to Makena Landing. And then I think it attracting too many sharks, about that time they stop putting in the wharf for ship stuff yeah. And the way they used to ship pipi was they put ‘em in the cow pen. And the cow pen is that, you know where the restroom is? You see that area is stonewalled, yeah? The stone wall used to be that high. They chased the pipi inside and then they chased ‘em out to the beach, outside get launches, they strap ‘em one cow to each side and drive ‘em out strap ‘em in the heel lift ‘em and put ‘em in the boat. Yeah.
KT- You actually, you saw it?
C- I saw it, yeah.
KT- So the cows swim themselves?
C- Yeah cause I was old then. By 1988 I was sixty years old, so from about then I started knowing already. You know but about three, four years old, I no remember nothing.
KK- They swim right through the wave come up, if rough and all. If the boat come inside rough, they swim the cattle right through the row. The thing swim.
C- They just hook ‘em right around the head and they drag ‘em out with the launch, motorized launch.
KK- The one they get out there they gotta carry ‘em by the stomach, no more dock. The same what is in there now. And when I went look the cattle seen them the first time the guys drag ‘em…whoa the bugga swim! And like you said the shark, the thing stay attracting sharks because the slaughter house stay around.
C- Was there yeah.
KK- Funny where they get the cattle, they going make one slaughter house.
C- Yeah, but Ulupalakua had a large slaughter house. They had tanning operation and everything, you know for the hide.
W- Keli'i, you see the gentleman over there?
KT- Yeah.
W- He’s eighty five, his name is Charlie Aki and he’s probably the oldest living paniolo for the ranch today.
C- He work Kaupo Ranch.

KT- Is he ohana or just friends.
W- The wife was ohana.
C- The wife was ohana to us.
KK- He working contractor?
W- No he's just, he works for our contractor. He's non labor, you know he just likes working. He doesn't want to stay home and do nothing.
KK- He stay down here early, last time I came here was…
W- Yeah, he works full eight hours. He doesn't stop he just works. Only stop he did was lunch break, that's how much…
KT- Where he live?
C- He lives uh, homestead in Waiehu.
KK- Waiehu Kou.
KT- How does he come, car?
KK- He drive his own, he get his own truck. He get one white truck.
W- He still can ride a horse yet.
KK- When he come here, early.
W- He still does some, when the lunch have round up, he still goes.
KK- He's Aki, last name?
W- He's actually Kahaleauki, yeah?
KT- I saw a name, Kahaleauki somewhere over here, right here, Kahaleauki.
C- I tell you one story. Charlie and I are talking. I always knew Charlie as Charlie Aki but his legal name is Kahaleauki. Kahaleauki.
KK- Ceclia Kahaleauki.
C-Yeah, yeah. Anyway, I said "Aki, how come Aki?" He said, "Oh, um my father part Pake." I said, "Oh, yeah." He said, "yeah, my father from China." And you know the reason why I ask is almost all the people that got "Ah" something is part Pake, almost all of them.
KK- I show you the map Honokahau get Ah Sing, the whoe balance get all the Pake's and then get the Hawaiian connection, right. But like you said get the Pake. And he is a Pake, like all those, all the Chun family, the Keahi family, they all Pake.
KK- The name is from Kahikinui where the Tahitians went arrive, Tahitinui. You know Kahikinui, that's where the name come from, from Kealakahiki go right to Kahikinui.
C- That's how you going justify it for him anyway right! (laughing)
KT- What can you recall that you liked to leave. As I said we going transcribe this, we going bring you a copy for the family, put the pictures in. What would you like your family to know? Your offspring, you know, that might be significant.
C- Oh you know one of the things I think we losing track is the places, the names of the places over here has changed. Now I agree, I tell my family. But it's names of places is almost something you gotta live there to know the point, the fishing hole, the bays that are named separately, you know as you go along this place. I was probably taught a lot more names than I can't really remember. You know I didn't live here all the time, I don't use the names all the time. So the consequence, I would like to see the names of places change. Like, one of the things I hate to see Palauea become part of Makena. Palauea to me is Palauea. You know there's some key places on Maui.
KT- Let's look at so I can relate to what you talking about. So right there in between….
C- See Palauea's way down here yeah.

KT- Right.
C- This is Pu'u'ola'i
KT- So what you would like to see is keeping the ili's like it used to be instead of adopting what the people are doing with it for their convenience?
C- Yeah, right. At least keep some of the major, you know Palauea is a pretty big sand stretch. No go change the name to whatever they want to call it.
KT- So, as we looking at this map here, anything significant happen here that you'd like to relate?

C- About four to five years old. Went to Ulupalakua School. When I graduated Ulupalakua I went to Lahainaluna. When I graduated Lahainaluna, this was 1949, I went to the mainland to school named then I went in the army and that's where I met my wife. I got out of the army, went back to school, went to work.
KT- What was her maiden name?
C- Laureen Sakugawa.
KT- Sakugawa, okay.
C- Yeah, she's a Maui girl, but I lived in the mainland for 39 years. I was gone between the years 1949 and 1988.
KT- So, question. That life, you think, gave you the edge now as a Hawaiian, in Hawaii?
C- Well, you know my parent's were, were they wouldn't sit still for unfairness. My mother always thought that many Hawaiian's got cheated because they were, they lacked the energy to challenge certain things. My father was the same way, you know and I was brought up that way and my going to the mainland perhaps made me keener about certain things.
KT- What did you do up there?
C- I worked for a company named Leber Brother, you know I started as a chemist and then went up to manufacturing and…
KT- How did you get the expertise, Military?
C- From working.
KT- To be into that occupation that you got.
C- That field? Oh, from my college, yeah because I got a degree in Biological Science. You know my minor is in Plant Pathology actually. And I went graduate school at Southern California, you know.
KT- How many children you have?
C- I have five children. One son and four daughters.
KT- What do they do?
C- Well, they're all married now, except my son. Um my daughter's, believe it or not, all graduated from University of Hawaii. They started elsewhere, they started. Momi didn't, she graduated from California, but she went to University of Hawaii for a while. But they all started different places. One started in Los Angeles State, the other one started Indiana State. Another one started Indiana University, another started in Missouri, yeah. And those, the three oldest ones came home to Honolulu and graduated from UH. The youngest one however went back to the mainland to finish.
KT- So what kind of field of work are they in?
W- You know our oldest, Keiki Kawaiaiea, you know her? That's the only one that's in the Hawaiian movement.

C- She's in Hawaiiana, she basically does Hawaiian curriculum, yeah. And my second daughter's a school teacher. My third daughter, what she got two degrees? She's in art but she's basically a home wife. And my youngest daughter is a house wife now. She just gave birth.
KT- None of them are asking that they want to come home.
C- Well, four of the girls live in the island. Three of the girls live in the island, one lived in the mainland. Two live in Honolulu and one live in Big Island, the oldest one lives in Big Island. And they're a little too young to retire so.
W- has three and then the oldest one by the way graduated with her degree in teaching Hawaiiana. She teaches at Nawahi, she's a school teacher there.
C- In fact she went to the first class of….
W- Immersion school.
C- First immersion school in Honolulu.
KT- Oh really?
W- She was the graduated out of the University with a degree in actually in Hawaiian teaching Hawaiian. She's a school teacher. She's the first one of the Hawaiian immersion kids to graduate out of college, so we're very proud of that girl. And she's teaching there you know in Nawahi and enjoying it. And she enjoyed and she's working right now on her Master's.
C- My oldest daughter used to go stay with relatives like my mother and father speak fluent Hawaiian. So my relatives in…
KT- Your mother and father? You father was Chinese you said, right?
C- No my father's only quarter Chinese, half Chinese rather.
KT- Your grandfather was pure Chinese?
C- My grandfather's pure Chinese.
KT- Ok, but did he learn? Do you know if he learned Hawaiian?
C- You know I don't know. He must have learned a few words, you know. All the people he delt with at the store were Hawaiians. There were no other Pake's here except him.
W- Well you grandmother spoke a lot of Hawaiian.
C- Yeah my grandma spoke, his wife spoke fluent Hawaiian of course.
W- She must have.
KT- It's the principle of immersion, living right?
C- Exactly, he was immersed!
W- You remember in the class what you told us one day? You got kind of frustrated with all of us trying to learn Hawaiiana?
KT- I cannot remember anything!
W- You got up and you said, listen you said, "don't be afraid to speak what you're learning now because you'll never learn to speak Hawaiian unless you speak it." And you told us and discussed Oleo in Hawaii. You don't remember that? You don't remember that right? And that influenced a lot of them, our haole ones, started to speak Hawaiian. Better than us.
KT- One of the most challenging thins for me is, you remember me, yeah? Come one I mean how many people I meet right? You remember what I said? Just like you telling me…..

W- Gee! We were with Hokulani at that time, she was one of the first kids in the immersion program learning. Kupuna's, Tutu's coming in … I haven't forgotten you, yeah. Gosh, you were the only male at that time, you were the first male, oh other than Boogie. You and Boogie, you remember that? You and Boogie were the only male that came.
KT- Yeah. So most of your children you had on the mainland or you had???
C-All my children was born in the mainland.
KT- All?
C- All of them yeah.
W- But our oldest daugther she was akamai. To learn Hawaiian she went to the Kupuna's, she went to the tutu's. She came to Makena, she went to Molokai during her spring break you know and things like that to go learn the language. And that's how she, and then she tuturoed a girl from Ni'ihau. You know, English and she would tutor her in Hawaiian.
C- Ni'ihau dialect.
W- Yeah, so that's how she picked it up really fast. So she was very smart but she was really into it. That's what she decided she was going do for her life career.
KT- Lot of the kupuna's are, really made an imprint in my mind. Loud and clear you said the problems with us Hawaiians is we want to be jack of all trades and master them yeah. So I cut back half, so I just focused on…and even now I'm coming back again so I'm really getting back to my language and trying to satisfy the hula area. And to make impact in trying to retain what you guys are telling me about these culture things. In fact the guy that I'm recommending you guys call, I'm turning over my history on Maui and History of Hawaii class to him to sit in for a semester. I want a break but by me doing what I'm doing, this is another reason. It works together, you know because coming to meet you folks I learn new things.
W- What's your reason for doing what you're doing with Kimokeo, working with developers?
KT- If we cannot come out, don't do this, who will do it? Haole? They won't put in the true and the Kupuna will not talk to them. So they won't be putting in what really used to be like. So what kind of impact are they going to make? If we are true to what we say to you folks then you going to see it in the report. And that's my take on this. You know I look at what can I give back? Kupuna have given me so much, the Aina has given me so much, now's my chance.
W- Do you get, you know because you're doing this kind of stuff, I'm just curious because you're doing this kind of stuff. Do you ever get feedback where our locals are saying you're working with the developers, you're working with…they don't know the true meaning of what you're doing and they say they don't realize that the reason you're doing this is so that you get the true feeling, the true value of the aina to the developers.
KT- You guys follow; you guys take Maui News?
W- Yeah.
KT-You guys follow the Oluwalu thing, okay?
W- Yes, I have been, yes.
KT- Okay. So Kimokeo and I walked into the local boys because the local boys who were leading that presentation are canoe people We never know, we just do it. Kimokeo

and I you know, we don't ask for permission anymore. We just do and later on people going to say wow those guys really were on it, they were sincere. Here is their works.
W- I ask you that question because for so long Ed and I have been sort of activists too, yeah. I don't like that word too much but there was a reason for us doing that. We've always been very particular about Makena, yeah. And there's certain things we have been and we did that because we felt that we had to do that for our kids, yeah. And then of course when we get different kind of throw backs from some the local you know but that was just kind of thrown out the window. But you get it both but for us, for him, Makena is such a passion for him that I'm, I fell like it's important. Like we support Makena. And people don't understand really why we support Makena. There's a reason for us doing what we're doing. We want to make sure that things are all right the way it should be, you know. But we think, but people don't understand that. But that's why I ask you because it's a hard place to be. It's really hard.
C- You go up there and Makena is asking, Makena Resort is asking for rezoning parcels, roughly 100 acres. And uh, you know they're the only developer along this coast that doesn't use coastal waters for development. The shorelines are free; you can still roam in and out of that place. You know the stuff in front of the church they never owned, you know they owned stuff behind the church. They're very community oriented even as slow as we are but the people that speak against development think I'm a developer, I'm not. I'm listening to this developer because I don't trust the other developers. You know that's all that's there.
KT- Kimokeo got me involved with them too. When the lead archaeologist found out that the father and I worked Hokule'a, he said I want to meet Keli'I because he knew the connection. And so he's been telling developers that he's working with me. You guys gotta use these guys, they're sincere guys.
W- He's so akamai about archaeology and his father is too. And that's why I admire, I really admire.
KT- And he's sincere, that's important.
W- He's really sincere.
KT- He tells it like it is.
W- Yeah, we have found that out and it's a hard place to be, because you're now with Charlie and I can understand why you're doing this because you really don't want just anybody to do that. It's important. And I wish local's would understand that.
KT- They eventually will but at this point in time, it takes time. Our people are really, you know, they ku'i first before they listen. And that's why they all in back of the bus.
C- And there's some truth to what some of the locals say. You know they used to come down here and all open space and I said to them, "you didn't feel you were trespassing then, but you feel you're trespassing now?" I said, "You're doing the same thing then. I said the difference is you might have behaved differently." You know you pick up you're opala (rubbish) after you left, you know you kept the place clean. You didn't come down here and dump your cats and dogs and your rubbish and all your old junk. I said people do that here, you know. It wasn't uncommon to find this lot, when the road was going through, with old engines. Rubbish people just dump out of the car, you know stuff like that. Guess who's picking it up? Another local, now why are they doing that?
KT- It's still happening today?
W- Yup, it's still happening.

C- Yup.
Kt- I keep asking myself, I mean where are they? Where is their brain? I mean what's making them do it? Every time I tell myself I run 'em, write editorials and say when they do that, they're not only defacing but they're also abusing their right as a local. They're abusing their local gods because eh, who going have to live in a cesspool? So, and it's not only local, however you know locals participate in it.
C- Back in the old days you didn't have a whole bunch of people. We've owned this place since the 1940's. You know and before that is was still family property, my great grandfather bought it. And even as a kid in the 40's and the30's hardly anybody came down here. But when the road's came then a lot of people came. And the island people they were much more humble, "oh can I stay over here?" They asked. You know it's such a nice thing to have a local say, "Uncle Eddie, can I park over here and go down there?" Oh, yes! But no, you find that the other people they come here and they say, "Oh, you not supposed to build a house over here. This supposed to be open land, blah, blah, blah." I says when do you start paying the taxes over here? You know 'cause taxes were always the principle ownership around this place. But the thing that's really changed is may people bring liability concerns. And the liability concerns makes all the residents really a lot more cautious of what they're allowing to go on. You know, so. Where before as a kid, we never worried about it. But our old folks kept us straight. You don't do this, you don't do that, you know. You stay out of the water from certain kind water. You always have somebody with you.
W- You know a lot of the responsibility, the things the Hawaiian's, were losing. They didn't keep up with their responsibility and nowadays they want to ku'i first, you know. And it's sad and it's sad. It seems like they're strong people yet they needed leadership to tell them you have to do this, you have to do that. They need to learn to do it themselves. And I hope the new generations are learning this.
C- I have a really mixed feeling on how the Hawaiian's get blamed. A lot of the Hawaiian's they can stand around and look and watch what's going on and compare it to yesterday versus today are not really the property owners so therefore cannot really speak. You know, where before as a kid the people I knew were all property owners. They lived here, they paid the taxes. Now they have left they've sold their property, you know transplanted by people that don't own property. They use the place, I don't mean they misuse it but the fact is they don't have the same passion for the place therefore don't treat it likely, you know. And that's what I see. Once your main space leaves, if you don't get good replacements, it's going to change.
KT- So right there is developed. That where Angus used to be.
C- Right.
Kt- What is coming up over there?
C- Ah, oh that? The pipes and so forth. Angus lives further down you can't see where the house was but Angus lived, you know where the parkinglot is? He lived right next to that, yeah. That development is something I have to do because when I….in the process of settling my court case I rezoned the property so that I could sell a smaller lot. Then I had to subdivide it. I had to actually subdivide away from this tax fee what it is I'm going to sell. And in the process of subdivision the County requires certain improvements. One is I had to put a swail that took care of the drainage that came through this property. The other is I have to put in a 12 inch water line fronting the

property, at my cost. And they called me a developer. And all I'm trying to do is save family land.
KT- How it's worked again. We gotta be training young kids to do research so they turn it back.
W- That's right, that's right.
KT- Yeah, because..
W- You know what? These kids coming up I tell them if you haven't made a choice yet but you love land go be archaeologist. Go be archaeologist because I don't want archaeologist come from the mainland to do archaeology work here. I'd like to see our locals do our work.
KT- That's why I have a nineteen year old I've been trying to. And Aki wants to train him but young boy right? Rather surf than be with Uncle Kimokeo and me so what can I say?
W- But I wish our kids would kinda look down that way.
KT- I hear you, yeah. Lawyers, you know, all the key positions that can help prevent further taking of all our things that we value.
C- You know when I was a kid I couldn't do anything unless I did my work first. I had to do the housework, the farmwork, before they let me go out. And then they gave me freedom to do that. But they always knew where I was you know.
W- But today is different, today get cars today. They hele on now.
C- Well kids live at home but they don't have responsibility as a family and I don't understand that. You know, I still feel responsible for my family. And for my father and mother's way of how they brought us up, how I think was a notion of theirs to begin with. You think our kids think like me, or like us? I think, yeah to a large extent they do. But I can point to families that didn't make any kind of an effort that way. And I think maybe it's brought up in this big city syndrome, you know. They got all the kinds of activities they belong to different kind clubs and different kind training.
W- You Kula? How come I didn't know you went out there?
KT- Seventh grade I went out to Kamehameha.
W- Oh, I see that's why, you went to Kamehameha.
C- So what year did you graduate Kamehameha?
KT- Sixty, so Hoku Padilla came later.
W- Did you know Hoku them?
KT- Uh, no later.
W- She's a remarkable woman.
KT- Kamehameha is a good foundation for our children. I don't know how Maui Campus going to fair because my daughter is going to graduate from Oahu
C- All day students?
KT- Maybe from Molokai and Lanai.
C- Cause I told her I went to Lahainaluna and boarding school at the age you go through those four years you know from 13 to whatever.
KT- So what year was that?
C- Forty five to forty nine.
KT- When did Earl Kukahiko go through?
C- Uh, he graduated '51, I think.
KT- Oh, wow.

C- He was at school while I was there. I think he was a sophomore when I was a senior.
KT- Cause we research Kahoma. And you know like I'm saying we just getting into this so. The other thing I haven't answered you is, I didn't know but what's happening now is two more things; it gives me access to talk story with you folks, more intimately than I would and the second it gives us the keys to go into these areas that we wouldn't be able to go into. Like we research Kula 1800 which is the across, the farm county over there coming down Pulehu.
C- Oh, Omapio area.
KT- Omapio, okay. It helped me determine because I knew King Kekaulike had petroglyphs. I knew another one had petroglyphs. We went to an area. No so my final report was we came to a bed of petroglyphs from here to that coconut tree. At the end was a big pohaku like this with Kanji writing's on But the final report I wrote that there were pockets throughout all the beds comings down. Because after interviewing the different peoples up in Kula they told us where they had petroglyphs on different streams, there was an indication that the families would be bringing stuff down, stopping point. To document you know, writing story about their lives. So, I would've never known that everyone of them had. So it's become very rewarding personally to take this. And Kimokeo, you know, I told Kimokeo if I going do this with him, he go get the contracts. I'll be the writer. I'll do research and stuff and it's working out good. So now he wants to expand to Big Island because he has some contacts. And Kauai is his home island so we already went Kauai look at what we would want to participate in. But anyway, thank you guys so much for your time.
W- Thank you for the information.

## *Interview: Bonnie Herbert*

**By Keli'i Tau'a/ Kimokeo Kapahulehua**
**October 20, 2006**

***KT- Keli'i Tau'a***
***C- Consultant***
***H- Hamby Kahawai (mother)***

KT- So, Bonnie, we're going to pick up where mom left off. You're now employed at?
C- Kamali'i Elementary School.
KT- Which is further down the road than where this will be built mauka; pending it's built. However, Lipoa is where the water runs down and gets into Kihei School. Does it get into yours?
C- No.
KT- Yeah, because you're a little higher, yeah. I'm not going to quote who told me what you know but share what you know about Kihei.
C- Well, my grandfather, John (her dad John Akina) was born in 1900 and he was born on the island of Kahoolawe. And the reason why I bring that up is because the Akina's were not in Kihei in the 1900's because my grandmother didn't receive land until maybe ten- fifteen years later and that land was here on Maui. And so my grandfather, Auhana which we mentioned earlier, was raising cattle for-what ranch was that? On Kahoolawe, he was raising cattle on Kahoolawe. My grandfather and Alex Akina, which is Aunty Minnie's father; they were born on Kahoolawe. So, what I know is after that. So, as far as Kihei before the 1900's, I don't know. So anyways, they came over to Kihei and in about the 1920 census, my grandfather John Akina, would do his, they would do business here right where we are right now at Kalepolepo there was a village and it was like the hub of Kihei. So, Kalepolepo (which was the Koa House which we are in right now) they had the Koa House where my grandfather did a lot of business, they did a lot of trading.
KT- So, was that where the Pacific Whale Foundation?

C- The Whale Sanctuary?
KT- Yeah. So, they told you about the Koa House, or you witnessed it as Koa House yet? You were young enough you paid attention that's the Koa House.
C- Yeah, and through research; through genealogy research where we were trying to find my mother's grandmother. We were trying to look for Luka Kalua'u and we found here through the land deed when her grandfather died. That's how we know that she had the two brothers, Apele and Ho'opii. And she carried the Kalua'u name. So when they came here about 1920, Kalepolepo, this village was going and then it wasn't until after this village started, then they had the plantation put into place. And the rest of the store is; the store and the post office she was talking about; in the back there was the whole plantation camp like. Panio Salbedo, which was a long time Kihei family, he was born in that Kihei camp.
KT- Pure Filipino?
C- Pure Filipino, and he tells about the different areas; his sister is still living. They all passed away, he only has one sister, and I don't know her first name but she's Mrs. Maeda. She lives right across the street from me so she tells me a lot of things about the Kihei Camp and you know as we was researching for our family name. So well, getting back to the point where my mother said the two brothers were asked to come down to survey the land; the rumor you was telling me about the different homestead.
KT- Right.
C- So, the homestead was the Waiohuli Homestead. And Waiohuli Homestead is where I live; Keala Place, Waimaihai.
KT- I cannot understand you say where you live because you tell me you are at Maalaea?
C- No, I live on Keala Place in Kihei.
KT- Oh, okay.
C- Okay, so anyways I live in Kihei. I live behind Foodland on Keala Place which is one of the flood places because the water's diverted. The water is diverted away from where this project is on the golf course. It comes around the golf course and then comes by-you know Douglas "Butch" Akina's place?
KT- Right, Peterson.
C- No, I mean my cousin Butchie-his real name is Douglas. Anyway, Butchie; the water comes underneath the highway (they diverted the water under the highway) away from the golf course and so it comes by his place on Alahele and then comes through Keala Place and then goes down to Kalama Park where there's the bridge (the old part of the park) that's how the water is diverted away from that area when my father built the highway. The reason why I brought up my grandfather and how they came to survey the land and where the water was, they noticed that Kaonoulu was where the water came down. And that's why, I guess, it populated first. According to the census records the village isn't called Kihei Village or Waiolohui Homestead; it's called Kalepolepo Village. And so, after the 1920's, I guess 1930's (you were born 1937?) you can tell that there's a long span of years that my mother wouldn't have contact with her grandparents and her ohana, yeah. They all died. So, any other questions?
KT- Where you're working; How many years you been there?
C- This year going be fifteen years.
KT- Wow.
C- In the Hawaiian Studies Kupuna….

KT- At Kamali'i?
C- I was at Kihei School for 10 years and then Kamali'i just celebrated their ten years being in Kihei. So I moved from Kihei School, which was at 10 years, and I served 5 years at Kamali'i.
KT- So, are you aware that the street on Keonekai and coming back a little north that they found some petroglyphs down in the community? Kimokeo and I went to fetch one of the last remaining but there was a whole flood of petroglyphs and the development company continued to pursue it and bulldozer it. The next day the guy was bulldozing.
C- Oh. Was it in Keonekai by where the storm drain is?
KT- I didn't notate the exact roads. Kimokeo just drove it in and we went down and he went down in the riverbed to get the petroglyphs.
C- Oh yeah, that's by the storm drain.
KT- But, these two books that I pulled out will indicate and demonstrate (if you thumb through it real quick, that one in particular) you'll see that for the most part a whole bunch of these riverbeds were- still have their ancient petroglyphs. So it's not unusual for this one to be found, but so low. Because of the kind of petroglyphs that were found, just from me being in the culture, I'm seeing that because they were so close to the ocean, they didn't spend that much time to do their art work as much as they did mauka like in this area. Whatever riverbeds we found, we've gone through all of them and they're pretty much everyone, holds some petroglyphs. But, so- In your area (for both of you) can you remember Hawaiian families that used to live, or might still be living (outside of your ohana cause I got Waitecha and as you can see quite a few).
H- The one that I know is the Kukahiko's. They were one of the Hawaiian families. The other one….
C- Kenolio's.
H- And then the other one would be Julia Saffery, yeah. But she passed on.
KT- She moved Oluwalu, yeah?
H- No she died, she died. She used to live right down here, or right up here, no right down. But what that Street next to Nama'o….
C- They live right on South Kihei Road.
H- That was another Hawaiian family. The Kua'ana family; the son that's still living is William- no I'm sorry, his children. And he lives up in Maui Meadows.
KT- How old would he be?
H- He would be about my age, yeah.
KT- Is he retired or is he still working?
H- He's retired, he's retired from contract construction.
KT- William Kua'ana.
H- William Kua'ana is his father and they were one. And then they had the um….what was the one married to Peggy, what's the last name?
C- Ka'ake?
H- Our cousin, what's her last name?
C- Hamili; she's a judge, yeah?
H- She became a judge but she was an attorney. She was here practicing law. Her dad came here and who else? I'm visioning all the way going down to Kihei.

KT- I'll keep you visualizing and maybe you can create some more. Bonnie being in the system that long, doesn't it motivate you to get a higher degree so that you can accomplish other things?
C- Yes, I've thought about it. It's going to be very diversified.
H- And her, she has so much talent.
C- Probably not. Probably not go back to school, maybe just…
KT- It's not necessary but it is very influential for your ancestry where they can look at somebody they can focus on and say, "I want to be like." And they move towards it, yeah.
H- Can I say something? She shared something with me this morning that I was so overwhelmed, so impressed. I told her that the talent she has; she knows her words, she knows how to reach people, she knows how to get their train of thoughts to where she wants them to be- in righteousness of course. And she was doing a job for my, I'm just going to say it, for a company (I won't say the name of the company) and she was on what is called a collection agent who would go and collect all the funds that they had put into the jar. And I was amazed that she had that talent. And I said she should go into a collecting agency company.
KT- Starting her own.
H- On her own and work for all these people who cannot collect from other companies. You know, I learned one thing in construction; when we bought our first machine, the advice we had is if you take your machine up to work and you're not going to get paid, take your machine home and go to bed. That was the soundest advice that we had. You don't want to go there and put all your hard work and then not get paid. And this is what she has been doing. I mean the respond was, how did you do it Bonnie? How did you do it? How did you get them to respond? And that's the talent she has. I was so amazed, and then I was thinking I would even help her but I got little bit money….
KT- Let me come back to the…. We can talk about that some more down…
C- I just love to see what makes people happy, what works with them. So, because I work with children and I use a lot of methods in my teaching; and I've developed some teaching methods that a lot of the teachers use in their classroom especially for our Hawaiian kids. If there's a Hawaian child in that class, I will give more than a hundred percent. And I hate to say it, but if there's no Hawaiians in the class I just go with whatever needs to go. But if there's a Hawaiian child in the class, I make sure that he knows that he/she is valued and this is their culture. So, it works for me.
KT- So in the same way with these activities here; Our Hawaiian people going read this. This is their culture. This is what it was. This is what it is. This is what it can continue with all of your folks' mo'olelo.
C- I do have a mo'olelo because before they built the Kihei School here we went to the old Kihei School here where my mom attended (over here in South Kihei Road) used to be the Kihei Center; that was the school. So that was back in '79. We didn't move into the school till maybe about '80. When did we move there?
H-We came back in '78, oh yeah '76 the school…
C- So about '78-'79 is when the Kihei School was built. And before that, my cousins who lived- the Achuna family- we're from the Auhana family, that's one side and this Achuna family is from another son, so that's why you have Auhana and you have Achuna. And the Achuna's used to live all over there like Aunty Maile Pohala, she was

actually Maile Mossman. She was the daughter of Agnus Akina. Agnus Akina lived, you know where….
H- Right across St. Theresa's Church.
C- What's that restaurant across St. Theresa's? Marco's Restaurant. Okay, right across Marco's Restaurant my aunty Agnes used to live right there. And then next to Theresa was Gladys Smith. Aunty Abby's still living. And what they would do (now this is just from their, I never seen them do this they told us the story at our family reunion) all back in that area where Kihei School is, there were graves. Now of course, when they were developing it they found graves; but past that was all the Kiawe trees that she was talking about. My Uncle Alex and his family they would go and pick, you know the Kiawe beans, and they would sell it to the boats of whatever.
H- The dairy, Haleakala Dairy.
C- So, of all the stories, that's the only Mo'olelo we have of that area. So I told my mom that when we come we'll tell you that story. But probably Aunty Abby will be able to-she's how old now?
KT- What streets are those?
C- Lipoa Street.
KT- Are they healthy enough to talk story?
C- Maybe their children will if they meet with the children.
KT- How old are they?
C- The children?
KT- No.
C- Aunty Abby?
H- Oh, Aunty Abby is way older; I think she's in her 80's. I think once she starts relating to you, I think she will really be able to tell you about the story there. I'm so thankful that you got all us.
C- Aunty Abby is, really, the oldest of all the Akina's right now living on Maui. She is the oldest. Because right now she has a sister but the sister kinda goes in and out of Hale Makua, Aunty Lilian. She lives right across from First Hawaiian Bank, there's that one house. They're the only Akina's (well, they're Salbedo's) but they're the only Akina's that actually own the property that was originally given from Kalua'u to my grandmother to her youngest son. And then after Achuna, who's their mother?
H- Aunty Lilian is Eugenea.
C- So, it goes William Kalua'u, Luka Kalua'u, Achuna, then Eugenea, then it went to Lilian because it was five generations that property they have across the Texaco or Shell. That's the property that they still own, well besides Uncle Butchie them. Uncle Butchie them, that's not the original property. The property they have was Kamaole II.
KT- So Bonnie, I got a question. Would you consider talking to them and see what they say about me coming to interview them?
C-I don't see why they don't….
KT- Well, some just don't want to and that's okay too.
C- I can ask them and call you up and let you know.
H- You live here?
KT- This is my wife's condo and I'm still going through with my upside house. Another, Aunty Paula Kalanikau shared with me that Papa Kealakeau in Kihei, some of the

teachers called that there were some spirit's hana'ino the kids over there. Can you tell us more about it?
C- Kupuna Ka'alakea?
KT- About the idea of spirits being at Kihei School.
C- At Kihei School?
KT- What did you hear or what did you experience?
C- I guess because it's our family land, I guess nothing never really occurred but I've had some teachers that wouldn't be able to teach in their class because of the spirits. But, Kupuna Ka'alakea would come; because he was a kupuna there, you were there when Kupuna Ka'alakea was there, yeah?
H- Yeah but I never experienced any of those.
C- Then when I came in, it was his last two years working for the school because he was getting too old and it was far and it was too hot. He had to drive, he couldn't drive anymore, that was another big reason. But he would come in and he would bless, so as long as Kupuna Ka'alakea was there, didn't have any pilikia. He was a Mormon, yeah?
KT- This is what comes out of this kind of thing but we're never aware; we're never aware that things are what it is.
H- When I came off my mission, my second mission, into my own home; I experienced the spirits in my house and I made it a matter of prayer and I figured I could call on my Heavenly Father the power given to come and remove it.
KT- So what house, in Waimea?
H- In Waimea and I pleaded, I cried everything and right after I got through, my whole being; I was just so calm and felt peace. And whatever spirit was in my house opened the door, went out and closed the door and never no more it happened. Shortly thereafter the Spirit told me, I was ready to go to church one morning and the Spirit said to me: If you want to go to the Celestial Kingdom, (these are the exact words) stay on that straight and narrow path. And that's how I guide my life, yeah. I can sense things that are very uncomfortable, you know, and I walk away because it's not my area, yeah. But that was one time I really called on Him. I called my Heavenly Father the heavens and it opened the door and it shut it. So I shared it first with my daughter-in-law and she told me and she said, "Mom surely..." I teach Gospel Essentials in the Church and that's why I told my daughter I can't stay here. I go to the temple they open Tuesdays and Thursdays; I go every Tuesday and Thursday. It's possible, our ward goes on Friday and if I have someone else to go with me on Friday (cause I don't want to go by myself, there's wild boars and all that on the road sometimes) and so they have this sister that works and the only days she can go is Thursdays and Fridays and she comes and she picks me up and we go.
KT- Anything else you want to say about what I'm interviewing you about?
H- You know I think my daughter really did a good job in covering the genealogy of my family, I am very impressed. It saddens me that my family sold all the property and not keep in so that they could hand it down to their children.

## *Interview: Hamby Kahawai*

**By Keli'i Tau'a/ Kimokeo Kapahulehua**
**October 20, 2006**

***Interviewer= KT and Consultant= C***

KT- So we're sitting here at Koa Resort on October 20 with Hamby Kahawai and her daughter Bonnie and they've been invited to come and participate and to share what they know about an area that they were raised (or lived) for a while as part of the report for the proposal to build Malulani Hospital next to Maui Tech Park. So, out of respect I'll go to mom first. Hamby, how old are you?
C- Sixty-nine, I'm sixty-nine years old.
KT- And can you give me your brief genealogy where I said Kahawai name which is your late husband.
C- Yes.
KT- But you personally were born Hamby?
C- Hamby Onauna Akina.
KT- Akina, so you're one of Richard's sisters?
C- I am the youngest daughter of John ohana.
KT- Oh, John, so big ohana. Where did you go to school?
C- I went to Kihei School, which is right about here, it was just the Kihei grade school.
KT- On South Kihei Road; and then where did you go after?
C- Then I attended St. Anthony Girls High School, it was then an all girls school but now I understand it's co-educational.
KT- During the time that you resided here, did mom and dad encourage you to learn about your culture or your family or things that are now lacking and now everybody wants to learn about?
C- Well, when I was growing up, I guess in the process of time our lifestyle was very Westernized, and English was of the essence because we never spoke Hawaiian; we were not allowed to even know the language, the Hawaiian language. We needed to know the English language and one purpose that we would be able to survive with this English language to be educated, to go on to college and go into a field, whether it be nursing,

lawyer, architect, whatever it may be that our lives would be better or the generation that is ahead of us.
KT- Exactly where was your house located where you grew up?
C- It was on South Kihei Road, 1764 South Kihei Road.
KT- What were the landmarks close to that?
C- Um..
KT- Maybe now, what is the landmark?
C- It's where, across- Kukui Mall, right across Kukui Mall coming back up to South Kihei Road.
KT- So, no house, no family there anymore?
C- No, everything is sold.
KT- What did your dad do?
C- My dad was a commercial fisherman. He was also a logger. He was also a mason and right during his retiring years he built several homes for rent.
KT- That's right, he was a developer himself.
C- Not only my dad but my father also had two brothers: Frank Akina and Alexander Akina. And they were, all three of them, were self-employed. My uncle Frank was a contractor and my uncle Alex was into the touring business and into the busing system. He also had a restaurant and that was our lifestyle.
KT- So, was it a fun life growing up?
C- Very much so. My parents and my uncles are hard working people. Self-sustaining, self-reliant, took care of their family and gave them all the education possible for them to have a better life.
KT- Describe logger, what does logger?
C- Okay, a logger is where my father (you would say a woodcutter) that he would go and do; you see this area was once with Kiawe trees, the Kiawe trees are also known as the Algarobia trees. And why I say logger, my father used to cut the posts for the Hana Ranch (twelve feet I think it was) and it was my job, after my father got it all set with the Hana Ranch would come down with the big loggin truck and pick it up. My job was to count every log that got into the truck and I would report that to my dad so that he could make the billing and give the purchasing order to the employer that pays for the Hana Ranch.
KT- Was the Kiawe original Hawaiian plant when our Hawaiians came to the islands?
C- Well, I don't know too much of the history of where the Kiawe tree came from, but I know that it was here when I was growing up. Whether it came during the time of the Hawaiians or whoever discovered the- I guess the Hawaiians discovered the islands, and I think they have brought all of these things to the islands. I don't think it was naturally grown here because they found that the Algarobia tree, as far as my knowledge is concerned, came from Africa. So, that's the only origin that I know about that tree. I never did the research, I wish I did.
KT- So, right now Kukui Mall surrounding you, was it wetlands?
C- Well, the history in regards to that question was; my grandfather who was Auhana Akina and my grand-uncle who was Auchuna Akina came, they were one of the first pioneers to come into Kihei and one of their purposes that they came here was to learn of the, when the rain came, how the water came down from the ocean. And they would be the one's that would say- everyone has a different name and different gulch and when it

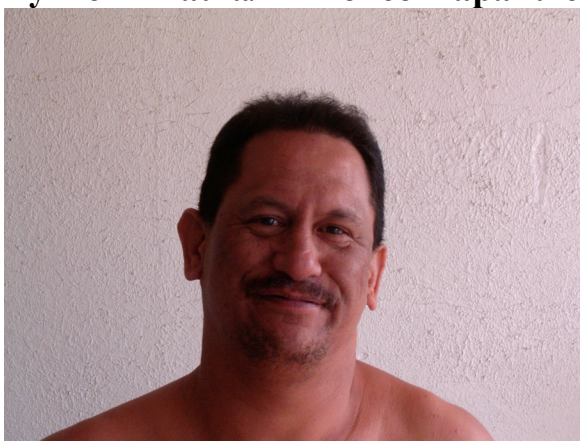
rains they would follow the flow of water and how much damage it did, what eroded the land. And that was their primary purpose and they started to have families out here.
KT- There were different names for different gulches?
C- I think so. I'm positive; each one has to have a name, just like children. You know……
KT- Yeah but did they create the names or was it- according to the maps that I looked at there was a Waiohuli Gulch, there was a Waiokoa and…..
C- That is correct.
KT- So, what you're saying is they just followed the existing names.
C- I'm not sure if they gave it the names or if the names was already situated on the lands, that I have no knowledge of. But I knew each one had a name and they had to follow through and watch the water fall, watch the water going through and how much erosion.
KT- So, since you lived back there, what can you remember that was built around you today? Kihei is becoming a very, it's growing. They say one of the fastest communities in Hawaii but when you were growing here, didn't the road end somewhere going south towards Makena?
C- That is correct.
KT- Where did it end?
C- Makena Road went as far as the end of- Auhana Street, that was the end and then the road from there on was just, we would call a dirt road or rocky road all the way down to Keonio'io But the road ended there.
KT- So what is the background of Auhana? It sounds Hawaiian but it's not Hawaiian, yeah?
C- Well, my understanding for the meaning of Auhana is: Hana is work and Au is like an electricity that continued to work. I guess it's part Chinese and part Hawaiian because Au is Chinese. But I guess my great grandmother Kalua'u had given my grandfather that name, Auhana. I guess they were a working family. The knowledge that I have of my great grandfather, William Kalua'u he was also a fisherman, a great fisherman because he had so many canoes. I mean, during that time it was by canoes and he had plenty nets and I think he had a vast ownership of land. And he had three children and one of them was Luca Kalua'u or Lucy Kalua'u was the only daughter then he had two sons; Apele and Achuna, I'm sorry Apele and Hoopii and they were the three children that they had.
KT- So, can you spell that last name so that we can transcribe it correctly?
C- Kalua'u: K-a-l-a'u, according to the records.
KT- Did any of your Kupuna tell you any significant Hawaiian sites of people that resided here in ancient times?
C- You know, I'm really sad to say but when I was growing up both my grandfather and grandmother died. My grandfather died in 1932, my grandmother died in 1936, I was born in 1937 so I never had no connection with any of my grandparents; both on my mom's and my father's side and I'm really sad. So now that I'm a grandma and a great-grandma, I want to share all the things that I know growing up with my grandchildren.and great-grandchildren.
KT- So, this is part of it, after we transcribe it you guys will get a copy. You can give that to your grandchildren and your ohana.

C- Oh, thank you. But, only the stories that my father; after we got through dinner around the dinner table then my father would share many stories with us about his growing up. Where he went to school…
KT- So, where did he go to school?
C- He went to school at St. Anthony's. I was impressed and because when I was doing the biology class and I was in the class and my father explained everything and I looked and him and I said, "What school did you go to?" and he said, "St. Anthony." You know, I was so impressed and he talked about where they lived in Wailuku and how they owned a store there. I guess my grandfather, Ah Sing Ah Chong, owned a store there in Wailuku and that's how they got to go to school. And then my grandfather was working at the hospital, it was called Maluhia Hospital and that's where they have the-what you call that, Makua….
KT- Hale Makua.
C- Hale Makua, yeah. Well, that was once a hospital and my father, my grandfather worked there in the pharmacy. So, he knew a lot about- he knowledge of the medical technology because when he moved his family here, if anyone got a cut of something, he would know how to nurse it. If they had a high fever he would take them down to the beach and put them in the water and the fever would come down. You know, there was no prescription at that time; they used everything that was natural in nature.
KT- So if we move up to the site, according to the map I showed you, is there anything significant that you think might be important for the reader to get from what you say?
C- Well, in this particular area, this map that you have here, I don't remember ever even entering that part of this property.
KT- There wasn't a road that goes all the way up there?
C- I don't even remember if there was a road. All I know is that, I think if I'm correct, Ulupalakua Ranch used to own this because this was a cattle range that I recall. There was all this cattle in this area. I don't know what they called it during that time but there was certain cattles that was here and grazing the land and then the cattle would move to the other area. That's all I know about this property that the proposal for the hospital is to be on.
KT- So, historically as you were growing up, did you witness or experience the trains coming down to, all the way to South Kihei, Maui. Did they come to Suda Store?
C- No, I don't even remember the train. I think by the time I grew up, I think they did away with that. The only thing that was there where Suda Store was the old Kihei Store, it was called, I think Alexander and Baldwin. I think they were the owners and the purpose for that store there was to service all of the plantation homes that was in that vicinity at that time.
KT- So, what was in that small Suda Store complex; outside of a store.
C- Okay, there was a general post office that was included in there. The mail would come there, I even remember our box number- 555. That's so neat you brought this up. I remember climbing up the hill. The store wasn't down because this was a flood zone area. So, the store was built very high, you had to walk up the stairs and then it went there and then there was this big building. And they had not only food supplies, they had material, pots, pans, anything that was general merchandise for people that would need all of these utensils and so forth. But that was the post office. And when I was growing up the Post Master was Mr. Ventura. And he lives right up here, I know his home was

right up there and Mrs. Ajirogi was the Assistant Post Mistress, at that time because they both were there when we went and got the mail. And that was a flood zone area, right in that area because that- the flood zone would come in that area. In fact, all the areas down where I was living, that was also a flood zone area until they had put that main highway- running that main highway- well my husband worked on it, so that's why I had a little knowledge of it. And they did it where they diverted all of these, they channel it into one area. So, the areas that would be free down in that area, the ones that would always be flooded, would be Welakahau, Keala Street, those were the two and up at Suda. They were the heavy flood zones. But in this area, I don't- I think that they diverted it. I'm not too sure, looking at this map, it looks like it's very well balanced to build anything there.
KT- So keep your thoughts on what you've shared so far and if you want to share anything else later on, I going divert my questions to your daughter.

***Interview: Kevin Mahealani Kai'okamalie***

**By Keli'i Tau'ā/ Kimokeo Kapahulehua**



**KT- Keli'i Tau'ā**
**KK- Kimokeo Kapahulehua**
**C- Consultant**

KT- So, Mahealani, your full name?
C- Kevin Mahealani Kai'okamalie.
KT- Where were you raised?
C- Um, I was born in Keokea, raised in Honua'ula and various other places on Maui.
KT- For all the Kupuna we talk to, not too many are familiar with Honua'ula because the name wasn't used before. Compared to, you're in fact, out of the nine Kupuna we talked to already, only you use the name due to the fact that you were born and raised there.
C- Hmm.
KT- What about your Ohana, your family, did they use that name?
C- Yeah used extensively in my family.
KT- So, can you give outside of your family name, some other families that did they live there around there with you? Who are some of your relatives that could have grown up over there? Any at all?
C- Many, yeah.
KT- Like who?
C- Well, my father was a Kai'okamalie, the Kai'okamalie's were here long before the sugar, long before the white man. We can trace our, my father's side, you know family tree genealogy whatever you want to call it, at least seven generations in that one particular area. Honua'ula which encompasses Keokea to Kanaio and all the ahupua'a's in between which is Paiahu, Papa'anui and so on. But I, and my mother was a Purdy so along with the Purdy's came other names.
C- This is my great grandfather, yeah.
KT- Wow. So the entire family were cowboys?
C- Generationally I guess you could say that there were members of my father's family and my mother's family also they chose other professions. Such as back spin, working for the mill, going where the money was at the time, yeah. At the turn of the century.
KT- What mill are you talking about?

C- Pardon?
KT- What mill are you talking about?
C- Uh, at that time I believe HC&S, Pu'unene.
KT- Where was it located?
C- Pu'unene and Sprecklesville.
KT- Was there a mill in Ulupalakua?
C- Yes. The history thereof, which I'm semi familiar with, since I lived in the mill at one time or resided in the mill.
KT- But you never see it actively being used?
C- No. That was way before my time, way before my father's time. Probably before my grandfather's time, so I don't know any family member's have anything to do with the mill. Probably sold 'em by then because of it's prevalence in the area.
KT- So did you folks own land in Honua'ula?
C- Ah, yes my family still does. .
KT- Um, now and before, how did they use the land? Ranching, farming, anything….
C- Oh, to my knowledge yeah some farming, ranching also. Yeah, my father raised cattle, my grandfather raised their own cattle aside from the ranch. Yes, farming definitely there's evidence of that.
KT- I don't know if you recall the first time I ever met you?
C- I think Kahikinui I bet.
KT- Yes, yes, so that leads us to having a great desire to talk story with you. You're a man of the aina and the la'au, the kanu. Of utmost importance we wanted to hear from you on the plants you're familiar with in the ahupua'a of Honua'ula and the plants there.
C- is there a specific ahupua'a that, that you're looking into?
KT- Well, our assignment is Honua'ula but…
C- Ah, we no more enough time for talk about all the plant of Honua'ula.
KT- Right, so the one's that you are most familiar, the one's that might be endangered that this company should really consider looking at to see what kind of preservation they needed.
C- That would, oh boy. Honua'ula is, in my opinion, one of the larger moku's around Maui and well, I shouldn't say that. It was one of the most undisturbed moku's on the island of Maui and it would take some kind of a classification in breaking down the lands in an effort to understand it's biological significance, importance, it's value. So that would encompass the low lands so on and so forth.
KT- So the moku in general, is there…
C- Probably there is more endangered species than any other one particular land track that I'm familiar with.
KT- Really? More than Kanaio, Ulupalakua?
C- Kanaio is a part of Honua'ula.
KT- Oh, ok. It's the same passion you and I talked about when we were walking Kahikinui and so forth.
C- Yeah you know, Kahikinui, well Kahikinui is Kahikinui.
KT- Right. Honua'ula, yep.
C- Kahikinui is something else. Biologically it's probably one of the most restorable land tracks probably in the entire state. It harbors a lot, Kahikinui. Honua'ula, Honua'ula on the other hand has been more utilized by modern man, thus creating probably the

innovation of a lot of it's resources but there's still a lot of microhabitats here and there. Botanically, ethno-botanically.
KT- How young were you to realize that it was important, or very important to learn about native species, our plants?
C- Twelve, thirteen, eleven, twelve, thirteen, somewhere around there.
KT- Somebody turn you on or just you?
C- Um, I guess my eldest brother sorta brought up the fact that my family was knowledgeable in, members of our family in the past, was very knowledgeable about Hawaii's natural history thus creating an interest in me at that age and at that time. I think we were hunting and when he shared this knowledge of our Kupuna.
KT- So as a young boy, what kind of hunting were you doing?
C- At that time goats. There was a lot of goats everywhere at that time.
KT- With guns or with bow and arrows?
C- Ah, both. I think I had a rifle and at that, on that day, and I think my brother was carrying a bow.
KT- No deer at that time?
C- Uh, I wasn't familiar….this wasn't, yeah this was in the seventies so the deer wasn't as prevalent as it is now. I mean even in the late sixties, there's very little evidence of uh, I mean of course the deer was here for fourteen years already. In 1969 was introduced in '59, Mayor Pueokahi, on Maui. So took a while for them to become prevalent probably not until the eighties, you know.
KT- If you can recall now, some people might be reading this document, or listening to this. If we put it on audio, who have no inkling of the lifestyle of a young Hawaiian man on the aina, would it be possible for you to be out there with your brother's or yourself, or maybe your brother because you mentioned it. Or your father and you folks walking on the land, hunting and while you're walking, dad or brother says, "Oh look at that plant." Or, "Look at that plant." Is that how you pretty much learned that because while you were, you just walked it and you saw it and they talked about it.
C- Yeah, pretty much. I guess I remember you know, my eldest brother, my father died when I was young. So my eldest brother pointed out something, um I can't remember what it was at this time but, yeah, eventually I became very interested in the plants of Hawaii in an effort again to identify with who I was or who I am still.
KT- For young people it's challenging to get turned on to plants cause plants no talk back, they don't..
C- Yeah, I noticed.
KT- There's not a two way communication that human beings tend to draw towards. So, so, I'm trying to get into what was the communication with you? What did you hear, see, feel, touch?
C- All of that. I heard, I saw and I felt something.
KT- Describe, describe that.
C- Oh, just when I'm…
KT- Take a plant.
C- I mean, I don't know, you know growing up, you know there were people paddling canoe, there were you know, there were other Hawaiian's dancing hula. Um, when I was growing up there was no Hawaiian speaking Olelo Hawaii but I remember, you know,

extensively paddling canoe and dancing hula and that was the two Hawaiian activities. And though I appreciated those acts of Hawaiianess I was, I was….
KT- You weren't drawn to it?
C- Um, I was but yet felt there was more. You know at the time growing up as a child in the seventies, um this the only Hawaiian things that you were exposed to; paddling canoe and dancing the hula.
KT- Yup.
C- You know, and I knew there had to be something more. Um, and then there was a lot of talk about the (farmer) mahi'ai, you know and taro. And then both, you gotta manage our land, our aina. I went look, wait a minute. I only see X amount of Kalo on this land, you know what is the rest of it made up of? And thus that peaked my curiosity I think trying to identify with this word called Hawaiian and being Hawaiian because I wasn't being, I probably was. You know being raised Hawaiian but just didn't know it at the time because we take all that we have and grow up with as youths, probably take it for granted. You know and probably don't appreciate it until we start to, our minds start to, you know not wander but our minds start to think about who we are and what we are and where we going be, you know in this thing called life. And for me that was around the ages between eleven and thirteen when I started to think about things on my own without being guided. So, you know and walking through places you know, such as Makena um lower Kanaio, you know with my fishing net, I can remember that not going to school. You know cutting out of school just to go throw net. I remember leaving bottles of water, and was glass bottles, back then shoyu bottles, filling 'em up with water leaving 'em here and there. You know one day just tripping around knowing that we going come back to this place. Or the next day, you know to fish or whatever, depending on what we were doing if we could get a ride that far. You know, we 'eh go fill up bottles with water, you know. But yeah, through walking the land, starting to notice you know the changes in vegetation, the more….. the less people you saw, the more vegetation there was so it started to peak my curiosity, you know and fishing the lowlands and hunting the Maui 'āina and the mauka lands, um you know you notice things like this once a man or a person I should say, starts to think about you know him or herself. You know as a human being, you start to develop interests in life and for me that began between the ages of 11 and 13. But I found time to come to what we called is the city at that time we make mischief too but you know, I never forgot our roots and then later on took it to another level as far as interests were concerned. I lost interest, it became my responsibility, or I felt it to be my responsibility to understand all there is to know about Hawaii's natural history, including it's scientific significance in the populace. I think it's an important part, a very important part of our culture. Probably the most important part of our culture aside from your 'ōlelo because in my heart I believe, you know the simple fact that over ninety percent of the time things in Hawaii are endemic, meaning found no where else in the world. It is my opinion that it is Hawaii's natural history, or it's biology that redefine the Polynesian and made him a Hawaiian so that's just my personal opinion. Others see differently, some others feel nothing when it comes to Hawaii's biology. Feel nothing, know nothing, and choose to know nothing. But it's, I feel it's changing, especially in the last ten, twelve, fifteen years. Unreal, I could count on half a hand the amount of native Hawaiians that knew more than three native Hawaiian plants. Now, now it's countless the amount of native Hawaiians that have, you know that are now interested.

KT- You have pioneered the area and that's what I was going to lead towards. In your opinion, outside of you, on this island, who are the more knowledgeable Kupuna, Makua, down the spectrum of really know about, you know the natural history, you know the plant.
C- Interesting question because um, you know at the time when I desired to understand more about Hawaii's natural history or it's biology, um I found that there was no Hawaiian's that I could turn to.
KT- No one right, no one.
C- Yeah, there was no one, at that time. At that single…
KT- On this island?
C- Yeah, on this island. Um, and then later I, you know not that much later I met a man named Rene Silva. After going to, after visiting some agencies, you know with my curiosity of things that I wasn't familiar with; um some individuals referred me to Rene Silva. I don't know why, they just noticed I was Hawaiian, I guess. And every time I walked into an agency, be it the Department of Land and Natural Resources, uh The Department of Agriculture, they you know, they found it quite peculiar that you know, here was this twenty something male Hawaiian interested in things that most twenty something people period were not interested in. Um, and it peaked their interest, I don't know, sometimes fear I guess. Sometimes I would come straight out of the mountain and I, you know, hadn't showered for four or five days, you know, at a time. And I don't know if you seen a man who came out of the mountain after four or five days, he sometimes look pretty scary! So, at times you know with experiencing anxiety, you know in an effort to understand what I had in my hand or had collected. I would go into the mountain for days at a time for the specific purpose to just collect vouches of things that I wasn't familiar with.
KT- Like, as an example…
C- Like, as an example?
KT- One excursion, you came back, what was in your hands?
C- What was in my hands? Oh, the list is endless but I remember one trip that I took and went into a few gulches in the Kahikinui area and let's see, one, two, three, three of the plants that I had collected had not been seen in decades. And in one case they thought to have been extirpated, at least from the island of Maui, a Hawaiian fern that doesn't have a Hawaiian name. Well, not doesn't have, we don't know the Hawaiian name anymore, that's how rare it is, that plant's the Molokai named after the island of Molokai which is the only place they thought had to have existed at that time. Um, referred to by Hawaiians to the entire genus. Um, a lot of the species in the family were referred to as Ha or Haha hadn't been seen in a couple decades, I guess. a native tree fern, not be confused with the hapu because this fern actually grew on a tree. And the one that I collected was growing on a Koa tree. Um, I knew by it's looks that it was a Waiwaiole but it looked different from the one I seen growing on the ground. The one that was growing in this tree, definitely was different. In my opinion in speciation, uh probably the genera was the same, which it was but I knew it was a different species from that, from the common Waiwaiole I see growing on the ground. So, I collected that. Um, those are the three of note on one particular trip but you know, I'd gather all kinds of stuff like Maua and various species of um even whoa there was even a curious Akala that I collected. Come to find out it was a rare variety of Akala. You know I noticed

there was some physical differences in it's appearance and so I collected it and I believe it was Fern Duvall that I first ran into. He's an ornithologist with the State of Hawaii, or at that time he was a ornithologist, I don't know what he does now, something different. But anyway, he said, "wow, this is…" ah I can't remember at that time, I have it written down, though. I haven't been doing well in the last couple years, physically so I'm a little rusty.
KT- So, Mahealani, you had looked in books about these plants before you went. So when you went and you looked, you compared what you saw in books and pictures and then realized then that was the kind of plant that you just referred to.
C- Yeah, yeah. Well, you not used to being able to identify families and genera, yeah. Definitely, but then it comes down, come in, I think five categories in a family you have a genus, you have a species, you have a sub species, and then you have varieties. So, so the first two parts were somewhat visible, you know right off the bat, you know. The family and genus, but oh boy, when you get into species, sub species and varieties, it's a very, very interesting world. And the great part about these scientific classifications is the ancient Hawaiian's did it too. You know they have more names for Ohi'a's then science does. You know, so they noticed, they noticed these slight or miniscule differences in these plants that grew in Papa'anui from the one that grew in Kanaio, from the one that grew in Hawai'i, from the one that grew in , from the one that grew in Kanahena. You know, despite it being the same plant, it had differences and the ancient Hawaiian noticed these differences. And when I found that out, I went like, "Wow!" You know, we are as brilliant now and yesterday as the scientists' think they are today. Or claim that they are today by, you know the only difference is we didn't have the means to document it in writing. Only in 'ōlelo and unfortunately through the genocidal acts of a foreign country, that knowledge was lost.
KT- And, are you, you went through the different ili's, or lele's, or moku's where each of the plant was located. Can you give name of the one that was at Makena and Kanaio because you trace a genealogical sequence of these plants were the same but little different. Maybe in color, maybe in size, maybe what was hanging on it. Like for example as you pointed out; Ohi'a, a wide perspective of Ohi'a pua ahihi was generic to Makiki on Oahu but still a lehua. And right up in Ulupalakua they had, right in front of the store was Lehua Melemele or they might have had another name. So, are you, did you make the comparison as such that the one you found in Ulupalakua had a name and you went to Kanaio, had the other name?
C- Um, unfortunately in most instances um, in most instances, not all in most instances those differences were recognized only in scientific terms and not in 'ōlelo. But, um I've tried to come up with some Hawaiian terminology for plant differences and I'm finding it quite difficult with the exception of the, the Ohi'a. You know the many names for the Ohi'a, Lehua Mamo, Lehua Ke'oke'o. Um, Ohi'a Ha just some differentiating in color and some differation in their actual physical appearance. Oh, you know Maile is a good one, you know there's the mountain, there's two mountain Maile, you know one is called Maile, one is called Maile Lauli'i which is a tiny leaf now, not a small leaf. Maile, but an actual tiny leaf, you know Maile so that's one example. Like I said unfortunately, you know the changes that took place you know, particularly in the last hundred years. You know, which in the millennium of time, is a very, very short time. Very short, it's a snap of a finger, a hundred years. It's amazing the knowledge that, that was, I hate to say lost.

KT- Not lost.
C- You know it's not lost, you know that's the wrong term.
KT- It's there for people like you and others you might have privy to groom. I'm only saying this from personal experience from where I was and where I am. By having people say, "oh, no it's not there, it's lost" and then diving into it and getting it. So, it's there but it's going to come to people like you and others, those that you train and so forth. Because they'll bring in a different spirit and they'll be able to connect to that spirit.
C- I agree, and I agree and it's no longer a hope because it's already happening, you know. Um, you know fortunately people like Rene Silva that have been able to influence the Makua to, to at least have a common knowledge of Hawaii's botanical treasures. Maui is a botanical treasure and I see it every day now, you know, driving through neighborhoods. You know it's not something I saw as a youth, or even as a young adult. Native Hawaiian plants being grown by everyday native Hawaiians, even non-Hawaiians. And you see it in people's yard's now, you know, Hawaiian plants. It's about time. I remember a conversation that I was having with Arthur Mederios.
KT- Now here's another individual.
C- We have, I was, I think in my early twenties when I met him. He actually flied me down. I was on my motorbike at that time. But anyway, I became friends with Arthur Mederios after a first confrontational meeting, I think. You know being a Hawaiian from Honua'ula and you know, my family, you know coming from the Big Island and moving from the Kipahulu area until finally settling in Ulupalakua. Um, you know, I grew up in a manner that you were supposed to be responsible, you know as a native Hawaiian. As a male in particular, you know, that was influenced partly by my eldest brother, by my uncles. You know how to be, and thus, I developed a personality. And out of that personality was born an attitude, you know I saw mistreating the land. And unfortunately those people were of a different shade of skin from me. So there I developed a, and when somebody of a different shade of skin possess more knowledge than you do and is checking upon your backyard, I going take offense! You know I started to hear about this guy named Art Mederios. Everywhere I turned because of my interest in Hawaii's natural history, particularly in Honua'ula and Kahikinui. Apparently when I was walking around in the one area this guy named Art Mederios is walking around in another area.
KT- But close by.
C- But close by, I never met him so, um…. So I guess there was this brief one or two year period where he and I kept hearing about one another and you know they're saying, "eh, there's this Hawaiian guy." I said, "what?" "You know there's this young Hawaiian guy I mean, you know that we haven't seen in a long time." So I guess that was what he had heard about me and every time I ask someone that I thought had vast knowledge or broader knowledge of Hawaii's native plants than I did, his name kept popping up. Whether it was Richard Nakagawa or Rene Souza, or Bob Hobdy, or who was at the nature conservancy at that time, more haoles but yeah Mark Deflin he say hey, I go anywhere. Because you know, I don't consider myself to be a prejudice but since so great wherever I can gain knowledge of things Hawaiian, not just plants, I going ask. Regardless and I going, you know, you gotta have a degree of respect for these non-Hawaiian's that treasure our culture, that respect our culture. Unfortunately, most of them don't, you know, the vast. But you know to those native Hawaiians that were very

helpful in helping me, you know, God bless them because I wouldn't have been able to do the work with the youth of Hawaii. With the youth of Maui, you know that I did without their respect for our culture because they're instantly, you know, boom, they dig in my background. They just said, "wow, you're a native Hawaiian who care, unbelievable, you know. Here we are to help you." So, I guess they were frustrated as I was at that time that there were no native Hawaiian's actively pursuing ways to preserve this very vital part of our culture.
KT- As far as you know Rene is not Hawaiian?
C- He is Hawaiian.
KT- Yeah, he is because he is Lopaka Aiwohi's uncle.
C- Yes he is.
KT- Yup. So, you got all this knowledge growing up but you were collecting that knowledge through brother and dad unbeknownst that this was valuable information.
C- Valuable, I don't know valuable. Cause I don't know. I think that's an understatement.
KT- That's why we're here talking because we put, we try to define value, you just spoke it in terms of now all these, pardon me, outsiders who come and build, see the value of native plants in their back yard. That's the value. What native plant's does for our aina, that's the value. Because native plants that can survive on our aina, makes the aina ulu or grow. If you bring in as we know, all these other species that become endangerous to the environment, it wipes out the whole community of plants and eventually us as an example. Like the Miconia can be very destructive so native plants, knowledge of it, valuable. From my eyes.
C- Invaluable. Um, response to that, yeah you know, as strong as some people, I don't know. I just chose. I believe all native Hawaiian's growing up at the time I did, had difficulty identifying what being a native Hawaiian was. I was interested in all kinds of things but I kept noticing this pull, and I believe that pull was spiritual. I believe it has something to do with the fact that my father loved and respected. It was a difficult time, the cowboy time, especially with the great cowboys, and I consider my father my grandfather to be great cowboys. Cowboys not supposed to go play with plants. (laughing) You know the wahine's went go play with plants but you know the stories I hear from Dr. Fleming's daughter and my aunt's.
KT- Who was... Who was your aunt?
C- Oh, Vivian, Dolly Kai'okamalie, my father's younger sister. She's the only one in our family that actually had first hand account of the love that my father and my grandfather had for native plants. Not aloud but.
KT- She's still living?
C- Yeah she's still living.
KT- That's who we gotta get to.
C- Okay. But yeah, she was, I was already head, you know up to my nose in, for lack of a better term, loving the 'āina already when she shared her stories with me. Of course I knew my grandfather because the scientist had already told me about my grandfather. Wow! You know, everywhere I would go they would ask.
KT- Oh my gosh, Mahealani! Your grandfather is in the books that I have been reading. I only see his name now. I can bring you references. That's the man.

C- Everywhere I would go they would ask me the question, 'Who is William Kai'okamalie to you?' and I says, 'My father.' And they would look at me like I'm lying and I remember one person saying, 'Oh, you're too young.' It might have been Dr. Lyons from, not Dr. Lyons, not Machelic, that was the shell guy. Oh, God, I remember Par telling me that they arrested this guy in Hawaii for trespassing and he died a few years back and I met him like three times. But I remember him asking me who William Kai'okamalie was. He was the botanist at Lyons Arboretum, damn he's one of my hero's and I can't remember his name right now. But anyway, he had asked me and I told him he was my father and he looked at me and he said, 'You're too young.' You know, real stand offish like, don't lie to me, kinda. The way of speaking to me he said, 'You're too young.' I said, 'Oh, my grandfather's name was also Kai'okamalie.' And he looked at me. I had just given a talk, in fact, on Kahikinui on the area at a conservation conference and he looked at me and there was a tear that started coming down this man's eyes. You know that was the most touching experience but everywhere I would go, oh God, Dr.Lameru, very, very interesting man. I didn't know him very well but during the times that I had the privilege to be in his presence was, it's unbelievable. You know when, you know us native Hawaiian's we all love our culture, we all love who we are. We all now have a profound respect for who we are, you know this sense of being proud of who we are. But to see non- Hawaiians, you know to have that same passion, whoa, it's an incredible thing. You know, and it cause me to have a more profound respect for other cultures as opposed to just diving into ours. I read a lot about the Mayan's and various other Indian cultures but the Mayan's in particular peaked my interest because they were ahead of their time. It was an incredible thing. You know, I likened the way….boy you know, we have over two thousand names flowering plants in Hawaii. Our culture, our culture now, is less than two thousand years old. (laughing) That's an incredible feat in my opinion to give names to over two thousand species and varieties of flowering plants, ferns and grasses. Boy were you, that's the amazing thing I recognize you know, in my personal pursuit to understand hopefully all I can, or all there is about Hawaii's natural history, about it's botanical treasures, from the Hawaiian perspective and from a scientific perspective is. You know that's gotta be one of the wonders of the world, you know, the fact that we went name over two thousand plants, being one of the youngest cultures in the world. You know, a mere sixteen hundred years old, you know the Hawaiian, the native Hawaiian. The biological significance of where we are in relationship to the development of a culture in a mere fourteen or fifteen hundred years before Captain Cook came and developing a cultural system of living, breathing, surviving. You know I think it was an incredible thing and everything you look at, you know, our culture involves a plant or more. Everything, from the hula; there's twelve hula plants. From building a canoe; from the hull to the, from one end to the other of a wa'a. You know, one plant of another, one tree or another, you know was implemented. You know everything we did, you know every day survival depended on our surroundings. And the fact again that over ninety percent of the flowering plants in Hawaii are endemic, boy. To me it is the most vital part of our culture, aside from our ability to communicate with one another is our plants. And here in the new millennium… Honestly I never thought, the way I was going, I never thought my body was going to survive this long, and I'm a young man. It's just I dove hard and I feel very fortunate to be alive, actually despite being in my early forties. I don't know, I feel lucky

to be alive to see, not the renaissance, but that's the wrong word. The revolving of the native Hawaiian and the acknowledgement of our plants, in my lifetime is a blessing. I remember trying to impose upon other native Hawaiian's how important the plants are. They acknowledge that, yet desired not to know anything more than that. And now today, these young Hawaiians, and you especially these young Hawaiians, the University of Hawaii studying to become land managers in an effort to manage our resources. Boom! It just happened man, in like fifteen years, in like twelve or fifteen years. From not even being acknowledged as a vital, vital meaning present day, part of our culture. All we know was maile, go get a maile go dance the hula. You know we get bougainvillea's and plumeria's on our po'o, that's always the wrong plants. But more and more I feel very blessed because I thought this day would never come, not in my lifetime. You know, even native Hawaiians would recognize how vital our non managed lands are, for lack of a better term. Kalo, the hula and the canoe paddling, people acknowledge the fact that these resources are still all around us, you know. I don't care where you are on the island of Maui, you park someplace. I don't care where you are, within five miles, within a five mile radius of any point on the island of Maui, I can take you to an endangered species. Any point, any point on this island, I can take you to an endangered species. In other words, present day, it's a part of our future. It's not a part of our past, brah, it's a part of our future and we should be doing everything we can to preserve every ounce. Not just because you know, get ilima lands on West Maui we going denude all the ilima lands despite it's commonality in the biological community. That doesn't make it ok to destroy it. To build, you know, public's it's inevitable. Inevitable, what is inevitability? You know when you're dealing with the people's and it's not just about plants, the things I do with my life, in my life in the community. You know, it' isn't just about plants, it isn't just about a family thing, it's about all of us. I believe this desire is an unselfish one and those people that surround me, or I've surrounded myself with, you know we just want to be able to preserve it long enough for the next generation of native Hawaiians, or whomever, to come up with better solutions. Because modern day man brings with him the ability to wipe out everything that defines people of culture, yeah so all people of culture we need to. Not just native Hawaiian's but all people of culture. Americans, they have no culture, so they can't, they don't get it. They can't fathom the significance and the importance of one plant. I would stand in front of that dozer for one plant because it's not about one plant. If there's only one population, there's another population of Maheapilo down the road braddah. But we're not talking about that population of Maheapilo's down the road, we're talking about this one. That's just me, you know. I live in a development, you know I exist in a development, you know with my sore back I have right now and right now all I have is my books and my field notes for now, until I, I hope I become healthy again. But that's how important it is, the native plants of Maui, the native plants of Hawaii. It defines us as a peoples.

KT- In your neighborhood of Honua'ula, if you can recall when you were growing up, the most significant plants that were there when you were growing up that you've seen and that you'd like to see forever that you don't see too many other places but it's there. Especially in the area we're talking about.

C- Yeah, you know, the funniest thing is um, just in my lifetime things have changed. Land has evolved into something that is, something very un-Hawaiian. The pasture

lands, just in my short lifetime, I've seen tracts of land, I mean the Uluhe plant, when I was ten years old, through the Kahikinui forest was incredible. Now you cannot find Uluhe, it's a very common fern, very, very. The most common fern, Uluhe. If you drive around east Maui, on the windward side of east Maui, man I remember Kahikinui, man. Gee, I couldn't make my way through it, it would terrify me to see Uluhe because I knew I had to get from point A to point B. The only way to point B was through the Uluhe. Now you cannot find Uluhe on the ridges, only in the gulches. So, just in my short lifetime... So you know that's one because I was terrified, I was petrified of the conditions because I was too small, other plants of interest of course.
KT- What wiped them out? And now that you say, I can see it in my mind's eye,
C- Yeah, well the introduction of ungulates, you know way back when from Vancouver's time, you know, all the way up to the present and the management and or the lack thereof of, of these ungulates or these hoofed animals is what's cause the denudation of habitat. Yeah, pigs, goats, in particular, pigs and goats in particular. Um, and of course cattle. Us descendants from the Paniolo we like to think that they were always managed but till this very day we still have wild holoholoa(animals) on the island of Maui. And when I say wild, yeah. If you stumble upon one, you know, you may get hurt.
KT- Yep.
C- If they see you from afar, they will run. But if you stumble upon one of these animals, and I speak from personal experience, dodging, you know, dodging a twelve hundred pound hoofed animal behind the, wasn't a tree, oh boy. You know, a twelve hundred pound animal in the forest, uneven terrain, he has the advantage. So, till today we still have these hoofed animals. Hopefully they're more managed. You know there are spikes in their population growth and right now we're experiencing a spike. Nearly a two thousand one. Five, six in particular the pigs and goats. You know we've noticed a spike in their population growth, despite it being that, I don't know, some say it's because other lands are being more managed today. We're seeing spikes in other areas. So if that's the case, then it's a good thing, but other significant plants was the Mamane tree growing up. Um, I remember the Oheohina, there's an Ohimauka and an Oheohina, Ohimakai. But they were statues' trees, I remember, so yeah, there wasn't that much because they was used for the Ohia. You know and my father's later day life the mamane firewood, you know for make imu. You know most people think Kiawe was always here. Kiawe is an introduction. It's an interesting story. They say the father or the grandfather or the great-grandfather of all the Kiawe trees in the State of Hawaii, well, what some people refer to as the State of Hawaii, comes from that one tree in Thompson Square in Oahu.
KT- Wow.
C- I find that story too interesting to not believe because it's an example of how non-native plants, when arriving here without their natural enemies to keep them in balance can do. You look much of the kiawe on our leeward east Maui, it's kiawe. I mean if you ever have an opportunity to take a helicopter ride from Kahului Airport going Mauka, above Omaopio, or getting into the Omaopio and the Pulehu area, going straight across to Makena, the dominant species is Kiawe. The dominant.
KT- Tree, yeah.
C- Yeah, you know, biology. You know seems monotypic, when you get into the microhabitats and then you start to see the Wiliwili lands with the Keahi trees and the

Lama trees and the tiny plants like the Nehe and all that stuff. But just like the people of Hawaii.
KT- All those plants you just mentioned are all found in Honua'ula?
C- Yeah. Yeah.
KC- Yes, all of them. The Keahi, the Lama, Iliahi and I can go on and on right off the top of my head I can probably name fifty trees, just trees that existed in Honua'ula.
KT- But they're overrun by Kiawe.
C- They're dominated by Kiawe.
KT- Yup.
C- And it's up to us, you know, it's up to us. I think, you know for me personally, much of the battle, much of the battle in this….I wouldn't say gone, I just not healthy, that's all. Fortunately, you know throught working with people like Rene Silva, Anna Palamino, Art Mederios was able to, oh boy that's the man, have been able to influence the significance and the importance of Hawaii's native plants. You know, introducing them back to the native Hawaiian. It's encouraging to see keiki blurting out names of Hawaiian plants. Unreal! It's a great thing.
KT- Where did you see that?
C- Um, where did, right while being employed on the Ranch and welcoming Maui's youth to come and see native Hawaiian plants. That's remarkable to see that how much percentage of these young Hawaiian kids already knew. Yeah, and being involved in other facets of the Hawaiian culture, just going on ecno hikes, I guess. I hate to use the archaeological. Just going up on looking for cultural sites, you know, with groups of people and seeing their kids. 'Oh, Papa look, Akoko. Oh, Papa look, the Ilima. Oh, Papa Amai'opio . You know, and you didn't see that just ten years, twelve years ago, never. You would never see that so, in a short amount of time, for some reason, you know, like I said earlier. I thought this day would never come. I used to cry in the mountain. I'm a big boy, I used to cry in the mountain. You know, when are we going to get it? I remember trying to solicit funding from the United States Fish and Wildlife Service and taking them on a field trip in Kahikinui and despite them willing to give the funding, they weren't getting it. You know, it wasn't about the money, the field trip wasn't about the money, it was a portion of the field trip. The purpose of the field trip was to show them and inform them that there are native Hawaiian's out there that cared. Whose sole life passion was to hold on, to preserve these very, very rare habitats. The habitats in particular more so than the individual species, what was happening to our native eco systems. The habitat destruction caused the dissipation in speciation or biodiversity and I knew it was so important. I don't care if you get one hundred endangered species. If you don't have a habitat for those endangered species to exist in, you have no plant. That plant will cease to exist, inevitably. Maybe not today, maybe not tomorrow, maybe not next week, inevitably it will die. The purpose of the field trip was to inform them that there a group of, at least one group, of native Hawaiians that got it, that knew it. But, come to find out, they're the one's that didn't get it. You know, it was the experts. And their frivolous mannerisms, you know, in a very spiritual place, you know. I remember it was around Thanksgiving because they were talking about turkey and sh** and I couldn't help but walk off from the loop and… What gulch was it? I think it was an off gulch. Was it Kamaole? Must have been Kamaole, I remember going into Kamaole Gulch and just visualizing the faces of my eldest brother, my father

and this vision I have of Akua. I was saying 'Bless them.' You know, I was angry, so angry I wanted cry. So angry I did cry. I don't know, it's hard to find anger and hate when you're in such a spiritual place. And I saw that and that moment changed me forever as a person. You know, I not going lie. I grew up angry. Very angry. Um, but that moment with the non- Hawaiian, the Hawaiian and the scientist, you know, in a very spiritual place, it changed my life forever. At first I was angry. I had visions in my mind of beating them right then and there. You know, visions, actual visions of beating 'em and I walked off. I realized they was funding for us, in these people that I wanted to beat. And after walking into Kamaole Gulch I realized, wow, you cannot blame somebody. You know there are other facets of life that I'm ignorant in, you know, so forgive them for their ignorance. For they not know who or what we are. I thought they would. They were the one's actually pushing for the funding; all we had to do was come up with the plan and another plan to execute the plan. You know, that's all we had to do. And in our minds at the time, you know, it was the activities. Management activities were fairly simple. Very, very difficult but in theory, simple. It changed my entire life right there. Right then and there I knew how important it was to get out and share whatever knowledge I had with whoever would listen. That one moment changed my life and that's what begun this process of physically, actually going out. You know at the time I didn't know how to do it, going out and soliciting groups of people to come to my backyard and share with them. You know, I look at that mountain as a part of me. In particular the leeward side because it's been so, what's that term? Not ignored.
KT- Passed over. Passed over.
C- Yeah, they say that land was destroyed you know. So they were telling me in the early days, you know, when I was going asking, you know. Just naively walking into agencies saying, 'You think you guys get some money so we can protect this stuff?' No, that's not the place to spend money at the time. Restoration was not, was not in anybody's vocabulary. You know at that time was a funny thing. 'Restoration? No we don't have money for restoration. We live in the real world.' You know that twelve, fifteen year journey, these last twelve of fifteen years was an incredible one. All kinds of money going into every island on the leeward side, you know today. And it's just, I like to believe despite….there are other projects going on, you know, on the Big Island. But nothing like what was happening here on Maui. You know the support of the community at whole. Even the non-Hawaiian community, we have work parties, work days. More non-Hawaiian's than Hawaiian's showed up for these work parties. And these work parties consisted of humping Keawe posts over lava fields, you know, to go protect individual populations of things we felt important. Never mind what science says. This is what we viewed to be important. Science not going help us. We went out and we raised our own money to buy fencing material to protect our cultural resources from further denudation by animals and loss of habitat. And now you go, you know despite it being small areas, you should see it from an airplane now. Last time I flew to the Big Island, I was flying back, you could see the work. You could actually physically see from the air, you know, the work that's been done in the last fifteen years. And I like to think it's happening on all the Hawaiian Islands because of what took place here on Maui. And that's how special we are on Maui. And that's how special undeveloped places, such as Honua'ula, Kahikinui, Kaupo are. Very, very vital to the survival of our culture and us as a people's.

KT- We've been spending a lot of time on plants. But in terms of cultural significance in Honua'ula, what areas or, items, or sites, are very valuable to you?
C- The funny part is, we were just working in a corral couple months back. Same corral, same proximity. Same corral that my father worked in, that my grandfather worked in, my great grandfather worked in. I know this because I have actual pictures of this actual corral that my father worked in, my grandfather worked in and my great grandfather worked in. Just a couple months ago, literally in tact. Wendell Wong looks down from his horse and goes, "Hey, what is this?" (laughing) The Ulumaika right there. Hunting…Oh, where was this place, Kanaena. We call it Kauai pasture. We was hunting this place called Kanaena. Walked over this stone wall to go retrieve one deer. Go down, cut the deer, walking 'em back up, climbing over the same stone wall, the exact same place. In the wall lies a poi pounder and this is just nine months ago, one year ago. Cultural significance? Hmm…cultural significance, culturally.
KT- They all are one.
C- Yeah, you know, culturally, you know, period. Places like Honua'ula, you know in my opinion, gotta stop already. You know I've seen plans to develop much of what's left of Makena. I've seen plans drawn up by the land owner's. Three of 'em. This was by accident. You know, I don't know. Development, in my opinion, should be concentrated in areas where we're not going futher in desecration of our culture. In the tracks of land, you know, open to such things. You know if it's inevitable, you know, get cane fields that's all being, you know. But places like Honua'ula. You know despite it being extensively. You know, the cultural significance of land such as Honua'ula, Kahikinui and Kaupo. There's not many places where you can just walk and see… I don't want to say the past, because people say the past is the past. That's not what I said, that's in the past. Seeing me, seeing who I am, you know. And that identification is very important to my future, I feel, because it defines who I am. Integrity, you know, as man. I see hard work in the cultural side. Ask anybody's working, they going tell you that's one of the hardest people I've ever been around. See, it's not just our past, it defines who we are. And you know, define our future as a people. That's how important places like Honua'ula is for our keiki. There's places like Honua'ula, Kahikinui and Kaupo that's still harbor our history. Our natural history. Our cultural history. Those places should be preserved inevitably, for that simple reason. Because these are the last Hawaiian places, Honua'ula, Kahikinui, Kaupo. In my opinion the most, again I don't like this term, for the lack of a better term, these three moku, in my opinion, are the most culturally significant. Culturally valuable. And it's not just because of the cultural sites that exist there but the botanical treasures. And it separated us, the plants separated us and it allowed us to have a culture. It's the plants in my opinion. Again, you know, we're trying to talk about culture but that is the culture. The plants, it is the most vital part of our culture. It defined us, it separated us. Not just the miles of separation between continents or other land masses.
KT- I must tell you Mahealani that this information is very valuable. You present cherishable memories of Honua'ula because you present detail information. So very valuable, this information that hopefully people that we're doing this for will really look at your words. Really, seriously what they're proposal. That's why Kimokeo and I go at this with passion because we're collecting vital data to assist in the preservation as much as we can.

C- Yeah, there's no, I mean, lot of things have been documented. I mean places like Honua'ula, I mean just…. If you were to be dropped, you know aerially, anywhere in Honua'ula, it's a hop, skip and a jump to the nearest cultural site or something significant. Siginificant in Hawaii. Literally anywhere in Honua'ula, Kahikinui and Kaupo a cultural site, a rare plant or significant plant. It doesn't have to be rare, you know, a plant significant to our culture, a cultural site. I mean the fact that we're finding Ulumaika in one cattle pen that's been used for at least four generations, for at least four generations, Ulumaika stay popping out of the ground! You know, slingstone, brah, slingstones was another, in this corral. Thousands, and thousands, and thousands of head of cattle were processed through this pen, brah, and we're still finding. I know 'cause we're finding part of our culture. You know, it doesn't seem like much but try think of that one. One cattle pen, brah. Imagine what's outside of that cattle pen in these less disturbed tracks of land, Ulumaika. I mean finding one poi pounder in the year 2004 or 2005 in one stone wall, that's cool brah. That's cool. Most people may not be able to appreciate little things like this. You might have to be Hawaiian to have that appreciation.
KT- And then like you said, even now, some non-Hawaiian's have a greater appreciation than Hawaiian's for those kinds of finds. Those who have been schooled in the importance of our culture.
C- Yeah people, fortunately, people are people. I don't know. We, yeah. A lot of non-Hawaiian's out there that actually deserve to be respected and appreciated. You know, that brings us back to a whole nother….
KT- But I've been keeping you here sitting in this position, I know it's uncomfortable. So, you want to say any last words in respect to this?
C- Um, no, just again to reiterate how significant. I don't care if the property is dominated in the Kiawe trees. You know, the fact that they, certain lands in Honua'ula are dominated by Kiawe trees, you know. It doesn't take a whole lot of effort. All you need to do is look around and you going see. You going see the Native Hawaiian right there. You know, whether it be in a cultural site, a plant, a heiau. Yeah, you know, places like Honua'ula, Kahikinui, Kaupo, again should be taken out of the development realm. Just because it's the last Hawaiian places on the island of Maui, in my opinion. Whatever development is there hey, you know, it's there. But enough already. I'm not against development. No, I am against development but now they put up all these buzz words now: culturally, sensitively, ah. I don't know, I don't know what that means. Developing it, there is no sensitivity in that. You know? Just, just think again, look again. And you know when it comes to places like Honua'ula, Kaupo and Kahikinui, we need a place to take our kids to show 'em our culture. Gotta draw one line somewhere, take it's time. Not here, there. This here, ppffhh. You know we deserve it as a peoples, so. Nothing like da kine brah, being on the land and talking about that land. Boy I miss the mountain.
KT- So the real dilemma is how do we do it.
C- Yeah it is. Oh boy, that's why I went change jobs, to hopefully become a part of a change.

## *Interview: Paula Kalanikau*

## By Keli'i Tau'a/ Kimokeo Kapahulehua
## September 20, 2006

***KT- Keli'i Tau'a***
***C- Consultant***

KT- Okay, so I'm sitting here with?
C- Paula Kalanikau
KT- Any Hawaiian name?
C- Kapela-Kapela is my Hawaiian name.
KT- Presently, how old are you?
C- I'm sixty-eight years old right now.
KT- You resided in the area in Kihei?
C- Yes, we moved to Kihei in the early sixties, so it's going to be forty years now.
KT- You've seen a lot of change?
C- Oh, Brother Tau'a! Many changes, definitely many changes.
KT- Some good, some bad.
C- Some for the good, most for the bad.
KT- So, cite come good things you see have happened.
C- Well, you know, I was a school health aide at the Kihei Elementary School years ago back in 1970. The enrollment at that time was only about 180 students and the move took place back in eighty-two. The current Kihei Elementary School now mainly because of the growth and the flood and Tsunami area where they were then located so it was a need for them to be moved for the safety of the children as well as the community in the area. So, that's a progress-that's one progress I see that's tremendous. The growth; now it's 2006 from 1960 the 1960's, we never had, we had a little post office by the old Suda Store, which was originally owned by A&B ( and I believe it still does, not sure if it was bought out).
KT- So one of the buildings there was a post office?
C- Yes and our postmaster at that time was John Ventura (who has since passed away a long time ago) and he was then our postmaster. There was John Ventura, his wife Clara

and Ben Torres-all of which today are deceased. There was another clerk which was Jerri Serrao who was also a clerk there at the time. She was a Carvalho, Mary Carvalho's daughter.
KT- She's still living today?
C- Jerry Serrao and the husband is now living (Joe) who is a retired policeman living in Hilo. They moved to Joe's hometown where he was raised. However, Mary Carvalho, I understand is still living in the island in Kihei.
KT- So, was Mary's family a long time resident in this area of Kihei?
C- Mary, I believe, is one of the original Kupuna's. I believe she was here before I even got here. They lived on Ewa street, I believe, right across Waipulani and Ewa Street and if I'm not mistaken she's still there. They just celebrated her birthday about two months ago.
KT- How old would she be?
C- Eighty, I believe. I think they said was eightieth birthday- and I missed that darn it.
KT- So her name- her name is Mary Carvalho?
C- Mary Carvalho, yeah. She was also a part-time delivery service person that delivered for the post office in between when they were short handed. And to my dismay I became one of the employee for the post office too! (laughter) So that was kinda fun because I learned from Ben Torres, from John and Clara Ventura, the Ralph's, and whatever people there was here. We delivered like- 8:30 we left the post office- before noon we were back because there wasn't that many homes. Miaymoto's used to live way down by Wailea- well Wailea didn't exist at the time, it was only Kiawe. We had Mana Kai wasn't even there, was only Kiawe's. Then across the Miyamoto's and a few houses, and that's about it. We did our route and we were back. There was Ilikai was kinda brand new, yeah? And Kimoke Apartments, but there was so few that when you did your delivery you were back before lunch. Today delivery is lunch time; they're still delivering at my house. (laughter) So that was one progress: the school, the post office ( which has since moved to Azeka One Phase one and that's big progress or I'll say tremendous- along with the growth must have something new). Another thing that I find tremendous is Azeka one and two phase which we was ma'a with the, or used to, with the old Azeka Store. When we first moved here had only one little building with these little butcher shops and they didn't have gas today, gas pump like they do then, we used to go pump our own gas then go back inside pay for it- or pay for it then go back outside and then pump our own. There was one, only one! One of those stands, and the same for Suda Store- they had only one little stand where you pump your own and pay for it and move on. And Bill Azeka and his wife, you know, had this little market which we really enjoyed because momma and papa store you get to know everybody. The aloha is so tremendous. You know, it was just so close, we were just so close knitted community. That's another growth. The Azeka Place, the Post Office, the fire- we never had a fire department in Kihei. At the time Wailuku Fire or Kahului Fire Station used to come down. And so many times the old folks would say, "Oh by the time they come to Kihei there will be only ashes remain."
KT- So when you really think about it all through those years, can you remember any major disasters? Maybe people were more careful then. Nowadays I hear the siren going up and down.

C- Well, no not then. You know, we only had one way in and one way out. There's no traffic like we have today, up there Piilani like we had only this one little road down South Kihei. In and out if we had a bad storm- let's say if we had a Kona storm, up the mountains rain, the water come down through the river by Suda and it overflows, big time. And that maybe it's once every ten-fifteen years that does happen really bad, maybe sometimes sooner. And if that happens and the water flows over that little ridge; we can't go in or out. So don't plan to go out or in.
KT- Where is this again?
C-By Suda Store the little gully over there.
KT- Oh, okay- Waiohuli.
C- Cannot go in or out so don't try. The only disaster found out back then (and I think was in the seventies) we lost a car, the car was swept over that little bridge and out into that little water out there from the storm. But, and then we had Kihei, Suda- Suda Suda Store used to really catch it because the flood really come down heavy. I think a flood was one of the major issues for Kihei then and still is. It's just not really controlled and many of us realize that we're in a flood indented area but I don't see that much progress except for the highway. Now you have a way in and out in case of a disaster.
KT- So, we're talking about first….
C- The bridge by Suda, Waiokea or Waiakea.
KT- Suda Store where Upcountry is Waiohuli.
C- This is Kaonoulu back here, back- where's, this is Waikolani, you have another map? Waiakea Gulch I think it is. You know Upcountry they have that Waiakea?
KT- Right.
C- The gulch come right down by Suda, that's the one that flood.
KT- Okay so what I wanted to establish is: that was the gateway into Kihei. Suda Store was a landmark where people would come in; either off Maalaea or across Puunene. Now, at Puunene during the years you were here there was a local airport was there.
C- There was the- that was a Navel Air Station.
KT- But Kahului Airport didn't come into existence until later.
C- Yeah not till, well, they have the old Kahului Airport but not- yeah they was in Kahului but they wasn't as established as this. It was a really small airport.
KT- So, Paula as you- right now as you're riding from Puunene Post Office, coming across to Suda Store you see all these brick buildings.
C- Coming across now. (laughing)
KT- Those brick buildings originated from the World War.
C- At Suda Store- across Suda Store?
KT- The Highway from Puunene all the way to Suda Store…
C- Oh, yeah they have bunkers out in the field there.
KT- They're bunkers from 1942.
C- During the war, yeah they are.
KT- So if we come right in front of Suda Store there's kind of a breakwater, small…
C- River.
KT- Small stone wall going out, did that have to do with the military?
C- This is by Suda Store- that little? Yeah, they had to do some adjustment there because of the flood. I believe by the Corp of Engineers at the time.

KT- Okay, that is a very significant spot for your late husband today because there's a canoe club that he was responsible to start.
C- Um, that was back in 1972.
KT- 1972, did it originate right there and never moved? Or…
C- It never moved, um…. what happened was a number of men got together and decided that; Brother George Perriera, there was Brother George Kaanana, Kuana, had many more in the neighborhood and my father-in-law, Ben Aviera . They talked about the culture, the Hawaiian culture, and canoe, and the youth in the vicinity because there was not enough going on for the youth. And perhaps that would bring the community and their families together, if they started something like that. So, they put all their heads together and decided they were going to give it a try. And so back then they formed the club; got their board of director's; got their bylaws established; did fundraiser's; got permission from the County, did this, did that, had to do everything right. And then they had a luau over there. They kalua pig, consecrated the grounds, blessed it and they had a kau kau and they all invited the community.
KT- Was that a little, it's not a hotel….
C- Sugar Beach?
KT- All of those buildings there, was it there when the canoe club started?
C- When they first started it was there.
KT- The whole, all of those buildings were there?
C- Those buildings were there and amazingly enough, you know, with so many hau trees and Kiawe trees at the time that you really couldn't see the buildings then.
KT- So the city and county willed the land to your husband and these other men.
C- Well, it was a lease at the time. I'm not sure whether they had willed it to the club. But that was… a lot of things had happened down the years. There were other new members, new board, and they were trying to get the piece from the County, actually, to maintain it and get it from the County.
KT- So, if we start from there and we come down from South Kihei Road; there were a lot of wetlands and they still exist, some wetlands.
C- Yeah, there is. Kealia is one of 'em, we all know that Kealia Pond is definitely and it's already under the Federal Government to maintain it as such. We also have one that, and I'm surprised, (I'm not sure what they're going to do with that) just before the Whale Center here, it's a wetland there.
KT- Right.
C- And even mauka of the highway the wetlands.
KT- So let's keep traveling down South Kihei Road because right here at Koa Resort and Koa Lagoon. It's called Lagoon because it was wetland and there's still some.
C- Makai here, where you live, it's a wetland. That's where it is, the Whale……
KT- The Whale Sanctuary is there but it's still right there and if we go further down on the left hand side by the new Safeway, coming down, there's some wetlands there.
C- By Longs, behind Longs it's all wetlands. As a matter a fact, Brother Tau'a, that's all wetlands. Where Longs is, is wetlands. Those all had been filled in.
KT- So the Catholic Church, wetlands? Was it filled to build the church or was it wetlands?
C- That was wetlands that I can recall and then there was a small church there, this is a new church. That's all area over there is all wetlands. The water goes out to the ocean.

KT- Go down to Kalama Park; at Kalama Park does the wetlands stop?
C- No, there's wetlands if you notice by; there's that cross thing. I'm trying to think, between the old Kalama and the new Kalama Park.
KT- Okay.
C- There's some wetlands still over there but he, I think a lot of them had been covered since.
KT- So what I wanted to reveal in this report; that from Kealia, from Maalaea all the way to Kalama Park or maybe a little further, was wetlands.
C- You see, um, I'm taking myself back yeah. Yeah because even by Azeka Store-going down, makai side by the church and further there was all wetlands. That was filled, even mauka.
KT- So there might be a break, even after Kalama, but we know that if we go further down into Pu'u-o-la'i was all wetlands. So, many people who come to Maui today would not have been able to visualize that; in fact if they buy property close to the beach they might be sitting on wetlands. You know their house might be on wetlands.
C- Right.
KT- So, in establishing that, we come back to where we are doing the research. And it's above, interestingly, where you were working quite a bit of your life at the school.
C- Oh yes, at the new Kihei school, at the Lokelani Intermediate, yeah.
KT- Because what we're researching is for the Maui Research and Technological Park. So we did mention again that periodically there was water that came down and threatened where you folks were at the school? Below….
C- Yes, we had run off, we did.
KT- What street is that on?
C- Lipoa; and the residents actually, on that street, used to always complain to the County because the water always runs into their home.
KK- So as you and I can see it right now, outside of the first building for the Maui Tech Park, there wasn't anything else up there?
C- No.
KT- Because there was pasture land, ranch land.
C- Mmhmm, there was, that's right.
KT- Ulupalakua and…
C- Remember though, there is a gulch that come from up there, that come down. That's why when they built the school there was much discussion to where the water was flowing because the river was running pretty close to the school.
KT- So, if we go all the way down to the ocean; Where about's was the water ending up?
C- Okay, the water was ending up by down Lipoa across, by Star Market and even on the street and of overflow across the street. Because they had nowhere to go, no drainage, so when they built the school's they definitely had to build this tremendous drainage to allow some relief. And now, still when it rains, the water still runs down towards; some of the flow runs down that Lipoa Street.
KT- So, one of the concerns of the local people is to have access. It's called gathering rights; either mauka or makai. Were the school students ever taken on excursions mauka of the school? Was there any reasons for them to go up and look at the native plants and stuff that were there?
C- Not to my knowledge. Not to my knowledge.

KT- Do you know if there are any native plants up there that would be used?
C- Well, no I don't know, because they had cattle's before and they still do. So if there was any, I don't know if there's any surviving.
KT- Kimokeo and I had privilege to research what is called Kula 1800 which gave us access onto private ownership of land. So we were able to walk some of the riverbeds from Haleakala down and to our surprise every one of them have petroglyphs.
C- I'm not surprised. I'm not surprised. Right on the side of Lokelani Intermediate School, oh I'd say back in the late 70's early 80's, Brother Ka'alakea (David Ka'alakea) walked the side of that premises upon the property of the Lokelani Intermediate School cause they were having lots of problems with the school. When I say problems they were….
KT- Spiritual problems.
C- Spiritual problems, yeah. So, I don't know if he ever shared that but we walked together with the principle.
KT- Who was the principle at the time?
C- At the time was Marion Muller.
KT- Okay.
C- And he told me go with him, and I did. And he told me, he wala'au to me, that the side there is their walk.
KT- Is the path that they walk
C- Is the path.
KT- So, can you remember if it was going mauka-makai or Makena to Wailuku.
C- Well, at the time he pointed from mauka-makai. Maukakamakai, he said go down. And I believe this is where the pilikia was yeah because the school is pretty much in the path. But there was blessings, there were several blessings on the school and he did the final one that day of the walk. So we know that much but this is probably why you see a lot of petroglyph too yeah.
KT- Well, the; from small kid time, since I'm a Kula born, I was aware because I've walked some of the ravine's and I saw the petroglyphs. But because I've accumulated more knowledge now I know that our Kupuna used to use the riverbeds to bring logs down; either for canoes or the iliahi, the Sandalwood, to bring down to the area of Suda Store or Makena Landing to ship away.
C- Yeah, that's how my papa used to do when they used to go get bamboo it was usually through the riverbed.
KT- That would be the most logical and lighter way of bringing it down. Any family stories that can connect to the area that we're talking about? What's your opinion, as an example, of this Malulani Hospital that they want to build here?
C- Well, with the growth, you know in Maui, and in the Kihei area; I think a good cause. There'd be challenges. If they could get the staff to fill all these positions for that hospital, I think it's good. I think there's a misunderstanding who the hospital's for. Because they were saying it's only the rich get's in. But that's not what I understand from what I read. The misconception there or miscommunication; and I think because this is in the making it's gonna take a while. In the meantime Kihei is growing; Kahului and Wailuku is growing; I feel there will be a need on the way, yeah.
KT- Your mo'opuna, your keiki will need a place to go.
C- They will be needing, so I'm thinking about them more than myself.

KT- So the mayor made a statement on a presentation recently. He said, "The good thing about Oahu is if I sick I can go St. Francis, you know I can, there's ton's of hospitals." If you sick here, where you go? Only one and that's limiting the community. And the fastest growing area's on this island is right here where we are.
C- Yes, we're growing leaps and bounds and we're talking about, you know (and I think you read about it with KCA, which I'm a member of) is talking about supporting the high school that they want to put here also. And that too, is overdue. You know, our children here, our kamali'i's in order to participate in high school activities they have to stay there after school. They have to find their means of getting back home and it's a big sacrifice on the family who works one-two jobs and try to make arrangements for them. So by the time all of these are through, hopefully shortly in due time, they will be able to have their own high school and their own activities there.
KT- The area where we're talking about, are there any cultural things you can think of that you'd like to bring up? Like, I have the documents that there were several heiau's within this area.
C- I believe there is a small one near the school, not very far. So I'm thinking there's possibly some more up there, which we should look into. And I know that there usually is archaeology studies and that should be our primary and foremost.
KT- All of these, these three are archaeological studies from different companies in different times. So now, the important part to this whole thing is the cultural part, which you are sharing because what you have been telling me already is not found in archaeological reports.
C- Oh, okay.
KT- You know the water and how it affects the community and stuff, it's very valuable.
C- You know when I go to the meetings at KCA, their concern to (in Kihei too) in general is the flood; the flood indented area. We know that we have all the gulches: Waiohuli, Ka'onoulu, Keokea, Kamaole; they all flow down to Kihei. As you build, as you build- there's more water coming down. So in their master plan, I'm not at liberty to say that they're not studying that (I'm sure they are) but how are they going to divert some of these concerns, is my concern.
KT- When your husband was alive, or even now, does your family go down holoholo to gather?
C- The kahakai You know, when we first moved down here, oh we loved it because the water was so pristine! The limu was so plentiful.
KT- What kind of limu?
C- All kinds-limu kohu (Well, limu kohu was not as much here as I'm sure in Paia, we used to get some out of Paia.), but lipoa, the waiwaiole, and ogo (was one of the most common one's you could find here), and even the eleele. You outside the old Kihei School, up there on the papa, all nice and clean. My papa used to enjoy coming up from the Big Island and be able to see it there-so clean, right from the water. No more sand, was so wonderful. Then you go down behind, now they call St. Theresa, same thing; plenty limu, same kind limu and the eleele back there was so clean. My papa brought something to my attention, that I didn't realize that he always told us that about Waipio Valley. He said, "You know where this is river rock? This is river water coming down." I say, "How can you tell daddy?" He says, "Because spring water, I know this is spring water." And he said, "Where water like this runs, the moi comes." I said, "Is that right!"

He says, "Well, baby I told you that when we were in Waipio. What's the matter with you, you forget?" (laughing) He scold me and then I thought, oh yes I should've remembered that because he used to always tell us that about Waipio Valley. So he said there's plenty Moi out here. As I look back today and I think about that; I think where is it today? Our water is polluted.
KT- Yep.
C- Our limu is polluted. They're going to say, they go pick today plenty young families bring their whole she bang- there's limits in what they can take now. But there's very little left now. You go in the ocean; I think some people they go and throw cloths, or something because the limu come all white. So, just the other day we were down the beach comparing to what was then and now. And even my kamali'i's now (they're all grown they have their own families) they says, "Oh mama! This place is such a mess compared to before." And that little park that we call Mai Po'ino 'Oe Park was such a lovely beach. We used to go; when I come home work from the hospital over the weekend, Saturday's, everybody pau make their job, everything pau- bring ukana down the beach we go down there spend the morning with our people, our children and my kane. And was beautiful, I used to just marvel and enjoy that ocean. Today, I have to look around because the water is so polluted I'm afraid that there's something there I cannot see. (laughing)
KT- That's where my wife went to go swim in the ocean.
C- They think today that it's pretty; I think it was prettier years before.
KT- Oh, yeah.
C- There's no comparison whatever. That's the original Hawai'i, Kihei that I see when I first moved here.
KT- So, very important point you make there because that's what I wanted to bring out: the relationship of mauka-makai and what our people expected to get. And so in future development we need to take a look at what we do so that we can try to re-pick what we still have and try to get it to (for lack of a better word) rebirthing the limu's and bringing back the Moi.
C- Yes, well, we do have an environmental problem, we know that, and we have all this run off from the cow courses, from the boats. It's interesting how they plan to alleviate that-if it's going to help our ocean-at all. Because I was told that the boats have to be out there, if there's any discharge, I don't know how many miles out there but my understanding and maybe they do research in there; my understanding is no matter how far out you go, the current will bring it in.
KT- Kimokeo just made mention that the past vice-president is going to be here October 1st to talk about green-building green houses where everything will be broken down within one's home so that there won't be solid waste being disposed. Everything goes back to the ground.
C- Well, you know what was? When we were kamalii, we never throw anything in the ocean-in You know our-everything that we cleaned in the garden was never thrown away. It was used for fertilizer; we use compost, compost, compost. When we took out of the ocean, whatever we took, we made sure we didn't leave any opala back there. We clean our mess. My concern is how we going to clean the mess today that's over there. We try to do it on our community day work but our limu is coming on the sand and staying there. Is it the current or what? Because the limu it comes and stays, never used

to be before. What is it that's causing it? What is it? The limu never stayed, when the current go back down, the place was always clean. Now it's no more, the limu all come opala over there. Is it the time?
KT- What they're putting in the, what they're building is affecting the currents that changes the cycle of the-the movement of the limu. So that's one of the conferences that I was involved in and Kimokeo on how and what can we do to make those changes.
C- Because it's hauna and I know that the neighbor takes a lot of them right here across the street from Koa Lagoon. He comes down here with his machine to scoop it up and take it to compost it. But that's only there. And these people here hired him to do that.
KT- So it's a political thing that has to be passed. Well, you're pointing out what used to happen in Kahului Harbor which they went and got those machines and…
C- A lot of that. Even before we did, Kahului had that-for many years-had that problem. We didn't have that, now we do! Now we do big time.
KT- What do you think of the fish pond being rebuilt through Kimokeo?
C- I like that. I like that. I think the restoration is a good thing for our fish pond because it is a fish pond that needed to be revitalized and rebuilt and I think they did a good job. They work hard.
KT- It's still ongoing but..
C- Yeah, and that's not the only fish pond. There's several more down the way by the VFW Hall out there.
KT- You know the names of them?
C- A'ole. But Kimokeo said that they gotta work on that on the way later on. It just has to take time and grants.
KT- So this one her is not kalepolepo. Kalepolepo is a major big name that was here but the one that they're working on now it just slipped my mind.
C- The one they just pau?
KT- The one right next to that pink ah….
C- Yeah, I know which one you talking about. The park is right there, Kalepolepo Park.
KT- Right by VFW. So it fits into what you and I just went through in wetlands that our people had built resources among the ocean side.
C- Yes, they did and that's where their livelihood was. And should still continue to be, we're losing all that you know? We lost- I shouldn't say we losing, we lost because we don't have any fishponds. We don't have the wetlands that they once had.
KT- I think, you know, presently it's not just a Hawaiian thing but many of the Caucasians have more passion to retain some of these Hawaiian cultural things than the Hawaiian's themselves.
C- Oh I think definitely, I do.
KT- So it behooves the kind of passion we have to try to keep influencing.
C- I think a lot of our Hawaiian people are concerned about what was and is but they come to some point where, Brother Tau'a, they feel that nobody's doing anything about it. Or no sense talk because talk is only cheap, cannot do nothing without… But I think talking to some of our po'e (people); a lot of them kinda give up. Like oh, nothing's being done, they're not going to do anything about it. That kind of attitude they have, you know, and that's sad but unfortunately that's some of the attitude I get and they don't want to get involved, but plenty waha.

KK- You know, I can understand that and that's what amazes me about my partner Kimokeo, just keep doing.
C- Yup, straight ahead, no complain just straight ahead. Yeah, I admire that man, he is awesome and he's taught me a lot from what he's done.
KT- The one area I keep trying to work with him is the gospel.
C- He knows, he keeps telling me, "I'm coming, I'm coming one of these days."
KT- Well he says, "I start my day, every day on my knees" and so that's good.
C- Yeah, he doesn't forget Akua, he's a good man.
KT- But, if you can think of anything else you can let me know because you know where our interest of research and what we want to provide.
C- Oh, I'm definitely interested in them having a High School here. I think the children deserve that; a hospital. But we need to be also aware of what our ancestors have established in these areas and be mindful to developers and County and State and what would be our priorities. And that is our priority: to look after our aina.
KT- I going pose you a question as a Christian going person who on this earth: If we found a major heiau or major Hawaiian temple, what would your action be? Would you like it taken away or would you like it to be reestablished as a historical piece for your moopuna or for your community?
C- This is my point of view because I guess that's the way I was brought up and that's what I was taught; to have what is there stays there, and undisturbed, and treated with respect.
KT- I just recently went to go and bless a homestead up in Wai'okuli-third phase, Keokeo side. I sat with one of the most admired Hawaiian scholars and she was my teacher and she told me exactly what you said. She said, "If the bulldozer's bring up, it was meant to be for them to show themselves so that we can stop." So I was really appreciative of that because as you know that and as you brought up; we're always faced with spiritual experiences on our aina-that's what Hawai'i is. So if we know how to malama (to take care that) it will make the whole area much better.
C- Pono, yeah I firmly believe in that because it's the way I was brought up and it's respect for our Kupuna's, our loved ones.
KT- Anything else you want to share?
C- No.
KT- We really appreciate you coming for this interview.

## *Interview: Robert Pahia*

**By Keli'i Tau'a and Kimokeo Kapahulehua**
**January 18, 2006**

***Interviewers= KT/KK and Consultant=C***

KT: So, I'm sitting here with Mr….
C: Robert Pahia
KT: You have a middle name?
C: Robert "Hale" Pahia
KT: Hale like Hale
C: Hale like the Hale
KT: Who gave you that name?
C: My mom gave me that name because she thought that the name Hale, she meant to name me after my uncle Harry. And believing the word Hale was actually Harry but I believe that name was given to me probably not from her but spiritually from someone else because they said that your name takes on your personality and I've always had that personality of always welcoming people into our home.
KT: On your hand give me how old you are. Fifty, wow. I thought you were younger than that, maika'i. So, just to jump right on why Kimokeo and I wanted to talk to you and that is, we are cultural assessors for the land across the Ag park. They want to build Ag subdivision. So when you enter off Pulehu Road off the opposite side. Presently it's Haleakala Ranch. You have any ideas about stuff that were there before?
C: I have no idea what was there before.
KT: Okay, this is why we really wanted to talk to you. Cultural assessor gathers information and then makes an intellectual, a spiritual wherever the cultural assessor is. Our thought was we're looking at what was there before. How did this survive if there were any communities within the area. In other words, what was happening on that area. So we transpose to Ag and our thought is you're one of the premiere kalo growers. I don't know how that happened. You want to tell us how you got into kalo because the first time I knew you, you weren't a kalo man.

C: You know, I grew up on the island of Oahu in the area of Kahalu'u and many of my friends were involved in growing kalo. It was grown all around where I lived in Kahalu'u and there was no attachment to me at the time but it was just always around me. And my friends were all taro farmers but I never got into it. And then when I moved to Maui and I was working down at the low elevation site near on Hansen Road, we had a project over there and….
KT: When you say we, who?
C: The University of Hawaii.
KT: Okay.
C: So the expansion agent Ted Hori started, he thought it was a crop that we should look into so he started growing a couple of different varieties of taro. And then my friend from Oahu flew in and he started planting kalo seeds in me. His name is Keoki Fukumitsu.
KT: Was he your childhood friend?
C: He's a childhood friend, we grew up together and he was one of the taro farmers that I mentioned. So he started getting me interested because he started naming and teaching me about different Hawaiian taro's. And from that point on because of the interest I had shown in the taro my farm manager assigned me to the taro projects along side with the plant pathologist Dr. John Cho. So, when I was working with the University of Hawaii that was my kuleana. And that's where I had garnered all my knowledge about kalo but it was just a natural attraction for me to grow it and started off growing it on a small piece of land up in Kula, at a calabash auntie's house. And then I learned the need for more property when you're growing kalo because of the abundance of oha. Then I, and all of this, my wife and I, my daughter, we were growing the taro on the side while I was working for the University of Hawaii. And every year our taro fields got bigger and bigger and at the same time though I'm still working on the taro projects with Dr. Cho learning more about taro and Hawaiian taro's. Because I was involved in the University system and working with all this taro and different people I met a lot of different people who were involved. I just took a special interest into the Hawaiian varieties. The reason being well, they were Hawaiian and I found out that at one time we had over 300 varieties and right now there's only 80 at the most that are still alive today. So I took it upon myself to make this my kuleana in perpetuating all the different Hawaiian varieties. Not only that but teaching people the correct names and how to identify it. And because I was working with the UH and doing all this taro research work and on my own growing my own taro and growing all the different varieties, I got to eat all these taro's. I got to identify all these taro's, so therefore I had a greater insight and knowledge of the different varieties, where it grew best, under what kind of conditions, etc. Then I moved to a ten acre parcel where my wife and my daughter, we farmed the taro and…..
KT: Where was that?
C: This was down at Pulehu. And then we moved to the Kula Ag park to a 30 acre parcel where Juanita and I farmed, we opened up 15 acres of it. And all this time I'm learning more and more. And from there I ended up going down near the airport area got some land from HC&S to farm down there then I ended up in Maliko farming kalo out there. But my expertise really is in dry land taro. Growing wet land taro's a little different. I wouldn't say that I have, I would be an expert in that field but I have knowledge that can help a lot of the wet land growers. Yeah. So, since I moved up here

I've been focusing on building my house and I just grow taro to eat at home and what I've done now because I'm not doing it on a large scale. What I do is I act as a consultant to help others start up taro farms so they don't have to reinvent the wheel and I can save them a lot of time. Anyway, like I said that's my little kuleana in this whole cultural renaissance. You know it's to teach people different types of taro's that the Hawaiian had. Our people had and to learn how to identify taro's and teach them, especially in the dryer land area how to grow it and grow it well. I've learned through trial and error.
KT: Let me ask you some questions. To bring out the reason why we're talking story. So, you were right across where we are researching which is called Kula 1800. And from what you just said, what are the optimal kalo plants that would do great in that area?
C: It's interesting because that piece of property right across Kula Ag park there is a band of land that goes from Ulupalakua all the way over, right on that same elevation it goes all the way over all the way down to Haiku area. I would say it stops by Pukalani and the reason why I say that because of the difference of rainfall. So, therefore changing the soil makeup.
KT: So it was in the same alignment as Kula Ag where you were that goes to Kula 1800. All the way to Ulupalakua.
C: Yup.
KT: So what did you find? I mean outside of the rainfall. So, what do you think our Kupuna put in that. You think, number one. Do you think they were aware of that?
C: Aware of the band?
KT: Yeah.
C: Yeah, I'm sure they were.
KT: What indicates that you think they did know that?
C: Well, because of some research and I've read books about how our Kupuna farmed. They farmed in every type of conditions there are. Down from the a'a the pahoehoe to the swampy area's all the way up to the mountains. So they just were akamai, they would have planted everywhere and if I grew it there with the little knowledge I have and I found out how well it does in this band, I know they planted over there.
KT: So, Kimokeo and I had privy to walk where you did. And we concur that you really had a prolific amount of the different varieties that you did. Can you name some of them?
C: Oh, yeah I can name them all, but there's about five or….
KT: Do you have a list?
C: Yeah I do.
KT: A hard copy?
C: Yeah.
KT: Can we get a copy so that we don't have to go over that right now on this.
C: Sure, I can give you a copy.
KT: Can I walk away with it tonight and then make a copy?
C: Sure.
KT: So, as you said, trial and error. Fifteen acres is a lot of acreage to plant kalo. And all you had 30 acres but you put 15 of them in kalo.
C: Yup, yup. And we would plant half acre at a time, my wife and I and my daughter.
KT: Describe the planting of it.
C: Well.

KT: Did you follow moon calendar?
C: Well, because it was very difficult to follow the moon calendar because of the lack of time I had and during the harvest you had a whole lot of huli of oha that you don't want to waste so I can't be waiting for the new moon or the next moon because then I would waste the huli. So I just. It was beneficial because I planted just throughout the whole year so I got to see the difference when you don't plant with the moon, with the new moon, and it makes a big difference. So yeah it was beneficial in that regard because I could see the difference.
KT: But at least you were aware that that was really true that our Kupuna followed relentlessly moon calendar.
C: Because I got to plant on the different moon's I got to see the yield's on the different varieties and the different times. So yeah, big time, definitely.
KT: In terms of size. In terms of amounts?
C: It's in terms of size, I mean they had it down so wired, it's in terms of size and in terms of oha throws.
KT: What about taste?
C: Even in terms of taste, just the overall the whole aspect of it. Our Kupuna's just had it down wired. Now that I don't grow on such a large scale I plant strictly by the moon.
KT: So, what time of year you found to be the optimum time to plant?
C: Optimum time is if you want to plant your huli optimum time would be in late winter or early spring. Late winter or early spring. The reason for that is by the time you plant it takes about 2 months for it to get a good start and then if you time it, it will go right into spring where you have the long day period. Therefore you have greater growth. More growing time. But, there's so much.
KT: Many of my Kupuna, including my 'ohana always encouraged me to talk to my plants. Did you ever get into the habit of that?
C: All the time! The plants talk to us.
KT: Describe that, describe for those who don't understand it.
C: You know I always talk about, people talk about aloha 'aina and malama 'aina and when you malama the plants they dance for you. And then they make music. It's truly one of the aspects of really hearing the heartbeat of our 'aina. I mean, it's awesome. We always talk to them. We sing to them, we play music. They talk back to us and it's just a very, very spiritual thing. We work really hard. And then we go lie under the big makua kalo's in the shade and rest and we just, uh, give us a good rest. We just love to watch them dance 'cause they would dance in the wind for us. And when it rains we would go under the makua plants and take shelter. It's just something that I wish everybody could experience.
KT: Have you told this to anybody else?
C: I've told it to a few people. Those…I tell it to people who I know can appreciate it because there's a difference if I told someone who really doesn't have an appreciation for it. It wouldn't have that impact. Where as you can feel it from the person who would appreciate it. But, anybody who grows the kalo, they will know what I mean.
KT: I interviewed Lynn Mateaki and she was sharing with me that many of the farmers there that when no rain they don't plant. They let their land go follow. But you said that you plant all year round. So you didn't follow rain cycle?
C: No, I planted year round.

KT: What was the mentality of that? Is your mana'o saying no need rain? Describe.
C: No, rain is an important ingredient, an important component. And the reason being especially in this belt. There's a lot of, there's more beneficial points to growing in this belt versus non beneficial. Now, being that it's in a dry area with not too much rainfall, it's very warm, cold nights, very warm days. It's very beneficial because we never have the problems that people who grow in the wetlands have. Because they have a lot of rainfall, they have the Phytophera leaf blithe, the fungus. Okay now, that's a major problem for the growers today, I mean, throughout the state. If you grow in like Hanalei anyplace that's wet, Keanae they have a big problem with it. So we never had that problem. However, on the flip side of that because they have the rain, they don't have the problems with the aphids, or the thripps or the mites. Yet, we do on our side. So, we would watch the weather. Especially during the summer months when there was a lot of heat what I would do was I would watch. Because I know that's when the high population of pests come in, I would watch they would come in on the perimeter of the patch. And then what I would do is I would set up an overhead and I would stimulate rainfall, because when you have rainfall the aphids don't come, the thripps don't come and the mites don't come. So I feel in my opinion that it's more beneficial growing in a dryer area because you can simulate rainfall. Yeah you gotta deal with weeds but it's better that you don't lose a crop and you still can control the pests.
KT: Did you create that approach? Or was it someone….
C: No, I created that approach.
KT: That's a wonderful approach.
C: It's just through trial and error. And I would talk with people in the wetland and they told me we don't have problems like that unless they have a drought.
KT: Wow. What would you like young people to know about what you've learned concerning kalo or other plants?
C: I would like young people to know, number one: That our Kupuna took growing taro to another level.
KT: Describe that.
C: And the reason why I say that because I was fortunate enough to eat over 2000 varieties of taro. I've tasted taro from Tahiti, Samoa, Tonga, Vanuatu, Tonga from Nepal from Africa. So I've tried a lot of taro's and when you eat the Hawaiian taro's there's no comparison. So what they did was see back in the day.
KT: You need to come back and describe that statement, no comparison.
C: In regards to viscosity. See there's a way we classify taro when we have taste testing. The Hawaiian taro's the taste, the texture, the aroma everything. I mean everything about it is just at a way higher….
KT: That you weren't able to find any other.
C: I couldn't and I ate plenty taro from all over this world and it didn't even come close. And I got to pass that on to the researchers because they wouldn't eat the taro's so they would be guessing on what they should. You know like John Cho what he breeds with you know he doesn't eat the taro so I gave him a lot of insight you know what his breeding program and what not. Also, I want people to know to learn the different families of Hawaiian taros, learn how to identify it so when they pass it on they can pass on the correct information. Because what's been happening in the past, a lot of people are spreading taro around but they're giving them different names. So, you know that's

very common. But if they know how to identify it and we have a standard for them to measure against then they can confirm it for their own selves. And I feel that Hawaiian people need to know this and it's a shame because when I go to like old time farmers, Kupuna's like that you know. And I understand why. You know they have knowledge of maybe 2 or 3 taro's but I understand why because everybody, the Hawaiian people, they would grow a lot of different varieties of taro in a suggested area and then just pick up which one did well there and they stick with that. And that's why for example, Oluwalu the grew the Kumelele, that's popular over there. Hana they grew the Haupu'u. In different area's they grew the specific types of taros.
KT: What was popular in Kula?
C: In Kula it was the Ohe'. The Ohe taro because it was very resilient against the cold. However, because I had the chance to grow it all different elevations I find that the Maui Lehua, the Lehua Maoli, the Ele paio and I'm growing like about 18 different varieties now out here just to see which one adapts better. And I found that probably the best taro to grow in my opinion is the Lehua variety. Because it seems to do well down in the low regions as well as up in the high region. As well it does well in the wet areas, although it's susceptible to the leaf blithe like almost every other taro. But, I find it does well. I find in Kula the Lehua does well and it makes good poi as well as good table taro.
KT: The uh, Hanalei poi, what kind of poi are they using?
C: Well they try to get as much Lehua as they can but it's very difficult because there's such a high demand amongst the other millers. So, they definitely tried to use strictly a Lehua variety. Whether the Lehua Maoli, Lehua Palai'i, or the Maui Lehua they call it Kauai Lehua. You know different Lehua's. However, you see the difference between Hanalei poi's and the rest of the poi's is the way they handle it. It's the way they prepare it to making poi. What they do is that they remove the skin prior to cooking, so after it's cooked there's no handling, less bacteria on the poi. So after it's cooked it goes, directly after it's grinded, it goes directly to a container and from there directly into refrigeration. So you have no chance of it fermenting at all and you have no bacteria in it. That's why a lot of people say that. Some people say they like it because it stays fresh a long time. But then you find the Kupuna they don't like it because it doesn't sour. Now like my other friend in Kauai, Makoale, he grows it the old. He's a miller, he mills it the old way. He says his customers they want it to sour. So you know depending on your customers.
KT: So, somebody told me that Hanalei poi they put flour into. That's not the case?
C: No, that's not ok. What they do is if they can't get enough Lehua they blend it. They blend it with either a Moi or even some Palauan varieties.
KT: Just to stretch their product, huh?
C: Just to create a greater mass.
KT: You left what you were doing due to the end of a contract or you just wanted to move on to something else or?
C: Well, I've always wanted to do something to leave for my children to pick up. We were doing it and it was my wife and I and Kiana my youngest girl. It's very hard work and I got discouraged to tell you the truth. We had the market, I mean, what I did was I didn't go out and find the market. I created the market. I created my own market. And what I did was because nobody was growing the different varieties of Hawaiian taros, I started growing the different Hawaiian taros. And, what I was going to do was grow these different varieties of Hawaiian taro, get it out there on the market, give people a

chance to learn about it for one thing. And then give them a chance to taste different poi's. And what happened was it just my partnership with this guy in Kula fell through and we worked very hard to get it to a place where now I can get it to a market. I mean I couldn't supply the demand here on Maui, let alone Oahu. But I was just getting there; you know getting enough acreage to supply it. And what happened was just you know people get greedy.
KT: So the, where you were at the Ag park, everything was grubbed before you planted. You just didn't take the land and started planting. In other words the preparation or the soil gotta be at the point.
C: Well, this parcel that I was farming on, it was farmed before with onions and different veg crops. So when I came in with the taro, it grew very well because it was like first time growing a different crop in the soil, so it did very well. I did fertilize, and in regards to fertilizing- I'm not all against synthetic fertilizers but I do believe in an integrated approach. Like for example; if you're going to use a synthetic fertilizer okay to grow your crop, well now you gotta grow your soil. In other words you gotta go put back green manure crops in there, plow it in, you gotta build your soil so you can build up the beneficial microorganisms. Because synthetic fertilizers kill it. So it depends on how you deal with your soil. Because if you don't take care of your soil, and that's what's happening with a lot of the taro farmers. They not taking care of their soil. Now if you look at it the way our Kupuna's did it, they always did that. They would always grow the soil. Then grow the plant, and they would only plant in a specific plot at the very most 2 times. Because when you plant it the second time you're not going to get as great a yield. Because of course your nutrients have become less.
KT: So the University is going through this patent controversy. What's your take on that?
C: Well, what they're trying to do is patent the hybrids. I know one has been patented. He bred what you call the Palehua. It had pretty good results and I'm sure this is the one's they're trying to patent. Across, it's what we call number six and number nine varieties but what it is, is a brother and sister. The parents being a Lehua Maoli cross with a Niue Waula. That variety coming from the island of Niue. The variety is, the number six is very good although it has a high oxalis which makes it a little itchy. However it's a good yielder and it's not resistant to the leaf blithe but it's highly tolerant. Which is very beneficial to all the people who grow in wetland because they're getting wiped out. As far as it being patented I believe that the real reason that they want to patent it is to try and create more money to put more monies into the research for, to help the farmers. My, the way I feel about it is, I feel it's a good thing. You know I just talked to Pomaikai about this. But anyway I think it's a good thing and the reason being is because if we don't try and get some kind of hybrid out there, we're going to lose the industry. Okay, then people think, well the guy's only in it for commercial reasons. Well, maybe he is in it for commercial reasons but what about the end user, the consumer. What kind of prices is he going to pay. I mean it's already ridiculous. If we don't have some kind of plant out there that can produce a yield, the industry is going to do down. I mean rapidly because I mean I've been in fields, I've been on fields in Kauai, Keanae and Wailua and it's terrible. I mean the plants are…it's just taking a beating. It's like letting our people out there go and then a disease comes in, they get sick and we don't create some kind of inoculants. So, as far as that going out in the field and people

growing it, I think it's a good idea. As far as the patent, I wouldn't worry about it. The reason being because once you get a couple plants it compounds it's oha in a dramatic way where you don't even…. I mean, yeah you supposed to pay maybe one cents or two cents. I think Hawaiians should be exempt from any type of residual type of payment for what do you call that…or royalty. I mean I feel Hawaiian's should be. Because they used our variety anyway to cross it.

KT: What you think on GMO?

C: Okay, you know GMO in a broad space, I think it's dangerous. I know the University had to take a stance, a pro stance on it and you know they say that it has to go through so much tests with the EPA and this and that to even get into any type of GMO production. You have to have all these permits by the food and drug administration, the EPA and this and that. However, as we know in past nothing is a certainty. So, as far as a GMO product being produced and the pollen somehow getting in the air and maybe somehow inoculating another type of plant, uh, who's to say. It's just like, the way I see it, it's just like medicine that comes out in pill form and they give it to people for so many years and then they find out it's no good. Well, remember now from the start the food and drug said it was safe and so did the EPA, but they didn't find out till five years later that it was detrimental to the human body. Now on that take, that's the same thing that could happen with GMO altered plants. I'm not worried about the taro. The reason being. The reason being I'm not worried about the taro, number one ok; how different varieties came about in Hawaii is because long ago we had fly that pollinated the various taro's. However, that fly is now extinct. That's why if you understand how a taro plant, the flowering, it self's itself. In other words it's a female and a male but they both mature at different times. And you don't have the fly to transmit the pollen. Therefore only man can transmit it. So in that regard, I'm not worried about it pollinating our Hawaiian taro's. But, I don't think, as far as taro, I don't think we need to go that way. Dr. Cho's not going that way. I know because I've worked with him side by side, I know what he's doing. And what they do is, he uses GMO technology and what we do is…. For example I'll tell you. We go down to Fiji, we find this one taro. We found that it is totally resistant to the leaf blithe. So then what they do is they take tissue analysis and then they analyze it genetically, they look for specific markers in these varieties that are resistant. And then they try and find other taro plants that are resistant. And I mean resistant, not tolerant. And they try and look for other markers in here so they're try and identify which markers are they looking for and what they do is they'll take this plant and they'll breed it into another Hawaiian plant. When the babies come out, then they analyze this. They look to see if those markers are in there. What it does, it saves them time in hybridizing, in breeding. They're not genetically manipulating it but through hybridization they're manipulating it. Through natural process, really.
KT: So, what are some of the plants, the taro plants, you would suggest be considered in that area then?
C: Well, like I tell everybody. Number one, why are you growing it? I think you gotta answer that question first. Are you growing it commercially? Are you growing it for your family? You know that depends. Because then there's different growing techniques if you want to grow it for your family versus commercially. And it depends what is this

for. Is it for poi? Is it for Kulolo? Is it just for table taro? So that has, those questions have to be answered before I would suggest a taro. Now, because of the consumers…..ahh, I guess I could say ignorance of the different varieties out there and the different tastes. They're prone to lean to what they have known which is the red poi. Which is the Lehua variety, which does very well in that area. I, if I was to grow taro in that area again, I would grow Lehua. The reason being because the people who like to make Kulolo they want a red taro. The people who want to make poi want a red taro. The people who like table taro, they like the Lehua. And it makes good leaf for laulau's. So I would grow that variety if I was to grow any variety. And there's the old saying "Huli, is power." And you know what, that is true. Because I've run into so much people always looking huli. And if you don't have the amount of Huli, you know if you only got 10 then you only can sell….But if you have 10 thousand then you know. But you gotta start somewhere. And you know what's the saddest thing Kumu? Is these people that call me up every single year from Keanae and Wailua. And I mean every year they ask me for Huli. And I tell them every year, "What happened to the ten thousand I gave you last year? What happened to it?" They tell me, "well, uh.." Well, it's the same old story. Because they don't take care their land, their 'aina, it doesn't take care of their plants. So that's why they have either weak huli or sick huli. But I tell them, "You guys have to dedicate couple patches for just huli. You just dry land it. Because then you're not going have, well you may have the leaf blithe problem but you won't have the pocket rot." But at least when you dry land it, the huli, the oha comes out healthier. Why I don't know but I just know it is. And that's why they kept on calling me because I would grow it from the dry land and it would be huge. So when you got a bigger huli and you put it in the ground, it's easier for it to take. It's easier for it to grow and everything.
KT: Now I have something to show you…..pictures…..

## *Interview: Henry Rice*

**By Keli'i Tau'ā/ Kimokeo Kapahulehua**
**November 2, 2006**

***Interviewer= KT- Keli'i Tau'ā and Consultant= C***

KT- Cultural assessment comes through the Governor's office, back a couple of Governor's, who saw the concern of many of the cultural sites being lost by development; bulldozing and so forth. So, what they put, not into law, but they put a statement within the developing process that the developing company's need to consider having a cultural assessment done on their property. Because, if it was found that there were some major sites on their property and they didn't follow the process, then they could be sued big time and that's why this activity has come to for. My partner and I, who your son-in-law knows very well because of our assistance in blessing his property that they're developing, and because we're locals, we're Hawaiian, we grew on the land it was recommended why don't we go do it then to have mainlander's come in and do something just because they know how to write. So, that's the idea of it so we're just rookies. We're just about one year young in doing this and I thoroughly enjoy because my lifetime has been always in Hawaiian Cultural things and my education is leaning toward the culture so having the opportunity to walk the land, and like I said, today I have privy to talking to somebody who was raised on Kaono'ulu Ranch, which I never was aware of. I knew all, you know, like I said I knew where your family house was and Kikiwi's because this was my stomping grounds but nothing about the Ranch. So that is my- can you give me background of you first, age, just personal stuff that I can document? Oh, by the way, before you start what we're going to do is whatever you say, we'll transcribe, bring it back and you will look it over and edit. And if you approve then we'll submit it as part of our report.
C- Um hmm, no problem.
KT- So, with that in mind.
C- Well, like yourself I was born in the Kula hospital too, about 68 years ago.
KT- How many sibilings?
C- We have a son and a daughter and three grandchildren.

KT- But, your brothers and sisters.
C- I have one brother that lives on the Big Island, Hawaii.
KT- That's the one that's really been shooting stuff like in Hawaiian rights and so forth, is he the one?
C- No, I think that's the wrong way to put it. He's probably as Hawaiian as I am and he did not believe that OHA Trustee's should only be elected by Hawaiians. He felt that anybody who was born and raised in Hawaii, grew up as an American citizen, should have the right to vote for an OHA Trustee.
KT- So that's what's happening in this upcoming election.
C- Yeah. He's not shooting barbs at Hawaiians, it's just the opposite.
KT- See, misunderstanding of communication.
C- I think so.
KT- Yeah, so when my partner says we're going to interview you I thought, 'is that the family?' I knew the family and went ohh; it was a challenge to get out of my ignorance and my shell and see that it is beyond as you described doing my homework to find out why the statement was made.
C- I think, and he's a very good studier of Hawaiian language and if you understand what OHA stands for to the Hawaiians and the Hawaiian people here and the language, you'll see that what he did was according to Hawaiian language.
KT- Now that you tell me that, if you can give me his phone number I want to call him and tell him how I felt before and how I feel now, just from your explanation. My relationship with Doug …
C- His- he's got a little ranch on the Big Island.
KT- In the Waimea area?
C-The Waimea area and he probably can best be reached on his cell phone because he's probably on top of his horse.
KT- And he's your elder brother?
C- Yes, he's an older brother.
KT- And he's Oskie?
C- No, Oskie is our father, Oskie Rice is our father. His name is Freddy Rice.
KT- Freddy, okay, so both of you grew up on the ranch?
C- That's correct, yes.
KT- And dad was into ranching?
C- Uh, yes, actually my grandfather, which was Harold W. Rice, he purchased the whole ahupua'a of Kaonoulu from mountain to ocean from the Cornwell family.
KT- What year was this?
C- About 1915, almost 1916-1915.
KT- During the World War.
C- Yeah, umm hmm, right and I can show you on a map here.
KT- May I take pictures as you show me things?
C- This is the, you can get a feel, this was the original ahupua'a here when the top of the mountain going down into the ocean including the fish pond over here.
KT- Which is Kalepolepo.
C- That's correct. And it also included the Alae 1 and 2 and Koheo 1 and 2.
KT- Can you put your hand on where it starts again?

C- From here to the top of the mountain to the ocean. So, that and the ranch has stayed pretty much in tact in the family. My father, which is Oskie Rice, carried on after- actually my father and my uncle Garfield King purchased the ranch and brought it into a corporation in the early 1980's. Well, actually they brought it into a corporation in the latter, I'm sorry, in the latter 50's and then in the early 80's the ranch became a family limited partnership and from there I've run the operations.
KT- So, before I get too far into it, your full name is?
C- Henry F. Rice.
KT- What does the F stand for?
C- Flower.
KT- Who gave you the name mom or dad?
C- Both of them gave me my name.
KT- Why did they look at you as being a flower? Because I, you know as a student of Hawaiian culture I understand kaona, hidden meaning, what were they?
C- Flower is my mother's maiden name.
KT- No relevance if you don't know the background and you're going to say, "What's this male having a name of flower?" Okay, so you are how old?
C- Sixty-eight.
KT- So, you're my Kupuna. So, growing up in a family with a ranch, it's almost like growing up on a horse.
C- Yeah.
KT- So you're first moving transportation was like mom putting you on the horse your dad had simply put it.
C- Yeah, we rode a lot.
KT- So, did it become your passion or it was work?
C- It's a passion. It's a way of life. It's a quality of life.
KT- At its highest peak, how many cowboys did you folks hire?
C- At its highest peak, I would say there may have been 30 or more.
KT- Because of the expanse of area, not the entire area was pasture? Of course you could be grazing through the entire ahupua'a but…
C- I think the majority of the ahupua'a was in grazing but since then we've diversified a little. Down in the area that you're interested in, at one time we had a small piggery and a small farm there where the Maui Lu Hotel is.
KT- What was the farming in?
C- We tried everything from cucumbers to melons. Since then the ranch has three farms now but they're up here in the Kula area where farming had prevailed years before it became grazing land.
KT- So what are the crops up here?
C- Uh, well, we have a lavender farm up on our ranch which is Ali'i Changs and he runs that. And we have a hydroponics lettuce farm right below his lavender farm. And then we have a pretty large farming operation right below the Kula Rice Park where we grow corn, strawberries, zucchinis, onions; that's primarily what we grow there.
KT- And you oversee that?
C- That is run by a family that's farmed up here in Kula, they do the farming there.
KT- How many employees do they have?

C- I'm not sure how many he has but most of them are contracts that help on the farm but this has nothing to do with the area you're interested in.
KT- Yeah, but as I said my report will probably cover all the way up here because of how it affects.
C- Sure, well I can see your reasoning because our forefathers before us did the farming up here and the fishing down there and the lands in between were really traveled.
KT- Right. Now, so you've pretty much have ridden your entire ahupua'a; you yourself.
C- Yes.
KT- During the course of riding that area, did you see any cultural significant places that have been documented on the national sites that should be set up?
C- I don't know whether there are any significant that are on the national sites but, you know, if you travel the land, you know it, you'll see where old stone walls, when they were built and you'll see what we call holding pens where obviously as they traveled between the highlands to the lowlands kept the, they were camp sites, they kept animals caves.
KT- Yeah, I was just telling your son-in-law that it's ironic that we've had the opportunity to do this because we did for Charlie Jenks, it was called Kula 1800 I think you folks have some land…
C- Right adjacent to it, yes.
KT- So I was amazed at the petroglyphs that were found and I'm a student of Japanese culture too so in taking pictures of the petroglyphs in close proximity was this Japanese writing which translated with a name, I think it was Ito, which means Big Japan. And the name, but I was amazed and so getting back to being a cultural person of course our forefathers ran the logs down whether it was Koa or Iliahi to get to the ocean to ship and so forth. So, historically it's exciting to be there and looking at all of it.
C- Were those petroglyphs on movable stones?
KT- Well, it was along the revine and in shallow caves, just along the cliff side.
C- We see from time to time petroglyphs but they're on movable stones and they're most from Hawaiians before me telling me they're mostly where maybe the family rested while the man went down to catch the fish and he or she just doodled on the stones. Funny thing is, though, they used them also as they're markers facing where the best fishing was so that when they came down the following year they would see their marked stones. And if you walked the direct line to what it was facing it was pretty good throw-netting.
KT- So, as far as the ocean is concerned, you folks had access to the whole thing; were you active in fishing and things too or you just focused on being with the land?
C- No, our family, well our family's always been active in fishing too but not so much off of our land. By the time we were aware of, say the fishpond down at the bottom, it had pretty much deteriorated.
KT- Right.
C- But from listening to our older cowboys when they had the cowboy camp down more in the middle of the ranch, they would go down there and actively take care of the fishpond and fish in it, but those days are before my time.
KT- What did the camp consist of?
C- Just houses and stables and pens.
KT- Just living quarters.

C- Yeah, and working areas.
KT- So, did you folks ever diversify into other kinds of animals outside of pipi?
C- Pigs, we did a lot of pig raising at one time.
KT- Where abouts did that happen, up here?
C- First big pig operation was down where the Maui Lu Hotel is. Then we moved the piggery up to Makawao, we have quite a number of acres in Makawao; above Makawao.
KT- All right, even now?
C- Yes.
KT- So, can you share some of the stories some of the cowboys used to talk about that intrigued you or made an imprint in the life before your adult life. Anything significant that would contribute to the reader of this report that we're seeing a significance of these kinds of things.
C- Well, I guess as far as the land or the stewardship of the land, I think our family is- Whenever you raise animals off of the land, you begin to understand that it's the land that's the asset that you take care of and the grasses; New grasses, cultivating some of the old grasses. The animal is only the end product of how good you take care of the land and so I think when you listen to older people and our older cowboys, they had a great respect about that.
KT- But they didn't do anything about it, right?
C- I think what you'll find is no, they depended on, of course, nature and the rains like what is happening right now, which is beautiful. But where they saw better grasses, they would bring in seed our lands with the better grasses. And so you have a lot of diversity of good grasses that can withstand drought better and flourish a lot better during the rainy season. And that always impressed us as we were growing up.
KT- Well, personally, again being a student, I'm just enthralled of what our forefathers knew how they took care of what you're saying. And so that phrase that became more predominant during the preoccupying of Kahoolawe, which is Malama ka 'Aina, just is exactly what they were doing before that phrase came up but Kahoolawe they brought it up more.
C- Sure, oh yeah.
KT- So, even presently now, how many cowboys do you have employed?
C- Actually under the Ranch we have three. The rest are outside the employment of the ranch.
KT- How does that work?
C- Other people come in and, say like our farming operations, they're the employees of the farmer who's doing the farming.
KT- Okay.
C- That way we keep- it's very expensive to have a lot of employees today.
KT- Right. Where do you market your products?
C- The farming operations, everything is marketed on Maui; everything is locally. The hydroponics lettuce is a great demand for the visitor industry and now we're beginning to find out the local markets are really liking it. And of course the corn and the onions and the strawberries are all locally sold. Our cattle operation, all our beef, is shipped to the mainland after we wean them off the mothers; they're sent to the mainland for pastures there and then eventually the distribution of the beef on the mainland. Very little is

marketed locally. I should also say the ranch also has a land company, I forgot, which is another source of its income.
KT- You said Kaono'ulu Ranch is a Corporation.
C- Now it's a family limited partnership. It went from a proprietorship to a corporation to a family limited partnership.
KT- I was just thinking of all the diversification if you were making a decision for everything that goes on, it would be challenging to keep in order.
C- Well, I think the challenge today is the stewardship of the land and keeping the land from one generation, moving it to another generation to another generation without having it split up.
KT- Did you go away to college?
C- Yes, I went to grade school here on Maui.
KT- Kealahou?
C- No, I went to Kaunoa School.
KT- Where is Kaunoa?
C- Well, Kaunoa now is a Senior Citizen area.
KT- Oh, down there, okay.
C- My family says I started out there and I'll probably end up there.
KT- I don't know if that's a good or bad thing.
C- Then I went to Oahu for High School.
C- And then I went to the mainland for college and then came back to Hawaii.
KT- What did you study when you went to college?
C- I studied, I majored in animal husbandry and business financing.
KT- What school was that?
C- Colorado.
KT- Colorado State?
C- Yeah, Colorado State.
KT- So the intent of studying that is because you grew up in the, of course the interest that you would come back and continue your work.
C- Yeah but it's a nice compliment when you say you really didn't know where Kaonoulu was because we are a very low key family.
KT- Well, I'm embarrassed.
C- Don't be, it's a compliment.
KT- Well, my peers look at me that I should know these different life activities on this island but when I first was told it, where is that? So, yes, evidently you folks kept it very low key under the shelf there, type of operation. But what is shocking is for your finger to go from where it started all the way down there. You never looked at other ranching companies as competition?
C- No. No because they were all family.
KT- Erdman's?
C- Well, before the Erdman's it was the Baldwin's. They were on that side and of course the Baldwin's had Haleakala Ranch on that side; two different brother's but my grandmother was a Baldwin too. She was their sole sister.
KT- Ohh, is Rice a missionary family?
C- Yeah. Predominantly grew up on the island of Kauai but my grandfather came over here to work where he met his bride, Mrs. Baldwin, Charlotte Baldwin.

KT- Indirectly the Baldwin's have a big influence with my genealogical line. As you grew up and watched Maui evolve into what we are today, what are some of the precious things you would hope that we would continue retaining and use it?
C- Well, I think you'll appreciate it because you're a study of Hawaiian culture and Hawaiiana and we use, we sometimes use the phrase "The aloha spirit" a little loosely but in the true meaning of it all I think that's the most precious thing I hope we never lose between two individuals. I think there's a- I think the years ahead are going to be big challenges with respect to that kind of spirit being retained and I think it's the people, the Hawaiians (us who were born and raised here) it's our obligation to make sure that that does not, that that spirit is not lost as you get more people moving to Hawaii and doing business in Hawaii. So that's a big challenge. The other big challenge you're going to be facing is the natural resources of these islands and how you, the stewardship of them, and how they're maintained and how they're going to be integrated into the growth that you see happening; whether it's big farming and small farming or water or so forth. Those are big challenges ahead of them.
KT- Right. So, how many of the events of yesteryear can you recall now? Just a couple of Sunday's ago we had a major activity that shook up the entire archipelago but can you go back further? Can you remember the tidal wave?
C- Oh sure, I think all of us, at least that are my age, remember the 1946 tidal wave.
KT- Where were you?
C- I was riding down on the school bus from Makawao to Paia. (Laughing) So the police officer stopped the bus and said that the school had been washed down so we all cheered. We didn't have to go to school. (Laughter)
KT- Was it the same Paia School?
C- Kaunoa School, yeah. But then you know, afterwards going around with our father and seeing the, seeing how devastated the area was; I mean huge buildings being moved, you just, you know as small children, you couldn't imagine that the ocean had that much power. It certainly gave us a lot of respect for the ocean.
KT- So on your ahupua'a, no particular damage?
C- A little, like the fishpond and then it came in a little on the piggery operation but that side of the island didn't get as hard hit as our north shore did. It seemed like, I know the old Kihei Pier but it was already old.
KT- Where was that exactly, Kihei Pier?
C- Right across from Suda Store.
KT- Suda Store, okay; where the canoe club is.
C- Right, right.
KT- So, you folks used to go down there and jump off and play in that particular area?
C- Yeah.
KT- What can you recall was shipped in there?
C- Actually I can't recall anything being shipped in there because by then Maalaea Harbor was operating and I only remember that old Kihei Pier being used by the military from time to time. But I don't ever remember any commerce shipping being done out of there.
KT- Because you folks had animals, you could be mobile riding around a large area. A lot of the Hawaiian families tell me during their childhood their neighborhoods were far

so whenever they got together they had to make up their own games and so did you see your family creating anything?
C- I'm not sure creating anything but, yeah you had to make up your own games, right. Yeah we made up our own games.
KT- Like what?
C- Sometimes we would go to the movies and see a cowboy movie and so we had imitate cowboys and Indians riding the horses all over the ranch. But then a lot of times you did a lot of roping and things of that nature.
KT- A cowboy is a little different from other families I see because you got to work with animals. So, did your brother also go to college?
C- Oh yes.
KT- What was his field of study?
C- Same as mine. He majored in agriculture.
KT- Same college?
C- No, no he went first to New Mexico Military Institute and then he went to Cornell and majored in agriculture. He came back to Maui, worked for a short time on Grove Ranch.
KT- Grove Ranch, now you gotta describe, that's a new name for me.
C- Grove Ranch was part of HC&S.
KT- Oh, okay.
C- The lands that they didn't have in sugar cane, they raised cattle.
KT- Where was that located?
C- Below Makawao was their camp. And then he went to the Big Island and he managed Kahuku Ranch for many years and then for a brief period Freddy did commercial fishing, charter fishing outside of Kona.
KT- Is he younger or older than you?
C- He is older. And then after that he came back to the land and has been cattle ranching ever since.
KT- I think that it might be true that if it's in your skin you'll always get back to that.
C- I think so, I think so, yeah.
KT- So even today you folks…
C- He would be an interesting person for you to meet some day. He's a very astute in his Hawaiian language; speaks the old way.
KT- What made him interested in diving into the Hawaiian language and culture?
C- I think we've always-once you've been raised around the Kikiwi's, the Aweloa's, the Earnest Morten's; they all spoke Hawaiian, there's a natural. After you get older, to go back into really understanding what you're only listening to when you were young; it's a natural I think.
KT- Yeah. So, even those families that you mentioned, their offspring continued being cowboys?
C- Yes, one of our cowboys, Ricky Kikiwi, is a third generation. His grandfather, which is right above your head, which is Hua Kikiwi and his father was foreman over at Ulupalakua Ranch, Merton Kikiwi.
KT- Merton was his father?
C- Mmmhmm. Merton grew up on this ranch too. The person just to the left of Hua in the cowboy hat, right there right ahead of you by the door, that's Harry Aweloa who was

at one time the (in his retired years) was the pastor down at the Makena Church where Reverend Alika is now. That's me riding a bull.
KT- Where was this located?
C- Makawao.
KT- Where the…
C-Arena is now.
KT- And this was?
C- Wiliki; Wiliki Poepoe
KT- And?
C- That's Oskie Rice.
KT- Who is this here?
C- That's my brother Freddy Rice. He's still a very good roper. Over there in the corner is probably our most famous person, Earnest Morten.
KT- Right here?
C- Big family up in Kula.
KT- Describe him when you use the words famous. Why do you say that?
C- He's famous in my mind. (Laughing)
KT- Describe it from your perspective; to you why is he?
C- Well, he was foreman of this ranch for over fifty years. Born and raised up here in Kula; went to Lahainaluna where he boarded. In those days when you went to Lahainaluna, you stayed in Lahaina. He came back, here's another picture of him right there, he was a very, very, very strong personality. He could do everything. He could, he knew how to work with rawhide better than anybody I ever knew. We never had to call a veterinarian because he was a doctor in his own right.
KT- Which he just developed out of interest?
C- Uh huh.
KT- Nobody taught him?
C- Right. He, oh that's my old saddle; Hawaiian tree saddle. I had a replica of that tree made out of fiberglass and covered the same way and it's a lot lighter to saddle. As you get older those old saddles get heavier and heavier. So I had a lighter one made but covered the same way with the wilia moku and everything on top.
KT- And who made the ropes for you?
C- I have a rope from Earnest Morten and Henry Silva; the two skin ropes I really have, yeah. That particular rawhide rope is not a Hawaiian weave. It's a Espanola weave.
KT- So it's not locally made?
C- That on there is not locally made.
KT- This one?
C- Yeah. The crack whip is locally made, everything else is locally made but that's the old- I have that raw hide rope because it probably was the old, old way that raw hide ropes were made here in Hawaii. But, in later years the Hawaiian raw hide ropes that were made were a little thicker in order to handle the roping of wild cattle.
KT- Did you ever see it snap?
C- Oh, I've seen it snap.
KT- Really?
C- Once actually, but I think it was more my error than the rope's error.

KT- When I watched Henry putting it together; nothing can break it so it's a surprise for you to say that.
C- Well, mine was my error why it snapped. I had it on a sharp edge pulling it, pulling a steer onto a truck so you have to be; that was my fault. Those raw hide ropes would never break with an animal.
KT- So it kind of got caught rather than…
C- Yeah. What are we taking a picture of?
KT- The skull.
C- Oh, yeah. That too is a pretty heavy instrument, oxens, the yoke. That's what they lead the wild bulls down the mountain with. You'd have an oxen on one yoke and you'd have the wild bull on the other yoke and the oxen lead the bull down the mountain.
KT- So, that whole idea had to be, was it developed locally or did somebody go learn it from elsewhere?
C- Well, I think our history, you know what we; the Spaniards really came over and taught the Hawaiian's how to work the cattle; the Mexican Espanols.
KT- You think this was part of the teachings?
C- Yeah.
KT- Who, can you recall, who commissioned the Espanols to come and do this teaching to the Hawaiians?
C- Kamehameha.
KT- Thanks for helping me with that.
C- Vancouver brought the first cattle here, you know, and then they grew up on and then they got wild, too much in numbers and so…
KT- Just like the deer, you got any comments about what's happening with the flocks of deer? They're roaming your whole property.
C- Yeah, they are, they are. I don't see that much devastation by the deer so I'm not as concerned as other people are. Hunting keeps the numbers down. I think where the concern is, is down in Wailea where the deer goes and eats somebody's roses but on the Ranch I'm not too concerned. They're kinda nice to see once and a while.
KT- They're really getting, for lack of a better word, domesticated because we were driving to South Malu'aka researching writing for Dowling Company on the old Makena School and I swear 40 of them came across the road. We had to stop while they were crossing so I'm sure you have those large herds on your property.
C- Yeah, we have some.
KT- Any other wild animals on your property at this time? Not too many pigs are there?
C- Not that much but we have a few wild pigs. They mainly stay up in the waddle forest. We have a few down here but below the Kula Highway we have a few but that's it, deer and pigs. There are no wild goats anymore.
KT- Why is that?
C- I think they got hunted out.
KT- In your ahupua'a? I still see they're existing in…
C- Oh, over in Kipahulu and Kanaio; beyond Kanaio and into Kahikinui and Manawainui and over in Nu'u and yeah they're still over there.
KT- I guess the land is a little wilder than over here.
C- A little more tarried on the bottom but if you go mauka of Kanaio and you go in the mauka section of that side of the island it's pretty nice I think.

KT- So get back to your childhood days; did dad personally work with you folks of cowboy or just called the cowboy and said, "Hey teach my son, do this."
C- Oh no, my father worked with us every day; he was on the ranch every day.
KT- What was his major focus, cowboy, or ranching?
C- He was a cowboy.
KT- Born cowboy or became cowboy?
C- Born cowboy.
KT- Not in Hawaii?
C- My father? Yes.
KT- Started in Hawaii? Passed down from his father?
C- My grandfather had purchased the ranch. My father was a very, very young person so he grew up on the ranch. I have a picture of him somewhere; oh it's in my house. So he was a, he was very much a cowboy.
KT- As you pointed out, since it's a family limited ownership now, are you encouraging those in the family to carry on whatever it necessitates?
C- Oh, yeah.
KT- Well, it's so diversified, there's much interest in areas people could cover.
C- Oh no, our next generation's very much interested in the ranch. So yes, we're very lucky we have the next generation is a very large group and so we have many, many smart people that are ready to keep the stewardship of the land in tact.
KT- Ah, wonderful. So, on the bottom side, it basically was sold off like Maui Lu?
C- Ah yes, that was that beginning of what we call our Land Company. A lot of the properties down there have been sold and then we repurchased properties, commercial properties, on the mainland. So we have a Land Company with commercial properties on the mainland.
KT- So, Doug and your daughter had to go buy their piece of land what they're developing next to the Tech Park.
C- Yeah that really is a group out of Minneapolis where Doug is from and Doug's brother-in-law is part of the group that's developing that. And of course because Doug lives here on Maui, he helps kind of coordinate the Minneapolis office with the Hawaii office. My daughter is in real estate business herself.
KT- So it worked out well for them to…
C- So she's helping in the sale of; once those housing lots are developed I believe she's coordinating the selling of the lots. But she works for an independent realty firm.
KT- You keep mentioning your brother but you never took interest in the language per say?
C- I have a very keen interest in the language but I'm certainly not as fluent as my brother is.
KT- And he got it just by hanging around the cowboys?
C- Well, I think he worked at it in his later years; studied it. I think we all had it when we were young, just being around the cowboys, but that's cowboy Hawaiian language.
KT- Which is a whole culture in itself.
C- Oh yes, true.
KT- People who never get close to any of the people that work with cattle never get to realize the culture that is developed within the cowboys itself.
C- Yeah.

KT- No sugar cane on your property?
C- No. No sugar cane on our property.
KT- In fact, no pineapple; they stopped as they came close to you.
C- Right.
KT- And from your land going makai, it basically was exclusive ranching.
C- Yeah.
KT- Modern day uses.
C- Right.
KT- So we would never have seen any need for railroads to come onto your property?
C- No.
KT- All that part of Hawaii, Maui development stopped right at- so none of those business that had been prevalent on the opposite side of the land, there wasn't any need for those vehicles like the trains?
C- Right.
KT- They came out to Puunene pretty close to Suda Store and stopped right there.
C- Yeah, right.
KT- So, in some ways was it a victory that you stopped all of this?
C- No, no. You know I think your fertile lands got the sugar cane and the pineapple. Your non-fertile-arid lands, you'll find mostly in ranching.
KT- Well, that's what they say about Hawaiian Homelands; wasn't in the fertile areas they got. They saying all the junk land was thrown to the Hawaiians.
C- Where the Hawaiian Homelands are now, I would say from the topography standpoint, very hard to farm; but from fertile lands, it is very, very fertile. Some of our best pastures were over in their Koheo section, in their Waihuli section; probably the best soil, very strong soil. So, those homesteaders, especially in the Waihuli area and Koheo and Paupena in the Paupena sections where the homes are now are some very strong soils. We had great pastures over there. It's just rocky so it was very hard to bring into farming but for small farming they're going to be very, very well off.
KT- Just a couple of months or two ago I…
C- I would also add, as you are a student of Hawaiian culture, just walking those lands over there (especially the Paupena area and the Waihuli area) you will find a lot of Hawaiiana sites. I hope they keep them.
KT- Well, that's the intent. If you were to make a comparison there's no way close to your folks' ahupua'a in terms of cultural sites?
C- I would say it would appear to me that there was a heavier population in the Keokea, Waihuli and Paupena area than there was in this particular area; just from riding it. I don't know why, I would think the only reason I can see is that the land is so strong over there.
KT- So it's kinda ironic that the agriculture is done over there rather than over there.
C- Uh, because of the water being brought over from the Hana area over into the central valley, the strong soil and more level land; to have a large farming operation over in the rocky area and steep, pretty hard. So topography, I think, played a big role in your farming; the sugar cane and pineapple over there versus over here.
KT- As I drive the Waiohuli Homesteads I do recognize the face value just driving through the neighborhood, wow how beautiful; things area growing, just flourishing.
C- Yeah.

KT- So you just gave the key why.
C- So, I would turn around your statement and say I think the kingdom was pretty smart in giving the Hawaiians some strong properties.
KT- Well, it wasn't my statement. I'm just repeating what those have privy to… Well, Kahikinui is pretty rugged area, that's homestead land. I think, well you've had some cowboys by the name of….
C- In ten or fifteen minutes I'm going to have to go to another meeting. I didn't know it was going to be this long.
KT- Okay, so, let's look at summarizing then. If you had a wand, what would you like to see retained?
C- Me personally? I'd two stronger knees probably.
KT- Okay, going to what we're talking about in terms of the land and the islands; how we're affecting the people outside of the aloha.
C- Oh, that's a hard question. I don't know if I have an answer to that one. I think it's only natural that you wish things were slower like they used to be but then on the other hand I think that's only a natural feeling for a person as he gets older. I think the younger people want to see the growth and the opportunities and you have to understand that and respect that also. So, if I had a magic wand I don't know what I would do. That's a tough question.
KT- From an outsider looking at what you've experienced in life, I'm in admiration that you had the opportunity to do all the things that you've done.
C- Oh I'm a very lucky person, yes. Yeah, I think quite frankly anybody who is born and raised in Hawaii is a very lucky person.
KT- I want to take that idea because many are looking at themselves and they are saddened at life's challenges.
C- All you have to do is look around and see how beautiful this place is.
KT- But you can make a comparison. They don't know that. Well, I don't want you to have to rush to the next meeting. I certainly appreciate you taking the time.
C- Well, it's been a pleasure. Now do you and a partner and you have a business that you're doing this?
KT- I will give you a card.
C- You do have a card. Can I take off this microphone?
KT- Yes you can.
C- Oh good.

## *Interview: Henry Silva*

**By Keli'i Tau'a and Kimokeo Kapahulehua**
**January 7, 2006**

***Interviewers= KT/KK Consultant=C and Jody Silva (daughter) =J***

KT: So can you give me your full name.
C: Henry Silva
KT: How old are you?
C: Seventy
KT: We're sitting, in what is this place called?
C: Waiakoa
KT: You grew up here?
C: No, I grew up in Makawao.
KT: How long have you been living here?
C: Too long! Ah, forty five years.
KT: Forty five years. And you raised your lovely daughter and the rest of your children?
C: My son is older, she's younger. She's the spoiled one.
KT: They usually are, the girls.
C: Yeah, they're spoiled.
KT: Yeah, your dad, never spank. They know how to take everything. Where did you go to school?
C: Makawao Elementary.
KT: And then?
C: Then from there went to Hamakuapoko High School. And then…
KT: Which was, Maui High?
C: Yeah, Maui High. And then from there I went to MCC became a carpenter by trade.
KT: Oh, all that time your parents or your family was into Paniolo?
C: No my dad worked for the federal government. In the Haleakala National park. My brother Tony worked there too, my brother-in law Mike Pszyk, and my brother-in law Lionel Amoral and my brother-in law Lawrence Diego they all worked up there.

KT: Ok.
C: But I worked as a carpenter. We worked in Lahainaluna. We build our auto shop, machine shop, cafeteria there with Yoshimuri Contractor and Kinka Yamamoto. I don't know if you ever heard that name?
KT: Heard the name, yeah.
C: Heard the name. Yes both. So we were working there. I work with my brother- in law, Lawrence and that time we didn't have cars yet. You know, that I would drive. I got started driving when I was only 27 years old. Just little bit before that so then we got the license. Before you had to be 21 years of age, now they get 15 years they crackin' em up all over the road.
KT: Even before that!
C: So we had to catch ride you know.
KT: Yeah, yeah, yeah.
C: Then we would go down to Yoshimuri contractors and they would put us just like in the big cattle truck, like the old HC&S before had all the seats. And they would load us like that and we would go Lahaina on the old road now, you know, go like that. Take about one hour from Kahului you know, to go there and work.
KT: And yet, we still complaining.
C: Yeah! And then after that we go through to the Lahaina side I came to Wailuku Elementary and I work in Wailuku Elementary with Kika Yamamoto and Yoshimuri together the both of them I guess.
KT: So how did you get interested in cowboy stuff?
C: I always was interested in cowboy stuff but my mom and dad didn't want me to become a cowboy. And it's really hard for change, you know. See my dad never drove a car and my mom in their life. We all rode horse, all my sisters and us boys, we all rode horse. So after that we got through with Wailuku Elementary, I went too, I don't know if you know CK's, Tasty Crust, and Hale Lava.
KT: Yes, yes.
C: I worked on those buildings there. And then I came into Maui Land and Pine and I worked Maui Land and Pine and at times I worked in the field as planting pineapple.
KT: How old were you then?
C: I was about twenty three, twenty two around there. After I got into the pineapple and I did horse shoeing all my years, right to now and I still do a lot of horse shoeing. Mrs. Richard Baldwin took me from Maui Pine and called me if I would go and shoe horses in Honolulu. At that time was just when I was going get into Maui Pine real steady see. So I go down and the last time I went down was the same way, she took me out for about three months or so and I would go down and shoe horses. Honolulu for polo and then we start up here in Maui first and then we went Honolulu. Ok, I running my mouth- he went down, that's fine. And then we went down to Sprecklesville and we would ride the horses, those days you would ride the horses to the polo fields. I used to ride from Kapiolani Stable to the stadium for play polo.
KT: Wow!
C: Yeah, and we would ride from the barge up to Waikiki only had houses on the right side if coming up, going down only on the left side. This side of Waikiki was all swamps like Kanaha pond, yeah.

KT: So, let's fast forward, come back to Maui. What were you doing in that same kind of farm work stuff on cowboys that you can relate to?
C: So then after Maui Pine the Union came in and they said they was going get rid of the last hired employees hired on Maui Land and Pine. That time was called Haleakala Pine, I think it was yeah. And then from there I said well shucks they gonna throw us out I going get this job so I got this job from Elmer Carvalho as working in Maui Factors Ranch. And then from there I worked for them fifteen years on top Maalaea mountain and I worked on Kahikinui and then I quit them.
KT: What were you doing out there?
C: Any kind of job, fix fence, cowboy, rope, horse shoeing everything.
KT: Wow. While you were out there um, any things Hawaiian that you can relate to us.
C: Yeah, well I had a old friend Jim Hapakuka from Ulupalakua Ranch. I gave him a lot of hides. He was a real good hide braider, the same thing that I do. He always told me this story that he and his dad used to tell. The dad used to tell him have a canoe on the cliffs of the ocean, a big long canoe. And uh, when they would go fishing they would have another canoe way up almost on the-well that time was trails, no was roads up there now have the car road, but way up far up on the horse trail. So in the years I was working cattle and on the ranch there I found that canoe. But Jim always told me had one in the ocean but I never, me I'm not an ocean man. I like ground underneath, I no like water. Water is only to drink and take a shower, other than that that tub gotta be open. So I found a canoe on the top not far from the road. Almost perfect, I have the pictures. So I had this friend of mine and Steven Perreria was our boss and Steven tell go get that bull go rope that wild bull because we brought em down from the mountain to the road, no let em go back up you know. So, this friend of mine, Alan Silva he used to work for the fire department, in fact he had one uncle Ren Silva.
KT: Yeah.
C: Ok, that's his nephew and we worked together. He was a good cowboy that bugga. And we was chasing this dumb bull, him and I and my horse went jump this round hole about this big, he jumped the hole that's why I told Alan. " I going go rope the bull and then you come back help me. But you go push stones around that hole because the hole you know just on the ground." The bull had jump over and I came with the horse. Lucky the horse watching, we had good horses too. So I went there I rope the bull then he came by me, oh, he couldn't talk. He couldn't talk, I say, "what's the matter with you?" So he jump down he tie the bull on the tree. Come back to me all pale. I say "what's the matter?" "There, right there, I see one canoe in one hole." I tell, "no way!" He tell me, "yeah come, come, come." So we go back. From on top we look like that, yeah can see in em. Just one piece maybe about that much of the canoe yeah. So I think she was small yeah. He was just about to get married to this lady. So, ok we decided oh, make lunch everything we go walk down from the road cause cannot go the truck there with stones and all that. So we walk down and we got to the canoe and we took pictures and all that and we kept it, we no tell nobody cause we no want them go fool around the canoe. So after all those years went by never went back more there but I can go back there now I know the spot. And, we found the canoe we took pictures we kept our mouth shut we no tell nobody because we never want people go mess up the canoe. Cause you know how people is, they going try bring 'em outside and all that. Was, eh, was one long canoe you know might be from here to the corner from the house. Was big!

KT: You went down there?
C: I carry her on top here, the shoulder yeah, she was small. And, uh, so we took pictures and all and after about a year after that you know that always kept in my mind you know that Jim told me get one canoe in the ocean cliff. So I was crazy guy and my wife's uncle Steven and my father-in-law we was all crazy anyway. We drove these big bunch of goates and they went down and they saw one and they go down but. So my father went get the idea we join two ropes and I go down on the rope and he hold me by the stomach so I went down and I was scared you know going down. But all of a sudden I started going down the darn cliff yeah, just like noose like this here! The ocean down and I cannot swim. That's why I don't like the ocean.
KT: And you still went go!
C: I went down on the rope like that and we caught about fifteen or twenty goats over there. And then I jerked the rope and my father pull me up with the horse. When I went down the goats was, had the canoe. This is down by the ocean. It's about maybe about a mile different Jim would tell me they would carry the canoe and they would stand one on top the other on the cliff and they would pass, that's what his father would tell him, my friend Jim told me. And they would pass the canoe down then they would put the two canoes together and they would go fishing for the whole village.
KT: Wow.
C: They would never put the other canoe because with one canoe no could go. So had to get the two canoes.
KT: One side of the canoe.
C: Yeah, so just like one catamaran.
KT: Oh, so double hull then?
C: Yeah, that's what he tell me that his father used to tell him. See so I found that canoe too but I kept my mouth shut.
KT: Unbelievable for a portagee to keep the mouth shut.
C: I seen bodies lined up like that in caves. We used to sleep go down fishing. We used to sleep one place down by the ocean, nice place all the gravel you know. Never dawn on me and there were nice stone walls all around, you know. Maybe about that high. So he come here he come I took his uncle go show him the canoe. And then I told him this right here that's where get the other one on the cliff. And then as we went down we go sleep down there and here we put all our pop tents. And he say "oh, this is one Hawaiian grave." I say "this the best place for sleep everybody else scared come here." Ha! And we used to sleep over there all the time. Make right there on this place we go inside there was so nice the wall was about that high all around you know. So the wind no hit too much and we would put our pop tent and sleep, and when Alan come he tell me, "eh, that's one Hawaiian grave I not going sleep there." I tell him "well, you like go outside, you go outside. I sleeping right here." I quit that ranch and I always used to go fishing and sleep there.
KT: What kind of fishing?
C: I used to catch Moi a lot of Moi at the time. And Menpachi and Kupipi and Moana, Popa'a.
KT: So the regular shore fish?
C: Yeah, shoreline.
KT: Not Ulua.

C: Dry kind stone place where no can be too much big ones you know, cause I not going too far or close. Gotta get the long bamboo.
KT: I appreciate you honoring those discoveries. Of course you know the canoes that were placed down there that were in the caves upside usually used to be the coffins of our people, yeah.
C: And the cave was long you know you could go quite a ways in but had nothing. I thought might have had, get lot of petroglyph's back there. Not far from the road you can only walk from me to there and the petroglyphs on the old horse trails.
KT: This is Kahikinui?
C: Yeah, Kahikinui.
KT: This is all in Pulehu.
C: Yeah, Pulehu gulch.
KT: This one is a Haole artist
C: Plenty of this here that people went and scratched all around on some of them.
KT: Yeah, yeah.
C: I just started working Haleakala Ranch and I was "what is that darn writing." It never dawned on me because I never seen them elsewhere. After I got that always I watching, all over the place you see them.
KT: These haoles they beautified the place. Not everybody, but this is like the Garden of Eden. Look at all the colors, in all the petroglyphs on here. But it's an artist that lives on the top. So I took Kimokeo them including mine, so all the petroglyphs are along the wall. So where you saw it's the same kind of place that the rocks were this tall?
C: No, no right on the horse trail.
KT: Low kind.
C: Right on the horse trail over here where you go what's it called Twin bridges? They get one name for that. Right on the horse trail had the rock there and get some big brown rocks.
J: Almost to Waiopai.
C: This side of Waiopai. Plenty of people call that place you can go right down the ocean, called Pidgeon Pali. They get some Hawaiian name.
KT: Had different names. I used to be down there quite often, almost every weekend.
C: Over there get one hole with the windmill inside. You ever seen that hole with the banana trees inside?
KT: No.
C: You went pass right by the rock hole like that you can see the banana trees.
KT: Then it's through a river bed?
C: Yeah, it's like one pahoehoe? The kind bath right. We've been
J: And there's one by Kamehameha schools, petroglyphs right there.
KT: By Kamehameha schools.
C: Right inside the house where you were telling, that's where you get those pictures, yeah.
KT: This one is by 76 and then you go down you pass the Pulehu road going down, so it's down there.
J: By Kula glen, this one's Kula glen side. The one's we thinking of is more Kamehameha schools side.

C: By Hawaiian homes. Right there Kamehameha schools from Kamehameha school you coming up right in that big gulch.
KT: So we going up this way, we pass King Kekaulike, Kamehameha on the right.
C: You gotta go down through the pineapple field you know can go on highway.
KT: Kamehameha is on the right hand side.
C: Coming up.
KT: Pass the school?
C: Right straight line with the school on the opposite side of the school.
KT: Go Makai in the gully?
C: All in that gulch stay full right there.
KT: You know, maybe twenty years ago I was asked to go bless some petroglyphs right next to Kekaulike, the gully right there. Because Keola the canoe builder out of Lahaina they wanted me to go do a ceremony there. From that and my travels throughout the state of Hawaii I looked at why and where did our people put these petroglyphs. And for the most part every gully had petroglyphs. Every gully. And the reason for that is that they brought the Koa logs mauka. They have to take them down to Makena or to Kahului. So they went through the river beds and camp overnight.
C: Couple of days, carry that heavy bugga! Get wash get water.
KT: So they spend time drawing. Now Kimokeo is standing next to Pulehu again this is a very unusual one same thing. Oriental characters. It's one of a kind cause I've been throughout the stat studying petroglyphs and stuff. Never found this kind. So when I looked at it I went, "what, gosh." So it's a riverbed that. Maybe from here to those trees. This is all the petroglyphs and caves that we took leading to this. So when I saw and I put it all together I went of course. The orientals was brought in not only through Koa logs but Iliahi, sandalwood. Because they had to get it down to Makena or to Lahaina to ship to China. So that's why they drew this Chinese character. So I took this in. I teach at Maui Community College, Japanese students were sat down. I interviewed ten students and I said, "what is this thing." So they wrote, everybody consistent everybody wrote this line means. Dai ni hon which means big Japan. They couldn't get this one I gotta take to one of the older Japanese and see if they can get this. This one here is Ito. But this is close by to all these petroglyphs which is the whole bed of, the whole riverbed.
C: Yeah, I know Pülehu, plenty over here too. Right there tell you get plenty too. And then we get one way up on the ranch. Just like the mans, little bit more different. Steven Boteliho, he the first guy told me that. "Henry no look like one petroglyph?" So I'm passing on the horse caught my eye one time, but I never pay attention. But then had little bit more writing but just on one rock. Right where the honeybee stay. Right there get petroglyphs way up kind of way up now, it's above, oh about half way up Haleakala Ranch on that side.
J: That one, didn't Gerard say looks like the, wasn't he saying looks like one pregnant lady on something, yeah with that one.
C: Steven Boteliho tell me the same thing and she gave birth over there that's when right over there had like old Hawaiian houses.
KT: So bring me close to where that would be.
C: It's not too far from here it's maybe about 2 miles, 2 and a half miles, you gotta go up to the gulch on the car or horse to find it. We pass we have a tractor road that pass right there that's how I seen it.

J: That would be. That house that's closest to the Cameron house. It's probably closest to that, up on this Kekaulike Highway, up here.
C: Cause no more no other houses. This side Carter. Well actually Carter is closer than Cameron. Cause from Carter you just cut right over.
KT: But private land yeah?
C: Ranch land. Even the one down by King K, I can take you there. I get all the keys from the ranch. You can see them.
J: Now when you walk right up to them, I tell em high, high, very high.
KT: As I sit here in my mind you know it tells me how rich this island is. Unbelievable.
C: You just think how much time it took to cut that with one stone. Unless they had some kind of iron tool. But I doubt with rock.
KT: Stone on stone.
C: Yeah, and for cut you know and that damn rock is smooth hard rocks like that, yeah?
KT: That's truly possessing Mana, understanding Mana. Specifically we are, in behalf of this land group. Studying for, they want to put in agricultural subdivisions over here. That's one. This is Pulehu. This is right across the Ag park right in that area. Kimokeo and I ran across a pretty good sized Heiau. Maybe from here to your trees. You know the formation of the rocks.
C: Yeah, not too far from the main road yeah.
KT: No, that one is way inside of Pulehu.
C: Get inside Waiakoa pasture, I think so get one over there. But in this side Pulehu get too where they get all the rocks yet just like they made garden or something. They all line up like that in one big square.
KT: Yup.
C: And right over there on the other side, I'm not sure now if it's on that side or the other side Waiakoa side where get one well that Maui Land and Pine drilled. Get water over there.
KT: Right now I'm just transcribing the interview with Thomas.
C: This piece here all going sell? Because Maui Land & Pine own all that this side of Pulehu road down. Haleakala Ranch own certain portion and according to what Harold told me, Mr. Richard Baldwin, that anytime they bought land and they borrowed so much money from Maui Land & Pine he wouldn't take back in money he would take in land. So that's how he get pieces of land there you know more on the low side where pineapple could grow. Interesting though, yeah.
J: This area where they want to develop, you're looking to find out if there is anything more…
KT: Well as you can see on the other map that I showed you, right there is why we're doing what we're doing. But going back to the original reason to have cultural assessments is not only to look at where they want to propose and get permission but the surrounding area. So in my write up I'll be covering Kula, Kahikinu you know all Upcountry the entire ahupua'a and how they all fit together.
C: King K that side King K you go inside that gulch it's loaded. And I didn't go below the waterfall because right there is a big waterfall but I go all up and down there. You know look in there because we ride horse all inside that gulch. Then sometimes when the grass really big instead of ride horse we would walk foot.
KT: You never think take camera?

C: No, I'm not a photographer. I'd like to see the thing leave 'em there, don't touch it. I don't like now guys, you go take guys and then afterwards they go there they going scrape them. I hate that!
KT: Right, we don't want that. So, you know, as I'm talking to you in my mind I'm saying, and you know because I've been exposed to it. What can I personally do to have that remain like it is instead of having people like what you just described.
C: The thing is the boundaries over there is right down the center of the gulch. See so the guy that own the land from there to there, you no can tell him, he own that you know. Cause right here in Pulehu right here down here by King K the boundary right down the center of the gulch. But we had the fence on the side because you know, no can fix fence inside of all the stone you know all the pohaku. So we used to have them on the side of the gulch.
KT: By the way, what kind of horses were you guys riding?
C: I already had plenty thoroughbred, mostly thoroughbred horses when I first started Haleakala Ranch. Mostly thoroughbred then the quarter horses used to come more and more. Right now very little thoroughbred, mostly all quarter horses.
KT: Some of the horses had to adapt to the environment.
C: Yeah, mostly mares that they breed and they brought. Like Kaono'ulu Ranch bought a stallion his name was Jimmy, I think and then Dwight Baldwin bought a quarter horse stallion and then from then on they started to breed. And then Mrs. Richard Baldwin brought an Arab, which they had all thoroughbred stallions Makawao and all the studs that they bred too. Then she bought an Arab and then when racing got through they started to breed Arab's. It was good cattle horses, they all, you know it's the work you give them and the patience. You can train any kind of horse to work cattle.
KT: What is the Paniolo lifestyle that makes Paniolo unique?
C: Well in those old days was hard because you had no car. Everything was done either horse, donkey, or mule.
J: And sun up to sun down.
C: Sun up to sun down from dark to dark you work. There was no such thing.
KT: She got that so you must have said that, yeah?
J: I lived that! He's gone it's dark, he comes home it's dark.
C: I come home 9 or 10 o'clock night time 12 o'clock come home.
KT: Is that to say all of it was put in work or you spend time playing around and stuff.
C: Working.
KT: Ah, so work consisted of building fences…
C: Mostly we work with cattle and we working cattle plenty time, you know we driving one big area and we get 5-600 head and you try separate the cows with the small babies we let 'em go cause you get a lot of bulls a lot of steer that you going take out, you know. So that kind time when take. Even car lights we would take you know with the car lights so you could see. With full moon was good you can work with a moon. You work plenty with a moon.
KT: So, you just said it, you were able to learn the cycles of the moon?
C: Yeah.
KT: So outside of the times that is became full moon and the cycle is. That's all moon's getting big, right after mahelani then it dwindles little bit. So did you folks follow moon calendar for fishing too?

C: Yeah, my dad did when I was young, though. We would go get the opihi because then the full moon the water everything come more malia, yeah? You know you go. Me I'm not ocean, like I said I never was. My brother's all yeah, me I never cared for the water. To shower and that's about the best I like 'em.
KT: So what about you Jody?
J: I can swim but I rather be on the horse. I like my mountain.
C: I like the mountain too.
KT: Upcountry people tend to be like that. I'm guilty of that, if I didn't go Kamehameha my 7th grade year I wouldn't have learned the water. So, I guess that's how we grow up in the environment that we lived in, yeah. So small kid time outside of your regular work. What was unique about living in this neighborhood.
C: Here?
KT: Well, I mean Kula, Makawao.
C: Well, I got married to a Kula woman so then I had no choice.
KT: What was her name?
C: Judy Perreira.
KT: So your ethnicity is full, part?
J: Pure portagee. As much as we know.
KT: So how far back do you trace your genealogy?
J: Well, his mother came from Portugal.
C: My mother came direct from Portugal. My grand-dad my great-grand-dad came from Portugal. And then my dad, you know. I don't remember my grand-dad alive he passed away already. I remember my grandmother.
KT: When did he come?
C: Gee, I have no idea. You get a Portugese book in there. I cannot tell I know my mom came she was 8 years old. I don't know about my grand-dad, or my great-grand dad I don't know. I know came three boys and as far as we knew, my grand-dad lived over here in Kokomo. And then one was in Lahaina and the one in Lahaina that we knew about as far as we know he was never married. But we don't know if he had any children, you know what I mean. But, uh, he live in Lahaina. And then all the years, you know that's the only family we had. And then I had this friend Don Silva from Parker Ranch calling wanted if I would give him lesson on raw hide saddles and the braiding of the Hawaiian saddles and all that. So I said "Sure, why should I die and take it with me?" I learn from old Portugese cowboys.
KT: You have it in there?
C: Yeah.
KT: Can we watch it later and take pictures while you're describing it?
C: Yeah.
KT: Have you done that?
J: I can but it's hard work, hard on the hands.
KT: Done that in terms as far as documenting what I just asked.
J: No actually.
KT: I'll present it to you.
J: He actually has gone to the Smithsonian, 16 years ago and he went up. He was with the Culture of the Arts with Hawaii.
C: There was an old Hawaiian festival up there at that time.

J: Yeah, the State had a program where they would have him have a student, like and intern and they would teach you know to…
C: Teach guys braiding.
J: Yeah, to keep it alive.
KT: Who was it?
C: Craig Moore was one of them and had this guy from Honolulu, I think what was his name now? He could never learn, though. He was a good welder and all.
J: But he's taught nephews, my brother knows, he's got many other people.
KT: Some have it, some don't.
C: Yeah, and the thing it is, he found one other guy that might be one better student than him that would learn. Like Craig Moore was a good braider. A haole boy, he was really good at it. But he don't use it anymore. Now he's in Australia, just call me last night. Oh, New Zealand. Called me, we had a talk yesterday, oh about 20 minutes on the phone. And it's a funny thing. I have a friend of my Glen Souza used to work Hawaiian Air. He's related I think to that family. And he do real nice braiding. And now I have a young boy that started on the ranch, BJ Cabanting. Yeah, I think his dad works for Good Fellow Brothers, welder and oil and maintenance of the tractor and stuff. And he braided him a nice rope and then I have this crazy Chinese friend of mine now, Cully Chun, I don't know if you ever heard the name.
KT: Heard the name.
C: He used to work fire dept. and he get into, he braid him a nice rope. And he braid a couple pair reins already. And we just go through one, I think was Tuesday or Wednesday, and uh, he braiding them. So I never call em yet, I was going call him a while ago but I was busy braiding too so.
KT: So, it's an activity that you love doing just like some people love to sew lei's.
C: Yeah, it's like how before you go Ching store you bought all that making pheasant leis yeah. All pau, you no see that. Like I said I kept up this thing from 12-13 years old, I never stop.
KT: That's why you're the master. It's a challenge to convince young people to stick in something that they love and develop it so that they become masters.
C: So get one man right now, a good friend of mine, he's really good at it. He make bull whip, he make reigns, he make raw hide ropes. Now he's more into the raw hide ropes because he's selling them some $700 and $500. I created hundreds of them but I never sold one rope. That's all I did.
KT: Well, as earlier said, a lot of people only see the money in that.
C: I'm grateful quite a few honest men to earn a market. Plus the man show me plenty ride always you know. Because I used to go every night and then sometimes we would get together and we would all go fishing Kaholo Ranch with Steven and we would go down and he would tell, "this is one right a way, this is one right of way." I found out was up the mountain then the ocean we knew all the right of ways. All horse back, we used to go all horseback when I first got married.
KT: Right a ways, explain right a ways.
C: Hard for find em, because nowadays you take over here before right when you live down Pukalani Hwy. As soon as you get to the pineapple field, Pukalani Highway now not the new road now. Ok, so there had one right a way right straight to Makena right over, right up catch that King's trail you can come up ride right back.

J: So meaning that no one can fence it off or restrict you from going.
C: No, they made those houses Wailea and all. Those houses is on top the right of ways. They have no respect for the right of ways.
KT: I heard King's trail mentioned. Try describe as clearly as you can where would that be?
C: Actually if you go on Makena, you know Makena that road. You walk right on that road, it's about that wide. You can see some place go down the gulch and they set stone, plenty place wash out from the gulch because the people would use them. Like we used to, anytime would broke the Hawaiian's would fix. And that's the road, King's trail go all the way right to where I tell you the pidgin Pali, kinda dangerous gulch to cross right there, but you can still see 'em. I used to cross 'em on the cowboy horse. And you can go right through to Kaupo. And the other trail is up. You go up by Kanaio Church, the Hawaiian church. That's where the road used to go. And then used to come down and go right between that red hill. Right between, I don't know if you ever went there go right on top red hill, take you right to the horse trail. And over here get Davis, yeah Davis had one house. And in fact after you pass, you go over go in get couple houses right there. You see that small board gate, that's one right of way right down to the ocean, for go down to Pakau'i. I drive cattle all on that trails. All that Hawaiian homes back there I no think get one Hawaiian can fool me.
KT: You know Mr. Silva as we age, being where we are and here is your daughter and son. What do you think we can do to assist things left behind for them? You know this King's trail. The appreciation is not, you know, oh so what. But when you look at developing such a manner, progression, construction I mean the whole island. No machines, hand job, you know. How much work that was.
C: That's why I said that, we're supposed to preserve that. Even the people that go there, they brokin' em and bulldozing them.
KT: That's why we doing what we doing, this kind of work.
C: Yeah, they not worried about that, they worried about where they going put their house. And nowadays they no go with one hand or one pick or one shovel. They go with one bulldozer they scrape em off.
KT: How close up can you identify coming across?
C: Oh, some places is, you know because the ocean get all kind waves, eh? So the trails some places is come, come straight right. Close to water, mostly. And some go kinda little up.
KT: So no come mauka over here.
C: Nah.
KT: We follow Maalaea go Lahaina come around Kahakuloa come back.
C: The up trail from Kaupo used to come up to Kula here. Right straight through Kula.
KT: So you telling me had two?
C: Yeah, had one right on top and one below. Because right now you going on the road to Kaupo. You go there you can see the right of way yet on the right side of the road. Some places go below. Right there you get the petroglyph go below. And you get the other one on the same piece land, right next to the ocean. Not far maybe about, maybe from here 808. I tell you pidgin Pali get one road there and one road on top here. They only about that wide, you can see them, real plain. Plenty get stones, guys travel night time maybe you can. Well, those days no more light. Plenty of them had kukui oil. I

remember that was our time we used to burn the thing for light in the house. When we was even a young kid. Then afterwards came the lantern. But before that my mom guys, that's how only had light. And when come dark you go sleep and when get up come daytime you get up for work.
KT: By Ag park coming across again on the map where it shows, do you know if they had sugar cane coming all the way up there? Cause right now they have pineapple.
C: Sugar cane I no remember, but according to my wife's uncle and my father-in-law tell me they had pineapple on that area's there. Even over here down Kamaole over here. See all those big pines those that's all pineapple over there. That's what the old guys tell me. As far as our time was down this side.
KT: Jody when you go to work, what road were you using, Pulehu?
J: No, I use the highway.
KT: Why is that?
J: I take my daughter to school in Wailuku. And not good on the brakes.
KT: But as far as time, if you went through there is it fast there?
J: About the same, not too much difference.
C: You see before here they had Makena road go right down to Chang's place.
KT: Ulupalakua.
C: That was one road, I don't know why the county never pave the road. That's only what they had to do.
KT: They said insurance.
C: Yeah but they would pay the county. Why the heck we get our state for, get the insurance out of the state. What do you think?
KT: I agree. I just responding.
C: Would take her 20 minutes she would be down there.
J: So that area, where they're planning to develop, that is all pasture land right now. Across Ag park. And you used to.. you used to deal with cattle you used to drive cattle through there.
C: We still get cattle there.
J: Did you notice lots of other, besides petroglyphs, did you notice heiau's, did you notice anything else?
C: Funny where the rock wall stay, they never did plant over there look like, you know. I don't know if sand born or what you know because they never did plow. Above pineapple. And you know when I went there was all Keawe trees all covered and then all of a sudden they start put pineapple again. Cause pineapple was doing good they plant more area and more area. Just like you go down here right after Waikoa pasture from there down Maui Land & Pine own that right down to Kihei. Used to be called Big Waikoa. And that I think is 500-600 acres, that's a big area. And that come right up to the pineapple, that's all the same piece. Land here it's all go like this yeah. All go right from the top of the mountain it's Pulehu. I go shoe horse they give me this Pulehu address. Just go right down go all like this, this whole island it's right down to the ocean. Go behind, right across. It's an interesting thing, you know, I rode a lot all over this God darn place in our days. We never have no cars, all rode horse. Rode from Olinda we rode all the way go to the forest go to Keanae visit a Chinese friend my dad had in Keanae. And then we would go sometime overnight. We would do fishing, catch

fisha and all. The old man was a good fisherman, he was one cowboy go ranch inside Keanae side all in that mountains. Was hell of a cowboy.
KT: You guys would ride across?
C: Ride right through the forest yeah! From our house Olinda, went right through the forest go catch the Hanamanu gulch, the gulch on top is only one small little hollow. You know, then you get the new trail go like that you go right down to where we used to hook up fish. I forget the name…Puulau gap or something. Come right out to there and go to our friend's place. Down Keanae. Then we would ride home, we come home cause get plenty fish yeah. They put the fish all inside limu. So no spoil they touch the horse, because the horse come hot yeah. Then they put limu all inside like that. Get plenty limu against the horse and the fish all covered with limu. Forget that kind plenty. Nowadays you no even can see that big green limu all on top the stone.
KT: The green one?
C: Yeah, the kelp size. Thick yeah, so that bugga, just like she keep draining.
KT: See, this information?
J: Yeah, noboby know.
KT: Yeah and it's so precious.
C: Yeah we come I ride from Olinda then my dad go fishing down Makena and all. We come with one old Hawaiian guy. Andrew Puahi. He was a Kaupo man. He and my dad was really good friends. Big man, strong! Strong man, Andrew, and he had one son he was my classmate, Andrew Jr.
KT: What did he do?
C: Cowboy, he was horse shoer, he was a good horse shoer. Big man though. John Kahananui, Joe Poaipuni, all those guys. I work little while with them, I never work with Andrew Pohai, he died already. He was my dad's age yeah. But I work with Joe Poaipuni. John Kahananui I used to sharp his saw's, carpenter saw's. Nice Hawaiian man. John had little bit Chinese in him, though. But Joe Poaipuni was pure Hawaiian. In fact I still go shoe his horses. Old, old horses already getting hard time for hold the legs but we go shoe them.
KT: What made you go into horseshoeing? That's an art now. What made you go into that?
C: I love horses.
J: You had an uncle that taught you how?
C: Yeah, I had a cousin.
KT: What's the name?
C: Blacksmith in the days you know they get the touch yeah. Used to make wagon wheels and all my cousin Joe Freitas, but he learned from his dad, come from Portugal, yeah. And I think cousin Joe was born in Portugal, I not really sure but the rest was born in Kaupo. When he said the ship had leave Kaupo. Well Kaupo they came back this side. We work Kaupo for so many years, for I not sure now. But we used to tell they work over there plant sweet potatoes. And that's how they all plow, because wagons, eh. And they had horse and their plow for turn all these potatoes.
KT: What were they planting them for?
C: Was cheap the potato go mainland.
KT: Oh, yeah. Now I'm reading on the history for the gold rush they planted all those plants.

C: Even the corn. That's how the Chinese over here. We get China pasture over here that's the Chinese kind corn for go make whiskey mainland. They never like the Hawaiians make em over here, bum by the Hawaiians no work, yeah! But had some Podagee's used to make the okolehao, eh.
KT: Yup, that's how was.
C: I remember Andrew, I was maybe 10-11 years old I live in the ranch, Haleakala Ranch, because my sister just got married to one ranch boy. My older sister is a Bal. And I lived over there. I used to like hear the anvil he stay pounding pang, pang pang yeah. So I used to go down watch with him. He use to tell me sit down. Nice old man, big man! Big, big man.
KT: So he taught you?
C: He didn't teach me anything about shoeing. Just it got me for sit down, I like watch, you know the horses. He no like I sit by him my body might get step or something. My brother going get on his case yeah. Then I learn with my cousin Joe, about 12-13 years already I was starting to shoe little bit. I would go down and crank the forge you know any time you stop the cranking because you no more nothing motors. Afterwards, the ranch had one new motor the motor the motor keep turning the so we can make hot. Because it's with coal yeah? Now what I get on the truck now I just put the propane gas and I shoe with forge. It's an interesting thing. It's hard on your back, I say more in your mind yeah. Your head tell you your back sore, your back more sore.
KT: You going pass that art down to anybody?
C: Oh, no I get in fact I get one college guy Bill Johnson, he's a horse shoer right now. He's with me about 10 years right now I think. And then Glen shoed with me 13 years. Glen is good shoer, Glen Souza.
KT: So you do for the ranch?
C: Once and a while we go help them when they get hard time you know for catch up and they get plenty other jobs. So they say, "Hey, Henry come shoe." I rush right out.
KT: So your dad busy.
J: So ask us when the last time we shod our own horses?
C: About 6 months.
J: Needless to say we haven't been riding.
C: No sense shoe them no can go anywhere. Right now they hunting bird so once pau bird season we get our saddles out.
J: What they say, the mechanics car never fix. They carpenters houses never fix.
C: The cowboy get the worst horses. One friend I went give him one deer. Me and Gerard shot we went go by the road, was Kamaole house now and he tell me remember me Henry? He tell me no need deer right now. Now every time I pass I wave, different kind color guy now. He tell me he thought I got sun kissed was so black they no even see me. I laugh.
KT: So, I want to go see that over there but before I do I want to try to develop a summary of what we're talking about. If you had your way, what would you like to see happen in this area that I showed you on the map? That would be conservative enough that not interrupt the environment, you know. Your grandchildren traveling down there.
C: They could make a little park and put a little fence around. They get plenty Hawaiian trees that you can plant down there and would do really good.

KT: Many of the developers now, in order to get permission to develop. Have to put in, it's a requirement. Need park, need school, these big money guys. It's already in their plans.
C: Put plenty of them talk parks and all that, it's not the Hawaiian trees they put in on top. See you get the Wiliwili you get the Ohia you get the Sandalwood you get the Koa, you get the Kamani. Get plenty of the Hawaiian trees, some Hawaiian trees get trees over here that we don't even know the name even inside the mountain if you go, and even vines that crawling.
KT: If you don't know that Kimokeo is master of plants. He knows in's and out's. Yeah, he has a passion for plants. I agree.
C: That's how I feel.
KT: It's going to be in this where they can come to it and all we can do is say, this is our recommendation once we write it up.
J: I wouldn't, you know. If it's something that needs to be developed in that home for homes and such I would like to see it being not so commercial. You know more, you know keep it country.
KT: Well, this particular area, again is going to be agricultural sub.
C: They no need make 'em 1/8 acres. So you can plant some vegetables or plants or trees.
KT: But Mike pointed out something that is really preventing the mind to continue your folks line of work which is water, lack of water. Cannot make 'em yeah? Unless you have another way. You have another way on how things can continue to keep growing?
C: The only thing I would like to learn is how to swim, so then I can go in the ocean check what I can do with the ocean for take more land out of the ocean. Not going happen, yeah? Ok. No you know they always going be looking for that mighty dollar. It's an unreal thing.
KT: In the years of your life that you've been on this earth, you feel that you lived a great life?
C: Oh, I had good fun.
KT: Everything you've accomplished, you're really happy about. I love meeting artists such as you. There's a little more than just somebody off the street. I have said you know the story about carrying your fish with the limu. Any other ideas, stories you have?
C: Me with my raw hide braiding. I brought the first nylon ropes to the island. I met my friend Dutchie Shuman, Shuman Carriage. He just passed away, ok, I met him down there I met him I was shoeing horse in Kapiolani stable he came there with this nylon rope. First time I seen one nylon rope. Dutchie came asked, "oh, Henry you want to try?" Cause he was roping them and I was roping with raw hide rope yeah. So he tell me from now on I not going use the raw hide rope I going rope with this nylon rope. Ok so I was roping you know he was roping the animal the thing moved away. I tell him gee, where the heck you get this. He tell me, uh, saddle shop store in town. He tell, "I go take you. You go finish your job, us go." So he took me. I went down there I look at the ropes. I bought I think was 9 ropes and I bought the thing 2 or 3 cases horseshoe nails, cause at that time was hard time get horseshoe nails. And she gave me 10 cases of nails and I got all those nails plus what I could buy. And so I figured well, I bought that. Was $9.00 one rope, 40 feet. So I gave one to my cousin Raymond Freitas, I think it was 1 to my cousin Frank and I sold one to my friend. Same price, I never charge him nothing

more for the rope, $9.00. One to old man George and I think one to Jocintho's and I not sure if Steven Boteliho. And I kept the rest, you know. So then I gave one to my friend Wilfred Cambra and one to my brother-in-law Alex Vegas and I kept the rest. So I always had 2 or 3 extra. But, I still rope with my raw hide rope you go on top the mountain the nylon cannot work. The wind would blow the rope right back on you, with the wind. Even on top Kahikinui the wind blows you no can throw your rope against the wind so we would work with the raw hide rope.
KT: Wow. Did you learn about the different kinds of….
C: This bugga is only one little small piece over here was crack but the rest of the canoe was all perfect. But only small kind camera, no more the fancy kind camera those days. But we look all for petroglyph and take all inside had more petroglyph. And this all Kehekenui land. This is Alan Silva.
KT: How old would he be now?
C: Who Alan? He's quite a few years younger than I am, well he retired from the Fire Dept. but then they go by years service. Alan what you would figure, what 60?
J: I think what older than Norman?
C: I not quite sure I think they might be the same age. Cully Chun is 55.
C: I seen inside the cave had just like the roots. You know growing through the rock, I'm pretty sure that's what it was. Yeah, that's the roots coming through. See, now you get the canoe. Yeah but was almost perfect this one here, the one down the ocean but funny yeah, when Jim told me when I found 'em I see only half of the canoe. Just like somebody went take one saw and then cut 'em right down straight, straight. I guess from staying on the ocean cliff. Long the canoe was, I tell you might be from here to the corner like that, the house. Maybe a little further than that. And about that wide. Like that thick. And just like somebody went cut 'em. I guess the salt breeze come on top and you know keep on yeah.
KT: So, probably Koa yeah?
C: I think so! Because no more trees bigger than the Koa for come make like that. Over here, that's one big over here already.
KT: So, wasn't oiled or painted? Just decaying?
C: Yeah just decaying from old yeah. But the funny thing when the old man told me that I thought he kinda pulling my leg. The old man Jim. We used to butcher a lot of cattle and I used to skin and he used to love to braid ropes or whips or reins. So every now and then, we would ask. My boss, Steven Perreira, used to like that old man. Tell him, take take free. While he doing that he not making trouble. He was a good braider.
KT: So in other words the cattle you guys slaughtered you kept the skin, dried it out, then you cut it up to make the ropes.
J: The the pictures from the petroglyphs from Kamehameha schools I cannot find them, yeah, I cannot find them.
C: That's how I got interested in this darn thing. After that I always watch, just go. Get bodies over there. In fact a few months ago, no last year, my son and I was working one pasture down here, we call 'em Kekoa get the red cinder hill. He tell me, "eh dad you know that cave over there?" I tell him "yeah." He tell me, "eh, you know what get one hole there." I tell him I know the old guys tell me. I tell him I never go by. He tell me the stones fall down. He go there 3 heads just like one here one there one like that about

this area 3 heads like that. Look like the body stay like that. He tell me, "I wall em up so they no."
KT: How old is your son?
C: 43 going be 44.
KT: So he still cowboy.
C: Nah
KT: But he ride around.
C: I send him college that was the worst thing.
KT: Why is that?
C: Because maybe he could be cowboy, maybe he would be more happy then what he stay. (laughs)
J: He's not interested too much in the horses. He works for Island Movers delivery. And he has coins, he loves coins.
KT: At least you taught one of your children.
J: He's got some old Hawaiian money too.
C: Funny how things go on, yeah?
KT: Can we go look over there and take some pictures.
(walking)
KT: So every one of these you made?
C: Yep, every one of them I made.
KT: Is there a story in back of each one of these?
C: Well, this one here I call em my rubbish pile rope.
KT: Why is that?
C: Because below Kula Cemetary they had a rubbish pile. Everytime I would go there had this hide, I think that was made for a rug in the house. And I guess from staying in the house started to get all crooked as the years went by. So everytime we would go dump our rubbish, my wife and I. I would fool around the hide. So one day she told me like this, "Why everytime you come here you fool around that hide?" So I said well I take my pocketknife I cut a little strip like that about so long I pull. The thing wouldn't broke. I brought 'em home. And from all crooked I took little bit water with Hawaiian salt inside. Spread em on top, next morning came all soft. I strapped 'em up then I cut that and I braided that rope.
J: How many strands is that rope?
C: 8 strands. That's 8 strand, this is a 4 strand and maybe this is the only 6 strand rope you'll ever see in your life.
KT: It's truly and art.
C: And this here is one bull whip from old man Ernest Martin. I don't know if you know who that old man was, but this was his whip that he braided. They gave 'em to me for fix but it's so rotten I cannot do nothing with it. So I just kept 'em in memories of that old man.
J: And he braided that?
C: Yeah, he braided that. This one here I brought for fix, a friend of mine Alan was telling me he braided this whip with me. And this is all bracelet's that I braid for my girlfriends. This here was when I was up in Washington.
J: The folk art program. They sent him up to Washington?

C: Yeah, for one festival. And this is my friend Cully Chun now he was learning how he braided this. And this is all reins that I braid. See the one that I'm braiding yeah? And this is the saddle that I fix for guys. This is for my I guess my father and my grand-father's saddle.
KT: What is the material made from?
C: This is all cow hide wrap and it's braided under here. So that's how I spend my time.
KT: Wonderful.
C: Deer hide, the axis deer.
KT: You collect what people bring to you?
C: No, my son and I hunt so we shoot one I save 'em and cure the hide.
KT: Is it difficult to cure the hide?
C: No. This here. Here's all reins that I'm braiding.
J: So how long does it take for you to skin it, to strectch it, to cut it?
C: Skin em about 20 minutes , skin em out of the carcass and then I stick em about 3 days in water with lime and the hair all come out and then I take em all out. I stretch em on one piece of ply board about 4X4, you know. Then I stretch em all, nail em good and then clean all the flesh side real good and then put little bit Hawaiian pakai.
J: So in a week's time?
C: In one weeks time I got em braiding.
KT: Week's time. You don't sound like you're a man with a lot of time. So I appreciate this day that you're giving me to do this.
J: Always doing something, yeah?
C: Yup. One more rope here to start to braid.
KT: Hard work though, yeah?
C: Oh, kinda hard on your mind yeah? Plenty guys ask "your hand sore?" Sure sore.
J: Takes a lot of strength.
C: Real fun, while I'm doing this, I'm not making trouble. I'm in this garage here but I always I work here.
KT: And you standing up too, hard on your feet?
C: Well, with the horses on my back is heavier.
(laughing)
KT: Have you made one?
J: No I haven't. I think I made a ring once. Small little ring, really hard on the hands.
KT: Where did you go to school?
J: Here. St. Anthony and then I went to Oahu for 5 years did some business school and some beauty school.
KT: Did you know Antoinette Souza?
J: She's a little older than I am but yes, actually I think she's my brother's classmate.
KT: So you were Antone's classmate? Her brother.
J: He's 2 years older than me.
KT: I'm impressed.
C: Sometime you have time I show you those petroglyph's down there.
KT: I appreciate that. I'm going to find the time, make the time.
C: Well, if you let me know when you can.
KT: I gotta write down your phone number.
C: I'm sure Kimokeo would say how much we appreciate this.

J: I think he enjoys this, really he loves to share whatever, he has enjoyed this.
C: Then I can show you, you might even pick up something over there that I never pick up down there in the stone yeah?

## *Interview: Alexa Vaught*

**By Keli'i Tau'a/ Kimokeo Kapahulehua**
**October 20, 2006**

***KT- Keli'i Tau'a***
***C- Consultant***

KT- It's starting to record Alexa. First thing; you gotta speak up, number one. Number two: start with who you are your genealogy line (as much as you can).
C- Oh, okay. My full name is Alexa Odell Aheong Puaala Keaunui Vaught. I was born in Oahu and raised on Maui; when I was about a week old or two my grandma brought me home.
KT- Okay those Hawaiian names you might have to spell; so after Alexa.
C- O-d-e-l-l; A-h-e-o-n-g; P-u-a-a-l-a, K-e-a-u-n-u-i; my last name is V-a-u-g-h-t. I was born on Oahu, down in Kaka'ako and my grandma brought me home when I was about two weeks old and I was raised by my grandmother and grandfather. My grandma was Agnes Kane; actually she was Agnes Akeo and married to Moke Kane from Kauai. My grandfather Moke Kane passed away the year before I was born. My grandma remarried and married a man named Sam Paona from Lahaina. I don't know a lot about my grandfather that raised me except that they lived above the mill in Lahaina and he and he had two sisters. He helped, (after his brother-in-law passed away), Mary Levi, he helped his sister raise her children and my great grandfather was a Chinese man from China who married my great-grandmother who was Hawaiian from Lana'i and that's really all I know about them. My grandma came from a very big family. There were about 13 children, I think.
KT- Was she a Maui family?
C- She actually originated from Lanai; and then when she married my grandfather Moke Kane who came from Kauai with the Gays (the same family with the Gay, Robinson Sinclair, Gay and Robinson). One of my grandfather's auntie's married a Gay and so when the Gay's came to Lanai to get into ranching business and pineapple, the brought along my grandfather, Moke Kane. And as far as we know they were from Wainiha area in Kauai. I don't know that family because when I was born my grandpa was gone. So that family, I don't know. I know my grandmother had lots of children. She was a very

prominent person in Lahaina. When she married Moke Kane they moved to Lahaina and that's where she raised her children. My grandmother was very involved with (at that time) Waine'e Church and we were raised in the Waine'e Church. She was all things that you can think of. She was president of the Ahahui Kaahumanu; she was part of the Kamehameha Lodge because of my grandfather. So I basically was raised in Lahaina. My dad on the other hand, was from Hau'ula. He was a Keaunui; his grandparents lived up in Kahana Valley. They were farmers, they took care of all the taro, they had taro lands up in Kahana Valley. They lived (from where we understood my aunty telling us the history) they lived kind of in a commune where my great-grandfather was like the Konohiki for that family. They got together and they ate together, they did things together and because he was a Konahiki if you had a misunderstanding or you had an argument with somebody and if he would say one word; and he would say, "Oki" and that was pau; everything was finished. Then they moved, my grandparents, moved their family to Honolulu because my grandmother was ill and the closest place to the hospital was to move away from Kahana Valley. So they moved to Honolulu. My dad was a Stevedore; he started Stevedore when he was very young. He went into what started first as McCabe and Hamilton and eventually was bought out by the Matson Navigation. So, he was just a Stevedore worker and my dad passed away in 1987. In 1979, I had said to my dad, "you know dad, if I walk down the road and there was a first cousin that approached me on the Keaunui side I don't even think I would recognize them and I wouldn't even know that was my family." And I said, "I know all of my grandma's side, my mother's side. My aunties, my first cousins, my second cousins, but I don't know your side." And so, my dad got on the phone and called my aunt and they decided that they needed to get together and share and meet (for me at least) to meet my aunties and my uncles; my dad's brothers. He had only one sister and he had two brothers left. And so, with that in mind, they decided to do a research on their genealogy. And so, they did, they started that and they started prior to that and I think the benefits of the Mormon Church is that they do a lot of genealogy, the keep a lot of paperwork. And so, because our great-great-grandfather was a minister for the Mormon Church, there were lots of records that they could look at; and on the Keaunui side and of course it goes all the way back. The story I got was that there were three brothers and Kea'aunui was responsible for the Wainae, Wailua area; Komohonua was responsible for the Ko'olau side of Oahu; and Muliali'i was responsible for the Honolulu side. My genealogy wasn't important until I started teaching Hawaiian Studies.
KT- Because?
C- In teaching Hawaiian Studies for the Dept of Education in the Kupuna program. Because it was a mandated program in 1979 and by the time it started it got moving, I think, by 1978 the program started and it was a mandated program that children from K-6 should have Hawaiian Studies or should have Kupuna in the school. And it started as a Kupuna thing where they hired the Kupuna who were at home and who had all this wealth of information as grandparents. And so, the program started. And it started and there are still a few more Kupuna that started then. Especially I have one on Molokai; Aunty Eliza started out when they first opened the program. I went into the program because I love children and I didn't enjoy working at a hotel, I worked in a fine jewelry store, but I wanted connection with children because I teach hula. But I went ahead and I did get involved with the Hawaiian Studies program. So I studied the Hawaiian Studies

program in 1982 at Kahului School. Growing up I hated to read and when I started in Hawaiian Studies program I started to learn about the history of Hawaii and I was shocked because when we went to school we didn't learn about history; we didn't learn about Hawaiian history. And I was, I thought, when I was reading Hawaiian history and I'm thinking, how wonderful, look at us, we have history and we've been studying American History. What are we doing studying American history when we can study our own. And so, it was just something that I got involved in and I started to do research and one day I was reading a book and I came across a name that was familiar to me; I saw a name Maweke and I thought, "I heard that name, why do I know that name?" And so, it got me starting to read and I read a lot of things, especially Hawaiian history, very, very important to me. (laughing) So, it was very interesting and it still is and it's more so when I was actually teaching with the children. History was the thing that I really enjoyed. I mean, you know, the Hawaiian Studies program was you shared your history, you shared music, you shared the dance, you shared the culture, but most importantly you shared values.
KT- Right there, let me pop a couple of questions first. How old are you?
C- Sixty-five.
KT- What motivated you to get into hula and then eventually teach?
C- Oh, I was as a young girl I attended King Kamehameha III School in Lahaina and in my third grade year they had, in that whole school, there were three Hawaiian teachers- four, I'm sorry four Hawaiian teachers that I remember.
KT- Do you remember their names?
C- Yes, Sam Mo'okini; Annie Greg; Winifred Sandborn; and Emma Sharpe. And Aunty Emma had put in a notice through the school daily bulletin through school that she was going to start hula. And, I was in the third grade then, I was in Mrs. Sandburn's classs, I was very excited so I went home and I said to my grandfather and I said, "I'm going to take hula." And my grandfather said to me, "I don't have money for you to go take hula." And I said to him, "I think I can work something out." And he laughed at me. So, on the first day I went to class and I signed my name and Aunty Emma said, "Who are you?" And I told her and she said, "Who are your parents?" And I said, "My parents live in Honolulu but I live with my grandpa, they take care of me, my grandma and grandpa." "Well, who are they?" And I said, "Oh, Agnes and Sam Pauna." And she said, "Oh, that's my husband's ohana." And I said, "Aunty Emma I really want to learn how to dance but my grandpa said I don't have any money." And she said to me, "you know Alexa if you want to dance, all I want you to do is when we come to class, would you help me move the chairs?" Because we were dancing hula in a nursery, a preschool, she said, "Help me move the chairs on the side. Dust the floor with a dust mop and then after hula help me put things back." So I said, "Okay, I will do that." And so, being in the third grade that was my job; so every Tuesday I hurried down there and waited for her and she would drive some of the kids over but I was too excited, I would walk over. And it wasn't that far, it was like from Kamehameha III School to Campbell Park and I went over, waited for her, soon as she opened the door I did all my job and then I waited until it was my class. Well, I loved hula and she saw that I did and she noticed that I really did and pretty soon I was helping children to do their kaholo steps.
KT- Younger than you?

C- Younger than me. And as the years went by she started up an entertaining group called the Emma Sharpe Entertainers and then she brought in Kupuna and one of them was my grandmother who was already seventy years old. And then she brought in boys; one of my brothers (my brother that's a year older than me). And so we had a group of children and high school girls and then we had the young men and then we had the kupuna. So, with that, hula became my life and I have to say it was not only my grandparents but with Aunty Emma taking me under her wing and teaching me the things that I might not have gotten; such as how to act when you go out into public. I spent a lot of time on weekends in her home. When I was a Sophomore in high school she decided that I could be her alaka'i. So, on Fridays she would come up to Lahainaluna High School, right after, to pick me up and we came to Wailuku. Aunty Emma taught at the, I guess it was called the community chess building in Wailuku. She would take the little children and I would take the older one's that had had hula already; took them in another room and I taught them classes and she taught me what songs to teach them. And then, the following year we came down to Kihei and we taught at, what at that time was called Aunty Nani's. It's across Kalama Park and it was in a Quonset hut. Aunty Nani started a restaurant there; last name Aunty Nani Kupihea and Red Kupihea. Uncle Red was the manager of Snow White Laundry. And Aunty always wanted a restaurant and they had this Quonset hut and she served Hawaiian food; lau lau and poi and so forth. There was a small house on their property. There were two houses, one for them and there was another house. And she was somehow related to Aunty Emma, and so Aunty Nanai said, "why don't you come down to Kihei and teach? I have a house that you can teach at, and you know we don't have that many children." And so, we came to Kihei. After we finished in Wailuku, around six o'clock, we would come down to Kihei and the first class started at seven and then we would teach until about nine. And I remember one girl and she- her dad was the man that started the corn farm, Ben Miyahira was the last name. And it was really great and Aunty Emma also later on had a house down in Kihei and we would go down to the house after we got through dinner and then spent the night and then later on Aunty Nani said, "don't even go there, why don't you just stay here." And so, on Friday nights we would stay in Kihei with Aunty Nani and then got up early and we were on the road by quarter after seven to go back into Wailuku to go back and teach from eight o'clock until noon. She would do her classes and I would do the other classes and I think back and I remember Aunty Nina Maxwell in Aunty Emma's classes. We also had Mary Kanaha and her two daughters; Patty and Pricilla. They were somehow Aunty Mary's husband was related to Uncle David. And so, these were the ladies that we got together and they were part of the Emma Sharpe's Entertainers. And when they opened Maui Palms Hotel, we had the Sunday night shows at Maui Palms. And it was really strange because, not strange, it was just different today and I look at it and I think, "wasn't that great?" we didn't get paid and it didn't matter and we looked forward to it to going there and entertain. And it was just to go out and just dance. And when we got through dancing we always went up to Tasty Crust and had dinner and then came home.
KT- How many of you?
C- There were normally two cars; Aunty Emma had two station wagons. So, there were four girls.
KT- Can you remember some of their names?

C- Oh Yes. From the Wailuku side we had the three Kanaha girls. And then we had from Lahaina was myself, Masa Medieros (she was Masa Pam Long), Alice Aki Shimamura, Ella Cosma (I can't remember her maiden name), and basically- there was another girl-Patty Wong, from Wailuku, that came and we entertained. And then we had my brother Kk and then we had Alika Ross, Bill Labote, and then I had an uncle, his name was Keoki Levi and he was older than the rest of the younger people in there. And he was the life of the party, he loved music, he was a very, very big man; he was at least 6'4'' and he was about 300 lbs. And when he laughed, you couldn't help but laugh, he was so funny; and he loved to dance, he had a beautiful voice, he would sing and eventually in one of our shows there was a movie actor named John Hall (he did movies underwater and so forth) he came to Maui and he met up with my uncle and he decided my uncle should go home with him. So, my uncle moved to the mainland for a couple of years and then came back home. But, in entertaining, when we started to get paid Aunty Emma said, "Okay you're all going to get paid well." You know a dollar a night entertainment and we all laughed because by the time we left Tasty Crust we probably paid about 5 dollars. But it didn't matter; we did what we wanted to do because the group that I danced with, we all enjoyed dancing. So, it didn't matter, so what was five dollars a week? That was dinner and that was fun.
KT- So how were you then?
C- I was just starting high school.
KT- Such a young age, you were alaka'i.
C- Yes.
KT- Let me steer something here. From all that you said getting into; to you what is Kumu Hula?
C- It's someone who not only enjoys the teaching. To me it's how I look at children, how I can malama the children and share the knowledge that I have, not only the dance part but the values; How to be a good person; A good person in a sense where the values that you learn in hula because you don't always get it in school.
KT- How can you relate being educated in Hula from Kupuna to why we're sitting here which is an interview that has to do with the 'aina that possibly might open up to build a hospital? Is there any connection to what you learned and what you'd like to share about this valuable land that we're talking about? And maybe you can start off with what we talked about, which we don't have on the recording yet, which is going way back in the 12th Century with Mo'ikeha make that connection. Because it comes up where we're talking about is close to Honua'ula. So what is the connection? What is the family tie for, which is more valuable?
C- Well, because I was not physically in that line because I was in Maui, but reading and asking questions, a lot of things my family didn't tell me on my dad's side I have learned through reading the book. And the values that they had and what they did and how they helped people. On my thing, that's what I like doing. I like to help people in whatever way; whether it's children, whether it's newcomers, that is my thing. And wanting to know about Honoaula, kind of, I can see a tie that I have with Honoaula. I've been trying to learn about Honoaula. And then what we're talking about with the new hospital, I'm thinking, you know that's kind of a very important thing that we need to have a feeling. I know there's a lot of controversy about- there's a huki huki between Kihei and Lahaina and I'm saying, you know it is very important, number one, to have another hospital.

And you know, thinking, what would have happened, you know, if the earthquake was a big thing and the hospital, something happened to it. What would happen to people down here that would have gotten sick? So we do need a hospital. I can see we do have an opportunity for somebody to come in and build the hospital that is not going to cost the taxpayers any money. I think that it should be done. I think that Maui Medical Hospital should at least (or whoever is making the decision) should open his mind and say, "hey, maybe they're it." Okay. I've also heard people in Lahaina say, "You know what we need the hospital, so give it to us." Okay, but here's somebody that's started this hospital on his own and he's gone out to them saying, why can't they do it on themselves? I think they can with the amount of people they have there. It's just that maybe somebody didn't think about it, or they don't want to put the money out. Okay. For me, let's do it. And with more people, or more developments happening here, we need something.
KT- So, we're going to trace that but lay down your connection; what you read with Mo'ikeha. So that's the cultural part that we want to provide on the value of this area we're talking about. True ancient times because Mo'ikeha, they noted I think came in about 1200 A.D.
C- Its, well, I'm still not all really thinking about that. The name came up and I thought, wait a minute, because they talked about when Mo'ikeha came up different people were dropped off in different areas. And I was trying to find out about Honua'ula; how did this, who was dropped off with anybody and where. I guess what they were trying to do, and I love it for it, is that dropping off the family because everybody in the canoe were family; either a brother, sister, cousin whatever was family. So, to plant these people on these different places and to start something, okay, now I'm not familiar with that-with this area, but I'm assuming that they got it going. They built this place and what did they do? They built it for people. And what am I doing? In my things, to me it's almost the same thing. I'm taking people, or I'm taking children, and then trying to teach them how valuable it is. How valuable, first of all, you are. You're very special. Look back into your genealogy, if you can find any, and then take it on and try. Try and do something. And for me to come from that line and to think, "Look what they've started." How can you continue to do this? How can you share it? Not only basically with other people, but maybe my family understands. This is you, this is who you are and where you came from, this is what they did. You need to continue. You need to pass it on. You need to share what the knowledge that you know. Why did they come? They came okay. So, they built this place and they did well. You know, even when he went to wherever he went they just didn't go in and just lay; they worked at it. Um, the good example is when they went to Waipio and it was nothing and they built it into something. And that would be, I'm assuming would have been the same thing here, what they did because along the way that they went and dropped off different people. I know that two sisters were dropped off in Makapu'u; that was one of the sisters. I mean, that is a place of importance to them; Kahana Valley because of the family. And so, my going back to that and coming up too, I say, "wow, they knew what they were doing. How do I make myself as part of that? What do I do? How can I do?" And just by finding out more information and sharing it and teaching whatever people.
KT- Well, I'd like to think that by just you and I sitting here and providing this, which will be presented to the public, whoever wants to read as well, will take that information and continue focusing in on getting what your ultimate goal would be which is really

finding the answers to what was left here for us. So, how many years have you lived in Kihei?
C- Thirty- five.
KT- So, thirty-five is seventy?
C- 1971, Yes.
KT- So, today is October 20th and we just experienced an earthquake on the weekend and flooding from the tide, and ironically, your house was flooded.
C- Just my garage and my patio, right.
KT- But, this sense then how it is from the time you arrived.
C- Yes.
KT- The water does roll down.
C- Yes, we've lived on Ohukai Road for thirty-five years. Before we bought our house there was a big, major flood after a big heavy rain and the people on the mauka side of us had experienced flooding. And after that, we've had three flooding and most of it happened when they put the new highway up, the road. And under the road they have a big pipe and the water came down the road and flooded our house went right through the whole house and whatever. It was a job that they realized that they didn't do well; County came in did whatever. They protected us and the put a burm on it and somehow when they came to resurface the road they took the burm off so the water kept coming back. Lately, except for this, and the only reason that we could've prevented it was because we weren't home and unfortunately we weren't. So, it didn't do any damage except put mud in my garage. It would never have been a problem except when you're away. We were away for about 2 ½ weeks. With all the burning of the sugar cane and they must have wind because when our neighbor came over the drainage was covered with leaves and stuff and that was the problem. The water was draining properly but it couldn't go down the drain. So, if we were home, it would not have been a problem because we would have seen what was wrong and we would have kept the patio swept up like I normally do every week. I clean up the patio, there's no rubbish in there and stuff. It's just for 2 ½ weeks all the trash settled in there. So, it wasn't anything because like I said, if we were home it would not have been a problem and fortunately we had good neighbors and he went over and saw it and took care of it but didn't realize that it had gone into the garage.
KT- But being here for over thirty years from the entire strip of South Kihei; you've seen flooding areas, you've seen non-passable roadways. The more the buildings are put up, it behooves the developers to really look at the master plan and how to remedy these floods.
C- Yes, and I think like anything else, you would know where the water flows. You know, and you can tell. I mean- we on Ohukai Road, if it rains in Kihei it's not a problem. If it rains up in Kula it's not a problem because the water comes out and that's when we have a problem, basically. The normal rain in Kihei is not as bad, you know, because it's not coming down. The water's going down its normal drain or whatever. The County has gone in, and we've been after the County to fix the drainage and so forth. I had discovered that they were going to resurface the road; talked to my husband and he went to talk to the engineer and he said, "you know, we live on this side and we're catching all the water; you better rethink it." And they did. They did something so the water goes now down into the drain. But, it's only when we find out (and my son had said to me when he called) he said, "Mom, they had big rain up in Kula. Real heavy, ask

Uncle Tom to go to the house." And that's where that water came from because that drainage comes down and I think there is like a small little kahawai, the water's coming from Kula, and then it shoots down in there. The drain pipe is like a big thing and it's aiming right at the road so there's no way it is going anywhere else; it'll come right down the road. And so, when it rains there, Yes, and so many places (and I haven't been on that road) but like now we have the new highway. I remember when we first moved in and to get to cross when you pass Suda Store and you're going to go over that small bridge. I mean, there were times you couldn't go over. I mean, I know I did and after I did I thought I was dumb because I was on a Volkswagen and I went through and the water was really high. And then I thought, you know, I could have floated down in the ocean. You know, you don't even think about that. But with this new road now it makes it now where you don't have to. And it's like they say, only when it rains heavy up there do they have that kind of water problems. When we moved in our house we were told, in fact it must have been about two or three years after we moved in our house, and one of my uncles came by and he said, "I didn't know you lived here? Do you realize that I had to come over here and my job was to fill up this property?" And I said, "What are you talking about?" He said, "I had to bring in big boulders to put in. The property was below the road." And I went, "Really!" Then I said, "Is that right. When we had put in our yard, we ran into rocks but it wasn't rocks, it was boulders. We had taken out big boulders and moved it across the street. I mean they were humongous. And he said, "You know, that was my job. I didn't know you…" I said, "We didn't know anything." He said, "Yes underneath here you're sitting on big boulders." I thought, "My goodness." Then al my next door neighbors found out; they wanted to dig up some things and so they couldn't because had big boulders. We did what we could. Took out most of the big boulders and then put soil on it.

KT- So, to start with; up until the stoplight over there or just before that used to have sugar cane and mauka of Honoapiilani Highway was our cattle. There were ranches by Kaono'ulu, Ulupalakua; had different names. In the gulches that water came down from, in the report that we were able to have privy to go on this private land; almost every one of them (at least four of them) we found petroglyphs. Now, next to the new Elementary School…

C- Kamali'i.

KT- Keonekai then coming this way; there used to be, you didn't follow the story of makai of Honoapi'ilani had a discovery of a whole flock of petroglyphs. The developer let somebody go in with the bulldozer and moved it and the next day… So, we only got one existing picture that I haven't developed yet to show the importance of waterways to bring down iliahi, bring down koa to makai. Therefore, our people used to stay in specific areas. If you open up the Kula one right here and just turn to where there are pictures you'll see that…

C- Did you do all of these?

KT- Look how interesting that one is; Japanese characters, it's the same riverbed…

C- Is that Japanese or Chinese?

KT- Well, it's Chinese characters but Japanese exclamation. The writing on the left means Ito, which is the person's name. The one on the right is Diniho which means "Big Japan" and the one in the middle I have it written somewhere. But, it's been a wonderful journey that Kimokeo and I are taking in being able to walk this land because it's not

privy to maka'ainana you know. So these reports, which will be after the developers present it to the Maui Planning Commission, will be available to the public.
C- So this is what you've been doing?
KT- This is basically what this interview is about; utilizing whatever information comes from the interviews.
C- You know, it's so- well, and I'm partly wrong on that, because I was born and raised in Lahaina I most familiar with Lahaina. We lived, and I don't know if you're familiar with Hale Aloha? Okay, my grandmother was the caretaker of that and that's where I was raised. And so, then I left, when I got married we moved up to Haiku and then Olinda. So we were away, we were Upcountry for about ten years until we moved down here. So, all of the history that I knew was only of Lahaina. And of course when I went home one day and then I'm now back at our church, I discovered that our Hale Aloha was sold. Our property was sold. I about had a heart attack, how terrible! And it was sold and now I know that the County has it. But to me it was a part of our life. And now I'm back at our church, I've been there for a number of years, and all the things that we had before; our church we had lots of property. We don't anymore, we just have one more piece of property and I think how shameful that it happened. But, you know, it's who was the head of the church and what they felt they needed and so forth; but it's sad and I only know of that. I know a lot of history of Lahaina about the Kaua'ula wind and I was involved when it was my grandmother and all that kind of stuff. Coming into Kihei, when we moved to Kihei, I had to go to work because we bought a house. So, basically all I did was go to work and come home and not really learn about it. And it's only been recently, when my cousin passed away a couple of years ago, she gave me a book; Fornander's book on the Polynesian coming to Hawaii. Before she did she told me that she had this book and I looked at the book and I said, "Oh, I'd like to have one." So I came home and talked to the librarian at the school and she said okay and she looked and inquired into buying one of them. Well, it was out of print and the one that they had was $900.00 and I said, "Forget it." Well, before my cousin passed away, she handed me the book and she said, "This is for you. Please read the book and then pass it on to your daughter and then pass it on to your granddaughter." And so I said, "Oh, wonderful!" And so it's only because I got that book and I started reading and I'm going, "whoa, we were somebody. Our ohana was somebody." And what did they do and in fact I was just going over some stories that my aunty had written and cousins that had written for our 20th family reunion about how they were raised and stories and I'm saying, "you know, I need to do something." And so, I had just gone to a workshop in Honolulu before I went to the mainland and the Hawaiian Studies have a place based sessions where we go to the school and we try to teach the children about the school, number one and then about their place, you know, which was very, very interesting. And so, I automatically, not here in Kihei, I should be doing that, but automatically my thinking went back to Lahaina. And so I started and she said the idea was to start writing things about what you remembered and when you grew up. And so, I got really excited and while I was on the mainland and every chance I had, I was on the computer writing stories about what I remembered. And, I was talking to my son about it and I said, "You know, this is what I've been doing." He said, "Oh mom, that's really good." And I said, "You know, why don't you start writing? You grew up in Olinda, you really didn't know Olinda because we moved down when you were about 3 years old." And I said, "What do you remember about

Kihei?" "Well, I remember this and this and that." I said, "You know what? Why don't you start writing about it so your children will know what Kihei was when you grew up because it isn't anymore?" And he said, "That's right." He almost broke my heart when he said, "you know mom, you know when everybody's moving over here and there's no property and it's hard to get." He said, "Granted I have a house, I have my own place, I'm doing well. Sometimes I feel I just want to get up and move." And I said, "You know, that means you're leaving your island. You're going to go and you're going to think it's a good idea but then you're going to be lost because, you know, as a Hawaiian for some reason we're connected to the land." And I said, "Why make something better outside of Hawaii when you can do it here?" And he said, "You know you are right but sometimes…." I said, "Forget about people coming in and having gated property. Think of you, what do you want to do? What do you want to do? Where do you want your kids to go? How do you want your kids to be when they grow up? Do they want to be part of this land? Then you need to teach them. Say, 'this is where I grew up, this is what happens, I'm going to do this so you folks can have this but you have to learn how to carry it on and pass it on.' See son, you know more about Kihei. I worked so all I did was go to work, some home, go to work at the office and then teach hula at night and that kind of thing so I was all involved with that." But I said, "Now it's different. The job that I have now, I'm a lot more free so I'm now thinking I should have done this, I should have done that, but do it now. Learn about what area that you're living in." And it's only been- when I was in the mainland I was writing the stories about Lahaina I said to myself, "I don't know anything about Kihei." I really don't. Except I know about the fishpond and I know that it's not only there; there's lots of fishponds in Kihei. You know, did you know this? Did you know that? You know and it was only well, we went down here- what is her name, the Hawaiian girl that is down here used to be with the fishpond?
KT- Joann Olivera's niece.
C- Yes. And through them and through Kimokeo we learned about that and we were going to do another one and we were going to do it eventually through the Akina family; Bonnie is setting it up so that we will learn. And I said, "I want to learn more, I want to know more about this place. All I know is where I live because I've been working." Now I don't work as much, I'm thinking while I was on the mainland, I should come home and I should learn more and then you called me to tell me to do stuff like this. I want to know more about Kihei. I never learned. I never knew anything. People were always busy but a lot of them are not busy anymore and we have the time.
KT- What you're saying is important for young people to get. How old is your son?
C- Thirty-eight.
KT- So, it's not unusual for young people like him (maybe younger, maybe a little older) to have these feelings because it seems like other people are making decisions for us but we're letting it happen. So, like you said, it is how I feel and Kimokeo and many of us who are taking a positive, not a physical, approach but an intellectual positive approach to not only holding on but doing something.
C- Yes, and it's important that we do that, it really is important; we need to do that. And you know, I don't want to see my grandchildren moving off island. You know, they're all going to a good school now, they're very, very young and as much as I can I try to teach them different things; values, I teach them what I grew up in. When I grew up I learned a lot of things from my grandmother, values that were very important. Um, and

so, you know we have a way to better ourselves and to help one another. So I found out that I learned more from my grandmother so when I do things, I do things from what I had learned from my grandmother and I've taught my children the same values I learned. I was very hard and you probably came from the same kind of things I did when I was brought up; you were to be seen and not heard. You had no choice, you were just given things and you did it, there was nothing wrong with it; that's the way you grew up. But, I married a haole and my kids did not like the way I did things. When I moved into Kihei I was labeled as the meanest lady in the neighborhood with my kids.
KT- By your kids?
C- Not from my kids, the neighborhood kids because I was very strict with my kids. If I was not at home and they came home from school they had to stay in the house, do their chores. The only reason I did not want them to go out and play is that if they got into an accident there was no adult around. So, I was the meanest lady and it didn't matter. When my daughter became- was ten years old- she said to my husband, "I hate mom because she lives in another world. She's not in our world." And so my husband said we better sit down and have a conversation. I was very upset. If I could have I probably would have hung her on the tree, I was so mad. How dare you, tell me your mom, about that. So we sat down and I was very upset and my daughter said, "Mom, we're not in Tutu's world, we're in a different world." I said, "What is your problem?" She said, "Every time we ask you for something we don't finish our sentence and your answer is no." And so my husband said, "You know, if we don't resolve this, the kids are going to hate you forever. The kids will get in trouble or they'll leave you, whatever." And I was very upset and then I said, "Okay, I'll make a deal. I will try real, real hard. I will try to look what is happening in today's world and not look the way I was brought up. I will work hard at it and I will try to see how I can make things easy. I cannot do it overnight and there is no way I can do it in six months. It's going to take me a long time because I was brainwashed the other way." And so the kids said, "Okay, we'll go with you that way." I said, "You gotta be patient and I have to be patient." And so for three years we worked at it and I can turn around and I can say to myself how lucky I am because my daughter is more haole thinking, in a sense where the new technology coming up, she is very involved in that kind of stuff. So, her mouth is faster and so she just stays the way she is; and that's okay. On the other hand my son is very Hawiian and he's like I am. You don't get involved into anything unless you can see the outcome. And we both think that way. I had to say to him, "You cannot think like me because this is a different world. In my world it was okay but with today's technology with everything, the ideas of people it's very different. You have to look ahead and see how you can handle it."
KT- Even though that situation exists the Hawaiian values of ancient times have become more valuable than we gave respect to before.
C- That is so true and it continues. I see that now and I say to myself, "I'm so glad my daughter opened her mouth." If she didn't, I don't know where I would be, really. She made me see the idea to take all your Hawaiian-ness and then you look at the other side- you look at the American side and you take the good part of it but you keep what you learned in your Hawaiian. I see that in the way my kids are today. I see my son training my grandchildren and I do the same thing. Think Hawaiian; the values are important. And today, people respect him and his family because of his ideals and his upbringing and how he is. He doesn't jump at people or whatever; try to work it out. "Well, this is

the way I would do it." You know that kind of thing whereas other people will get upset. There are a lot of young families that are always saying to him, "You know, I don't know what it is but you kinda bring all of us together and your kids are very well behaved and your kids teach us things that we have not learned from our parents." And so, I see that happening and so I know for what I have learned I have taught and they're learning and they're teaching. Same with me; we're not only teaching ourselves, we're teaching anyone that comes in contact with us. You know Hawaiian style you have to be careful of what you say about other people. You know, it's not nice; not even kiddingly, it's not nice. My husband sometimes has a habit of just saying things in fun but not realizing that it's not always funny. Gotta be very careful and it's something that they have a hard time because they're not taught that way. We think before we open our mouths. I say, "You know one of the worst things I was taught, my grandma said to me, 'Be careful of what you say because you cannot take it back.' You cannot do that." You know? And it's something that you know, when we think about it, that's true. You know its how you're thinking.
KT- We're reaching 10:45 and I know you gotta be going out, leaving pretty soon so; In reflecting whether you know, or historically looking at it, there has been major change in this the ahupua'a of Honoaula. The area that we're investigating really comes under the ahupua'a of Kula which includes Waiohuli, Kaonoulu. So, as a person working in Hawaiian Studies in the DOE, you folks have had experts come and talk about plants. You as a Kumu Hula know that value of plants. Are there any things that have made an impression upon you of the plants that exist in this area that we're talking about?
C- No, only from what Kimokeo had said to me a long time ago. I guess when he first got involved with Honoaula about all the different plants that they had in there. I don't see a lot of Hawaiian plants at all.
KT- You know the name Mahealani Kaloku'okamaile? See this picture, he's in that one right there.
C- Did you do this? Did you folks do this?
KT- Yes, this is our work. This is his philosophy: He said anybody can drop him anywhere on any island in Hawaii and he can point out the indigenous plants of Hawaii. The point being it still exists but it behooves us to learn what it is.
C- Yes.
KT- So, I think one of the grants that should be developed is utilize his passion. You know he's doing construction work building houses and his bosses are saying, "Eh, you don't belong doing this. You belong talking about who you are and what you know." So, I agree. I mean, here is a young man in his 40's. Do you know Renee Silva?
C- No.
KT- These are the names you should keep. The name Silva. Now, I just assisted in Mahealani in the protocol in doing a blessing for the KIRK Kahoolawe group. The weekend before the earthquake, the Saturday before the earthquake, and their goal was to go into Kula and do protocol to send the rains to Kahoolawe because it's getting dry; and the rest is history. You can take it for what it's worth. Whatever they did, did it have effect or what? But, this man, as a Hawaiian, is one of the brightest, passionate, I mean…. I cannot let these books out yet because they haven't been presented but I would love to run a copy. I might have a black and white copy if you want to take a copy.

C- You know my grandfather… See, what is his name? Elden, Elden Levi is an entertainer and his grandfather's name was Levi Ka'iaokamalie. They dropped the Kai'iaukamalie and he went by the name Levi. When Elden got married, Elden shocked everybody in the whole church when the minister said, "I would like to present you to Mr. and Mrs. Elden Ka'iaokamalie." My uncle's son (who was the Elden) dropped, changed his name without his father knowing. They were just totally shocked and father was hurt and then afterwards they said, "Why you hurt? He's brining the name back, that's what it was." So that's how my tie in; in fact Hamby's niece, I heard that somebody hit and run they had a funeral tonight, there was that Arcangel boy 25-26 years old was hit by a car (hit and run) and they're having the funeral today and tomorrow. It's his grandmother who should have been a Ka'iaokamalie instead of Levi and they all come from up that area. And so, as a child my grandma used to take me up to Kanaio and it was all the same family and I didn't realize that they lived up there. Somebody said, "You used to go up there?" and I said, "Yes. It was near the main road and then we went there and the lady's name (all I knew) her name was Aunty Mileka and she lived right on there on the main road going into Kanaio before you go into Kaupo. And we went up there at least two three times a year and it was a family thing. And I go, "I remember that." And so, one of the boys that works with Hawaiian Studies is Russell Ka'iaokamalie and he's at Makawao School.
KT- I wonder if that's the brother?
C- I was just wondering, Yes.
KT- How old would he be?
C- Russell? Maybe in his late 30's if anything early 40's.
KT- Did he work on the Mo'olele, do you know?
C- I think he's involved with Kahoolawe also. His wife is now a school teacher at Kamehameha Schools.
KT- Might be the younger brother.
C- Could be, Yes; But that's interesting that you're talking about they went over to Kahoolawe last weekend and my sister happened to be on that. KBH went over to paint the barracks and they didn't pau and so she was telling me- Actually she's my half sister. We both have the same mother but we were raised; she came back, my mom had her, when she was born my mother couldn't take care of her. My grandma brought her home, I was in the fourth grade, I raised my sister. And we got married and my grandpa said, "I'm going to go pretty soon, you need to take care of the children." I had my sister and a cousin living at home and after my grandfather passed away I took my sister. My cousin couldn't go with me and then my husband said, "I don't like this idea of us taking care of her and somebody pick her up and take her." So we adopted her. But she had an experience on Kahoolawe. And she said that the morning they were out doing the rising of the sun and she said just before they did a presentation of- they had taken a coconut and she said the earthquake started. And she said it was unbelievable! Everybody had to go back to the barracks and everything and they had a ho'oponopono because they didn't understand. She said, "You know what? I wasn't being negative." But she said, "I was thinking, did I cause that? And all of a sudden maybe the way we were thinking caused it." And I said, "Well, you know, did you guys talk about it?" And she said, "Yes we did." My problem, Keli'i is that I was raised with Emma Sharpe as the Kumu Hula or as a student, whatever, I learned a lot from her. I never- Aunty Emma was not a chanter.

She taught us the traditional; Kalakaua, Ae ala o Pele, that kind of stuff. She was afraid at that time to teach us something that maybe we could not handle. And so therefore, she was more of an Auana then she was Kahiko. And so, my knowledge, every chance I get to go to whatever workshop I can, I want to learn because I never learn. And I want more so now to learn the different protocols and the different oli's. I have a granddaughter who went to, she's at St. Anthony's and she's very young, she's only seven years old. But last year she was six years old; she went to Kamehameha School for summer program. I don't know who was up there that taught them to dance, to sing and taught them oli. This is my gifted child, this little one. She came home and she did and oli for me. I had chicken skin, I sat down and I thought, "Wow, I need to do something with this child." She's a tomboy but when she dances hula there is no tomboy in that girl but she loves, I've been trying to teach her to do simple chants to pa'i the ipu and do things like this because I find that she is probably the most gifted one than my other two. They all dance hula but this one is very, very special. To pick up an oli and to sound, and she was only six years old and to come out with it; I was very impressed. I was very impressed with this child and I thought, "Okay grandma you don't know anything about things like that, the kahiko stuff. We need to get somebody to do something with her." And that kid will take-she is a learner; she's a child that you don't need to tell her what to do. She will walk in my house and she'll say, "Grandma your house is messy." And I could have dishes in my sink and she will just go right over there and she will start and she will look around, you know. Or if somebody walks in, or they come to my house; I have company they don't even know and she's the one that walks in and she says hello and she gives them a hug. You know, that kind of thing that is normal for me to do. And I'm seeing that and I'm saying, "Well, at least I'll have somebody that will pass it on." And you know, it's sometimes it's nice to have children that are very akamai but that's all they are and they have no common sense. And I have my oldest granddaughter and my daughter are both like that. But this child, I swear she is very gifted. She is as bright as can be. She is very loving and caring. She's just taken all of her- what she knows- I'm saying her Hawaiian blood and she's found all the things she can do and she does it. I mean way beyond me and I'm thinking, "Whoa, that one's going to take care of my halau. That one is going to carry on what I had and be even more better than I am." And I said, "I need to help that child. I need to expose her to the things that I know she can do." I mean a fabulous basketball player, a softball player, a soccer player, hula dancer; I mean everything. I mean, hey I can do auana, that's my thing you know, but it's more, you know; and how lucky. So I'm looking around and I'm saying, "You know I gotta send this kid someplace, she wants to learn you teach her." You know, to give a child a knife and tell her to cut onions, it's unheard of for a six year old; not this one. Show her how to be careful and everything and she can do it. That's almost scary, you know, to have that.

KT- Today we're more with it but me out of it, looking at it; the world is changing so quickly that the people are changing and periodically there will be such children and I'm glad you have one. But, two things I want to say. Number one, what came out of your mouth at the early stages of this interview saying that you're a non-reader; I'm a non-reader. I always looked at. Okay, I tell my children, "I don't like to read. But your dad is holding a doctorate degree. And why is that? Because I found what I'm passionate in doing and that's how you gotta enter your life." So my son went to MCC, quit both

semesters, then he went back for the third time and I don't know what he's doing now because I kept trying to coach him to take the classes you love first. But he went the opposite way. See, no listen. But that becomes a challenge when they want to be independent and not use the advice of the makua or their kupuna. It creates some challenges for them. He will succeed but why go the hard way?
C- Yes, go around first, Yes.
KT- Yes; Here's the path, go through the path and create more just like your creative child here. You show 'em how and she just go.
C- Yes.
KT- And that's how they need to be.
C- I think my son, my son is the- he's East Maui Irrigation Vice President and he works with all the Hawaiian boys out in Hana. He went to college for communications and came home and applied at A&B only to find himself working out in the fields. And the idea behind that was, "Mark, you have communication skills. You need to communicate to this- we brought somebody from the mainland, they don't know how to communicate with the people in the field." So he went and he was very good at it and it was strange because he's married to a Filipino. He knows more Filipino than his wife does because when she came here (they moved to America for a new life) the mother said to the little girl, "You gotta learn English, you not going to learn Filipino." So, and which is okay. But then when he went to work to Kailua and they were still kind of, you know, haole boy, you know, he doesn't know us local people and then they found out he does. And then they go, "Boy, how you know all this local stuff?" And he says, "My mother's Hawaiian. I'm Hawaiian." "You're Hawaiian?" He said, "Yes, I don't look like it but I am." And so, he works with them and he said, "Once they found out that I wasn't really a haole, I can work with them, they can work with me and I can…" He said, "What I'm trying to do is I'm trying to help educate them." But they're finding that, going to work is a good thing. Hey, I can be somebody. Hey, look at me, I'm better now. And he said, "That's how you do it." And I said, "Well, you have a gift to do that." Both my children have a gift of sharing their culture; taking what they've learned, taking their, all the values that they've learned (well not so much the Hawaiian cause they know that) he said, "Mom, they're changed now. They're very proud of themselves. They feel like they're somebody now." And he says, "I don't ride 'em. He said, "That's not my thing and when they do a good job you guys say thank you, you know." They said, "What is wrong in saying thank you because without them, I wouldn't have the work done." So, it's become a normal thing for him. My daughter is the same way; she pick up people and she teach them, she train. No, the way I learned it at home, we do it like this and don't be nasty because you know, she's the boss and whatever. You know, don't do that to people, that's not right, you know, that kind of stuff. So they learn those things but to pass it on! And then I'm finding that the grandkids have learned those things and I'm saying, "How lucky." So, I know they know. I know they have the values which are important and I'm happy for that. So, I in turn, whoever is in contact with me, they're going to have to learn from me. And a lot of friends that we have from the mainland come back year after year and I, "Oh, we're going to a party." And they, you know, "Let's not do this." You know and they say, "Eh, stop and think. If it was you, what would you want them to do?" And those are the just the simple values. But they're not trained. They don't do things automatically.

KT- Here's something you posses that was passed on to me early by Hoku Padilla and when I moved back to Maui she made this prolific statement that I agree uipon. She said, "The culture has been carried on by hula halau's and coming close." And the reason why I embrace Kimokeo's friendship, he asked of me if I would help him when he was the President of Kihei Canoe club. That's how we became close which has lead to ceremonies here and there; but, when you really think about it, that's true. However, other areas had come from it, but those two things are the foundation.
C- I've had hula kids for so long and you know, I don't even think about it but parents do say (and look at it and I don't think it's true) but they say, "You know Aunty, you not only taught the kids hula, you taught them values; you taught them how important they were and that they should think about other people too. And for what they've learned in hula class that they should share with other people." And you know, our kids have gone away to school to the mainland and I still work with the kids who go off to school; they'll call home and they'll talk to their parents and their parents will tell me, "Aunty I gotta make 15 hula skirts." "Oh, Yes I'll be alright, I'll make it." The kids are going to have it, that's fine, no problem. But these are not Hawaiian kids. These are other nationalities and I'm saying, "Am I doing that? Am I actually doing that?" And if I am, then I'm glad I am. It's not only my grandchildren. And my goal everyday ever since I got into Hawaiian Studies class in teaching, if I can go to school and make one child happy at the end, I'm doing okay. You know, if I can give them a squeeze and they say, "I love you." That's my day so I can do that.
KT- Was it by accident you got recruited, or you just….
C- No, I wanted to do it. I mean, I was working at a fine jewelry store at one of the hotels down in Wailea and I went (in fact was Itntercon) and I was- a new lady had come aboard to take over and she was on my case and she said, "I don't want you to be particular about everything in the store. I want you to sell." And I said, "Well, I can sell but I'm a very fussy person about jewelry and stuff and I'm fussy about bookwork and stuff." She said, "Well, I don't need that." So she made me upset. So, I had called DOE and I had talked to Ron Okamura and I said, "I understand you have a Kupuna program. I don't know anything about it, can we talk story?" And he said Yes so I went up and he said, "You know by the way (and this was like on a Thursday) by the way next week Monday we have a two week workshop on Maui. Kamehameha School is coming over and training teachers and Kupuna and if you're interested you can go to that." And I said, "Well, I don't know. I'll think about it." So I called my husband and I said "We need to talk." We went to lunch and I told him about the program and my husband's way of thinking was money because we had both built KNUI Radio Station and I had worked with the radio station and I was still doing stuff at the radio station and I was doing my job and teaching hula and I told him. You know I said it sounded like a real good thing I really want to get involved in. He said, "How much money are you going to make?" And I said, "Eight dollars and hour." And he said, "Is that all?" And you know, we had just bought our house and stuff and I was very disappointed. So, I got out of the car and he came out and he said, "You know what, take the job." And I said, "What changed your mind?" He said, "All this time you were talking to me about what the Kupuna has to do and stuff, you face just lit up." He said, "Take the job." So I went back to work on Friday and the lady was still on my case because she was a new manager. And she said, "Now I want this and this and this." And I said, "Oh, you know what? I'm turning in my

resignation. Sunday is my last day." She said, "What did you say?" She says, "Do you have a job?" I says, "No." She said, "Then why you leaving?" I says, "Maybe you would find somebody else better than me." She said, "Well, who's going to do my books?" I said, "I don't know but I'm leaving, I'm sorry I will stay until Sunday." She said, "That means I have to come back again." I said, "That's not my problem, that's yours." So on Sunday was my last day and I went to the meeting and I didn't know anything and I got in there and I thought, "My goodness, is this us." And for two weeks, it was just a wonderful program.
KT- Do you remember who came over?
C- It was the two ladies from Kamehameha School; Maheanlani something. Pescaia and somebody else from Kamehameha School.
KT- Little older then, Pescaia.
C-Yes. And so, I got involved in that and you know, I was so lolo because I didn't know anything and that was during the summer. Kekealani had just become the new po'o for that position. So, I went in and I checked in and I got involved and I thought, 'wow'. From that I was so excited, for two weeks, I couldn't wait to go to class. It was like, years later, it was almost like I was involved with Aunty Kanakaole; when she came to teach it was something like that. They kept saying, "You know what, it's nothing that you gotta learn. Stop and think; how were you brought up? What kind of valuesd id you learn? That's what we want, it's got nothing to do with reading the book. This book here shows you, gives you ideas if you're looking for something on the wa'a or something, it tells you. That's all. It's what you grew up with and I said, "really." And they said, "Yes." And I went to school, I didn't start work until February of the following year. I was terrified and she said, "just remember; just go down." So, I went in told the teachers this was my first time, "You're going to learn and I'm going to learn." And then as I was teaching, I go, "Whoa, that's right, that's what I learned at home." So it became very easy.
KT- Do you know, what is his name from the Carvalho family?
C- Yeay, Ka'aehui? No.
KT- Relative to Ka'aehui, what was his name. Anyway I turned over my cultural classes at MCC to him. Oh, Hinano Rodriguez; they're ohana. But Hinano was a professor at UH when I used to go. When I was working on my doctorate he was a teacher so I used to go sit in his language classes. He emailed MCC, he said, "You know, I'm pretty good at the Lahaina ahupua'a but the Eastern side I'm not too good." So they kicked it to me to respond to him. So I called him up and I said, "Hinano, this is how you approach this." Because he was thinking he was falling short of what the job required. I said, "Hinano, you know, you've been there in the classroom. You know 90 percent or more are po'e haole. Just by that fact, you know you know more than them. So because you know more than them, you can work with them because you know more than them."
C- That's true. And you know, my biggest thing is there was a teacher and I was teaching her class (it was a sixth grade class, I think) and we were talking about sugar cane and there was a word that I used; oh, the word "hapai" and I was telling the kids what hapai was and I was showing you know, so that they would understand. And the teacher said, "excuse me Kupuna, that is not Hawaiian, that is Japanese." I went, "No, I think you're mistaken." She said, "Nope, that's what we use in our house." I said, "Oh, your father work in the sugar plantation?" She said, "Yes." And I said, "Your father

would come home and say 'I tired today, I had to hapai ko.'?" She said, "Yes." And I said, "It's Hawaiian. Your father was learning the Hawaiian." "No I grew up with that, that's Japanese." I said, "No, that's Hawaiian." And so I'm saying, you know, people don't realize and that's what we do. It's our nature, we just throwing the Hawaiian words and so it becomes part of their culture and they think it's theirs, you know; which I think is great. But teaching Hawaiian Studies really, really- I don't really enjoy my job right now.
KT- Which is?
C- I'm like the resource teacher going and…
KT- For the DOE?
C- Yes. Kind of keeping tabs with the school. I have a good relationship with all the principals, all the sasa's. I don't have problems and they like to work with me but I miss the teaching. So, whenever I go to a school and the Makua is not there or the Kupuna, I jump in there. I just get involved in there and I teach and then of course I do a mistake because then they say, "Will you be our Kupuna?" "No, I'm sorry I cannot." (laughing) But I really enjoy it and I do that with the kids at hula, I teach them values and stuff.
KT- Every school has a Makua or Kupuna?
C- Not all, I'm looking for people. I need one at Iao and there's couple of; well, Lihikai needs somebody. It's very difficult to find because they like the pay, the pay is good now it's 20 dollars something, 22 dollars or something like that.
KT- My question, just like Mahealani; I made a statement, in there I left in the interview was, oh and even my transcriber who worked on this she said, "Wow, he-by this report (which I'm going to find a copy for you)…" By what she read of his work prevented her from away.
C- Really?
KT- That's how powerful. He's only in stories but he was grounded at a small keiki time. I was in Kahikinui doing a ceremony in the 80's; you familiar with Kahikinui?
C- Yes.
KT- You know, there's that hill that is the Luala'inua and the Kahikinui ohana had a house on the right hand side for the people go plan and so forth. So, I was there and so you can visualize. I was there looking up the road and I see this movement coming down the road. And I know, I mean this is from Kanaio. Where this guy coming from? And Kimokeo is like him. Kimokeo goes up and down the mountain by himself. These are the kinds of guys that I'm so appreciative…
C- He looks like Russell. Next time I talk to Russell; he looks like Russell.
KT- So I told him, "What, why are you so passionate?" Well, you know we're doing this with developers but the way he looks at it, you know, developers say, "Bulldoze, no more any culturally significant things." And what they're referring to is no more heiau's and no more stone walls and stuff. But his mana'o is 'eh, as a cowboy right in the corral I look down at my horse and there is a ko'i or an ad (you know the front part of it) what is that if that's not cultural." And generations have used this corral but that ko'i was for me to pick up to come to come to the realization.
C- Well, this has been very, very wonderful.
KT- Likewise. Let me go look for that report. So the process is I'm going to transcribe, come back to you to let you look at it to approve and then we'll have your signature and then submit it.

C- Okay.  Wow, that's a lot of work!

Appendix F
Preliminary Engineering & Drainage Report

*Established 1969*

# Preliminary Engineering Report

## Maui Research and Technology Park Master Plan Update

Kihei, Maui, Hawaii
TMK: (2) 2-2-24:1-9, 14-18, 31, 32, 34 and 36-46
(2) 2-2-02:54 (por.)

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**Preliminary Engineering Report**
**for**
**Maui Research and Technology Park Master Plan Updated**

# 1. INTRODUCTION

## 1.1 Purpose

This report describes the existing infrastructure in the vicinity of the Maui Research and Technology Park and identifies the key improvements that will be needed to develop the MRTP as proposed in its updated Master Plan.

## 1.2 Project Description

The Maui Research and Technology Park (MRTP) is located mauka (east) of the intersection of Piilani Highway and Lipoa Parkway.[1] (See Figure 1-1) Prior to its development, the lands comprising the MRTP were part of Haleakala Ranch. The MRTP was the vision of a core group of community leaders in the early 1980's who sought to diversify the economic and employment base on Maui beyond tourism and agriculture. The MRTP is now home to a diverse range of companies and government projects working in such areas as computer science, disaster mitigation, information technology, high performance computing, space surveillance, scientific research, optics, and photonics.

Since its inception in the late 1980's, the approximate 411 acre MRTP is only at approximately 10 percent build-out, with 11 lots sold and approximately 180,000 square feet of structures in five (5) buildings with a total of approximately 400 employees. Today, everyone

[1]Lipoa Parkway is referred to as Lipoa Street makai (west) of Piilani Highway.

working in the Park commutes since the development has no housing and few support services or amenities. The proposed Master Plan Update utilizes the principles of New Urbanism and Smart Growth to transform the current, single-use large lot research and technology campus into an integrated and vibrant mixed-use community focused around a regional knowledge-based industry[2] employment base.

The Master Plan will be implemented in phases, with key infrastructure tied to the phase of development and as the improvements are warranted. Figure 1-2 identifies the current zoning of the MRTP and Figure 1-3 identifies the two phases of the implementation program. Phase 1 will be located directly off of Lipoa and will consist of residential, mixed-use commercial, civic, and the employment core land uses. Building upon the land uses in Phase 1, Phase 2 will consist of residential and employment land uses on either side of Lipoa Parkway.

## 1.3 Project Location

The Maui Research and Technology Park is located in Kihei, Maui, Hawaii, approximately 0.2 miles east (mauka) of Piilani Highway. The Elleair Golf Course borders its westerly boundary, Waipuilani Gulch borders its northerly boundary and open pasture land currently owned by Haleakala Ranch Company lies along its easterly and southerly boundaries. The MRTP project encompasses approximately 411 acres, of which approximately 37.45 acres have been sold or developed. (See Figure 1-2)

[2]Industries characterized by highly-skilled workers in fields such as science and research, biotechnology, clean technology, information technology, disaster mitigation, education, healthcare and medicine, media production, and professional services and similar knowledge based organizations.

Primary access to the MRTP site is from Lipoa Parkway, which intersects Piilani Highway approximately 0.2 miles west of the project site.

## 1.4 Project Site Topography

Elevations across the project site range from approximately 270 feet above Mean Sea Level (MSL) along its easterly boundary, to approximately 160 ft. MSL along its westerly boundary and approximately 73 feet at the Lipoa Parkway / Piilani Highway intersection. The average grade across the project site is approximately 3.2%; however, this varies considerably at the many knolls and gullies present throughout the MRTP site. (See Figure 1-4)

## 1.5 Development Phases

The MRTP is envisioned to be developed in two (2) phases. Phase 1 of the project will include an 86 acre employment core, 58 acre *Village Center*, 39 acre *Makai Residential* and 6 acre existing *Drainage Detention* area encompassing an area of 189 acres. Phase 2 of the project will be comprised of a 90 acre *Knowledge Industry Campus* and a 124 acre *Residential and Knowledge Industry Expansion* area encompassing 214 acres. Lipoa Parkway, which will be subject to further improvement in both Phases, encompasses an area of 7.9 acres. (See Figure 1-3)

The *Employment Core*, which is part of Phase 1 of the MRTP, will remain exclusively in employment uses, although incidental supportive retail uses will also be permitted.

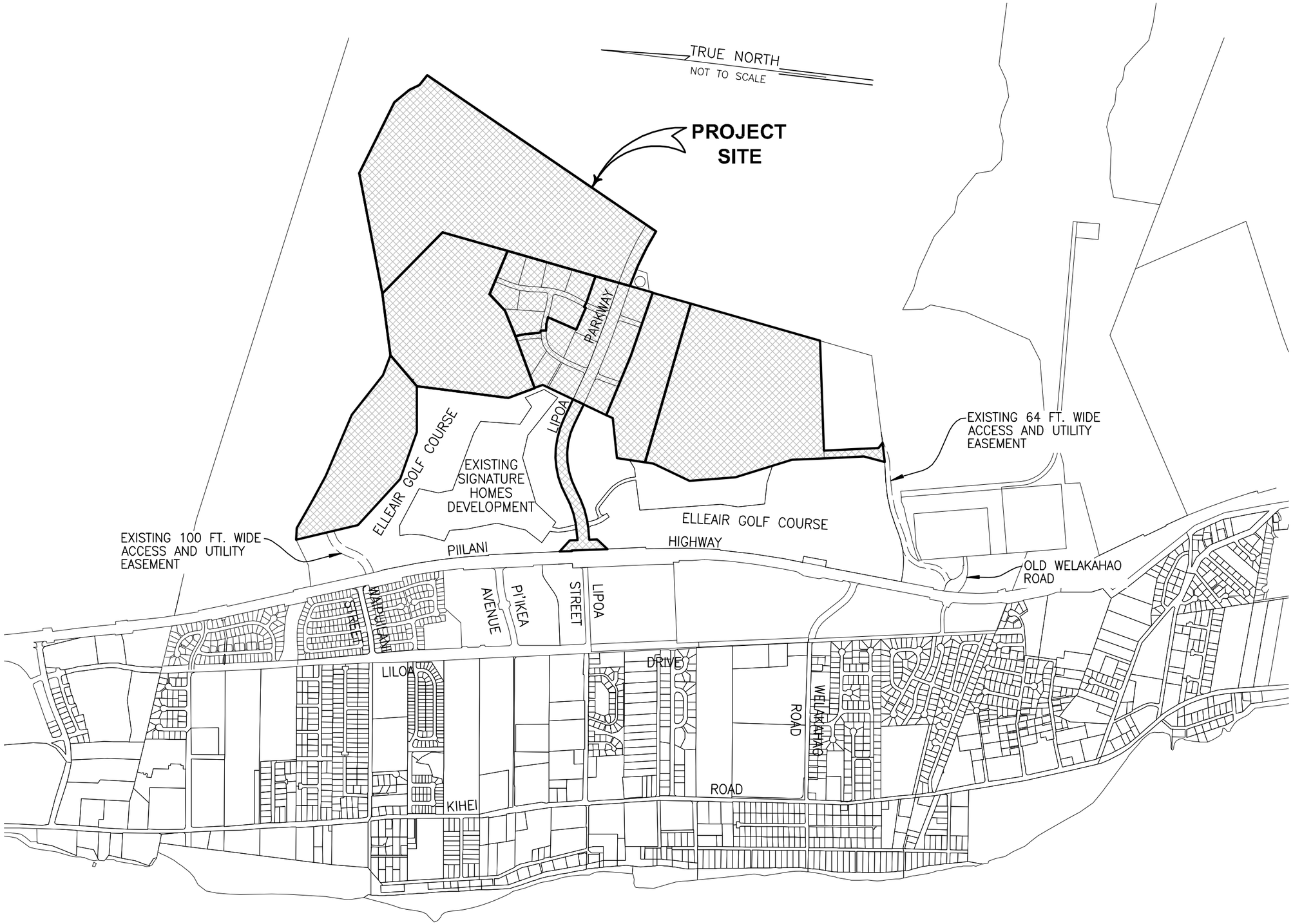
The *Village Center* is included as part of the Phase 1 development and is expected to be a flexible area containing space for incubating new businesses as well as supportive retail, civic uses, residential uses and open space.

The *Makai Residential Area*, an area designated to provide additional housing in a variety of formats appealing to MRTP business owners and employees, will be included as part of the Phase 1 development.

The *Drainage Detention* area located within the limits of Phase 1 is the site of an existing drainage detention basin that was originally designed and constructed to support the Piilani Village development located downstream of the MRTP on the westerly side of Piilani Highway. This detention basin will not be utilized to address the drainage requirements for the MRTP project.

The *Knowledge Industry / Campus* area, which is part of the Phase 2 development, will provide large new areas for employment expansion and diversification.

The *Residential and Knowledge Industry Expansion* area, which will provide land for employment, residential expansion and open space, will also be included as part of the Phase 2 development.

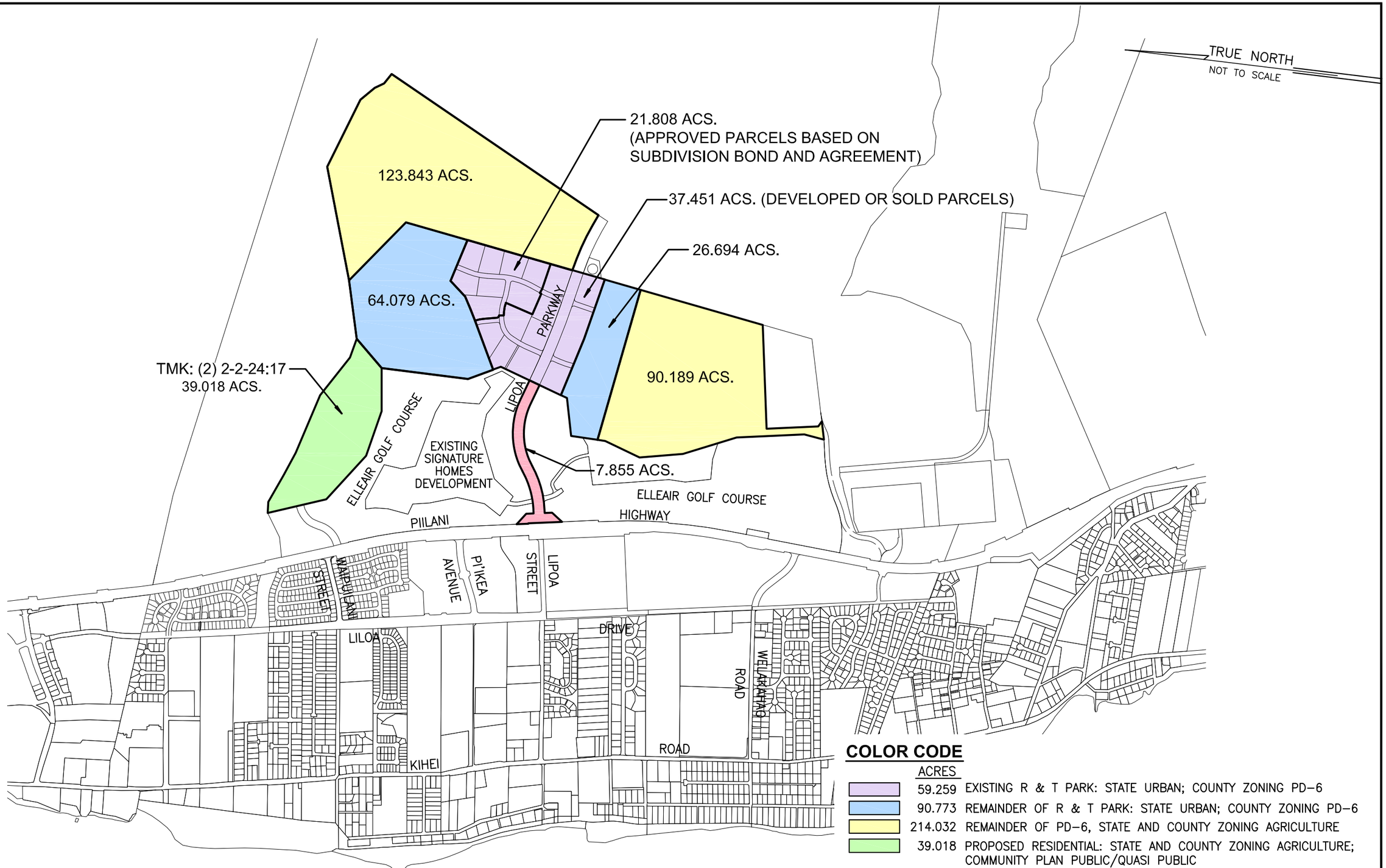



# LOCATION MAP

NOT TO SCALE

**FIGURE 1-1**

V:\Projdata\08proj\08028 (Maui R&T Park - Master Plan)\dwg2008\exhibits\Land Use-00.dwg




## COLOR CODE

| ACRES | |
|---|---|
| 59.259 | EXISTING R & T PARK: STATE URBAN; COUNTY ZONING PD–6 |
| 90.773 | REMAINDER OF R & T PARK: STATE URBAN; COUNTY ZONING PD–6 |
| 214.032 | REMAINDER OF PD–6, STATE AND COUNTY ZONING AGRICULTURE |
| 39.018 | PROPOSED RESIDENTIAL: STATE AND COUNTY ZONING AGRICULTURE; COMMUNITY PLAN PUBLIC/QUASI PUBLIC |
| 7.855 | LIPOA PARKWAY (EXISTING STREET): STATE URBAN; COUNTY ZONING AND COMMUNITY PLAN AGRICULTURE |
| TOTAL: 410.937 | |

# CURRENT ZONING

NOT TO SCALE

**FIGURE 1-2**

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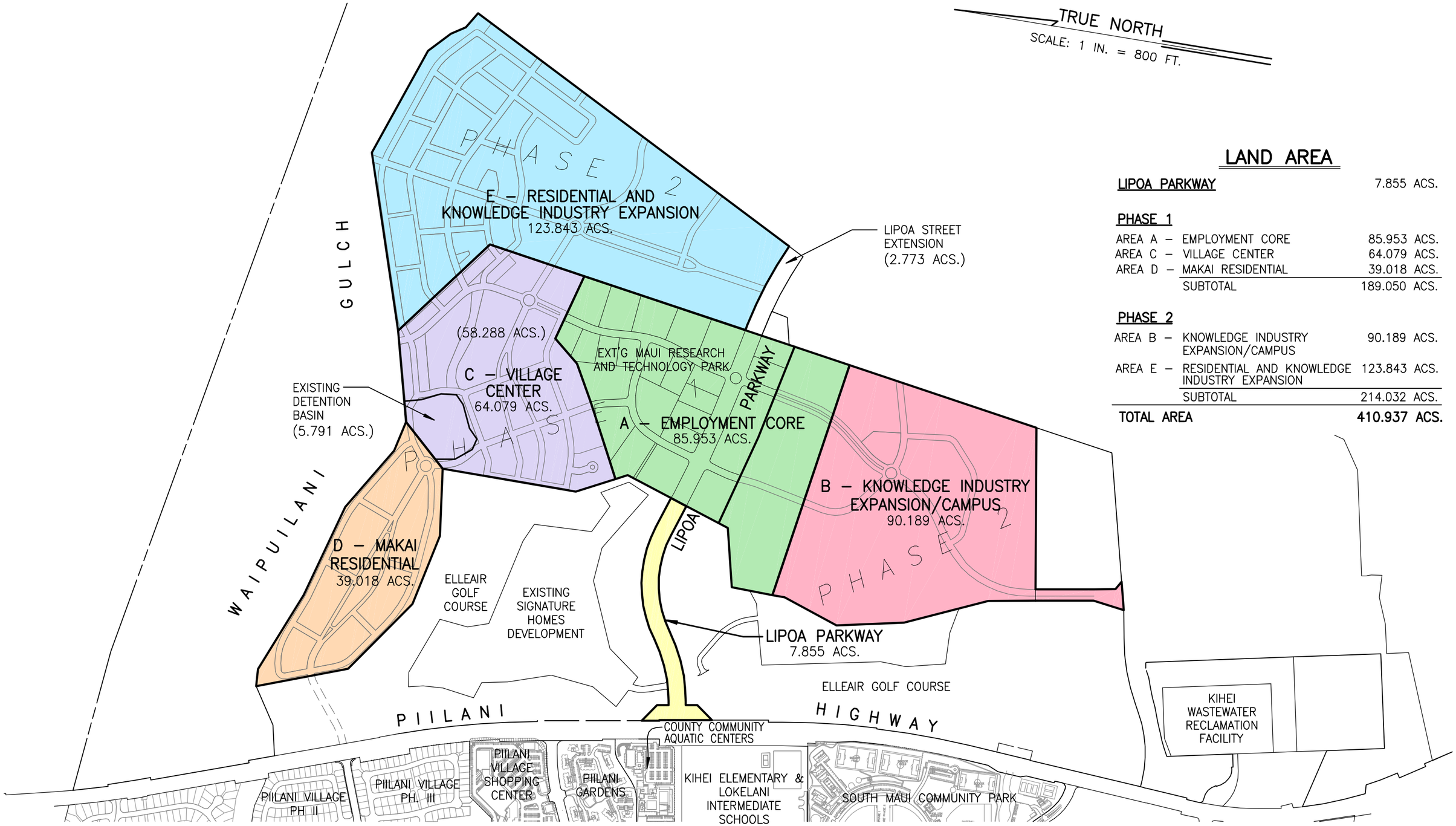



## LAND AREA

| | | |
|---|---|---|
| **LIPOA PARKWAY** | | 7.855 ACS. |
| **PHASE 1** | | |
| AREA A – | EMPLOYMENT CORE | 85.953 ACS. |
| AREA C – | VILLAGE CENTER | 64.079 ACS. |
| AREA D – | MAKAI RESIDENTIAL | 39.018 ACS. |
| | SUBTOTAL | 189.050 ACS. |
| **PHASE 2** | | |
| AREA B – | KNOWLEDGE INDUSTRY EXPANSION/CAMPUS | 90.189 ACS. |
| AREA E – | RESIDENTIAL AND KNOWLEDGE INDUSTRY EXPANSION | 123.843 ACS. |
| | SUBTOTAL | 214.032 ACS. |
| **TOTAL AREA** | | **410.937 ACS.** |

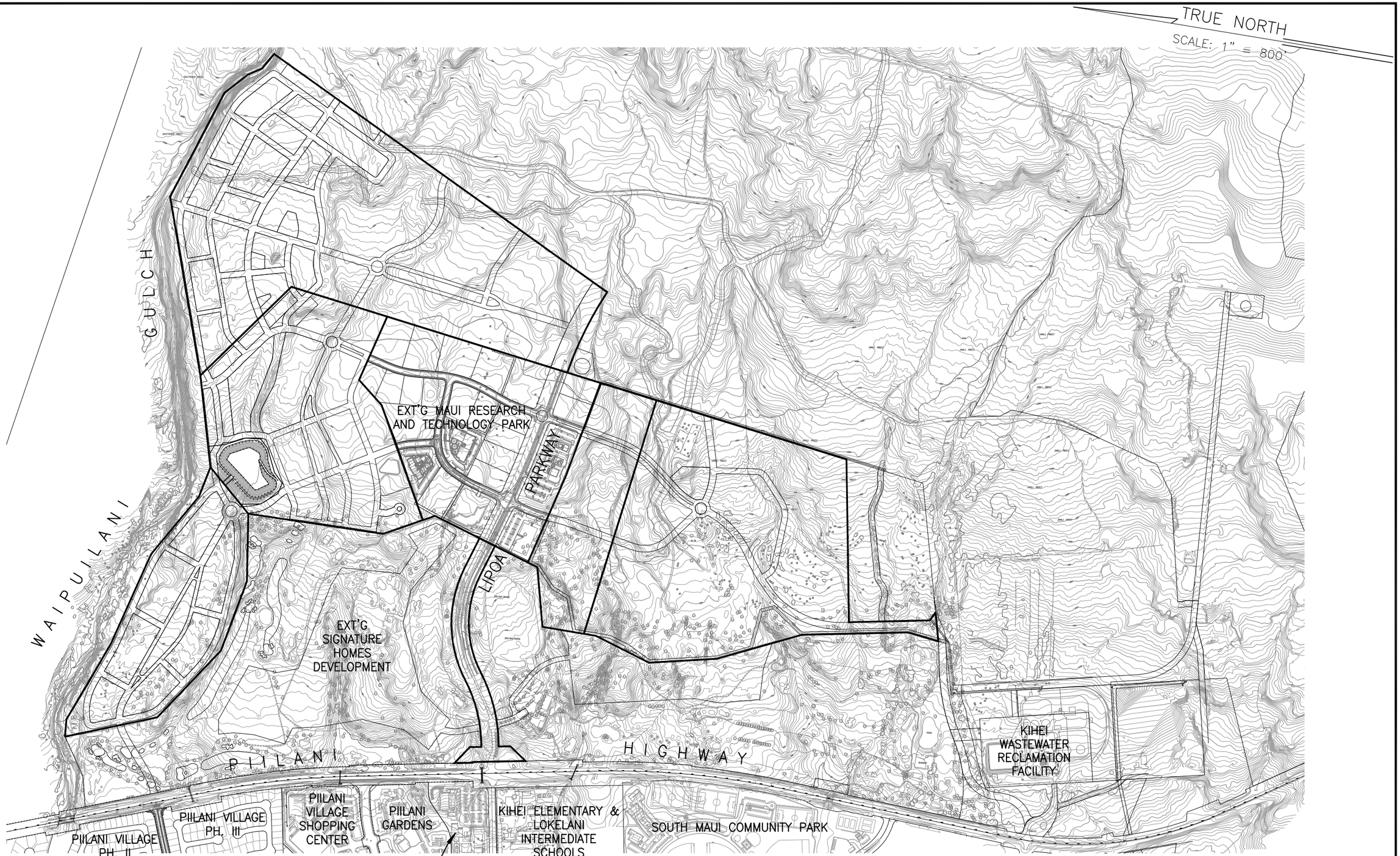
## PHASING PLAN

0 800 1,600 2,400 3,200

SCALE: 1 IN. = 800 FT.

**FIGURE 1-3**

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Preliim Engineering\Exb-Phasing-00.dwg




# EXISTING SITE TOPOGRAPHY

0 800 1,600 2,400 3,200

SCALE: 1 IN. = 800 FT.

**FIGURE 1-4**

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Land Use-00.dwg

# 2. WASTEWATER SYSTEM

## 2.1 Existing Infrastructure

The existing lots in the Maui Research and Technology Park (MRTP) are served by a privately owned and maintained wastewater system which collects and conveys their wastewater to the Kihei Wastewater Reclamation Facility (KWWRF) for processing. Existing gravity sewer mains located under existing roads and within designated sewer easements collect wastewater from the existing lots and convey it to an existing sewer pump station located near the western boundary of the MRTP project area. This pump station, in turn, lifts the collected wastewater through a 6-inch force main to a transition manhole located near the southern end of the MRTP project area. The wastewater is then conveyed by a 10-inch gravity sewerline to a second pump station located near the northeast corner of the Kihei Wastewater Reclamation Facility (KWWRF), which then lifts the wastewater through a 6-inch sewer force main directly into the headworks of the KWWRF. (See Figure 2-1)

The existing sewer pump stations have a capacity of approximately 880 gallons per minute (gpm), or 1.26 million gallons per day (mgd); the 6" force mains can accommodate approximately 880 gpm, or 1.26 mgd, of wastewater flow based on a maximum flow velocity of 10 feet per second in the force main.

The Kihei Wastewater Reclamation Facility (KWWRF), located just south of the MRTP project area, has a treatment capacity of approximately 8 mgd and currently has unused treatment capacity. The facility is also capable of producing R-1 quality effluent; however, the County of Maui's reclaimed water system is only able to utilize about 40 to 50 percent of the R-1 effluent generated by the KWWRF -- most of which is used for irrigation by the limited number of properties now within reach of existing reclaimed water distribution pipelines. The unused R-1

effluent which remains is disposed of through existing injection wells located on the KWWRF site.

## 2.2 Wastewater Demand

Wastewater flow projections for the MRTP were developed using land use, land area and unit count data multiplied by corresponding demand rates adopted from the Maui County Wastewater Reclamation Division.[3] The computed wastewater flows are summarized in Table 2.1 below.[4]

**Table 2-1** - Wastewater Flow Projections

| Type | Flow, Q (mgd) |
|---|---|
| **Total Project** | |
| Average Daily Wastewater Flow | 0.50 |
| Design Average Flow | 0.55 |
| Design Maximum Flow | 1.85 |
| Design Peak Flow | 2.31 |
| **Phase 1** | |
| Average Daily Wastewater Flow | 0.26 |
| Design Average Flow | 0.29 |
| Design Maximum Flow | 1.12 |
| Design Peak Flow | 1.38 |
| **Phase 2** | |
| Average Daily Wastewater Flow | 0.24 |
| Design Average Flow | 0.26 |
| Design Maximum Flow | 1.05 |
| Design Peak Flow | 1.24 |

[3]Maui County Dept. of Environmental Management, Wastewater Reclamation Division, "Wastewater Flow Standards," February 2, 2000.

[4]Supporting calculations may be found in Appendix A.

## 2.3 Proposed Improvements

Wastewater improvements needed for the expansion MRTP will consist of new gravity sewer mains located primarily within planned roadways to collect wastewater from the developed lots and convey it a new or existing sewer pump station that will then convey the wastewater by force main to the Kihei Wastewater Reclamation Facility for treatment. The expanded wastewater system will be connected to the existing MRTP system and continue to be privately owned and maintained. (See Figure 2-1).

Wastewater generated by the northern portion of Phase 1 and the northeastern portion of Phase 2 (Residential and Knowledge Industry Expansion Area) will be collected by gravity sewer mains and conveyed to a new wastewater pump station that will be located at the low point of the collection system near the western tip of the MRTP. The new pump station will then lift the wastewater through a new force main to a new sewer transition manhole located at the high point on Ho'okena Street near the currently developed portion of the MRTP. The wastewater will then continue on through the existing MRTP wastewater system by gravity flow and force main to the KWWRF for treatment.

Wastewater generated from the southern portion of Phase 2 (Knowledge Industry/ Campus Area) will be conveyed by gravity sewerline to either the existing sewer pump station at the western boundary of MRTP or the existing pump station near the southern end of the MRTP close to the KWWRF. The wastewater will then be conveyed by force main from either pump station to the KWWRF for treatment.

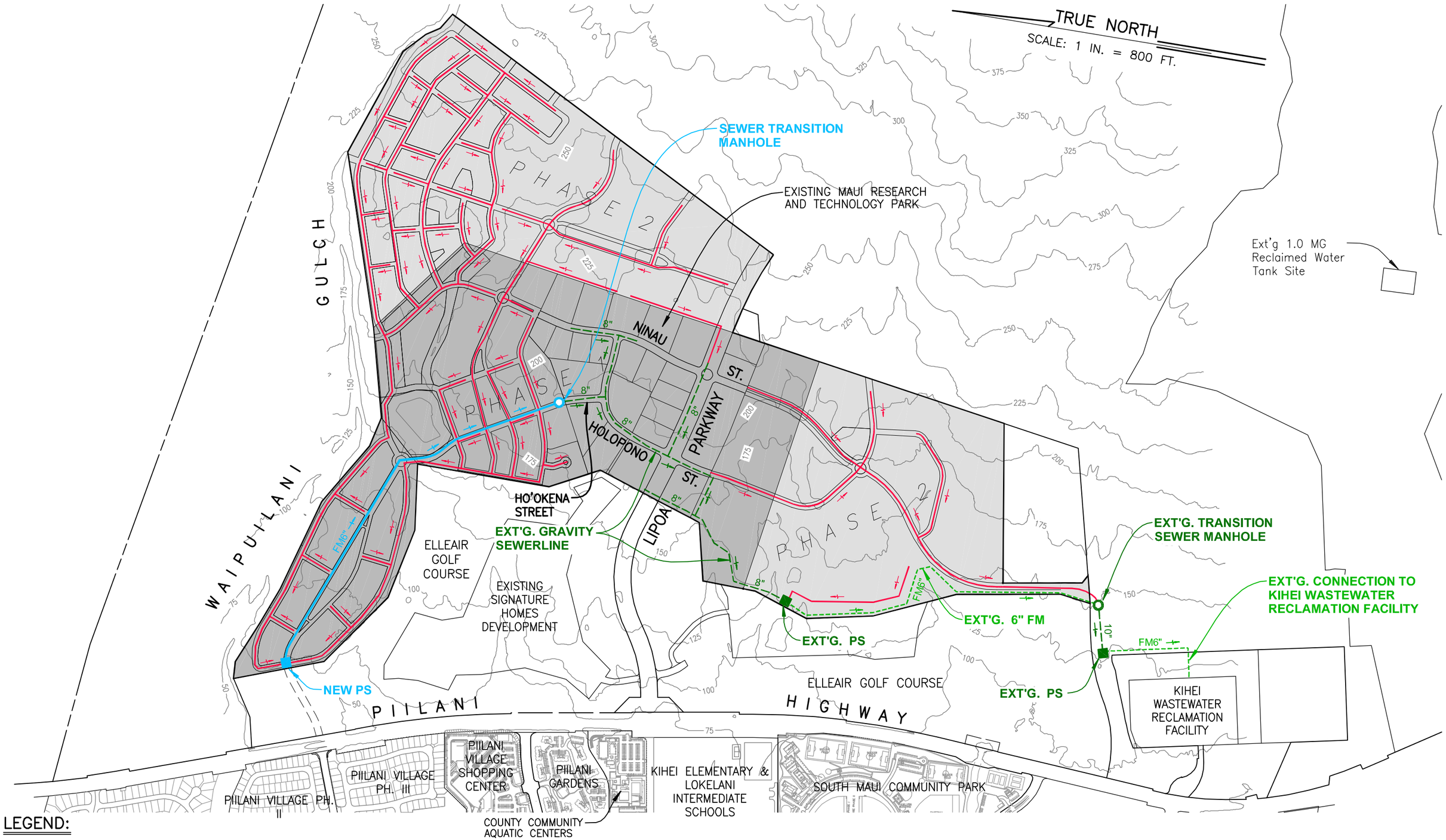
Incremental improvements to increase the capacity of the existing MRTP wastewater pumping system will be required to accommodate the larger design peak wastewater flows generated by development Phases 1 and 2 as they are built out. Capacity improvements and modifications to the existing force main connection at the headworks of the KWWRF may also

be required by the County of Maui to accommodate the increased wastewater flow into the facility.

The MRTP has an agreement allowing a wastewater connection and discharge of up to 25,000 gallons per day (gpd) into the existing private wastewater gravity and pump station/force main system in the adjoining Signature Homes Development located west of the MRTP. This wastewater flow is ultimately conveyed to the existing MRTP wastewater pump station located near the western boundary of the MRTP project area. It is not anticipated that the MRTP will exercise this option; however, this option remains available should circumstances change.

## 2.4 Treatment Capacity

The County of Maui currently treats an *actual* average daily wastewater flow of approximately 3.4 mgd at the Kihei Wastewater Reclamation Facility. Wastewater Reclamation Division records indicate that cumulative *allocated* wastewater flows at the KWWRF total approximately 6.75 mgd as of June 30, 2011. The KWWRF has a treatment capacity of 8 mgd; therefore, the amount of treatment capacity which remains available is 4.6 mgd based on *actual* average daily flows, or 1.25 mgd based on *allocated* wastewater flows. Since the design average wastewater flow from the MRTP is expected to be approximately 0.55 mgd, there is currently sufficient treatment capacity available to accommodate the project. The County of Maui, under the provisions of Hawaii Administrative Rules, Title 11, Chapter 62 - Wastewater Systems, Section 23.1, is required to initiate a facility plan when the *actual* wastewater flow reaches 75 percent of the plant design capacity and implement the facility plan when the actual wastewater flow reaches 90 percent of the plant design capacity. Consequently, treatment capacity at the KWWRF should remain sufficient to accommodate development of the MRTP over time.




LEGEND:

- 6" NEW SEWER FORCE MAIN
- 8" NEW GRAVITY SEWERLINE
- NEW PS — NEW PUMP STATION
- EXISTING GRAVITY SEWERLINE
- EXISTING 6" SEWER FORCE MAIN
- Ext'g PS — EXISTING PUMP STATION

# CONCEPTUAL WASTEWATER PLAN

0 800 1,600 2,400 3,200

SCALE: 1 IN. = 800 FT.

**FIGURE 2-1**

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Prelim Engineering\Exb-FM-00.dwg

# 3. WATER SYSTEM

## 3.1 Existing Infrastructure

### 3.1.1 Potable Water System

The Maui Research and Technology Park (MRTP) is located within Maui County Department of Water Supply's Central Maui Water System service area. Potable water for the 18 existing lots within the MRTP currently comes from existing wells located in upper Waiehu and North Waihee which draw groundwater from the Iao and Waihee Aquifers. Potable water from these wells is pumped into to an existing 1.0 million gallon (MG) capacity concrete water storage tank located in upper Waiehu[5], then conveyed across the isthmus by the Central Maui Water System's 36-inch diameter transmission main to consumers in South Maui. Water for the existing lots in MRTP is then taken from the 36-inch Central Maui transmission line into a 16-inch diameter waterline which runs from Liloa Drive near the Lipoa Street intersection, along Lipoa Street and Lipoa Parkway to the project site to supply the existing MRTP potable water distribution system.

MRTP has an agreement with the County of Maui, Department of Water Supply (DWS) to construct a 0.5 MG water storage tank at an approximate elevation of 330 feet by the year 2014 to serve the future needs of the MRTP. Under the terms of this agreement, the existing 18 lots in the MRTP may rely on a connection to the County water system for their potable and fire protection water needs without having to construct a 0.5 MG water storage tank. Development beyond the first 18 lots before the year 2014 would require the completion of the 0.5 MG water storage tank.

[5]The floor elevation of the 1.0 MG Waiehu Storage Tank is approximately 490 feet MSL.

The existing MRTP distribution system consists of 12-inch waterlines located within the existing roadways fed from the 16-inch transmission line on Lipoa Parkway through a pressure reducing valve. Due to the high water pressure in the 16-inch transmission line, a pressure reducing valve was installed at the MRTP water distribution system connection to reduce the water pressure to approximately the same pressure that would be obtained after the 0.5 MG water storage tank is constructed in the future.

### 3.1.2 Non-Potable Water System

The Kihei Wastewater Reclamation Facility (KWWRF) produces R-1 quality effluent which is the highest quality reclaimed water under the State of Hawaii, Department of Health Standards.

The County of Maui has established a limited reclaimed water distribution infrastructure to facilitate public reuse of the R-1 quality effluent generated by the KWWRF. This system consists of an existing 1.0 million gallon (MG) concrete tank located east of the KWWRF at elevation 300 feet above mean sea level. A distribution system consisting of 16-inch and smaller reclaimed water distribution lines deliver R-1 quality effluent from the 1.0 MG concrete water storage tank to users located primarily north of the KWWRF. The R-1 quality effluent is primarily used for irrigation purposes. The existing irrigation systems for the landscaped common areas and developed parcels in the MRTP now utilize R-1 quality effluent from the KWWRF by drawing it from the existing County 10-inch R-1 waterline which runs along the easterly (mauka) boundary of the MRTP.

## 3.2 Water Demand Estimate

Potable and non-potable water demand projections were based on land area and unit estimates using consumption rates adopted from the Maui County Department of Water Supply's *Water System Standards.*[6] A 60% potable/40% non-potable demand ratio -- the ratio recommended by the Honolulu Board of Water Supply for dual systems[7] -- was also selectively applied in certain instances to break total demand down into potable and non-potable water demand components.[8] The projected water demand for MRTP is summarized as follows:

**Table 3-1 -** Summary of the Average Potable and Irrigation Requirements for the Portion of the MRTP Expansion Not Supplied by DWS

| Phase | Developed Area | Average Daily Demand (GPD) | |
|---|---|---|---|
| | | Potable | Non-Potable Irrigation |
| 1 | Employment Core | 18,877 | 19,609 |
| | Village Center | 225,743 | 114,854 |
| | Makai Residential | 211,260 | 25,660 |
| | Drainage Basins | -- | 9,632 |
| | Total for Phase 1 | 455,880 | 169,755 |
| 2 | Knowledge Exp / Campus | 40,084 | 59,460 |
| | Residential and Knowledge Industry Exp. | 302,101 | 144,114 |
| | Total for Phase 2 | 342,185 | 203,574 |
| Total for Both Phases | | 798,065 | 373,329 |

*Source: Tom Nance Water Resource Engineering, "Evaluation of Source Supply Alternatives for the Planned Expansion of the Maui Research and Technology Park," March 1, 2012.*

[6]County of Maui, Department of Water Supply, *Water System Standards*, 2002, Table 100-18: "Domestic Consumption Guidelines," p.111-3.

[7]See Appendix B-1.

[8]See Appendix B-2.

**Table 3-2** - Required Potable Supply Capacities

| Stage of | Average Daily Demand (MGD) | Maximum Daily Demand | |
|---|---|---|---|
| | | (MGD) | (GPM) |
| End of Phase 1 | 0.46 | 0.69 | 475 |
| End of Phase 2 | 0.80 | 1.20 | 830 |

## 3.3 Proposed Improvements

### 3.3.1 Potable Water Supply

#### 3.3.1.1 Source Alternatives

The County of Maui Dept. of Water Supply-operated public water system remains the preferred source of water for expansion of the Maui Research and Technology Park. Unfortunately, because the Maui County Dept. of Water Supply has indicated that they cannot commit to providing potable water beyond the existing 18 lots within the MRTP, MRTP has proposed an alternate, privately owned and maintained potable water source and distribution system to support further expansion. (See Figure 3-1)

The Maui Upcountry Community Plan prohibits the use of wells developed in the Upcountry plan area from being used as a water source for another plan area and thereby constrains the location of a new well source. The Upcountry Community Plan boundary in the vicinity of the MRTP is the 600-foot elevation contour, which means that wells developed to serve the MRTP must be located below this elevation contour.

The "Evaluation of Source of Supply Alternatives for the Planned Expansion of the Maui Research and Technology Park"[9] identifies two (2) alternate sources of water for the project and outlines the improvements required to provide the privately owned and maintained potable water system for the MRTP. These alternate systems would all be privately operated and separate from the existing DWS water system currently serving the 18 existing parcels in the MRTP. The two source alternatives are summarized as follows:

1) **Source Alternative 1 - Offsite Brackish Wells at 580-foot Elevation**

This alternative consists of five (5) offsite brackish wells spaced 1250 feet apart with a capacity of 360 gallons per minute (GPM) per well located at the 580-foot elevation on land currently owned by Haleakala Ranch Company. Three wells would be developed to accommodate the needs of the MRTP Phase 1, and the remaining two wells would be required for Phase 2. Offsite improvements associated with this alternative will include a 0.25 million gallon (MG) brackish water head tank located at the 590-foot elevation, a 12-inch transmission waterline to a Reverse Osmosis (RO) treatment plant using a high pressure filtration process to produce potable water, two disposal wells to discharge the concentrate (wastewater) generated by the RO process, potable water storage tanks at the 375 foot elevation, and a 16-inch distribution waterline connecting the storage tanks to the MRTP's potable water distribution system. The RO

[9]Tom Nance Water Resources Engineering, "Evaluation of Source of Supply Alternatives For the Planned Expansion of the Maui Research and Technology Park," February 7, 2012.

treatment plant will consist of three 250 GPM treatment trains for Phase 1 and two additional 250 GPM treatment trains to accommodate Phase 2. (See Figure 3.2a)

2) **Source Alternative 2 - Brackish Wells Within the MRTP**

This alternative consists of five (5) onsite brackish wells located along the easterly portion of the MRTP, spaced 1,500 feet apart with a capacity of 400 GPM per well. Three wells would be developed to accommodate the needs of the MRTP Phase 1, and the remaining two wells would be required for Phase 2. A 0.25 MG brackish water head tank and RO treatment plant with two disposal wells to discharge the concentrate from the RO treatment plant would be located within the MRTP. The RO product water would be pumped from the RO treatment facility into potable water storage tanks also located within the MRTP at the 212-foot elevation. Three wells would initially be developed to accommodate Phase 1 of the MRTP and two more wells developed later with Phase 2. The RO treatment plant would consist of three treatment trains for Phase 1 and two additional treatment trains for Phase 2. (See Figure 3.2b)

#### 3.3.1.2 Storage and Distribution

A total potable water storage capacity of 1.5 MG of will ultimately be needed to supply the combined fire protection and domestic use needs of Phases 1 and 2. This will be provided incrementally by constructing a 1.0 MG tank with Phase 1, followed by a 0.5 MG tank with Phase 2.

Source Alternative 1 will utilize concrete tanks constructed above the MRTP at the 375-foot elevation on land currently owned by Haleakala Ranch Company. Source Alternative 2 will utilize concrete storage tanks constructed within MRTP at the 212-foot elevation and employ pumps to provide water pressure comparable to having storage tanks at the 375-foot elevation.

A 16-inch distribution main will connect the potable storage tanks to MRTP, where a new network of 8- and 12-inch distribution mains will be deployed to supply the individual lots within the development. Figure 3-3 depicts the potable water storage and distribution system described.

#### 3.3.1.3 Water Service Agreement with County of Maui

The MRTP currently has an obligation with DWS to construct a 0.5 MG water storage tank at the 330-foot elevation by the year 2014 to service the existing 18 parcels in the project. However, since alternative sources of water will be utilized for the project, the Owner will address the possible amendment of this obligation with DWS.

### 3.3.2 Non-Potable Water Supply

#### 3.3.2.1 Primary Source

MRTP will continue to utilize R-1 quality effluent from the Kihei Wastewater Reclamation Facility (KWWRF) as its primary source of non-potable water to supply its landscape irrigation demand. Expanded usage of R-1 reclaimed water from the KWWRF offers the dual benefit of conserving potable

water and reducing the amount of reclaimed water that the County of Maui must dispose of using injection wells.

The County of Maui Wastewater Reclamation Division which oversees the R-1 reclaimed water system has indicated that there may be periods where the R-1 supply may not be sufficient to accommodate the landscape irrigation needs for the entire MRTP because of constant fluctuations in the quantity of wastewater treated at the KWWRF and limited R-1 water storage capacity in the County's reclaimed water system. This may be particularly evident during the drier part of the year when the demand for R-1 quality effluent is the greatest. Therefore, to ensure that there will be a reliable supply of non-potable water available to satisfy MRTP landscape irrigation demand, additional non-potable water sources and associated storage and distribution infrastructure will need to be constructed to supplement the County of Maui's reclaimed water system.

#### 3.3.2.2 Supplemental Sources

The "Evaluation of Source of Supply Alternatives for the Planned Expansion of the Maui Research and Technology Park" identified three (3) alternative sources of water from the development of new wells for the MRTP. Provisions to provide supplemental non-potable water have been incorporated into each of the alternate water sources as follows:

1) **Supplemental Source Alternative 1 - Brackish Wells at 580-Foot Elevation**. Under this alternative, the 5 brackish wells at the 580-foot elevation will pump the water into a 0.25 MG brackish water head tank

located at the 590-foot elevation. A 6-inch waterline from the 0.25 MG brackish water head tank will supply the non-potable brackish water to the non-potable water storage tank at elevation 350 feet that feeds the MRTP non-potable water system in the event that there is insufficient R-1 water from the County of Maui Reclaimed Water System available to supply MRTP's irrigation demand. This alternative will require a booster pump station to lift the R-1 quality effluent from the KWWRF – whose non-potable storage tank is located at elevation 300 feet – to the new MRTP offsite non-potable water storage tank at elevation 350 feet.

2) **Supplemental Source Alternative 2 - Brackish Wells Within MRTP**

Under this alternative, the five (5) brackish wells located within the MRTP will pump the water into a 0.25 MG brackish water head tank located within the MRTP site. Brackish water from the 0.25 MG head tank will be used to fill the 0.4 MG non-potable water storage tank located at elevation 202 feet when needed.

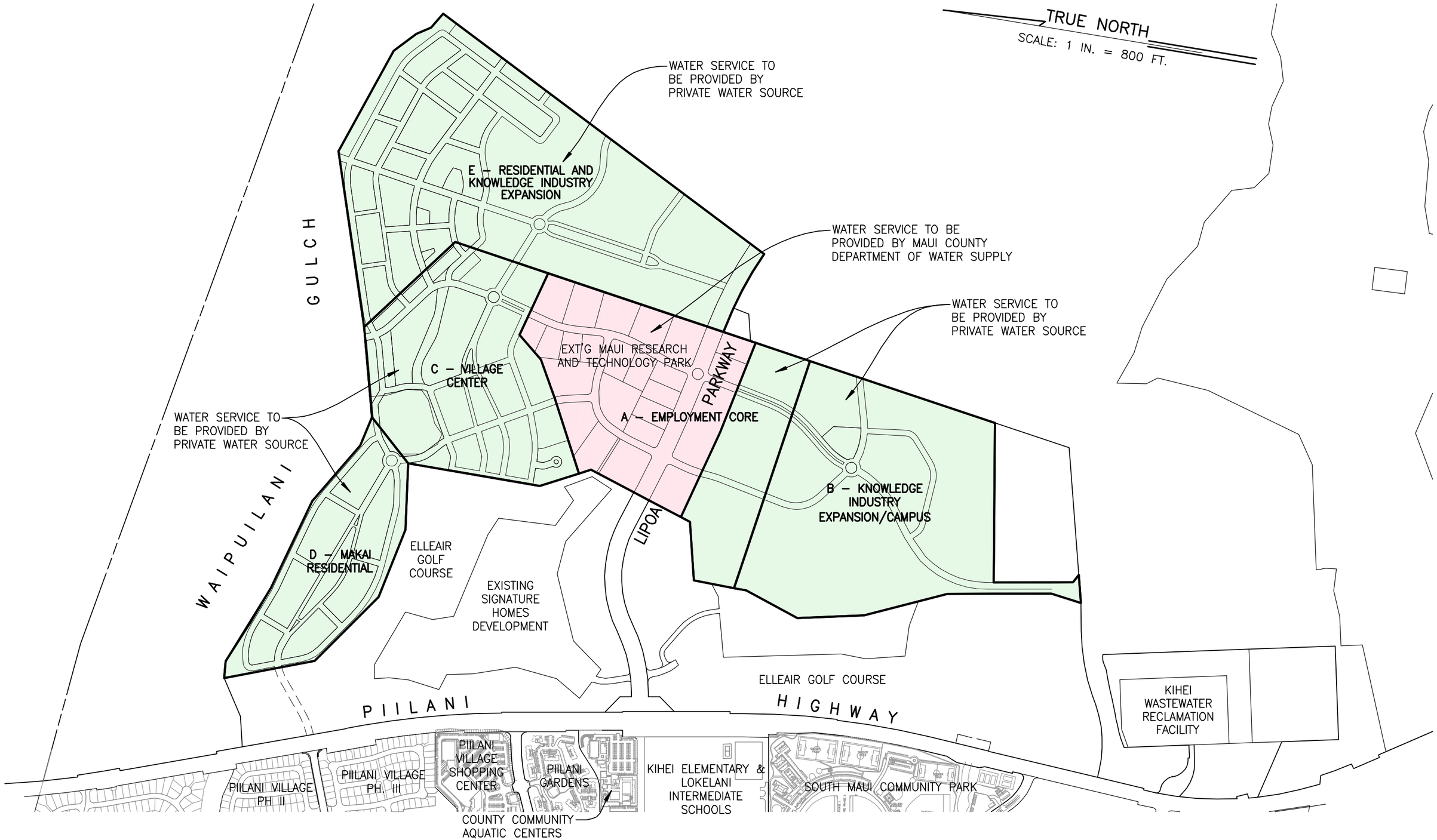
#### 3.3.2.3 Storage and Distribution

A total non-potable water storage capacity 0.4 MG of will be needed to supply the combined irrigation needs of Phases 1 and 2. Source Alternative 1 will utilize a single 0.4 MG capacity concrete or steel storage tank constructed above the MRTP at the 350-foot elevation on land currently owned by Haleakala Ranch Company. Source Alternative 2 will utilize single 0.4 MG capacity concrete or

steel storage tank constructed within MRTP at approximately the 202-foot elevation and utilize pumps to provide water pressure comparable to having storage tank at the 350-foot elevation.[10]

A 14-inch distribution main will connect the 0.4 MG storage tank to MRTP, where a new network of 12-, 8- and 6-inch distribution mains will be constructed to supply the individual lots within the development. Figure 3-4 depicts the non-potable storage and distribution system described.

[10]The MRTP non-potable water storage tank will be sited 25 feet lower in elevation than the potable water storage tanks so that water pressure in the non-potable water mains will be approximately 10 psi lower than in nearby potable water mains, thus minimizing the risk of cross-contamination between the two water systems. The introduction of a pressure differential to the reduce cross-contamination hazard between potable and reclaimed water systems is a practice recommended by the State Dept. of Health and observed by the Maui County Dept. of Environmental Management's Wastewater Reclamation Division. (Ref. State of Hawaii, Department of Health, Wastewater Branch, "Guidelines for the Treatment and Use of Recycled Water," May 15, 2002, p.44.)




# POTABLE WATER SERVICE PLAN

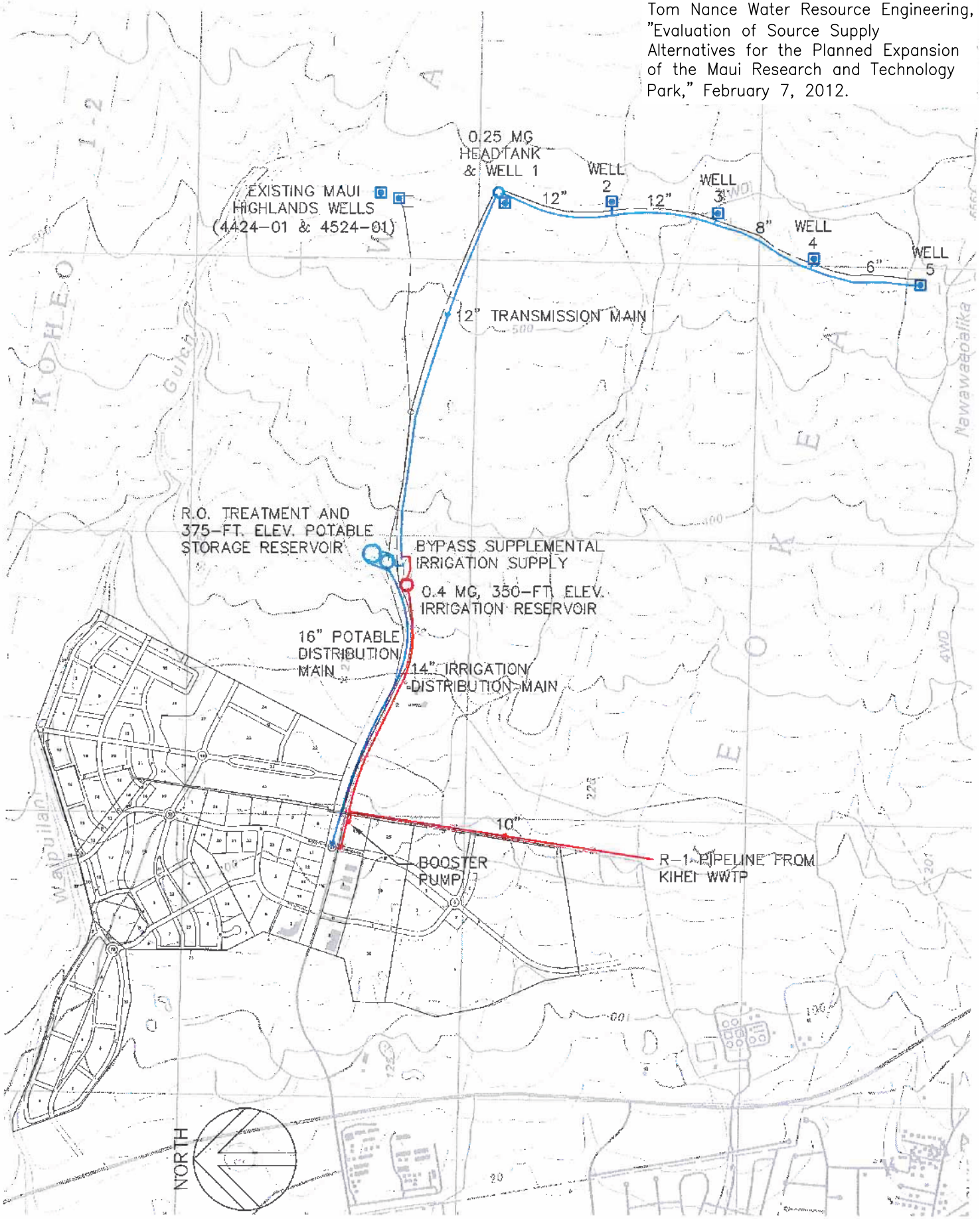
0 800 1,600 2,400 3,200

SCALE: 1 IN. = 800 FT.

**FIGURE 3-1**

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Prelim Engineering\Exb-Water Service-00.dwg

Source:
Tom Nance Water Resource Engineering, "Evaluation of Source Supply Alternatives for the Planned Expansion of the Maui Research and Technology Park," February 7, 2012.




GRAPHIC SCALE:

1500' 750' 0 1500' 3000'

# FIGURE 3-2a

**ALTERNATIVE 1**
**OFFSITE BRACKISH WELLS**

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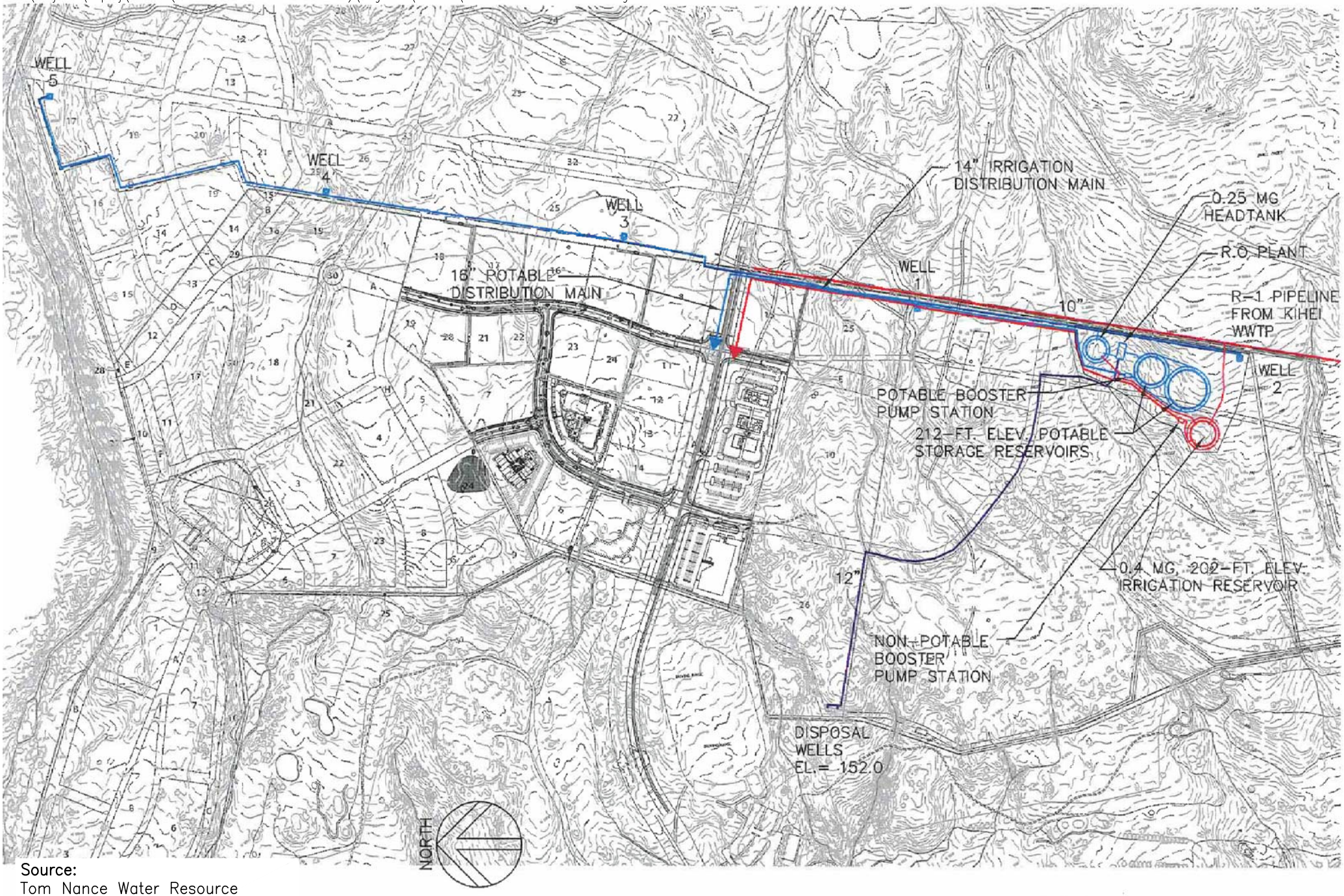
V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\EXB-Well-Alt-1-2-3-00.dwg

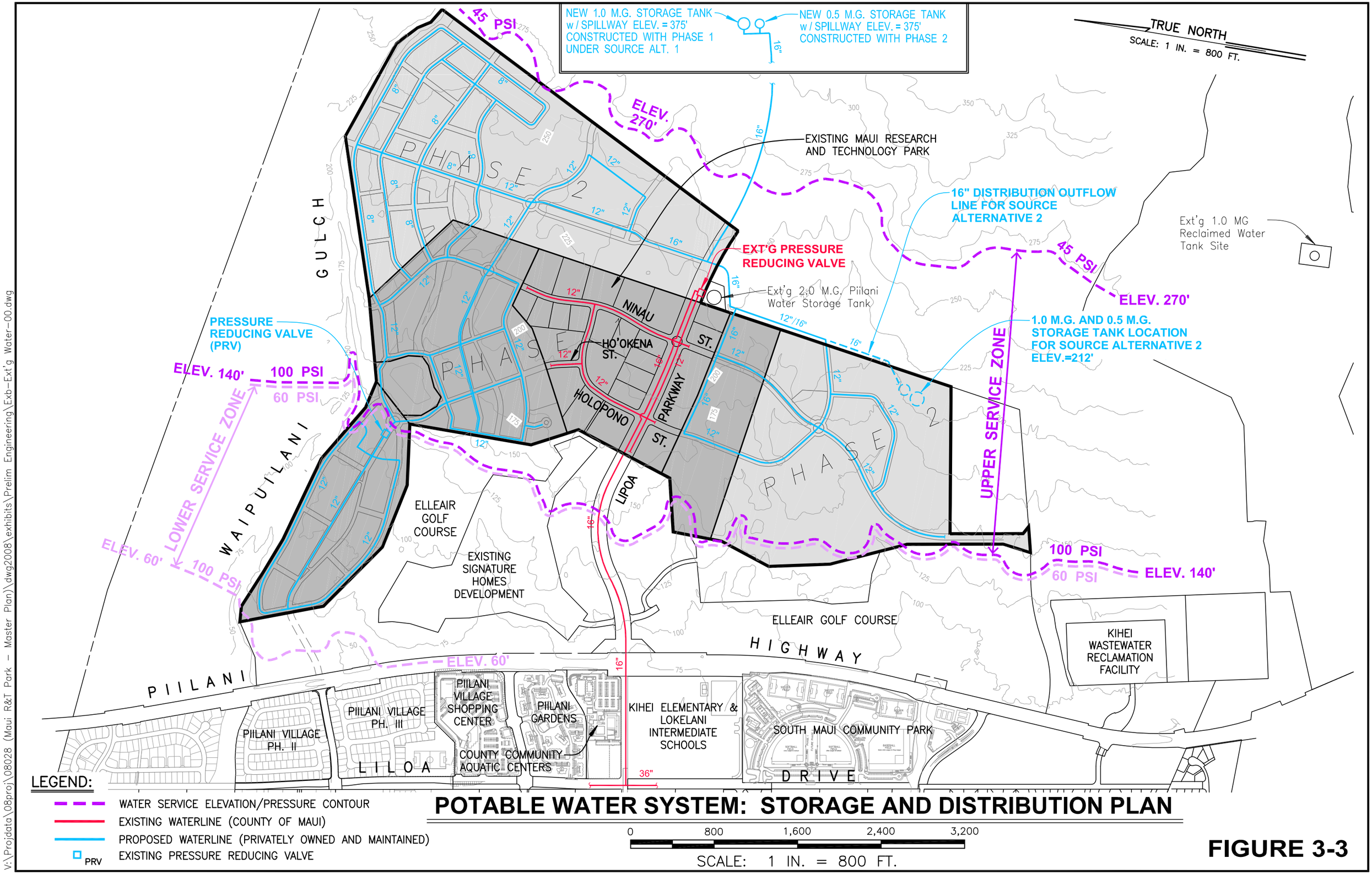



Source:
Tom Nance Water Resource Engineering, "Evaluation of Source Supply Alternatives for the Planned Expansion of the Maui Research and Technology Park," February 7, 2012.

GRAPHIC SCALE:
800' 400' 0 800' 1600'

# FIGURE 3-2b

## ALTERNATE 2
## ONSITE SYSTEM




# POTABLE WATER SYSTEM: STORAGE AND DISTRIBUTION PLAN

**FIGURE 3-3**

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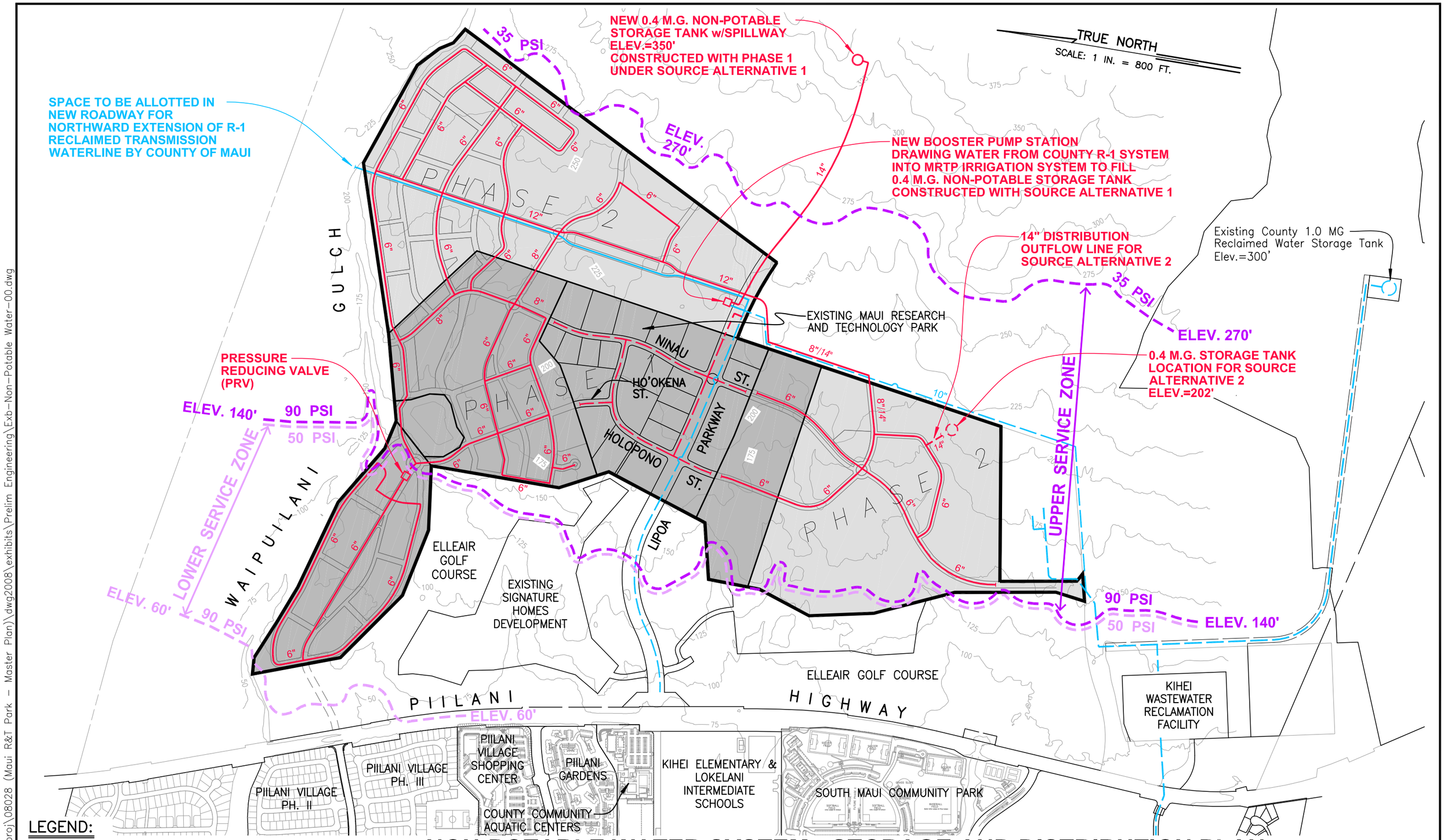


# NON-POTABLE WATER SYSTEM: STORAGE AND DISTRIBUTION PLAN

**FIGURE 3-4**

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Prelim Engineering\Exb-Non-Potable Water-00.dwg

# 4. DRAINAGE

## 4.1 Existing Conditions

The 414 acre MRTP project area is flanked by two major drainageways: Waipuilani Gulch to the north, and Keokea Gulch to the south. Undeveloped pasture land owned by Haleakala Ranch Company lies to the east, immediately upstream of the MRTP; the Elleair Golf Course lies to the west, immediately downstream of the MRTP. Piilani Highway and a portion of urban Kihei lie further downstream, closer to the ocean.

### 4.1.1 Topography and Soils

The undeveloped areas of the project site are currently open pasture lands with brush and scattered trees that are not being used for any particular purpose. The site slopes downward from an elevation of approximately (+) 270 feet M.S.L. on its eastern edge to approximately (+) 60 feet M.S.L. on its western edge at an average slope of roughly 3%. Six minor, natural drainageways run east-to-west across the project site.

According to the United States Department of Agriculture Soil Conservation Service's *Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii*, the predominant soil classification found on the project site is Waiakoa extremely stony silty clay loam (WID2). (See Figure 4-1) Waiakoa soil is characterized as having medium runoff and posing a potentially severe erosion hazard if left exposed.[11]

[11]United States Department of Agriculture, Soil Conservation Service, "Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii," August 1972, p.127, Map Sheet 107 and 108.

### 4.1.2 Flood and Tsunami Hazard

The Federal Emergency Management Agency's Flood Insurance Rate Map for Maui County places the MRTP project area in Zone X, which indicates that the project area lies outside of the 500-year floodplain.[12] (See Figure 4-2).

### 4.1.3 Existing Drainage Pattern

#### 4.1.3.1 Offsite

Storm runoff from the undeveloped lands mauka (east) of the project site flows across the MRTP project area in an east-to-west direction: runoff enters the MRTP project area along its eastern boundary and exits along its western boundary. (See Figure 4-3) Runoff leaving the MRTP project area continues westward, flowing across the Elleair Golf Course to Piilani Highway, where existing culverts pass the runoff under the highway. Various drainage facilities then convey the runoff through urban Kihei to the Pacific Ocean. The magnitude of the combined offsite storm flows which pass through the MRTP is approximately 1,300 cfs.[13]

#### 4.1.3.2 Onsite

Surface runoff from the undeveloped project site drains in a westward direction, flowing into one of the minor drainageways crossing the MRTP and

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[12]U.S. Department of Homeland Security, Federal Emergency Management Agency, "Flood Insurance Rate Map, Maui County, Hawaii," Community-Panel Numbers 150003 0576E, 0586E and 0588E, September 25, 2009.

[13]This 1,300 cfs flow figure represents a 100-year recurrence interval, 24-hour duration storm.

commingling with the offsite-generated storm runoff before exiting the MRTP project area toward the Elleair Golf Course, Piilani Highway and the ocean. (See Figure 4-4) Peak pre-development onsite runoff estimates for each drainage area based on a 50-year recurrence interval, 1-hour duration storm are summarized in Table 4-1 below.

**Table 4-1** - Pre-Development Peak Runoff Rates

| Onsite Drainage Area No. | Pre-Development $Q_{50}$ (cfs) |
|---|---|
| 1 | 29 |
| 2 | 71 |
| 3 | 54 |
| 4 | 23 |
| 5 | 83 |
| 6 | 53 |
| 7 | 33 |
| 8 | 27 |
| 9 | 6 |

*Note: Drainage Areas correspond to numbered Areas shown on Figure 4-4*

## 4.2 Drainage Plan

### 4.2.1 Offsite

Offsite runoff will be allowed to pass through the MRTP project site and continue to drain across the Elleair Golf Course and toward the existing culvert crossings at Piilani Highway without further mitigation as permitted under Maui County Drainage Rules.[14]

[14]County of Maui, Department of Public Works and Waste Management, "Rules for the Design of Storm Drainage Facilities in the County of Maui," Title MC-15, Chapter 4, November 2, 1995, Section 15-04-06(14).

### 4.2.2 Onsite

Development is expected to increase the peak flow rate of runoff generated by the MRTP project area. Peak post-development onsite runoff estimates for each drainage area based on a 50-year recurrence interval, 1-hour duration storm are summarized in Table 4-2 below.

**Table 4-2** - Increase in Runoff Attributable to Development of MRTP Project Area

| Onsite Drainage Area No. | Pre-Development $Q_{50}$ (cfs) | Post-Development $Q_{50}$ (cfs) | Increase in $Q_{50}$ (cfs) |
|---|---|---|---|
| 1 | 29 | 79 | +50 |
| 2 | 71 | 186 | +115 |
| 3 | 54 | 140 | +86 |
| 4 | 23 | 60 | +37 |
| 5 | 83 | 167 | +84 |
| 6 | 53 | 95 | +42 |
| 7 | 33 | 86 | +53 |
| 8 | 27 | 72 | +45 |
| 9 | 6 | 19 | +13 |
| Total | 379 | 904 | +525 |

*Roads and Residential Areas*

The increase in runoff attributable to the construction of interior roadways and the development of single-family and multi-family residential areas is summarized in Table 4-3 below.

**Table 4-3** - Increase in Peak Runoff Rate Attributable to Development of Roadways and Residential Areas

| Onsite Drainage Area No. | Pre-Development $Q_{50}$ (cfs) | Post-Development $Q_{50}$ (cfs) | Increase in $Q_{50}$ (cfs) |
|---|---|---|---|
| 1 | 29 | 79 | +50 |
| 2 | 71 | 186 | +115 |
| 3 | 54 | 90 | +36 |
| 4 | 23 | 35 | +12 |
| 5 | 83 | 88 | +5 |
| 6 | 53 | 58 | +5 |
| 7 | 33 | 49 | +16 |
| 8 | 27 | 30 | +3 |
| 9 | 6 | 7 | +1 |

This increase will be mitigated by constructing onsite drainage detention basins within each drainage area that will limit discharges to flow rates no greater than experienced under existing conditions.

*Commercial and Institutional Areas*

The expected increase in peak runoff attributable to the development of commercial and institutional areas is summarized in Table 4-4 below.

**Table 4-4** - Increase in Peak Runoff Rate Attributable to Development of Commercial Areas

| Onsite Drainage Area No. | Pre-Development $Q_{50}$ (cfs) | Post-Development $Q_{50}$ (cfs) | Increase in $Q_{50}$ (cfs) |
|---|---|---|---|
| 1 | 29 | 29 | 0 |
| 2 | 71 | 71 | 0 |
| 3 | 54 | 104 | +50 |
| 4 | 23 | 47 | +24 |
| 5 | 83 | 162 | +79 |
| 6 | 53 | 91 | +38 |
| 7 | 33 | 70 | +37 |
| 8 | 27 | 69 | +42 |
| 9 | 6 | 18 | +12 |

Each commercial and institutional lot will be required to mitigate its own increase in peak runoff due to development, and will be restricted to a downstream stormwater discharge at a peak rate no greater than at its pre-development level.

*Overall Post-Development Condition*

The collective result of all land uses employing peak runoff mitigation will be no increase in peak runoff downstream of the MRTP, as illustrated by Table 4-5.

**Table 4-5** - Result of Peak Runoff Mitigation
by MRTP Project Area

| Onsite Drainage Area No. | Pre-Development $Q_{50}$ (cfs) | Post-Development $Q_{50}$ (cfs) | Net Change in Runoff (cfs) |
|---|---|---|---|
| 1 | 29 | 29 | 0 |
| 2 | 71 | 71 | 0 |
| 3 | 54 | 54 | 0 |
| 4 | 23 | 23 | 0 |
| 5 | 83 | 83 | 0 |
| 6 | 53 | 53 | 0 |
| 7 | 33 | 33 | 0 |
| 8 | 27 | 27 | 0 |
| 9 | 6 | 6 | 0 |
| Total | 379 | 379 | 0 |

## 4.3 Proposed Improvements

Figure 4-5 is a Conceptual Drainage Plan illustrating a number of proposed drainage features which have been integrated into the updated MRTP Master Plan.

### 4.3.1 Stormwater Detention

Storm runoff generated within the MRTP will typically be intercepted by drain inlets located along roadways and in building site parking lots, then conveyed by underground drainline to a stormwater detention facility which will reduce the peak

discharge rate to pre-development levels before the runoff is allowed to continue downstream.

*Roads and Residential Areas*

Drainage detention basins designed to mitigate the peak runoff from roadways and residential areas will be distributed among the internal drainage areas within the MRTP; these basins will be sized to a 50-year recurrence interval, 1-hour duration storm in conformance with Maui County Drainage Rules.[15] The planned location of these detention basins locations is depicted in Figure 4-6; their approximate capacity and required performance is summarized in Table 4-6 below.

**Table 4-6** - Performance of Drainage Basins
Serving Roadways and Residential Areas

| Onsite Drainage Area No. | Corresponding Basin(s) | Basin Storage Capacity (ac.-ft.) | Increase in Runoff (cfs) | Reduction in Runoff (cfs) | Net Chane in Surface Runoff (cfs) |
|---|---|---|---|---|---|
| 1 | A, B | 4 | +50 | -50 | 0 |
| 2 | C, D, F | 11 | +115 | -115 | 0 |
| 3 | G | 3 | +36 | -36 | 0 |
| 4 | I | 1 | +12 | -12 | 0 |
| 5 | H | 1 | +5 | -5 | 0 |
| 6 | K | 1 | +5 | -5 | 0 |
| 7 | M | 1 | +16 | -16 | 0 |
| 8 | N | 1 | +3 | -3 | 0 |
| 9 | Subsurface Drain | 1 | +1 | -1 | 0 |

[15]County of Maui, Department of Public Works and Waste Management, "Rules for the Design of Storm Drainage Facilities in the County of Maui," Title MC-15, Chapter 4, November 2, 1995, Section 15-04-05(e).

*Commercial and Institutional Areas*

Each commercial and institutional lot will be required to mitigate its own increase in peak runoff due to development and limited to a downstream stormwater discharge whose peak rate is no greater than its pre-development level. Peak flow mitigation of this type can be achieved by constructing subsurface storage chambers or above-ground drainage ponds within each lot. Individual drainage detention systems such as these will be will be sized to a 50-year recurrence interval, 1-hour duration storm in conformance with Maui County Drainage Rules.[16] Table 4-7 illustrates the collective performance of the individual drainage detention systems installed by the commercial and institutional lots within each drainage area.

**Table 4-7** - Collective Performance of Drainage Detention Systems Serving Commercial Areas

| Onsite Drainage Area No. | Increase in Runoff (cfs) | Reduction in Runoff (cfs) | Net Change in Surface Runoff (cfs) |
|---|---|---|---|
| 1 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 |
| 3 | +50 | -50 | 0 |
| 4 | +24 | -24 | 0 |
| 5 | +79 | -79 | 0 |
| 6 | +38 | -38 | 0 |
| 7 | +37 | -37 | 0 |
| 8 | +42 | -42 | 0 |
| 9 | +12 | -12 | 0 |

[16]County of Maui, Department of Public Works and Waste Management, "Rules for the Design of Storm Drainage Facilities in the County of Maui," Title MC-15, Chapter 4, November 2, 1995, Section 15-04-05(e).

### 4.3.2 Drainage Channels

Drainage Reserve Areas have been incorporated into the MRTP Master Plan to accommodate the safe passage of offsite storm runoff through the MRTP project area. The alignment of drainage channels which convey storm runoff through these Reserve Areas will generally follow the natural flow path of the existing drainageways as they cross the project site. Modification to the sides of these natural drainageways may be necessary in order to stabilize their banks against erosion, confine them to prevent their overflowing during very large storms, and facilitate roadway culvert crossings. Figure 4-7 illustrates the location and proposed treatment of the drainageways crossing the MRTP. When channel linings are required, materials with a natural appearance such as grass, boulders, or a rustic stone masonry finish will be used wherever possible. Figure 4-8 is a conceptual depiction of such an application.

### 4.3.3. Stormwater Management and Water Quality

The MRTP stormwater management plan emphasizes the use of vegetated surface drainage facilities to treat and infiltrate stormwater in order to control water pollution, reduce peak flows and runoff volumes, and promote groundwater recharge.[17]

1) Vegetated drainage facilities such as swales[18], detention ponds, infiltration basins[19] and filter strips[20] utilize infiltration of stormwater into the soil and absorption by vegetation to remove trash and floating debris, suspended solids, and organic nutrients from stormwater. Reducing the urban pollutants which reach drainageways and coastal waters, in turn, improves the general health of the watershed.

2) Vegetated swales, detention ponds and filter strips slow the movement of stormwater as it passes through them, effectively detaining the runoff and

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[17]Calthorpe Associates and Chris Hart & Partners, "Maui Research and Technology Park Development Code," December 10, 2010. p.70.

[18]Vegetated swales (also called grassy swales) are typically long, narrow, gently sloping landscaped depressions planted with dense vegetation that collect and convey stormwater runoff, allowing pollutants to settle and filter out as the water infiltrates into the ground or flows through the facility. (Source: City of Portland, Oregon, "Stormwater Management Manual," Revision 4, August 1, 2008, Chapter 2: Facility Design, pp.2-48 to 2-52, 2-63 to 2-67.)

[19]Vegetated infiltration basins are flat-bottomed, shallow landscaped depressions used to collect and hold stormwater runoff, allowing pollutants to settle and filter out as the water infiltrates into the ground. An inlet pipe or sheet flow over impervious area conveys the stormwater into the basin, where it is temporarily stored until it infiltrates into the ground. Infiltration basins can be sized to infiltrate large storms where soils drain well, or overflow to an approved discharge point. (Source: City of Portland, Oregon, "Stormwater Management Manual," Revision 4, August 1, 2008, Chapter 2: Facility Design, pp.2-57 to 2-60.)

[20]Vegetated filter strips (or infiltration strips) are gently sloped areas that are designed to receive sheet flows. They are typically linear facilities that run parallel to the impervious surface and are commonly used to receive the runoff from walkways and driveways. Filter strips are covered with vegetation -- typically grasses and groundcovers -- which filter and reduce the velocity of stormwater. Runoff infiltrates into the soil below as it travels downhill through the vegetated filter. (Source: City of Portland, Oregon, "Stormwater Management Manual," Revision 4, August 1, 2008, Chapter 2: Facility Design, pp.2-61 to 2-62.)

reducing its peak flow rate as it moves downstream. This peak flow reduction, in turn, reduces the capacity demanded of both new and existing drainage infrastructure -- enabling the use of smaller diameter underground drain pipes and detention basins, for instance, and preserving the capacity of existing culverts and drainage channels located further downstream.

3) Aggressive use of infiltration close to the source where runoff is generated will reduce the volume of stormwater which drains to the ocean and allow it to replenish the groundwater aquifer, instead. Reducing the volume of stormwater sent downstream as runoff will also reduce erosion of drainage channels and exposed soils; this, in turn, will reduce the amount of sediment entering coastal waters.

*Streets and Parking Lots*

Roadway and parking lot drainage systems will be designed to infiltrate pavement-generated stormwater onsite to the maximum extent feasible[21] before discharging flows into the underground storm drain system. Pavement runoff will be passed through vegetated drainage facilities located in medians, bulb-outs, curb extensions, tree planters, and landscape strips to the greatest practical extent before entering the underground storm drain system. Where foundation soils are stable and well drained, and highly compacted subgrades are not required to support heavy wheel loads -- under pedestrian walkways or bicycle paths, for example -- porous pavements constructed from pavers or permeable concrete may be used to promote infiltration and reduce the amount of impermeable surface area created.

[21]Infiltration will be most effective in areas where well drained soils are present.

*Building Sites*

Residential, commercial, and institutional occupants of the MRTP will be encouraged to utilize vegetated drainage facilities in their building site planning to the greatest practical extent. For example:

1) Incorporating vegetated swales in landscaped areas to capture, convey and filter surface runoff from buildings, driveways and parking lots in lieu of direct interception by underground drainage piping;
2) Directing roof and parking lot drainage into vegetated infiltration basins located in landscaped areas instead of piping such runoff directly into the underground storm drainage system;
3) Locating vegetated filter strips between storm drain inlets and public gathering areas or pedestrian walkways to filter out trash and debris before it enters the underground storm drain system.

*Site Management Practices*

Residential, commercial and institutional developments within the MRTP will be encouraged to adopt operational policies aimed at reducing urban pollutants in storm runoff by actively controlling what enters the storm drain system. The following are examples of site management practices which can reduce water pollution.

1) Routinely inspect subsurface drain sumps, basin floors, drain inlets and drain pipes and remove all accumulated sediment, trash and debris to minimize the volume of pollutants washed through the storm drainage system to the ocean.
2) Limit irrigation-induced runoff to minimize the amount of fertilizer, pesticides and herbicides washed into the storm drainage system during the drier months of

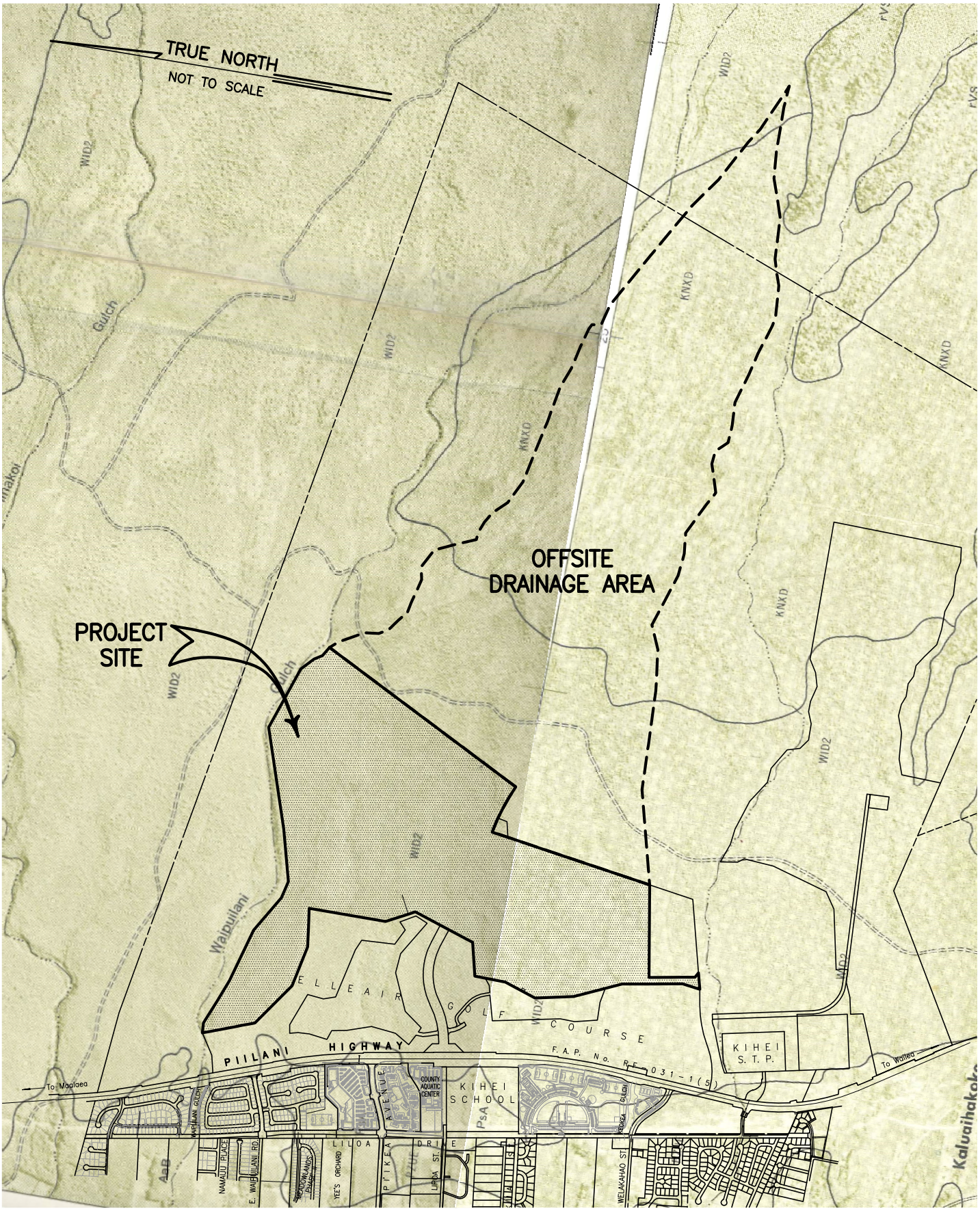
the year. Monitor and adjust irrigation sprinkler watering times to minimize irrigation runoff; monitor and adjust sprinkler coverage to minimize overspray onto driveways, walkways and other paved surfaces.

3) Encourage residents and require landscape maintenance personnel to gather lawn clippings, leaves, and cuttings and haul them to a composting facility to minimize the amount of green waste left behind and washed into the storm drain system.

4) Encourage residents and require landscape maintenance personnel to use non-polluting ("environmentally friendly") fertilizers, herbicides and pesticides when maintaining lawns and landscaping and/or adopt maintenance techniques which do not introduce chemical pollutants into the open environment.

5) Install sediment / pollution filters on storm drain inlets draining the designated car wash areas used by apartment and condominium residents and maintain these filters regularly.

6) Prohibit non-emergency fueling or vehicle repair and maintenance work by residents or service personnel in uncovered areas exposed to weather.




**Source:**
U.S. Department of Agriculture, Soil Conservation Service, "Soil Survey of Islands of Kauai, Oahu, Maui, Molokai and Lanai, State of Hawaii", 1972, Map Sheets 107 and 108.

# SOIL SURVEY MAP

# FIGURE 4-1

V:\Projdata\08proj\08028 (Maui R&T Park - Master Plan)\dwg2008\exhibits\Prelim Engineering\exh-soil-survey.dwg

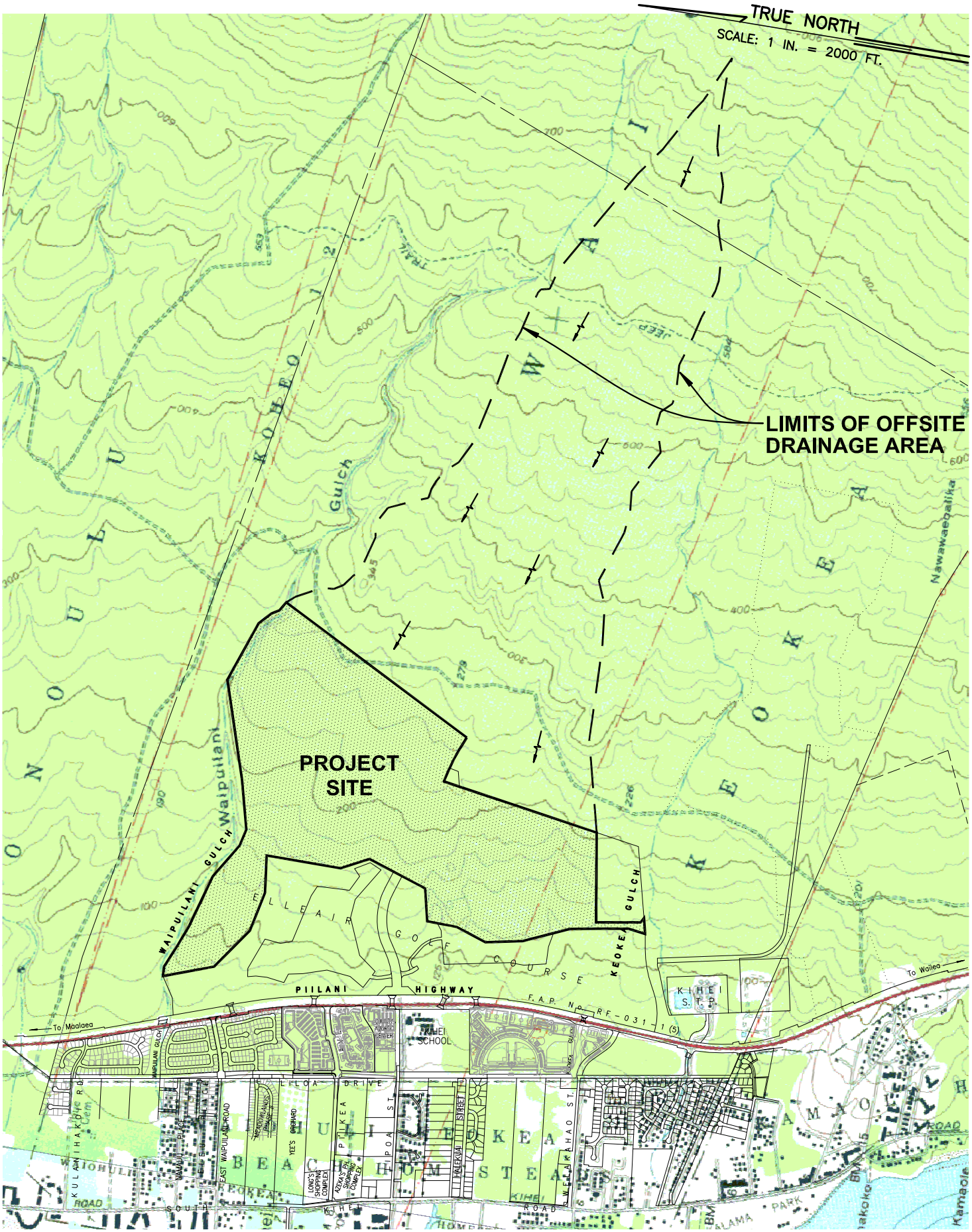
**Source:**
U.S. Department of Homeland Security, Federal Emergency Management Agency, "Flood Insurance Rate Map, Maui County, Hawaii", Map Numbers 1500030576E, 1500030586E and 1500030588E September 25, 2009.

# FLOOD INSURANCE RATE MAP

# FIGURE 4-2

January 25, 2012

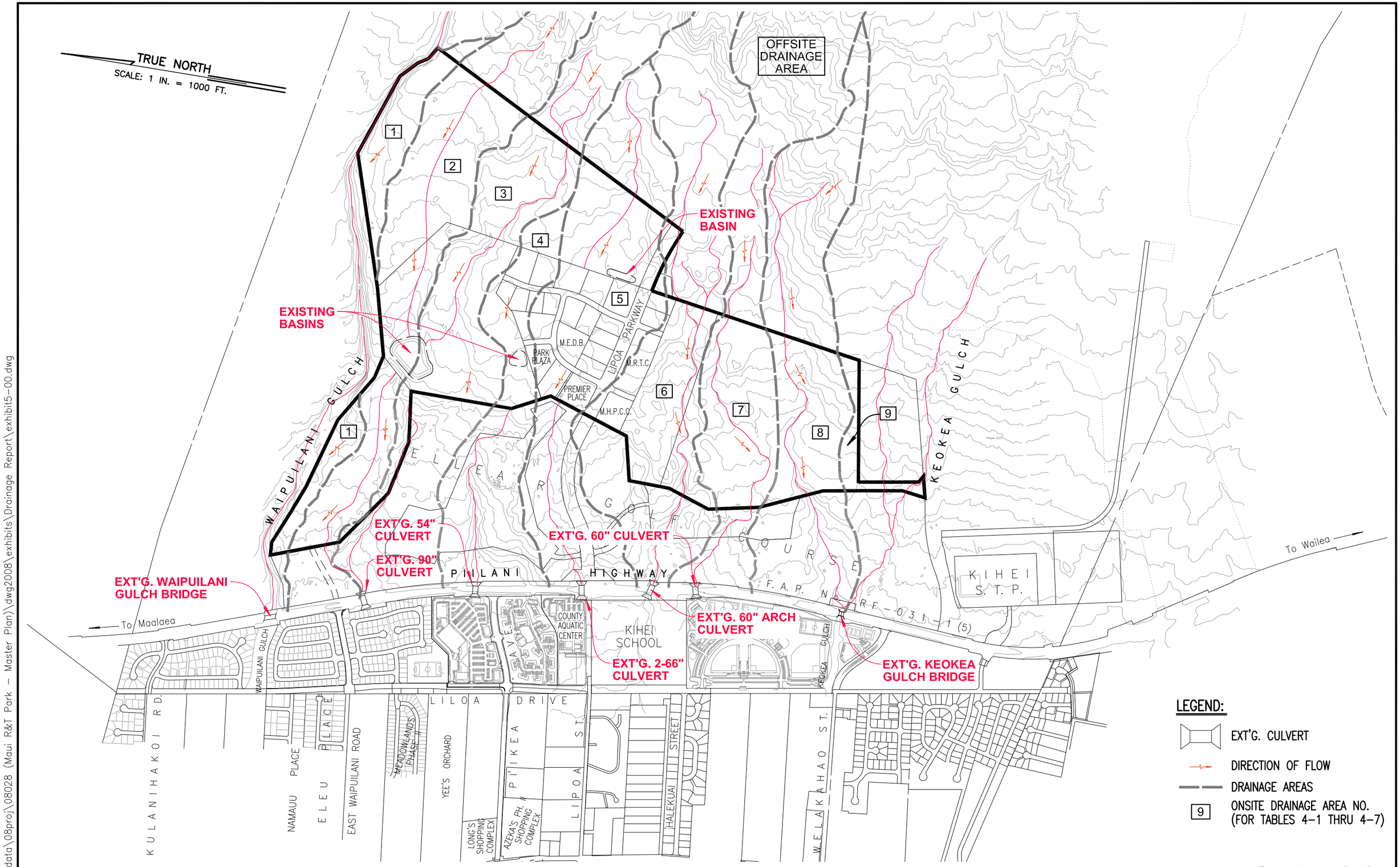
V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Prelim Engineering\exh-flood-insurance-00.dwg




# OFFSITE DRAINAGE AREA

**FIGURE 4-3**

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Drainage Report\exb-offsite drainage area-00.dwg

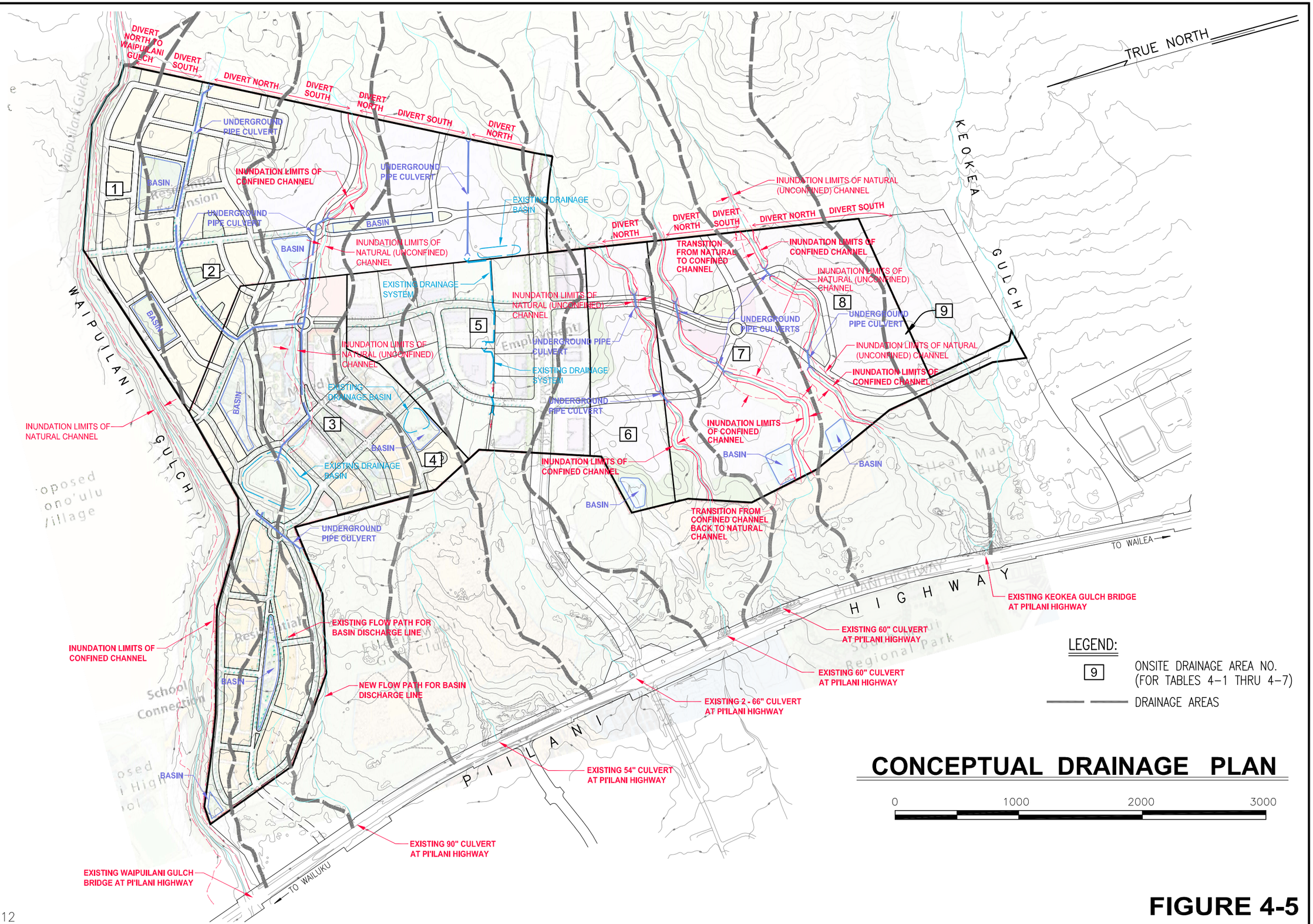



# EXISTING DRAINAGE PATTERN

**FIGURE 4-4**

February 27, 2012

V:\Projdata\08proj\08028 (Maui R&T Park - Master Plan)\dwg2008\exhibits\Drainage Report\exhibit5-00.dwg

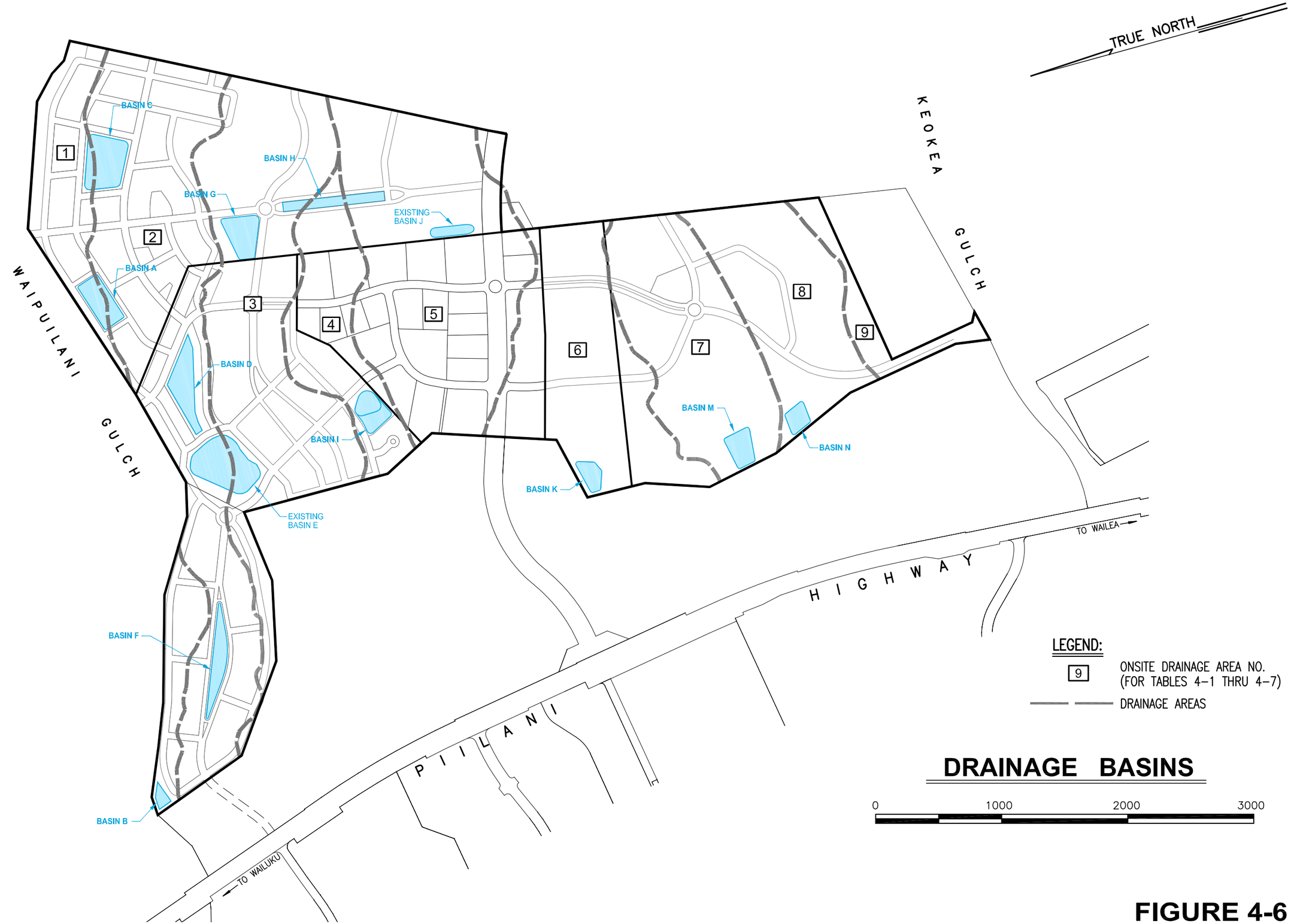



# CONCEPTUAL DRAINAGE PLAN

**FIGURE 4-5**

February 27, 2012

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Exb-Land Plan-00.dwg

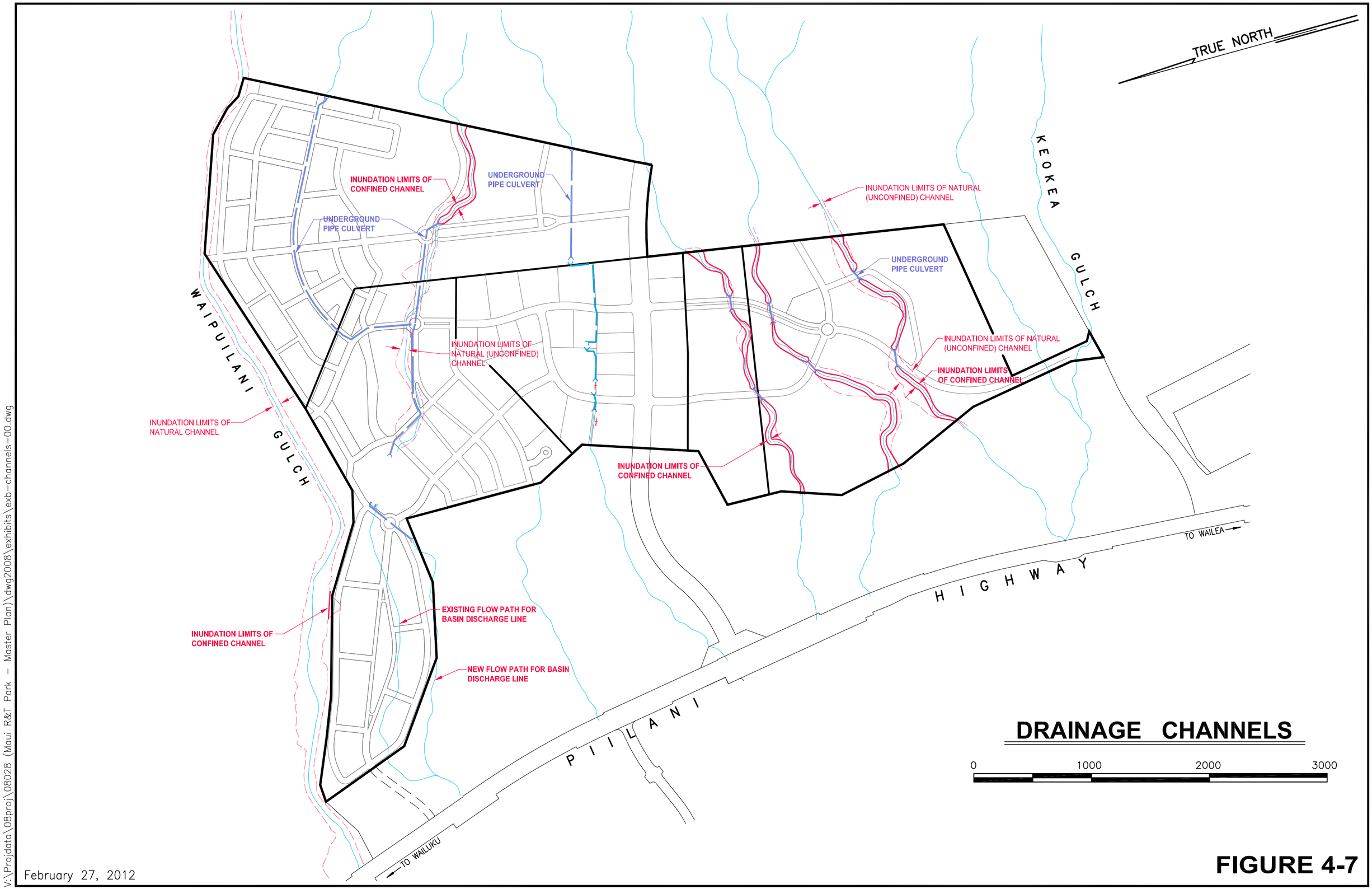



# DRAINAGE BASINS

**FIGURE 4-6**

February 27, 2012

V:\Projdata\08proj\08028 (Maui R&T Park - Master Plan)\dwg2008\exhibits\exb-basins-00.dwg




# DRAINAGE CHANNELS

**FIGURE 4-7**

February 27, 2012

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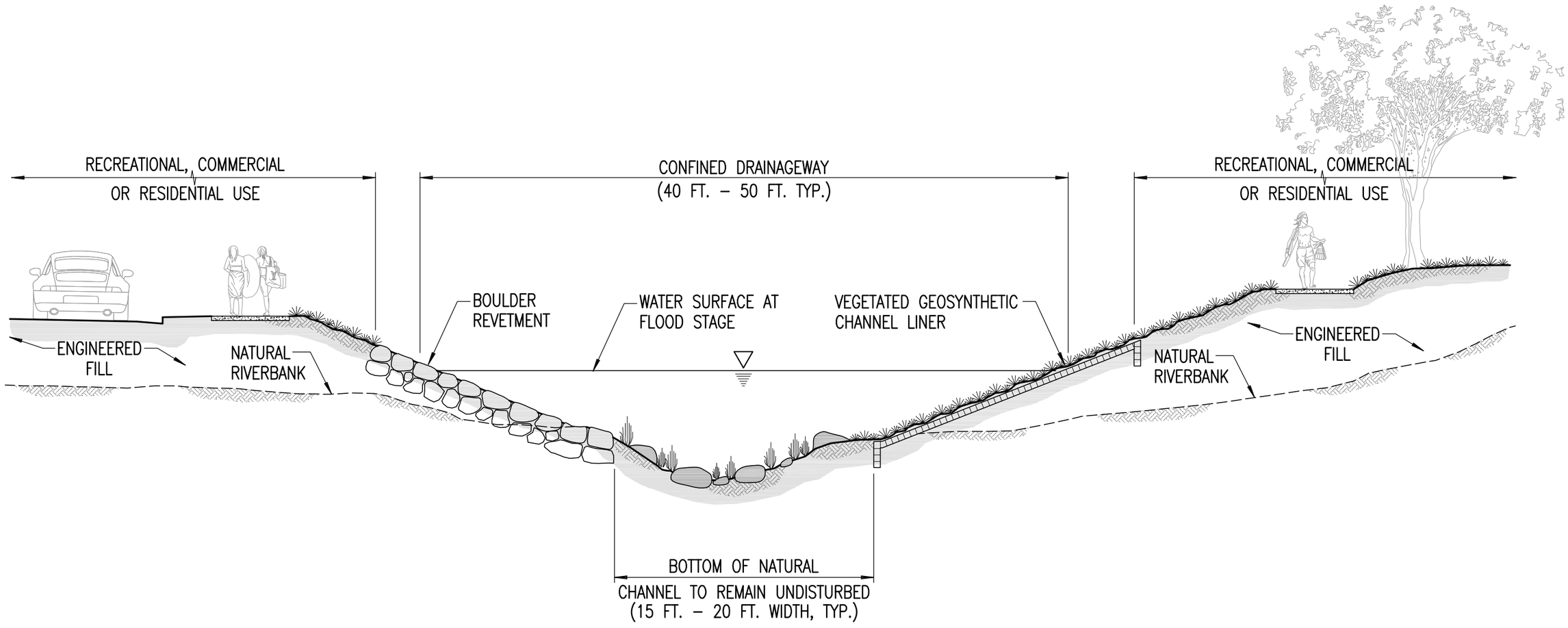


## CROSS SECTION AT CONFINED DRAINAGEWAY

APPROX. SCALE: 1/8" = 1'–0"

**FIGURE 4-8**

February 27, 2012

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# 5. ROADWAY SYSTEM

## 5.1 Existing Roadway Access

### 5.1.1 Regional Access

Lipoa Parkway is currently the sole means of access into the Maui Research and Technology Park. It exists today as a two-lane roadway providing east-west access between MRTP and Piilani Highway; however, it is designed to eventually be further improved and serve as a major collector with a four-lane divided roadway. Only the two eastbound lanes have been constructed to date: the westbound portion of the right-of-way has been graded, but has not been paved. Lipoa Parkway's intersection with Piilani Highway is currently signalized.

Piilani Highway is a four-lane highway that is owned and maintained by the Hawaii State Department of Transportation and serves as the primary north-south arterial highway linking the Maui Research and Technology Park to Kihei and the other cities on the island of Maui.

There are two other points along Piilani Highway where access from MRTP is permitted, but a roadway connection has not yet been made. The first permitted-access point is located near the northern end of the MRTP project area, roughly opposite the East Waipulani Road/ Piilani Highway intersection, where there is an existing 80 foot wide access permitted opening at Piilani Highway. MRTP has a 100-foot wide access and utility easement across the Elleair Golf Course to this 80 foot wide highway access opening. The second permitted-access is located at the southerly end of the project in the vicinity of the old Welakahao Road intersection with Piilani Highway. MRTP has a 64-foot wide access and utility easement which extends from old Welakahao Road (in the

vicinity of the Kihei Wastewater Reclamation Facility) and runs along the southerly side of the Elleair Golf Course over land currently owned by Haleakala Ranch Company[22] to the southerly end of the MRTP.[23]

### 5.1.2 Internal Access and Circulation

Lipoa Parkway serves as the primary east-west access route within the MRTP. It is currently configured as a two-lane roadway that can be improved to become divided four-lane collector roadway.

North and South Holopono and North and South Ninau Streets provide north-south access within the MRTP. These streets are two-lane roadways which connect to Lipoa Parkway. Portions of North and South Holopono Streets, North and South Ninau Streets, and Ho'okena Street -- another planned collector road within the existing 24-lot MRTP site -- have not yet been constructed. Construction plans to complete these roadways have been approved by the County of Maui under a bonded subdivision agreement with the landowner which ensures the completion of these roads if the adjoining lots are developed in the future.

### 5.1.3 Public Transit

The Maui Bus public transit system currently has two bus routes which serve the Kihei area with a one hour headway throughout the day. The Maui Bus system primarily

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[22]TMK (2) 2-2-02:54

[23]The two access easements to Piilani Highway described are depicted on Figure 1-1 in Section 1 of this report.

uses South Kihei Road within the Kihei area and accesses the MRTP twice a day.[24]

### 5.1.4 Bicycle and Pedestrian Access

6-foot wide concrete sidewalks constructed along the existing streets in the Maui Research and Technology Park provide the current means of pedestrian access. A 6-foot wide concrete sidewalk along Lipoa Parkway provides an improved pedestrian access route from Piilani Highway to the MRTP, and 6-foot wide concrete sidewalks located along the existing portions of Holopono and Ninau Street provide pedestrians improved access to the rest of the existing MRTP development. No dedicated bicycle facilities currently exist, so bicycles now share the pavement with motor vehicles.

## 5.2 <u>Proposed Improvements</u>

### 5.2.1 Regional Roadway Improvements

#### 5.2.1.1 Phase 1 Improvements

The *Traffic Impact Analysis for Maui Research and Technology Park* recommends the following improvements be constructed with Phase 1 of the MRTP[25].

1) Upgrades to the Piilani Highway / Lipoa Parkway signalized intersection to increase capacity, including:

   a) Construction of a second southbound left turn lane on Piilani Highway;

[24]Parsons Brinckerhoff, "Traffic Impact Analysis for Maui Research and Technology Park," November 2011, p.7.

[25]Parsons Brinckerhoff, "Traffic Impact Analysis for Maui Research and Technology Park,"February 2013, pp. 82-83.

b) Widening Lipoa Parkway to create separate left, through, and right turn lanes at the westbound approach to the intersection;

c) Widening and restriping Lipoa Street to provide separate left, through, and right turn lanes at the eastbound approach to the intersection;

d) Installing a second crosswalk on the north side of the intersection to improve mauka-makai pedestrian connectivity;

2) Construct a second eastbound left turn lane at the Piilani Highway / Piikea Avenue intersection;

3) Extend Hookena Street to the permitted access point on Piilani Highway near East Waipulani Road and construct a right turn in / right turn out second highway access for the MRTP;

4) Construct a direct pedestrian and bicycle access route between the Kihei High School and the Maui Research and Technology Park;

5) Design the MRTP roadway network with connectivity to adjacent developments to the north and south to facilitate the creation of a continuous roadway network mauka of Piilani Highway which will reduce dependence on Piilani Highway.

#### 5.2.1.2 Phase 2 Improvements

The *Traffic Impact Analysis for Maui Research and Technology Park* anticipates that the intersections along Piilani Highway will exceed capacity, requiring additional north-south arterial roadway capacity to accommodate the projected increase in traffic beyond the 2024 horizon year of Phase 1.[26] The following improvements are therefore proposed with Phase 2.

1) Construct the first two lanes of the north-south Mauka Collector roadway through the MRTP project area with provision for two additional north-south lanes to be added on a separate alignment when additional capacity is needed;
2) Extend at least three internal connector streets within the MRTP roadway system to the eastern (mauka) boundary of Phase 2 with connectivity to the Mauka Collector;
3) Construct a third access onto Piilani Highway at the permitted access point near the Old Welakahao Road intersection (i.e. where the Kihei Wastewater Reclamation Facility's driveway is currently located). Improvements will consist of:
    a) A paved two-lane access road from MRTP to Piilani Highway following the Old Welakahao roadway alignment;
    b) Signalization of the Old Welakahao Road / Piilani Highway intersection and installation of left turn, acceleration and deceleration lanes.

[26]Parsons Brinckerhoff, "Traffic Impact Analysis for Maui Research and Technology Park," February 2013, pp. 83-84.

### 5.2.2 Internal Circulation

Access and circulation within MRTP will be provided by an internal roadway network consisting of connector and local streets arranged in the modified grid pattern depicted in Figure 5-1. Six basic street sections will be utilized to facilitate the safe movement of motor vehicles, bicycles and pedestrians at compatible speeds and volumes. The internal roadway network and street sections are designed to distribute, rather than concentrate, motor vehicle traffic in order to provide a safe low speed street environment compatible with

pedestrians and bicycles as well as vehicles. This is a significant departure from the more common practice of designing streets solely to minimize the delay to motor vehicles.

**A. Lipoa Parkway**

Lipoa Parkway will be improved from its current two-lane configuration to a four-lane road section complete with pedestrian walks and dedicated bike lanes as depicted in Figure 5-2. These improvements will enable Lipoa Parkway to serve efficiently as both the primary vehicle and bicycle access route connecting an expanded MRTP to rest of Kihei. A 24-foot wide planted median island will separate travel in opposite directions, with wide landscaped shoulders providing substantial green open space.

**B. North - South Greenway**

The central 3,500 foot segment of Ninau Street will be become a 92-foot wide "North-South Greenway" which will serve as the principal north-south route through the MRTP. This North-South Greenway will feature a divided two-lane roadway where curbside parking is permitted and 7-foot wide walkways widely

separated from the moving-vehicle lanes provide a safe and inviting route for bike and pedestrian travel. (See Figure 5-3)

**C. Connector Street**

Connector Streets will be 60-foot right-of-way, two-lane streets with an 11-foot wide travel lane and 8-foot wide curbside parking lane in each direction. 6-foot wide concrete sidewalks will be provided on both sides of the street through *both* residential and commercial areas, enabling pedestrians to stroll comfortably two-abreast. (See Figure 5-4)

**D. Split Connector at Open Space (One-Way Couplet)**

Connector Streets will be split into one-way couplets (i.e. a pair of one-way streets) around planned open spaces in certain locations, but will maintain the same single travel lane with curbside parking configuration featured on the standard Connector Streets. (See Figure 5-4)

**E. Local Street**

Local streets will have a 52-foot wide right-of-way with two 8-foot wide travel lanes and 7-foot wide curbside parking lanes on either side. 5-foot wide concrete sidewalks provided on both sides of the street will facilitate safer walking by minimizing the need for pedestrians to cross moving-vehicle lanes in the street in order to reach the nearest sidewalk. (See Figure 5-5)

**F. Alley**

Greencourt, townhome and small-lot single-family residential developments may utilize “alleys” (shared driveways) to access garages located off of the public street. A typical alley supporting two-way traffic will consist of a 20-foot right-of-way containing a 16-foot pavement, which is sufficiently wide to let two

passenger cars traveling in opposite directions move slowly past each other. (See Figure 5-5) The use of alleys has considerable practical value to pedestrian-oriented communities as their use can dramatically reduce the number of driveway curbcuts, thereby minimizing the potential number of vehicle and pedestrian conflict points along residential sidewalks while significantly increasing the amount of curbside parking available.

### 5.2.3 Transit

MRTP will work with the Maui County Dept. of Transportation to expand and improve transit service as Phases 1 and 2 develop in order to make transit an attractive alternative to automobile travel for workers, residents and visitors. Transit stops that are well connected to pedestrian and bicycle routes will be planned and constructed as the project area's roadway system expands.

### 5.2.4 Bicycle and Pedestrian Improvements

The expansion of the Maui Research and Technology Park has been envisioned with pedestrian connectivity as a first priority.[27] Consequently, a substantial number of infrastructure improvements are proposed to make MRTP pedestrian and bicycle-friendly.

1) Sidewalks will be provided on both sides of all streets to establish pedestrian routes alongside vehicle routes to all locations within the MRTP;

[27]Calthorpe Associates and Chris Hart & Partners, "Maui Research and Technology Park Development Code," December 10, 2010. p.36.

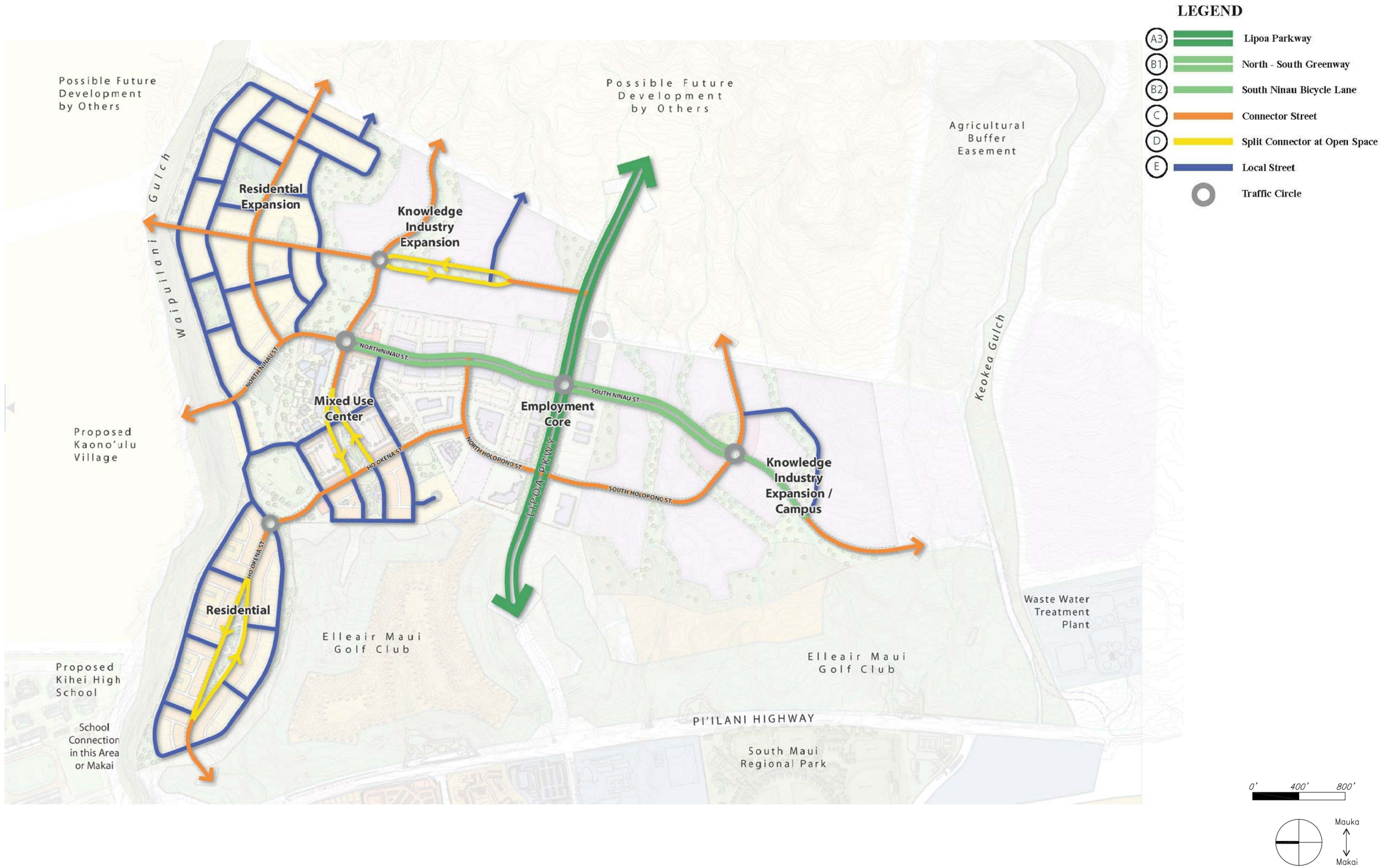
2) Internal streets will be small in scale with narrow pavements to calm vehicle traffic and make it safer for bicycles to share the road with cars[28] and for pedestrians to cross streets;

3) Upgrades to the Lipoa Parkway / Piilani Highway signalized intersection will include striping and other improvements needed to connect and create a safe transition between the bicycle lanes on Piilani Highway and the new bicycle lanes that will be constructed along Lipoa Parkway;

4) A direct bicycle and pedestrian connection will be made between the neighboring Kihei High School and the Maui Research and Technology Park;

5) An east-west bicycle and pedestrian trail will be established through MRTP Phases 1 and 2 along planned greenways and open spaces to facilitate a future linkage between the north-south bike and pedestrian trail along Liloa Drive and future development to the east (mauka) of MRTP as depicted in Figure 5-6.

[28]Calthorpe Associates and Chris Hart & Partners, "Maui Research and Technology Park Development Code," December 10, 2010. p44.

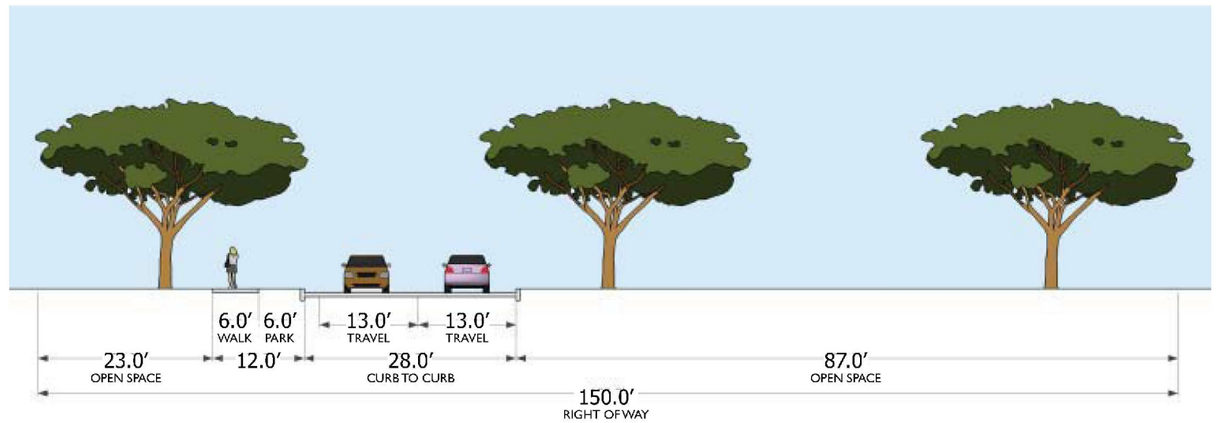



**Source:**
Cathorpe Associates and Chris Hart & Partners, February 2013.

# TRAFFIC CIRCULATION PLAN

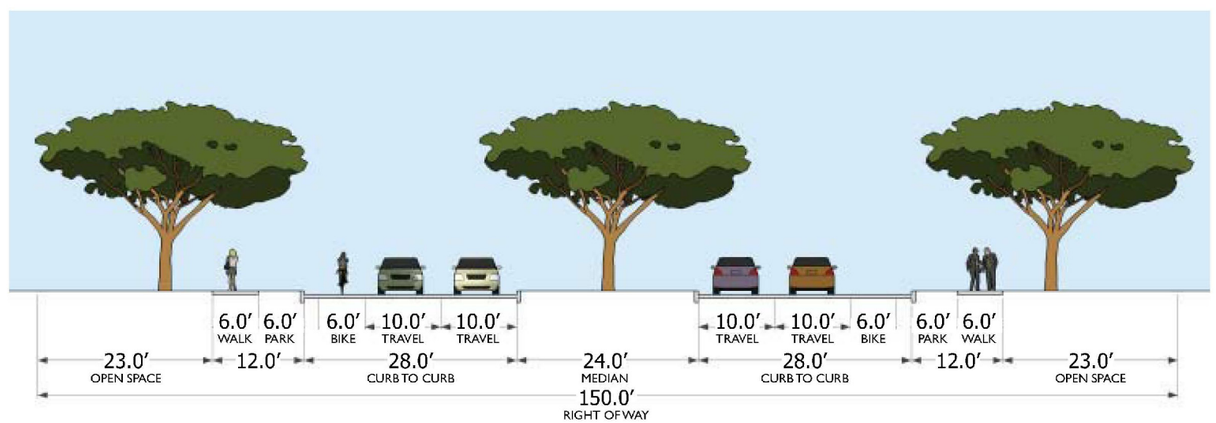
**FIGURE 5-1**

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Prelim Engineering\Exb-street-sections.dwg




A1

LIPOA PARKWAY (Existing)




A3

LIPOA PARKWAY (Final)

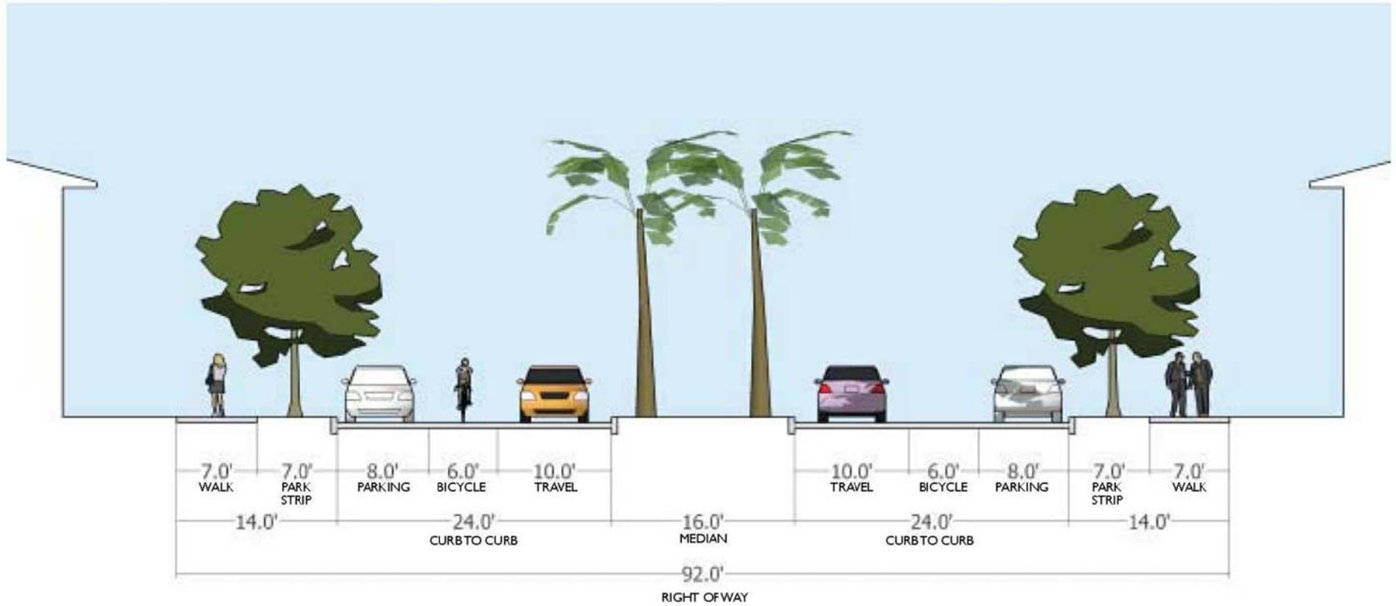
0′ 15′ 30′

**Source:**
Cathorpe Associates and Chris Hart & Partners, "Maui Research and Technology Park Development Code", December 10, 2010.

## TYPICAL SECTION - LIPOA PARKWAY

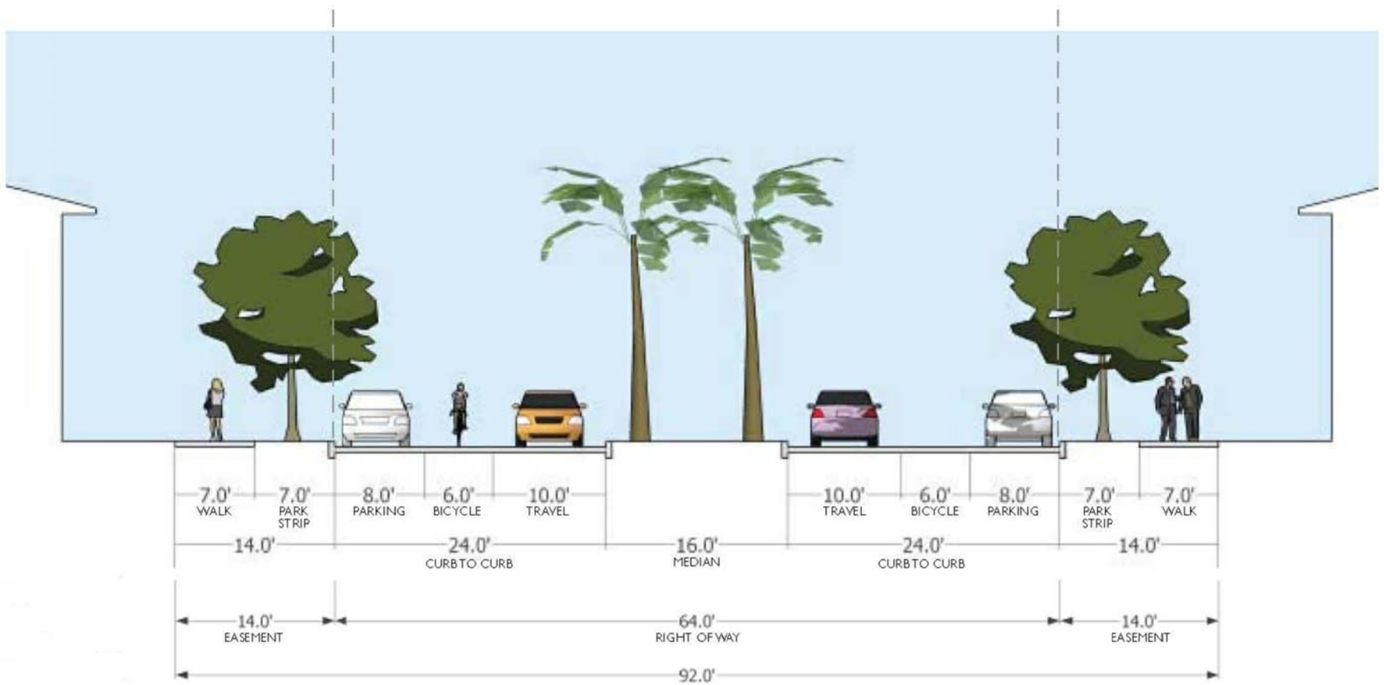
**FIGURE 5-2**

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Prelim Engineering\Exb-street-sections.dwg




B1

NORTH - SOUTH GREENWAY




NINAU STREET (Final, North - South Greenway Format)

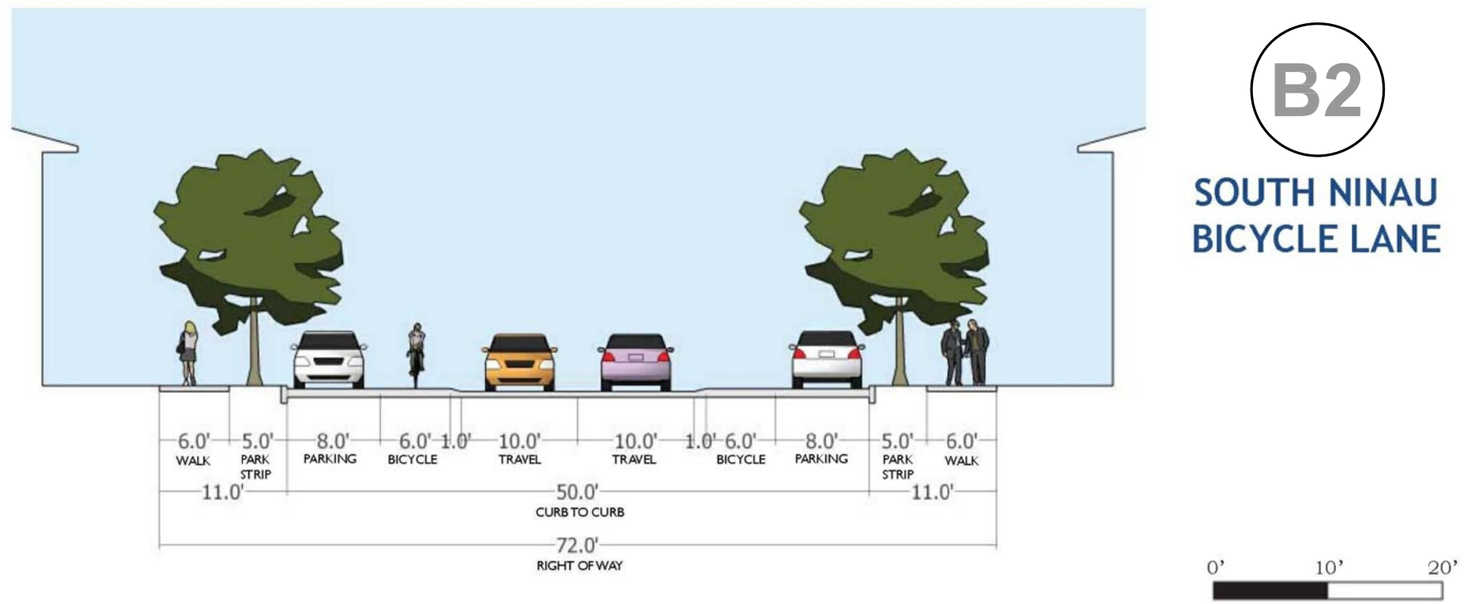
0' 10' 20'

## TYPICAL SECTION
## NORTH-SOUTH GREENWAY

**Source:**
Cathorpe Associates and Chris Hart & Partners, February 2013.

**FIGURE 5-3**

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Prelim Engineering\Exb-street-sections.dwg

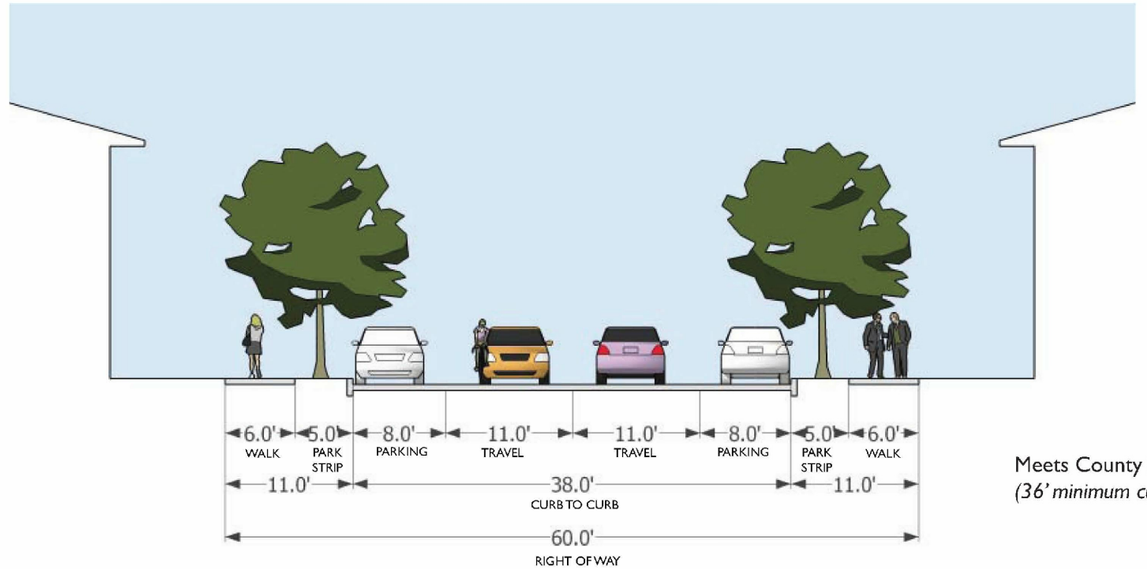



# TYPICAL SECTION
# NORTH-SOUTH GREENWAY

**Source:**
Cathorpe Associates and Chris Hart & Partners,
February 2013.

**FIGURE 5-3**

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Prelim Engineering\Exb-street-sections.dwg

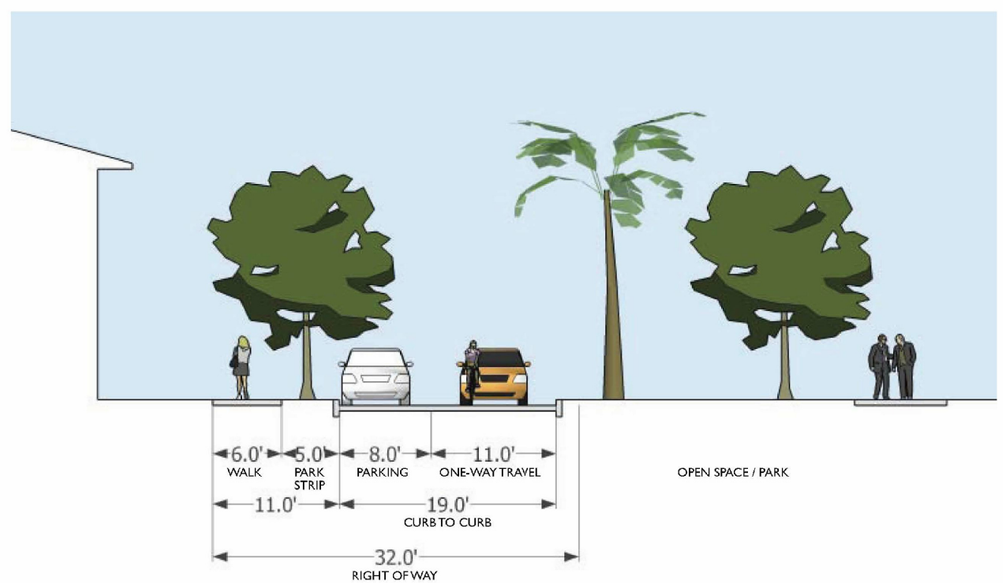



Meets County Standard
*(36' minimum curb to curb)*

C

CONNECTOR STREET

## TYPICAL SECTION - CONNECTOR STREET




D

SPLIT CONNECTOR AT OPEN SPACE (One-Way)

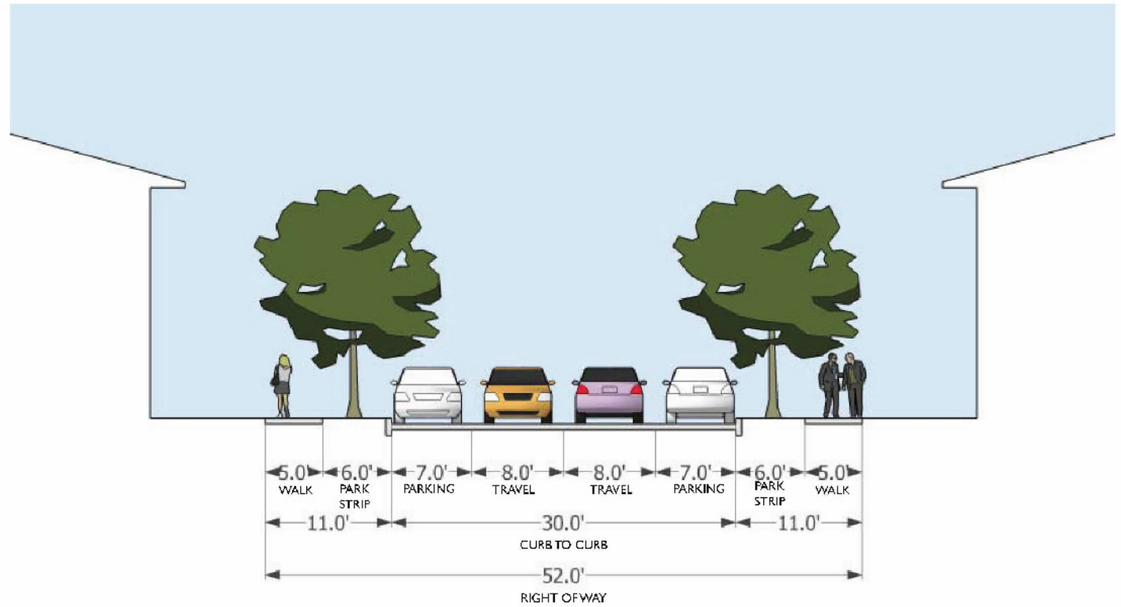
0' 10' 20'

## TYPICAL SECTION
## SPLIT CONNECTOR AT OPEN SPACE

**Source:**
Cathorpe Associates and Chris Hart & Partners, "Maui Research and Technology Park Development Code", December 10, 2010.

**FIGURE 5-4**

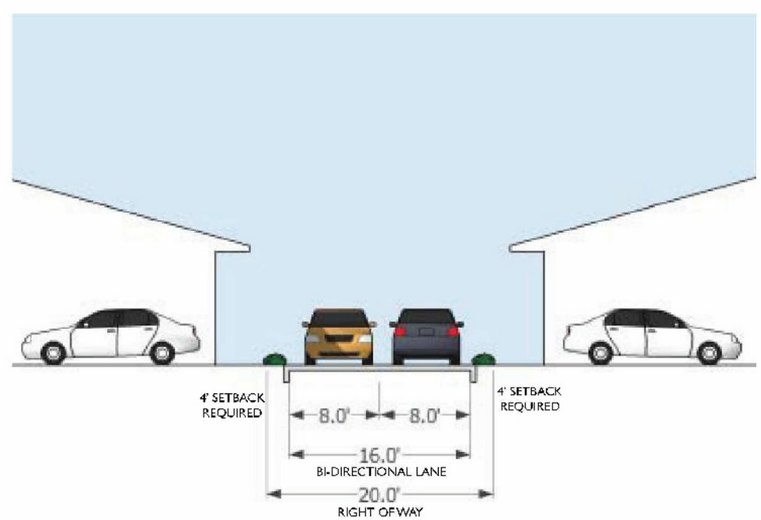
V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Prelim Engineering\Exb-street-sections.dwg




E

LOCAL STREET

## TYPICAL SECTION - LOCAL STREET




F

ALLEY
(two-way)

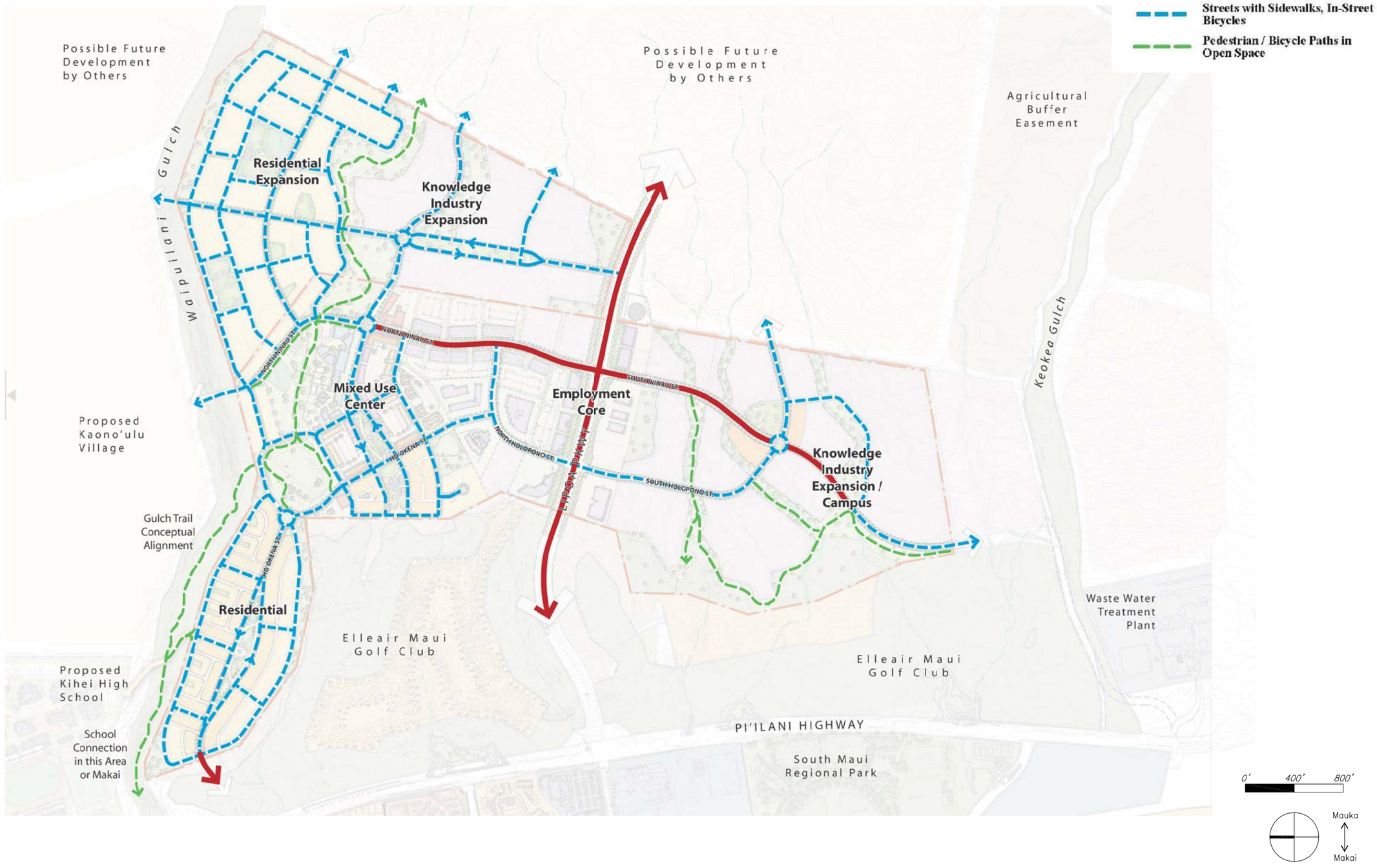
0' 10' 20'

## TYPICAL SECTION - ALLEY (TWO WAY)

**Source:**
Cathorpe Associates and Chris Hart & Partners, "Maui Research and Technology Park Development Code", December 10, 2010.

**FIGURE 5-5**

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Prelim Engineering\Exb-street-sections.dwg




**Source:**
Cathorpe Associates and Chris Hart & Partners, February 2013.

# PEDESTRIAN AND BICYCLE CONNECTION PLAN

**FIGURE 5-6**

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Prelim Engineering\Exb-street-sections.dwg

# 6. POWER AND COMMUNICATION[29]

## 6.1 Electrical

Maui Electric Company's (MECO) Maalaea Power Plant serves the Kihei-Wailea region from the Kihei and Wailea Substations, which are connected by a 69kV (kilo-volt) overhead transmission line that runs along the western shoulder of Piilani Highway.

The Kihei Substation serves the MRTP area. The substation transformers convert the 69kV transmission power to 12.47kV distribution power. 12.47kV distribution power is then transmitted, via primary overhead lines that are under-built below the previously mentioned 69kV overhead transmission lines. On East Lipoa Street, the overhead distribution lines are fed into an underground distribution system, which currently is tied into the MRTP main feed.

When fully built out, the electrical demand for the Master Plan update is forecast to be 23,750 kilowatts. Based on the anticipated demand, MECO anticipates a new substation be required in the first page of the project—along with associated electrical infrastructure, equipment and related easements.

Current plans for the project include adequate land for locating a new substation. Additionally, the project proposes to underground existing overhead power lines that run north-south along the mauka boundary of the southern portion of the project. These lines will be placed underground as the project is built out from the existing employment core towards the south. The developer will coordinate closely with MECO to ensure adequate service is provided.

[29]Summary prepared by ECM, Inc., May 2012.

## 6.2 Communication & Cable Television

Hawaiian Telcom, Sandwich Isles Communications, Time Warner Telecommunications, and Wavecom Solutions provide telephone and data connectivity service in the Kihei region, including MRTP. Oceanic Time Warner Cable provides cable service. The telecommunications infrastructure from the providers servicing the area consists of overhead and underground facilities.

Currently, Hawaiian Telcom, Time Warner Telecommunications, and Wavecom Solutions have underground systems in place at MRTP, but additional underground infrastructure may need to be installed to accommodate the proposed residential and commercial addition. Sandwich Isles Communications is currently sharing conduit and other infrastructure with another provider, but is planning to have a separate dedicated system in MRTP in the future.

Oceanic Time Warner Cable has one node servicing all of the residential lots in the area and another node servicing all the commercial lots. They feel that everything that is being proposed to be built on this project can be serviced with current nodes, which should be adequate for a while. However, in the event that additional nodes are needed, Oceanic Time Warner Cable will initiate their installations.

## 7. REFERENCES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United States Department of Agriculture, Soil Conservation Service, "Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii," August 1972.

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U.S. Department of Homeland Security, Federal Emergency Management Agency, "Flood Insurance Rate Map, Maui County, Hawaii," Community-Panel Number 150003 0576E, 0586E and 0588E, September 25, 2009.

# APPENDIX A

Wastewater Demand / Flow Calculations

**MAUI RESEARCH AND TECHNOLOGY PARK MASTER PLAN**
**WASTEWATER FLOW PROJECTIONS**

TOTAL PROJECT

1. Average Wastewater Flow:
   = 0.50 MGD (Obtained from Wastewater Flow Tabulation)

2. Maximum Wastewater Flow:
   = 0.50 MGD x 3.60 (Babbitt Peaking Factor)
   = 1.80 MGD

3. Dry Weather Infiltration/Inflow:
   =5 gpcd x 10,354 (Obtained from Per Capita Tabulation)
   =0.05 MGD

4. Design Average Flow:
   =0.50 MGD + 0.05 MGD
   =0.55 MGD

5. Design Maximum Flow:
   = 1.80 MGD + 0.05 MGD
   = 1.85 MGD

6. Wet Weather Infiltration/Inflow:
   = 1,250 gpad x 364 acres
   = 0.46 MGD

7. Design Peak Flow:
   =1.85 MGD + 0.46 MGD
   = 2.31 MGD

PHASE 1

1. Average Wastewater Flow:
   = 0.26 MGD (Obtained from Table A-1: Wastewater Flow Tabulation)

2. Maximum Wastewater Flow:
   = 0.26 MGD x 4.2 (Babbitt Peaking Factor)
   = 1.09 MGD

3. Dry Weather Infiltration/Inflow:
   =5 gpcd x 5,548 (Obtained from Table A-2: Per Capita Tabulation)
   =0.03 MGD

4. Design Average Flow:
   =0.26 MGD + 0.03 MGD
   =0.29 MGD

5. Design Maximum Flow:
   = 1.09 MGD + 0.03 MGD
   = 1.12 MGD

6. Wet Weather Infiltration/Inflow:
   = 1,250 gpad x 212 acres
   = 0.26 MGD

7. Design Peak Flow:
   =1.12 MGD + 0.26 MGD
   = 1.38 MGD

PHASE 2

1. Average Wastewater Flow:
   = 0.24 MGD (Obtained from Table A-1: Wastewater Flow Tabulation)

2. Maximum Wastewater Flow:
   = 0.24 MGD x 4.3 (Babbitt Peaking Factor)
   = 1.03 MGD

3. Dry Weather Infiltration/Inflow:
   =5 gpcd x 4,806 (Obtained from Table A-2: Per Capita Tabulation)
   =0.02 MGD

4. Design Average Flow:
   =0.24 MGD + 0.02 MGD
   =0.26 MGD

5. Design Maximum Flow:
   = 1.03 MGD + 0.02 MGD
   = 1.05 MGD

6. Wet Weather Infiltration/Inflow:
   = 1,250 gpad x 152 acres
   = 0.19 MGD

7. Design Peak Flow:
   =1.05 MGD + 0.19 MGD
   = 1.24 MGD

**TABLE A-1**
**MAUI RESEARCH AND TECHNOLOGY PARK MASTER PLAN**
**WASTEWATER FLOW TABULATION**

| | Parcel Area (Acres) | Unit Area (Sq. Ft.) | Dwelling Units | Employees | Contribution (gal/unit/day) | Avg. Daily Flow (gpd) | Comments |
|---|---|---|---|---|---|---|---|
| **A. EMPLOYMENT CORE** | | | | | | | |
| 1 to 5 Existing Buildings | | | | 400 | 20 | 8,000 | |
| 6 Future USPS Sorting Facility | 2.2 | | | 100 | 20 | 2,000 | |
| 7 Employment | 2.9 | | | 130 | 20 | 2,600 | |
| 8 Employment | 2.7 | | | 120 | 20 | 1,340 | |
| 9 Employment | 2.3 | | | 100 | 20 | 1,660 | |
| 10 Employment | 5.0 | | | 200 | 20 | 1,040 | |
| 11 Employment | 1.2 | | | 50 | 20 | 1,000 | |
| 12 Employment | 1.2 | | | 50 | 20 | 1,000 | |
| 13 Employment | 1.4 | | | 60 | 20 | 1,200 | |
| 14 Employment | 1.4 | | | 60 | 20 | 1,200 | |
| 15 Employment | 2.8 | | | 120 | 20 | 2,400 | |
| 16 Employment | 2.3 | | | 100 | 20 | 2,000 | |
| 17 Employment | 2.3 | | | 100 | 20 | 2,000 | |
| 18 Employment | 2.3 | | | 100 | 20 | 2,000 | |
| 19 Employment | 0.9 | | | 40 | 20 | 800 | |
| 20 Employment | 1.2 | | | 50 | 20 | 1,000 | |
| 21 Employment | 1.0 | | | 50 | 20 | 1,000 | |
| 22 Employment | 1.0 | | | 50 | 20 | 1,000 | |
| 23 Employment | 1.6 | | | 70 | 20 | 1,400 | |
| 24 Employment | 1.5 | | | 60 | 20 | 1,200 | |
| 25a Employment | 2.0 | | | 90 | 20 | 1,800 | |
| 25b Employment | 1.9 | | | 80 | 20 | 1,600 | |
| 26 Employment | 6.8 | | | 270 | 20 | 5,400 | |
| | | | | | **Subtotal:** | **44,640** | |

**TABLE A-1**
**MAUI RESEARCH AND TECHNOLOGY PARK MASTER PLAN**
**WASTEWATER FLOW TABULATION**

| | | Parcel Area (Acres) | Unit Area (Sq. Ft.) | Dwelling Units | Employees | Contribution (gal/unit/day) | Avg. Daily Flow (gpd) | Comments |
|---|---|---|---|---|---|---|---|---|
| **B. KNOWLEDGE INDUSTRY EXPANSION/CAMPUS** | | | | | | | | |
| 1A | Employment | 4.4 | | | 190 | 20 | 3,800 | |
| 1B | Employment | 0.9 | | | 40 | 20 | 800 | |
| 2 | Employment | 2.3 | | | 100 | 20 | 2,000 | |
| 3 | Employment/Campus | 9.9 | | | 370 | 20 | 7,400 | |
| 3b | Employment/Campus-Reserve | 11.4 | | | | | | No Development |
| 4 | Employment | 3.8 | | | 170 | 20 | 3,400 | |
| 5 | Mixed Use/Flex | 0.9 | | | 40 | 30 | 1,200 | |
| 6 | Mixed Use/Flex | 1.3 | | | 50 | 30 | 1,500 | |
| 7 | Employment | 4.0 | | | 170 | 20 | 3,400 | |
| 8 | Employment | 4.2 | | | 180 | 30 | 5,400 | |
| 9 | Employment/Campus | 11.4 | | | 430 | 20 | 8,600 | |
| | | | | | | **Subtotal:** | **37,500** | |
| **C. VILLAGE CENTER** | | | | | | | | |
| 1 | Hotel | 22.1 | 60,000 | 150 | | 300 | 45,000 | Assume 150 rooms |
| 2 | Mixed Use | 3.1 | | | 80 | 30 | 2,400 | |
| 3 | Mixed Use | 2.5 | | | 50 | 30 | 1,500 | |
| 4 | Mixed Use | 2.5 | | | 50 | 30 | 1,500 | |
| 5 | Residential | 2.6 | | 80 | | 255 | 20,400 | |
| 6 | Restaurant | 0.8 | 8,000 | | 100 | 80 | 4,160 | Assume 100 seats |
| 7 | Residential | 1.4 | | 23 | | 350 | 8,050 | |
| 8 | Residential | 2.4 | | 42 | | 350 | 14,700 | |
| 9 | Residential | 2.1 | | 10 | | 350 | 3,500 | |
| 10 | Residential | 0.9 | | 10 | | 350 | 3,500 | |
| 11 | Residential | 1.0 | | 9 | | 350 | 3,150 | |
| 12 | Residential | 0.9 | | 7 | | 350 | 2,450 | |
| 13 | Residential | 0.7 | | 4 | | 350 | 1,400 | |
| 14 | Residential | 0.9 | | 7 | | 350 | 2,450 | |

**TABLE A-1**
**MAUI RESEARCH AND TECHNOLOGY PARK MASTER PLAN**
**WASTEWATER FLOW TABULATION**

| | | Parcel Area (Acres) | Unit Area (Sq. Ft.) | Dwelling Units | Employees | Contribution (gal/unit/day) | Avg. Daily Flow (gpd) | Comments |
|---|---|---|---|---|---|---|---|---|
| 15 | Residential | 0.1 | | 1 | | 350 | 350 | |
| 17 | Civic | 3.9 | | | | | | Open Space |
| 18 | Civic | 6.2 | 100,000 | | 500 | 15 | 7,500 | |
| **D. MAKAI RESIDENTIAL** | | | | | | **Subtotal:** | **122,010** | |
| 1 | Residential | 3.1 | | 52 | | 255 | 13,260 | |
| 2 | Residential | 3.9 | | 64 | | 255 | 16,320 | |
| 3 | Residential | 3.2 | | 53 | | 255 | 13,515 | |
| 4 | Residential | 1.9 | | 31 | | 255 | 7,905 | |
| 5 | Residential | 2.5 | | 42 | | 255 | 10,710 | |
| 6 | Residential | 3.0 | | 50 | | 255 | 12,750 | |
| 7 | Residential | 3.5 | | 58 | | 255 | 14,790 | |
| **E. RESIDENTIAL AND KNOWLEDGE INDUSTRY EXPANSION** | | | | | | **Subtotal:** | **89,250** | |
| 1 | Residential | 1.3 | | 18 | | 350 | 6,300 | |
| 2 | Residential | 2.1 | | 30 | | 350 | 10,500 | |
| 3 | Residential | 1.4 | | 19 | | 350 | 6,650 | |
| 4 | Residential | 1.7 | | 24 | | 350 | 8,400 | |
| 5 | Residential | 1.7 | | 23 | | 350 | 8,050 | |
| 6 | Residential | 1.8 | | 25 | | 350 | 8,750 | |
| 7 | Residential | 1.5 | | 20 | | 350 | 7,000 | |
| 9 | Residential | 1.1 | | 15 | | 350 | 5,250 | |
| 10 | Residential | 2.9 | | 41 | | 350 | 14,350 | |
| 11 | Residential | 1.9 | | 27 | | 350 | 9,450 | |
| 12 | Residential | 3.4 | | 47 | | 350 | 16,450 | |
| 14 | Residential | 2.5 | | 35 | | 350 | 12,250 | |

**TABLE A-1**
**MAUI RESEARCH AND TECHNOLOGY PARK MASTER PLAN**
**WASTEWATER FLOW TABULATION**

| | | Parcel Area (Acres) | Unit Area (Sq. Ft.) | Dwelling Units | Employees | Contribution (gal/unit/day) | Avg. Daily Flow (gpd) | Comments |
|---|---|---|---|---|---|---|---|---|
| 15 | Residential | 1.9 | | 27 | | 350 | 9,450 | |
| 17 | Residential | 1.7 | | 24 | | 350 | 8,400 | |
| 18 | Residential | 2.5 | | 34 | | 350 | 11,900 | |
| 19 | Residential | 1.6 | | 23 | | 350 | 8,050 | |
| 20 | Residential | 1.8 | | 25 | | 350 | 8,750 | |
| 21 | Residential | 1.7 | | 22 | | 350 | 7,700 | |
| 22 | Employment | 4.1 | | | 180 | 30 | 5,400 | |
| 22b | Employment - Reserve | 2.2 | | | | | | No Development |
| 23 | Employment | 4.6 | | | 200 | 30 | 6,000 | |
| 23b | Employment - Reserve | | | | | | | No Development |
| 24 | Employment | 6.0 | | | 260 | 30 | 7,800 | |
| 24b | Employment - Reserve | | | | | | | No Development |
| 25 | Employment | 11.8 | | | 510 | 30 | 15,300 | |
| | | | | | | **Subtotal:** | **202,150** | |
| | | | | | | | | |
| | | | | | | **Average Daily Wastewater Flow (gpd):** | **495,550** | |
| | | | | | | | | |
| | | | | | | **Average Daily Wastewater Flow (gpd) for Phase 1:** | **255,900** | |
| | | | | | | **Average Daily Wastewater Flow (gpd) for Phase 2:** | **239,650** | |

**NOTES:**
1. PHASE 1 INCLUDES A-EMPLOYMENT CORE, C-VILLAGE CENTER, AND D-MAKAI RESIDENTIAL
2. PHASE 2 INCLUDES B-KNOWLEDGE INDUSTRY EXPANSION/CAMPUS AND E-OPTION LAND

**TABLE A-2**
**MAUI RESEARCH AND TECHNOLOGY PARK MASTER PLAN**
**TOTAL PER CAPITA TABULATION**

| | | Parcel Area (Acres) | Unit Area (Sq. Ft.) | Dwelling Units | Employees |
|---|---|---|---|---|---|
| **A. EMPLOYMENT CORE** | | | | | |
| 1 to 5 | Existing Buildings | | | | 400 |
| 6 | Future USPS Sorting Facility | 2.2 | | | 100 |
| 7 | Employment | 2.9 | | | 130 |
| 8 | Employment | 2.7 | | | 120 |
| 9 | Employment | 2.3 | | | 100 |
| 10 | Employment | 5.0 | | | 200 |
| 11 | Employment | 1.2 | | | 50 |
| 12 | Employment | 1.2 | | | 50 |
| 13 | Employment | 1.4 | | | 60 |
| 14 | Employment | 1.4 | | | 60 |
| 15 | Employment | 2.8 | | | 120 |
| 16 | Employment | 2.3 | | | 100 |
| 17 | Employment | 2.3 | | | 100 |
| 18 | Employment | 2.3 | | | 100 |
| 19 | Employment | 0.9 | | | 40 |
| 20 | Employment | 1.2 | | | 50 |
| 21 | Employment | 1.0 | | | 50 |
| 22 | Employment | 1.0 | | | 50 |
| 23 | Employment | 1.6 | | | 70 |
| 24 | Employment | 1.5 | | | 60 |
| 25a | Employment | 2.0 | | | 90 |
| 25b | Employment | 1.9 | | | 80 |
| 26 | Employment | 6.8 | | | 270 |
| | | | | **Subtotal:** | **2,450** |
| **B. KNOWLEDGE INDUSTRY EXPANSION/CAMPUS** | | | | | |
| 1A | Employment | 4.4 | | | 190 |
| 1B | Employment | 0.9 | | | 40 |
| 2 | Employment | 2.3 | | | 100 |
| 3 | Employment/Campus | 9.9 | | | 370 |
| 3B | Employment - Reserve | 11.4 | | | 0 |
| 4 | Employment | 3.8 | | | 170 |
| 5 | Mixed Use/Flex | 0.9 | | | 40 |
| 6 | Mixed Use/Flex | 1.3 | | | 50 |
| 7 | Employment | 4.0 | | | 170 |
| 8 | Employment | 4.2 | | | 180 |
| 7 | Employment/Campus | 11.4 | | | 430 |
| | | | | **Subtotal:** | **1,740** |

**TABLE A-2**
**MAUI RESEARCH AND TECHNOLOGY PARK MASTER PLAN**
**TOTAL PER CAPITA TABULATION**

| | | Parcel Area (Acres) | Unit Area (Sq. Ft.) | Dwelling Units | Employees |
|---|---|---|---|---|---|
| **C. VILLAGE CENTER** | | | | | |
| 1 | Hotel | 2.1 | 60,000 | 150 | 150 |
| 2 | Mixed Use | 3.1 | | 80 | 80 |
| 3 | Mixed Use | 2.5 | | 65 | 50 |
| 4 | Mixed Use | 2.5 | | 63 | 50 |
| 5 | Residential | 2.6 | | 80 | 320 |
| 6 | Restaurant | 0.8 | 8,000 | | 100 |
| 7 | Residential | 1.4 | | 23 | 92 |
| 8 | Residential | 2.4 | | 42 | 168 |
| 9 | Residential | 2.1 | | 10 | 40 |
| 10 | Residential | 0.9 | | 10 | 40 |
| 11 | Residential | 1.0 | | 9 | 36 |
| 12 | Residential | 0.9 | | 7 | 28 |
| 13 | Residential | 0.7 | | 4 | 16 |
| 14 | Residential | 0.9 | | 7 | 28 |
| 15 | Residential | 0.1 | | | |
| 17 | Civic | 3.9 | | | |
| 18 | Civic | 6.2 | 100,000 | | 500 |
| | | | | **Subtotal:** | **1,698** |
| **D. MAKAI RESIDENTIAL** | | | | | |
| 1 | Residential | 3.1 | | 52 | 208 |
| 2 | Residential | 3.9 | | 64 | 256 |
| 3 | Residential | 3.2 | | 53 | 212 |
| 4 | Residential | 1.9 | | 31 | 124 |
| 5 | Residential | 2.5 | | 42 | 168 |
| 6 | Residential | 3.0 | | 50 | 200 |
| 7 | Residential | 3.5 | | 58 | 232 |
| | | | | **Subtotal:** | **1,400** |

**TABLE A-2**
**MAUI RESEARCH AND TECHNOLOGY PARK MASTER PLAN**
**TOTAL PER CAPITA TABULATION**

| | | Parcel Area (Acres) | Unit Area (Sq. Ft.) | Dwelling Units | Employees |
|---|---|---|---|---|---|
| **E. RESIDENTIAL AND KNOWLEDGE INDUSTRY EXPANSION** | | | | | |
| 1 | Residential | 1.3 | | 18 | 72 |
| 2 | Residential | 2.1 | | 30 | 120 |
| 3 | Residential | 1.4 | | 19 | 76 |
| 4 | Residential | 1.7 | | 24 | 96 |
| 5 | Residential | 1.7 | | 23 | 92 |
| 6 | Residential | 1.8 | | 25 | 100 |
| 7 | Residential | 1.5 | | 20 | 80 |
| 9 | Residential | 1.1 | | 15 | 60 |
| 10 | Residential | 2.9 | | 41 | 164 |
| 11 | Residential | 1.9 | | 27 | 108 |
| 12 | Residential | 3.4 | | 47 | 188 |
| 14 | Residential | 2.5 | | 35 | 140 |
| 15 | Residential | 1.9 | | 27 | 108 |
| 17 | Residential | 1.7 | | 24 | 96 |
| 18 | Residential | 2.5 | | 34 | 136 |
| 19 | Residential | 1.6 | | 23 | 92 |
| 20 | Residential | 1.8 | | 25 | 100 |
| 21 | Residential | 1.7 | | 22 | 88 |
| 22 | Employment | 4.1 | | | 180 |
| 22b | Employment -Reserve | 2.2 | | | 0 |
| 23 | Employment | 4.6 | | | 200 |
| 23b | Employment - Reserve | 2.5 | | | 0 |
| 24 | Employment | 6.0 | | | 260 |
| 24b | Employment - Reserve | 3.3 | | | 0 |
| 27 | Employment | 11.8 | | | 510 |
| | | | | **Subtotal:** | **3,066** |
| | | | | **Total Per Capita:** | **10,354** |
| | | | | | |
| | | | | **Total Per Capita for Phase I:** | **5,548** |
| | | | | **Total Per Capita for Phase 2:** | **4,806** |

**NOTES:**
1. PHASE 1 INCLUDES A-EMPLOYMENT CORE, C-VILLAGE CENTER, AND D-MAKAI RESIDENTIAL
2. PHASE 2 INCLUDES B-KNOWLEDGE INDUSTRY EXPANSION/CAMPUS AND E-OPTION LAND

# APPENDIX B

Water Demand Calculations

# APPENDIX B-1

Honolulu Board of Water Supply Dual System
Water Use Criteria

Table 2

Summary of Water System Design Criteria

WATER USE CRITERIA

| Land Use | Unit | All Potable System | Dual System | | | |
|---|---|---|---|---|---|---|
| | | | Average Water Use | | Average Daily Demand | |
| | | | Potable | Non-Potable | Potable | Non-Potable |
| Residential | | | | | | |
| Single Family | GPD/Unit | 500 | 345 | 155 | 414 | 186 |
| Multi-Family Low Rise | GPD/Unit | 400 | 276 | 124 | 331 | 149 |
| Multi-Family High Rise | GPD/Unit | 300 | 207 | 93 | 248 | 112 |
| Commercial | GPD/Acre | 3,000 | 1,800 | 1,200 | 2,160 | 1,440 |
| Resort | GPD/Unit | 350 | 203 | 147 | 244 | 176 |
| | GPD/Acre | 4,000 | 2,320 | 1,680 | 2,784 | 2,016 |
| Golf Course and Parks | GPD/Acre | 4,000 | 600 | 3,400 | 720 | 4,080 |
| School | GPD/Student | 60 | 35 | 25 | 42 | 30 |
| Industrial | GPD/Acre | 4,000 | 1,184 | 2,816 | 1,421 | 3,379 |
| Commercial/Industrial | GPD/1,000 $Ft^2$ | 100 | 60 | 40 | 72 | 48 |
| Commercial/Residential | GPD/1,000 $Ft^2$ | 120 | 83 | 37 | 100 | 44 |

PIPELINE, STORAGE, AND WELL PUMP SIZING CRITERIA

1. Demand Factors

   a. AVERAGE DAY DEMAND. For land uses to be served by a dual system, a 1.2 factor is applied to the AVERAGE WATER USE rates to derive the AVERAGE DAY DEMAND. For land uses served only by the potable system, AVERAGE WATER USE and AVERAGE DAY DEMAND are identical.

   b. MAXIMUM DAY DEMAND = (1.5) AVERAGE DAY DEMAND.

   c. PEAK HOUR RATE = (3.0) AVERAGE DAY DEMAND

2. Fire protection can be met in either the potable or non-potable system subject to meeting all present fire protection standards.

3. Reservoir Size

   a. The potable reservoir volume shall be equivalent to MAXIMUM DAY DEMAND.

   b. The non-potable reservoir volume shall be equivalent to AVERAGE DAY DEMAND.

4. Potable and non-potable pipelines shall be sized for PEAK HOUR flowrates with a minimum residual pressure of 40 psi and maximum velocity in the main of 6 feet per second. Hydraulic analyses will utilize tank spillway elevations as the initial hydraulic grade line elevations. Pipelines providing fire protection shall also be sized for MAXIMUM DAY flow plus fire flow with a residual of 20 psi at the critical fire hydrant. Hydraulic analyses will use three-quarters full tank water surface elevations as initial hydraulic grade line elevations.

5. Well pumps for potable and non-potable systems shall provide MAXIMUM DAY in an operating time of 16 hours.

Source: Honolulu Board of Water Supply, 1984.

# APPENDIX B-2

Potable and Non-Potable Water Demand Calculations

Table 1

Projections of Required Potable and Irrigation Supply for
Phase 1 of the Expansion of the Maui Research and Technology Park

| Development Area | Land Use | Area | | Number of Units | Potable | | Non-Potable | |
|---|---|---|---|---|---|---|---|---|
| | | Acres | $Ft^2$ | | Unit Use Rate ( GPD / Unit ) | Amount ( GPD ) | Unit Use Rate ( GPD / Unit ) | Amount ( GPD ) |
| Employment Core (Portion Not Supplied by DWS) | Employment | 15.7 | 224,730 | -- | 84 / 1000 $Ft^2$ | 18,877 | 56 / 1000 $Ft^2$ | 12,585 |
| | Open Space (PI) | 3.2 | -- | -- | -- | -- | 1700 / Ac. | 5,440 |
| | Roads | 1.8 | -- | -- | -- | -- | 880 / Ac. | 1,584 |
| | Totals | 20.7 | 224,730 | 0 | -- | 18,877 | -- | 19,609 |
| Village Center | Hotel | 2.1 | 60,000 | 150 | 203 / Unit | 30,450 | 147 / Unit | 22,050 |
| | Mixed Use | 8.9 | 109,200 | -- | 84 / 1000 $Ft^2$ | 9,173 | 56 / 1000 $Ft^2$ | 6,115 |
| | SF Residential | 11.1 | -- | 100 | 6000 / Unit | 60,000 | -- | -- |
| | MF Residential | 9.9 | -- | 300 | 386 / Unit | 115,800 | 174 / Unit | 52,200 |
| | Civic | 10.1 | 100,000 | -- | 84 / 1000 $Ft^2$ | 8,400 | 56 / 1000 $Ft^2$ | 5,600 |
| | Park | 3.2 | -- | -- | 600 / Acre | 1,920 | 3400 / Ac. | 10,880 |
| | Open Space (FI) | 0.4 | -- | -- | -- | -- | 3400 / Ac. | 1,360 |
| | Open Space (PI) | 0.75 | -- | -- | -- | -- | 1700 / Ac. | 1,275 |
| | Retention (PI) | 1.9 | -- | -- | -- | -- | 1700 / Ac. | 3,230 |
| | Roads | 13.8 | -- | -- | -- | -- | 880 / Ac. | 12,144 |
| | Totals | 62.15 | 269,200 | 550 | -- | 225,743 | -- | 114,854 |
| Makai Residential | SF Residential | 21.0 | -- | 350 | 600 / Unit | 210,000 | -- | -- |
| | Park | 2.1 | -- | -- | 600 / Acre | 1,260 | 3400 / Ac. | 7,140 |
| | Open Space (FI) | 0.2 | -- | -- | -- | -- | 3400 / Ac. | 680 |
| | Open Space (PI) | 4.8 | -- | -- | -- | -- | 1700 / Ac. | 8,160 |
| | Roads | 11.0 | -- | -- | -- | -- | 880 / Ac. | 9,680 |
| | Totals | 39.1 | 0 | 350 | -- | 211,260 | -- | 25,660 |
| Drainage Retention | Open Space (PI) | 5.5 | -- | -- | -- | -- | 1700 / Ac. | 9,350 |
| | Roads | 0.32 | -- | -- | -- | -- | 880 / Ac. | 282 |
| | Totals | 5.82 | 0 | 0 | | | | 9,632 |
| Totals for Phase 1 | | 127.8 | 493,930 | 900 | | 455,880 | | 169,755 |

Source:
Tom Nance Water Resource Engineering, "Evaluation of Source Supply Alternatives for the Planned Expansion of the Maui Research and Technology Park," March 1, 2012.

Table 2

Projections of Required Potable and Irrigation Supply for
Phase 2 of the Expansion of the Maui Research and Technology Park

| Development Area | Land Use | Area | | Number of Units | Potable | | Non-Potable | |
|---|---|---|---|---|---|---|---|---|
| | | Acres | $Ft^2$ | | Unit Use Rate ( GPD / Unit ) | Amount ( GPD ) | Unit Use Rate ( GPD / Unit ) | Amount ( GPD ) |
| Knowledge Industry Expansion Campus | Employment | 40.9 | 188,272 | -- | 84 / 1000 $Ft^2$ | 15,815 | 56 / 1000 $Ft^2$ | 10,543 |
| | Mixed Use / Flex | 2.2 | 33,200 | -- | 84 / 1000 $Ft^2$ | 2,789 | 56 / 1000 $Ft^2$ | 1,859 |
| | Employment (Reserve) | 11.4 | -- | -- | 1800 / Ac. | 20,520 | 1200 / Ac. | 13,680 |
| | Park | 1.6 | -- | -- | 600 / Ac. | 960 | 3400 / Ac. | 5,440 |
| | Traffic Circle (FI) | 0.2 | -- | -- | -- | -- | 3400 / Ac. | 680 |
| | Open Space (PI) | 12.1 | -- | -- | -- | -- | 1700 / Ac. | 20,570 |
| | Roads | 7.6 | -- | -- | -- | -- | 880 / Ac. | 6,688 |
| | Totals | 76.0 | 221,472 | 0 | -- | 40,084 | -- | 59,460 |
| Option Land | SF Residential | 28.6 | -- | 300 | 600 / Unit | 180,000 | -- | -- |
| | MF Residential | 5.9 | -- | 179 | 386 / Unit | 69,094 | 174 / Unit | 31,146 |
| | Employment | 26.5 | 403,718 | -- | 84 / 1000 $Ft^2$ | 33,867 | 56 / 1000 $Ft^2$ | 22,578 |
| | Employment (Reserve) | 8.0 | -- | -- | 1800 / Ac. | 14,400 | 1200 / Ac. | 9,600 |
| | Parks | 7.9 | -- | -- | 600 / Ac. | 4,740 | 3400 / Ac. | 26,860 |
| | Traffic Circle (FI) | 0.2 | -- | -- | -- | -- | 3400 / Ac. | 680 |
| | Open Space (PI) | 18.9 | -- | -- | -- | -- | 1700 / Ac. | 32,130 |
| | Roads | 24.0 | -- | -- | -- | -- | 880 / Ac. | 21,120 |
| | Totals | 120.0 | 403,718 | 479 | -- | 302,101 | -- | 144,114 |
| Totals for Phase 2 | | 196.0 | 625,190 | 479 | | 342,185 | | 203,574 |

Source:
Tom Nance Water Resource Engineering, "Evaluation of Source Supply Alternatives for the Planned Expansion of the Maui Research and Technology Park," March 1, 2012.

# APPENDIX C

Drainage Calculations

## Hydrologic Calculations

**Offsite:**

The hydrologic calculations for drainage areas larger than 100 acres are based on the hydrograph method developed by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS)[1] and described in the "SCS National Engineering Handbook, Section 4, Hydrology (NEH-4)". Calculations were carried out using the "SCS Computer Program for Project Formulation, Hydrology (TR-20)", which utilizes the computational procedure described in NEH-4.

The curve numbers (CN) used in the hydrologic calculations were derived from USDA soil series and hydrologic group information and existing and proposed land uses for the relevant study area as recommended by USDA-NRCS in its publications entitled "Erosion and Sediment Control Guide for Hawaii"[2] and "Urban Hydrology for Small Watersheds"[3]. Weighted curve numbers were computed whenever a study area possessed a non-homogeneous mix of characteristics.

Concentration times used in hydrologic calculations were derived using the Curve Number (Lag) Method described in NEH-4.

100 yr.-24 hr. rainfall was obtained from Figure 56 in the Rainfall Frequency Atlas of the

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[1]Formerly known as the USDA Soil Conservation Service (SCS)

[2]United States Department of Agriculture, Soil Conservation Service, Erosion and Sediment Control, March 1981.

[3]United States Department of Agriculture, Soil Conservation Service, Urban Hydrology for Small Watersheds, June 1986.

Hawaiian Islands.[4] A 100 yr.-24 hr. rainfall of 10 inches was used for offsite drainage area computations.

**Onsite:**

According to the "Rules for the Design of Storm Drainage Facilities in the County of Maui,"[5] the runoff quantity for drainage areas of 100 acres or less is calculated using the Rational Method. The design storm is a 50-year recurrence interval, 1-hour duration storm and the precipitation is 2.3 inches.

Rational Formula:

$$Q = C \cdot I \cdot A$$

where, Q = *rate of flow* (cubic feet per second)

C = *runoff coefficient*

I = *rainfall intensity* (inches per hour)

A = *area* (acres)

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[4]U.S. Weather Bureau, U.S. Department of Commerce, Rainfall Frequency Atlas of the Hawaiian Islands, Washington D.C.: U.S. Government Printing Office, 1962.

[5]County of Maui, Department of Public Works and Waste Management, "Rules for the Design of Storm Drainage Facilities in the County of Maui," November 2, 1995.

# APPENDIX C-1

Offsite Surface Runoff (100-yr./24-hr.)

MASTER DESIGN STORM SUMMARY

Network Storm Collection: MyCounty

| Return Event | Total Depth in | Rainfall Type | RNF ID |
|---|---|---|---|
| Pre100 | 10.0000 | Synthetic Curve | TypeI 24hr |

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

| Node ID | Type | Return Event | HYG Vol ac-ft | Trun | Qpeak hrs | Qpeak cfs | Max WSEL ft | Max Pond Storage ac-ft |
|---|---|---|---|---|---|---|---|---|
| 10A-RB | AREA | 100 | 61.349 | | 10.3500 | 266.45 | | |
| 11RB | AREA | 100 | 35.822 | | 10.0500 | 243.20 | | |
| 13RB | AREA | 100 | 16.194 | | 10.0000 | 127.48 | | |
| 14RB | AREA | 100 | 131.396 | | 10.5500 | 459.94 | | |
| 14RC | AREA | 100 | 7.232 | | 10.0000 | 59.88 | | |
| 15RB | AREA | 100 | 79.150 | | 10.3500 | 332.73 | | |
| 15RC | AREA | 100 | 1.679 | | 9.9500 | 15.01 | | |
| 16RB | AREA | 100 | 31.091 | | 10.0500 | 227.22 | | |
| 17-R | AREA | 100 | 3.720 | | 10.0000 | 30.59 | | |
| *OUT 10 | JCT | 100 | 367.633 | | 10.1000 | 1317.53 | | |
| POND 10 IN | POND | 100 | 367.633 | | 10.1000 | 1317.53 | | |

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

| Node ID | Type | Return Event | HYG Vol ac-ft | Trun | Qpeak hrs | Qpeak cfs | Max WSEL ft | Max Pond Storage ac-ft |
|---|---|---|---|---|---|---|---|---|
| POND 10 | OUT POND | 100 | 367.633 | -- | 10.1000 | 1317.53 | | |

# APPENDIX C-2

Pre-Development Onsite Surface Runoff (50-yr./1-hr.)

**Warren S. Unemori** Engineering, Inc.
Civil & Structural Engineers · Land Surveyors
Wells Street Professional Center
2145 Wells Street, Suite 403
Wailuku, Maui, HI 96793

## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 3/29/11

### Area

Description: Pre-development onsite discharge [1]

| | | |
|---|---|---|
| Area (A): | 30.52 | acres |
| Impervious Area: | 0.00 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Weighted Runoff Coefficient (C): | 0.25 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 880 | ft. |
| Average Slope: | 4.1 | % |
| Time of Concentration ($T_c$): | 20 | minutes |

### Intensity

| | |
|---|---|
| Project Location: | Kihei, Maui, Hawaii |
| Design Storm: | 50-year recurrence interval, 1-hour duration |
| Rainfall Depth: | 2.3 in. |
| Intensity (I): | 3.80 in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 29.0 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 3/29/11

### Area

Description: Pre-development onsite discharge [2]

| | | |
|---|---|---|
| Area (A): | 85.22 | acres |
| Impervious Area: | 0.00 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Weighted Runoff Coefficient (C): | 0.25 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2000 | ft. |
| Average Slope: | 3.0 | % |
| Time of Concentration ($T_c$): | 29 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 3.31 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 70.5 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 3/29/11

### Area

Description: Pre-development onsite discharge [3]

| | | |
|---|---|---|
| Area (A): | 68.77 | acres |
| Impervious Area: | 0.00 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Weighted Runoff Coefficient (C): | 0.25 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 3267 | ft. |
| Average Slope: | 3.0 | % |
| Time of Concentration ($T_c$): | 34 | minutes |

### Intensity

| | |
|---|---|
| Project Location: | Kihei, Maui, Hawaii |
| Design Storm: | 50-year recurrence interval, 1-hour duration |
| Rainfall Depth: | 2.3 in. |
| Intensity (I): | 3.12 in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 53.6 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Pre-development onsite discharge [4]

| | | |
|---|---|---|
| Area (A): | 24.83 | acres |
| Impervious Area: | 0.74 | acres |
| Commercial Area: | 0.6 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.28 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2410 | ft. |
| Average Slope: | 2.7 | % |
| Time of Concentration ($T_c$): | 31 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 3.22 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 22.7 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Pre-development onsite discharge [5]

| | | |
|---|---|---|
| Area (A): | 66.39 | acres |
| Impervious Area: | 7.32 | acres |
| Commercial Area: | 8.3 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.40 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2679 | ft. |
| Average Slope: | 2.4 | % |
| Time of Concentration ($T_c$): | 33.5 | minutes |

### Intensity

| | |
|---|---|
| Project Location: | Kihei, Maui, Hawaii |
| Design Storm: | 50-year recurrence interval, 1-hour duration |
| Rainfall Depth: | 2.3 in. |
| Intensity (I): | 3.14 in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 82.5 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Pre-development onsite discharge [6]

| | | |
|---|---|---|
| Area (A): | 45.07 | acres |
| Impervious Area: | 1.40 | acres |
| Commercial Area: | 6.81 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.35 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2340 | ft. |
| Average Slope: | 3.8 | % |
| Time of Concentration ($T_c$): | 29 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 3.31 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 52.9 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 3/29/11

### Area

Description: Pre-development onsite discharge [7]

| | | |
|---|---|---|
| Area (A): | 40.48 | acres |
| Impervious Area: | 0.00 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Weighted Runoff Coefficient (C): | 0.25 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2497 | ft. |
| Average Slope: | 3.0 | % |
| Time of Concentration ($T_c$): | 30.5 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 3.23 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 32.7 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 3/29/11

### Area

Description: Pre-development onsite discharge [8]

Area (A): 32.53 acres
Impervious Area: 0.00 acres

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Weighted Runoff Coefficient (C): | 0.25 |

### Time of Concentration

Runoff Length: 2104 ft.
Average Slope: 4.1 %
Time of Concentration ($T_c$): 28 minutes

### Intensity

Project Location: Kihei, Maui, Hawaii
Design Storm: 50-year recurrence interval, 1-hour duration
Rainfall Depth: 2.3 in.
Intensity (I): 3.36 in./hr.

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 27.3 \text{ ft.}^3/\text{sec.}$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 3/29/11

### Area

Description: Pre-development onsite discharge [9]

| | | |
|---|---|---|
| Area (A): | 5.75 | acres |
| Impervious Area: | 0.00 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Rolling] | → | 0.03 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.28 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Weighted Runoff Coefficient (C): | 0.25 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 659 | ft. |
| Average Slope: | 5.6 | % |
| Time of Concentration ($T_c$): | 16.5 | minutes |

### Intensity

Project Location: Kihei, Maui, Hawaii
Design Storm: 50-year recurrence interval, 1-hour duration

| | | |
|---|---|---|
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 4.13 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 5.9 \quad ft.^3/sec.$$

# APPENDIX C-3

Post-Development Onsite Surface Runoff (50-yr./1-hr.)

**Warren S. Unemori** Engineering, Inc.
Civil & Structural Engineers · Land Surveyors
Wells Street Professional Center
2145 Wells Street, Suite 403
Wailuku, Maui, HI 96793

## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 3/29/11

### Area

Description: Post-development onsite discharge [1]

Area (A): 30.52 acres

### Runoff Coefficient

Weighted Runoff Coefficient (C): 0.55

### Time of Concentration

Runoff Length: 880 ft.
Average Slope: 4.1 %
Time of Concentration ($T_c$): 20 minutes

### Intensity

Project Location: Kihei, Maui, Hawaii
Design Storm: 50-year recurrence interval, 1-hour duration
Rainfall Depth: 2.3 in.
Intensity (I): 3.80 in./hr.

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 63.8 \text{ ft.}^3/\text{sec.}$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 3/29/11

### Area

Description: Post-development onsite discharge [2]

Area (A): 85.22 acres

### Runoff Coefficient

Weighted Runoff Coefficient (C): 0.55

### Time of Concentration

Runoff Length: 2000 ft.
Average Slope: 3.0 %
Time of Concentration ($T_c$): 29 minutes

### Intensity

Project Location: Kihei, Maui, Hawaii
Design Storm: 50-year recurrence interval, 1-hour duration
Rainfall Depth: 2.3 in.
Intensity (I): 3.31 in./hr.

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 155.1 \text{ ft.}^3\text{/sec.}$$

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2145 Wells Street, Suite 403
Wailuku, Maui, HI 96793

## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [3]

| | | |
|---|---|---|
| Area (A): | 68.77 | acres |
| Impervious Area: | 10.94 | acres |
| Commercial Area: | 46.45 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.73 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 3267 | ft. |
| Average Slope: | 3.0 | % |
| Time of Concentration ($T_c$): | 34 | minutes |

### Intensity

| | |
|---|---|
| Project Location: | Kihei, Maui, Hawaii |
| Design Storm: | 50-year recurrence interval, 1-hour duration |
| Rainfall Depth: | 2.3 in. |
| Intensity (I): | 3.12 in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 157.2 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [4]

| | | |
|---|---|---|
| Area (A): | 24.83 | acres |
| Impervious Area: | 3.34 | acres |
| Commercial Area: | 20.04 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.79 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2410 | ft. |
| Average Slope: | 2.7 | % |
| Time of Concentration ($T_c$): | 31 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 3.22 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 63.0 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [5]

| | | |
|---|---|---|
| Area (A): | 66.39 | acres |
| Impervious Area: | 9.69 | acres |
| Commercial Area: | 55.40 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.81 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2679 | ft. |
| Average Slope: | 2.4 | % |
| Time of Concentration ($T_c$): | 33.5 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 3.14 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 169.1 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [6]

| | | |
|---|---|---|
| Area (A): | 45.07 | acres |
| Impervious Area: | 3.36 | acres |
| Commercial Area: | 34.27 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.72 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2340 | ft. |
| Average Slope: | 3.8 | % |
| Time of Concentration ($T_c$): | 29 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 3.31 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 107.5 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [7]

| | | |
|---|---|---|
| Area (A): | 40.48 | acres |
| Impervious Area: | 3.34 | acres |
| Commercial Area: | 34.30 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.77 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2497 | ft. |
| Average Slope: | 3.0 | % |
| Time of Concentration ($T_c$): | 30.5 | minutes |

### Intensity

| | |
|---|---|
| Project Location: | Kihei, Maui, Hawaii |
| Design Storm: | 50-year recurrence interval, 1-hour duration |
| Rainfall Depth: | 2.3 in. |
| Intensity (I): | 3.23 in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 101.2 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [8]

| | | |
|---|---|---|
| Area (A): | 32.53 | acres |
| Impervious Area: | 1.29 | acres |
| Commercial Area: | 28.74 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.76 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2104 | ft. |
| Average Slope: | 4.1 | % |
| Time of Concentration ($T_c$): | 28 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 3.36 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 83.5 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [9]

| | | |
|---|---|---|
| Area (A): | 5.75 | acres |
| Impervious Area: | 0.21 | acres |
| Commercial Area: | 5.39 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Rolling] | → | 0.03 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.28 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.79 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 659 | ft. |
| Average Slope: | 5.6 | % |
| Time of Concentration ($T_c$): | 16.5 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 4.13 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 18.8 \quad ft.^3/sec.$$

# APPENDIX C-4

Post-Development Onsite Surface Runoff
Impact of Roadways and Residential Areas (50-yr./1-hr.)

**Warren S. Unemori** Engineering, Inc.
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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 3/29/11

### Area

Description: Post-development onsite discharge [1]
(for roadways and residential areas)

Area (A): 30.52 acres

### Runoff Coefficient

Weighted Runoff Coefficient (C): 0.55

### Time of Concentration

Runoff Length: 880 ft.
Average Slope: 4.1 %
Time of Concentration ($T_c$): 20 minutes

### Intensity

Project Location: Kihei, Maui, Hawaii
Design Storm: 50-year recurrence interval, 1-hour duration
Rainfall Depth: 2.3 in.
Intensity (I): 3.80 in./hr.

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 63.8 \text{ ft.}^3/\text{sec.}$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 3/29/11

### Area

Description: Post-development onsite discharge [2]
(for roadways and residential areas)

Area (A): 85.22 acres

### Runoff Coefficient

Weighted Runoff Coefficient (C): 0.55

### Time of Concentration

Runoff Length: 2000 ft.
Average Slope: 3.0 %
Time of Concentration ($T_c$): 29 minutes

### Intensity

Project Location: Kihei, Maui, Hawaii
Design Storm: 50-year recurrence interval, 1-hour duration
Rainfall Depth: 2.3 in.
Intensity (I): 3.31 in./hr.

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 155.1 \text{ ft.}^3/\text{sec.}$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [3]
(for roadways and residential areas)

Area (A): 68.77 acres
Impervious Area: 10.94 acres

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Weighted Runoff Coefficient (C): | 0.38 |

### Time of Concentration

Runoff Length: 3267 ft.
Average Slope: 3.0 %
Time of Concentration ($T_c$): 34 minutes

### Intensity

Project Location: Kihei, Maui, Hawaii
Design Storm: 50-year recurrence interval, 1-hour duration
Rainfall Depth: 2.3 in.
Intensity (I): 3.12 in./hr.

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 81.5 \text{ ft.}^3\text{/sec.}$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [4]
(for roadways and residential areas)

| | | |
|---|---|---|
| Area (A): | 24.83 | acres |
| Impervious Area: | 3.34 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Weighted Runoff Coefficient (C): | 0.34 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2410 | ft. |
| Average Slope: | 2.7 | % |
| Time of Concentration ($T_c$): | 31 | minutes |

### Intensity

| | |
|---|---|
| Project Location: | Kihei, Maui, Hawaii |
| Design Storm: | 50-year recurrence interval, 1-hour duration |
| Rainfall Depth: | 2.3 in. |
| Intensity (I): | 3.22 in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 27.5 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [5]
(for roadways and residential areas)

| | | |
|---|---|---|
| Area (A): | 66.39 | acres |
| Impervious Area: | 9.69 | acres |
| Commercial Area: | 8.30 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.42 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2679 | ft. |
| Average Slope: | 2.4 | % |
| Time of Concentration ($T_c$): | 33.5 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 3.14 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 87.7 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [6]
(for roadways and residential areas)

| | | |
|---|---|---|
| Area (A): | 45.07 | acres |
| Impervious Area: | 3.36 | acres |
| Commercial Area: | 6.81 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.39 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2340 | ft. |
| Average Slope: | 3.8 | % |
| Time of Concentration ($T_c$): | 29 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 3.31 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 57.5 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [7]
(for roadways and residential areas)

| | | |
|---|---|---|
| Area (A): | 40.48 | acres |
| Impervious Area: | 3.34 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Weighted Runoff Coefficient (C): | 0.31 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2497 | ft. |
| Average Slope: | 3.0 | % |
| Time of Concentration ($T_c$): | 30.5 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 3.23 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 40.2 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [8]
(for roadways and residential areas)

| | | |
|---|---|---|
| Area (A): | 32.53 | acres |
| Impervious Area: | 1.29 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Weighted Runoff Coefficient (C): | 0.28 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2104 | ft. |
| Average Slope: | 4.1 | % |
| Time of Concentration ($T_c$): | 28 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 3.36 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 30.4 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [9]
(for roadways and residential areas)

Area (A): 5.75 acres
Impervious Area: 0.21 acres

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Rolling] | → | 0.03 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.28 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Weighted Runoff Coefficient (C): | 0.30 |

### Time of Concentration

Runoff Length: 659 ft.
Average Slope: 5.6 %
Time of Concentration ($T_c$): 16.5 minutes

### Intensity

Project Location: Kihei, Maui, Hawaii
Design Storm: 50-year recurrence interval, 1-hour duration
Rainfall Depth: 2.3 in.
Intensity (I): 4.13 in./hr.

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 7.2 \quad ft.^3/sec.$$

# APPENDIX C-5

Post-Development Onsite Surface Runoff
Impact of Commercial Areas (50-yr./1-hr.)

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 3/29/11

### Area

Description: Post-development onsite discharge [1]
(for commercial areas)

Area (A): 30.52 acres

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Weighted Runoff Coefficient (C): | 0.25 |

### Time of Concentration

Runoff Length: 880 ft.
Average Slope: 4.1 %
Time of Concentration ($T_c$): 20 minutes

### Intensity

Project Location: Kihei, Maui, Hawaii
Design Storm: 50-year recurrence interval, 1-hour duration
Rainfall Depth: 2.3 in.
Intensity (I): 3.80 in./hr.

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 29.0 \text{ ft.}^3/\text{sec.}$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 3/29/11

### Area

Description: Post-development onsite discharge [2]
(for commercial areas)

Area (A): 85.22 acres

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Weighted Runoff Coefficient (C): | 0.25 |

### Time of Concentration

Runoff Length: 2000 ft.
Average Slope: 3.0 %
Time of Concentration ($T_c$): 29 minutes

### Intensity

Project Location: Kihei, Maui, Hawaii
Design Storm: 50-year recurrence interval, 1-hour duration
Rainfall Depth: 2.3 in.
Intensity (I): 3.31 in./hr.

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 70.5 \text{ ft.}^3/\text{sec.}$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [3]
(for commercial areas)

| | | |
|---|---|---|
| Area (A): | 68.77 | acres |
| Commercial Area: | 46.45 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.60 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 3267 | ft. |
| Average Slope: | 3.0 | % |
| Time of Concentration ($T_c$): | 34 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 3.12 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 128.7 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [4]
(for commercial areas)

| | | |
|---|---|---|
| Area (A): | 24.83 | acres |
| Impervious Area: | 0.74 | acres |
| Commercial Area: | 20.04 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.71 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2410 | ft. |
| Average Slope: | 2.7 | % |
| Time of Concentration ($T_c$): | 31 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 3.22 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 57.1 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [5]
(for commercial areas)

| | | |
|---|---|---|
| Area (A): | 66.39 | acres |
| Impervious Area: | 7.32 | acres |
| Commercial Area: | 55.40 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.79 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2679 | ft. |
| Average Slope: | 2.4 | % |
| Time of Concentration ($T_c$): | 33.5 | minutes |

### Intensity

| | |
|---|---|
| Project Location: | Kihei, Maui, Hawaii |
| Design Storm: | 50-year recurrence interval, 1-hour duration |
| Rainfall Depth: | 2.3 in. |
| Intensity (I): | 3.14 in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 163.9 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [6]
(for commercial areas)

| | | |
|---|---|---|
| Area (A): | 45.07 | acres |
| Impervious Area: | 1.40 | acres |
| Commercial Area: | 34.27 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Impervious Runoff Coefficient: | 0.95 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.69 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2340 | ft. |
| Average Slope: | 3.8 | % |
| Time of Concentration ($T_c$): | 29 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 3.31 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 102.9 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [7]
(for commercial areas)

| | | |
|---|---|---|
| Area (A): | 40.48 | acres |
| Commercial Area: | 34.30 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.72 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2497 | ft. |
| Average Slope: | 3.0 | % |
| Time of Concentration ($T_c$): | 30.5 | minutes |

### Intensity

| | |
|---|---|
| Project Location: | Kihei, Maui, Hawaii |
| Design Storm: | 50-year recurrence interval, 1-hour duration |
| Rainfall Depth: | 2.3 in. |
| Intensity (I): | 3.23 in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 93.6 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [8]
(for commercial areas)

| | | |
|---|---|---|
| Area (A): | 32.53 | acres |
| Commercial Area: | 28.74 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Flat] | → | 0 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.25 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.74 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 2104 | ft. |
| Average Slope: | 4.1 | % |
| Time of Concentration ($T_c$): | 28 | minutes |

### Intensity

| | | |
|---|---|---|
| Project Location: | Kihei, Maui, Hawaii | |
| Design Storm: | 50-year recurrence interval, 1-hour duration | |
| Rainfall Depth: | 2.3 | in. |
| Intensity (I): | 3.36 | in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 80.4 \quad ft.^3/sec.$$

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## HYDROLOGIC CALCULATIONS - Surface Runoff

Project Name: Maui Research & Technology Park
Project No.: 08028
Engineer: Derek T. Ono
Date: 5/2/11

### Area

Description: Post-development onsite discharge [9]
(for commercial areas)

| | | |
|---|---|---|
| Area (A): | 5.75 | acres |
| Commercial Area: | 5.39 | acres |

### Runoff Coefficient

| | | | |
|---|---|---|---|
| Infiltration: | [Medium] | → | 0.07 |
| Relief: | [Rolling] | → | 0.03 |
| Vegetal Cover: | [Good] | → | 0.03 |
| Development: | [Agricultural] | → | 0.15 |
| | | Composite Runoff Coefficient: | 0.28 |
| | | Commercial Runoff Coefficient: | 0.80 |
| | | Weighted Runoff Coefficient (C): | 0.77 |

### Time of Concentration

| | | |
|---|---|---|
| Runoff Length: | 659 | ft. |
| Average Slope: | 5.6 | % |
| Time of Concentration ($T_c$): | 16.5 | minutes |

### Intensity

| | |
|---|---|
| Project Location: | Kihei, Maui, Hawaii |
| Design Storm: | 50-year recurrence interval, 1-hour duration |
| Rainfall Depth: | 2.3 in. |
| Intensity (I): | 4.13 in./hr. |

### Flow Rate

$$Q = C \cdot I \cdot A$$
$$= 18.2 \quad ft.^3/sec.$$

APPENDIX G
Traffic Impact Analysis Report

TRAFFIC IMPACT ANALYSIS

# MAUI RESEARCH AND TECHNOLOGY PARK

KIHEI, MAUI, HAWAII

February 2012

Revised February 2013

PARSONS BRINCKERHOFF

Over a Century of Engineering Excellence

# TRAFFIC IMPACT ANALYSIS

# MAUI RESEARCH AND TECHNOLOGY PARK

Kihei, Maui, Hawaii

February 2012

Revised February 2013

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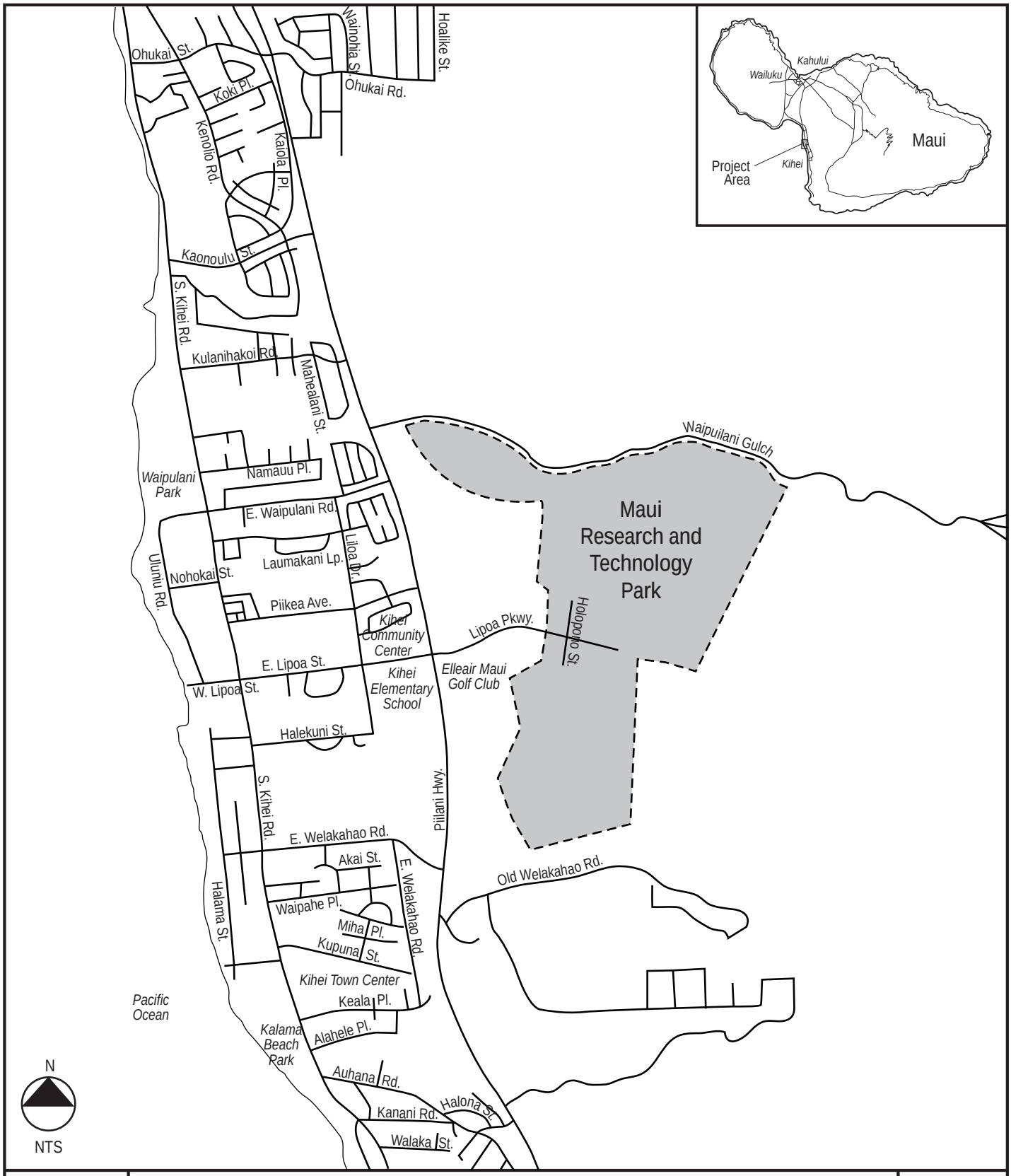
# I. INTRODUCTION

The Maui Research and Technology Park (MRTP) is located mauka (east) of the intersection of Piilani Highway and Lipoa Parkway (called Lipoa Street makai (west) of Piilani Highway). The vicinity map is shown in Figure 1. Prior to its development, the lands comprising the MRTP were part of the Haleakala Ranch. The MRTP was the vision of a core group of community leaders in the early 1980's who sought to diversify the economic and employment base on Maui beyond tourism and agriculture. The MRTP is now home to a diverse range of companies and government projects working in such areas as space surveillance, communications, scientific research, advanced materials development, optics, and photonics.

However, since its inception in the late 1980's, the approximate 432 acre MRTP is only at approximately 10 percent build-out, with 11 lots sold and approximately 175,000 square feet of structures in five (5) buildings with a total of approximately 400 employees. Today, everyone working in the Park commutes since the development has no housing and few support services or amenities. The Master Plan Update proposed utilizes the principles of New Urbanism and Smart Growth to transform the current, single-use large lot research and technology campus into an integrated and vibrant mixed-use community focused around a regional knowledge-based industry employment base. The planned housing will target industries characterized by highly-skilled workers in science and research, information technology, education, healthcare and medicine, manufacturing and professional services and similarly related knowledge-based organizations.

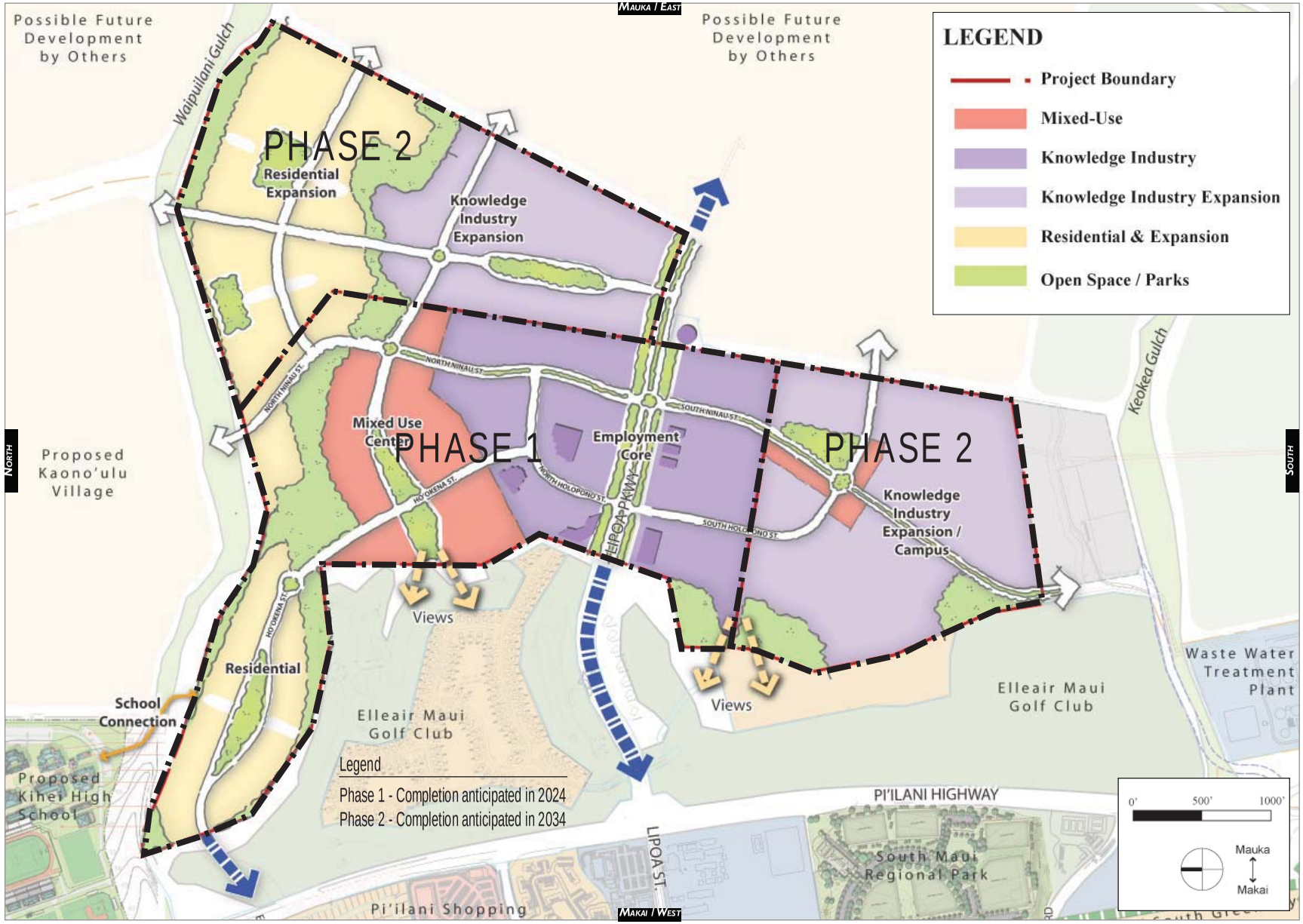
The Master Plan will be implemented in two phases, with key infrastructure tied to the first phase of development and as the improvements are warranted. Figure 2 identifies the two phases of the implementation program. Phase 1 will be located directly off of Lipoa and will consist of residential, mixed-use commercial, civic, and the employment core land uses. Phase 1 will consist of the following:

- 723,200 Square Feet (SF) of Employment
- 100,000 SF of Retail
- 750 Residential Dwelling Units (DU) broken down as follows:
    - 150 DU Mid-Rise




Vicinity Map

Figure 1




Conceptual Development Plan

Figure 2

Parsons Brinckerhoff

Maui R&T Park
February 2013

    - 450 DU Single Family
    - 150 DU Townhouse
- 150 Hotel Rooms
- 102,000 SF of Elementary School.

Building upon the land uses in Phase 1, Phase 2 will consist of residential and employment land uses on either side of Lipoa Parkway. When constructed, Phases 2 will consist of:

- 1,014,800 SF of Employment
- 500 Residential DU broken down as follows:
    - 100 DU Mid-Rise
    - 300 DU Single Family
    - 100 DU Townhouse

This report documents the traffic impact of the MRTP development and evaluates roadway conditions with and without MRTP.

Phases 1 and 2 of MRTP were analyzed in the horizon years of 2024 and 2034. For each phase, four scenarios were analyzed:

- Scenario 1 – No Build. The No Build scenario represents the background conditions without MRTP development scenario. Only existing roadways and those roadways committed by other developments, the State, and the County are included.
- Scenario 2 – Build. The Build scenario adds MRTP development generated trips to the No Build scenario. The assumed roadway network is the same as in the No Build scenario.
- Scenario 3 – Build with MRTP Roadway Improvements. This scenario represents the Build scenario with additional transportation improvements committed by MRTP.
- Scenario 4 – Build with MRTP and Regional Roadway Improvements. The final scenario represents the Build with MRTP Roadway Improvements with other needed regional transportation improvements in the analysis year (2024 for Phase 1 and 2034 for Phase 2).

# II. EXISTING CONDITIONS

## A. EXISTING LAND USE

The proposed MRTP expansion site is located mauka of Piilani Highway and both north and south of Lipoa Parkway. The MRTP is envisioned to continue to serve as a major employment generator for the island of Maui. Existing development in the MRTP is on five parcels, with a variety of private companies and government projects working primarily in high-technology related fields. Buildings are one and two stories, and all development (as required by the existing design guidelines) sits behind deep setbacks. Most roads have sidewalks, and large canopy shade street trees are a dominant feature.

The existing Elleair Golf Course is located makai of the proposed development areas, between the proposed development and Piilani Highway. This is an 18-hole golf course with the front nine and clubhouse located south of Lipoa Parkway and the back nine located north of Lipoa Parkway.

Hokulani Golf Villas is located along Lipoa Parkway just makai of Elleair Golf Course. Hokulani consists of condominiums mixed with single family homes.

Public facilities are located makai of Piilani Highway, along Lipoa Street. North of Lipoa Street is the Kihei Community Center, while the Kihei Elementary School/Lokelani Intermediate School complex is located to the south.

## B. EXISTING ROADWAY SYSTEM

Piilani Highway provides primary regional and sub-regional access to the MRTP study area. Within the study area, Lipoa Parkway/Lipoa Street provides east-west traffic circulation, and Piilani Highway, South Kihei Road, and Liloa Drive provide north-south traffic circulation.

<u>Piilani Highway</u>

Piilani Highway provides primary regional mobility for the Kihei and Wailea-Makena areas. Between Mokulele Highway to the north and Kilohana Drive to the south, Piilani Highway is a four-lane major arterial roadway. Further south between Kilohana Drive and Wailea Ike Drive, it is a two-lane major arterial roadway. Paved shoulders are provided along the entire length of Piilani Highway and exclusive, median left-turn lanes are provided at intersections. Many intersections also have exclusive right-turn deceleration lanes on

Piilani Highway. Within the project study limits, Piilani Highway intersects Lipoa Parkway/Lipoa Street at a signalized intersection. Piilani Highway has a right-turn deceleration lane at the southbound approach and exclusive left-turn lanes at both south and northbound approaches. The posted speed limit on Piilani Highway is 40 miles per hour. Within the study area, Piilani Highway forms signalized intersections at:

- Piikea Avenue
- Lipoa Parkway/Lipoa Street

Within the study area, Piilani Highway forms unsignalized T-intersections at:

- Kaonoulu Street
- Kulanihakoi Street
- East Waipuilani Road
- East Welakahao Road
- Old Welakahao Road

South Kihei Road

South Kihei Road is a collector road providing north-south mobility and property access within the Kihei Community. It is generally a two-lane roadway. Major segments of South Kihei Road have been improved to provide either a median turn lane or parallel parking on the makai-side. Sidewalks were provided on these enhanced segments along with striped bike lanes. Unimproved sections of South Kihei Road usually have only two undivided traffic lanes. The posted speed limit on South Kihei Road is 25 miles per hour. Signalized intersections on South Kihei Road near the study area are:

- Piikea Avenue
- Lipoa Street
- East Welakahao Road

Lipoa Parkway/Lipoa Street

Mauka of Piilani Highway, Lipoa Parkway is a two-lane, undivided roadway providing access to MRTP and Elleair Golf Course. It is configured to allow for future expansion to a four-lane roadway with raised median.

Makai of Piilani Highway, the roadway is named Lipoa Street. It is configured as a two-lane roadway with a painted median for left-turn lanes. Between Piilani Highway and Liloa Street, there are two unsignalized, T-intersections at the driveways for the Kihei Recreation Center and Kihei Elementary School. The Lipoa Street/Liloa Street intersection is signalized with exclusive left-turn lanes provided at all approaches.

The speed limits at both Lipoa Parkway and Lipoa Street are posted at 20 miles per hour.

Liloa Drive

Liloa Drive is part of the future North-South Collector in the Kihei area and is located approximately midway between Piilani Highway and South Kihei Road. Within the study area, just south of Lipoa Street, Liloa Drive is configured as a two-lane roadway with painted median, while north of Lipoa Street, Liloa Drive, has two lanes in the northbound direction and one lane in the southbound direction. North of Piikea Avenue, Liloa Drive reverts to a two-lane roadway.

The posted speed limit on Liloa Drive is 20 miles per hour.

Piikea Avenue

Piikea Avenue is a collector roadway oriented in the mauka-makai direction. Piikea is four lanes between Piilani Highway and Liloa Drive and two lanes makai of Liloa. Piilani Village Shopping Center is located on the north side of Piikea Avenue between Liloa and Piilani. Piikea Avenue provides access to the adjacent residential community and is part of the overall roadway network providing mobility in the Kihei area.

Piikea Avenue's intersections with South Kihei Road and Piilani Highway are signalized. The traffic control at the intersection of Piikea Avenue and Liloa is a roundabout. The posted speed limit is 20 miles per hour.

## C. PUBLIC TRANSIT

The island of Maui is served by the Maui Public Bus Transit System, operated by Maui County. Kihei is served by the Kihei Villager and Islander bus routes. The Kihei Villager route is the shorter of the two, serving Kihei and Maalaea. The Kihei Islander route extends further to the north and south, connecting Kahului to Makena via Maalaea and Kihei. Both routes operate with a headway of one hour throughout the day. Within Kihei, the Maui buses use South Kihei Road. Currently, the bus accesses MRTP twice a day.

## D. EXISTING INTERSECTION GEOMETRY AND CONTROL

Existing traffic conditions were observed and documented, and operations of study area signalized and unsignalized intersections were analyzed. The existing intersection operational characteristics established base conditions for comparison to future operations with and without the project.

Traffic-related data was collected for each of the study intersections. Traffic turning movement counts, field observations of intersection operations, and general intersection characteristics were noted. Geometric lane configurations, intersection traffic control, and traffic signal phasing and timing data were collected. Intersection geometry inventory included the following:

- Number of lanes and lane widths,
- Crosswalk locations,
- Unsignalized intersection control,
- Signalized intersection locations,
- Posted speed limits.

These data were used as inputs into the intersection analyses. Appendix A contains the traffic count data.

## E. EXISTING TRAFFIC VOLUMES

Traffic turning movement counts were conducted at the following intersections from Tuesday, November 16 to Thursday, November 18, 2010 during the AM and PM peak hours at the following intersections:

- Piilani Highway/East Waipuilani Road
- Piilani Highway/Piikea Avenue
- Piilani Highway/Lipoa Street/Lipoa Parkway
- Piilani Highway/East Welakahao Road
- Piilani Highway/Old Welakahao Road
- South Kihei Road/Piikea Avenue
- South Kihei Road/Lipoa Street
- South Kihei Road/East Welakahao Road/West Welakahao Road
- Liloa Drive/Lipoa Street

These counts were supplemented with additional counts.

- Piilani Highway/Kaonoulu Street
- Piilani Highway/Kulanihakoi Street
- Liloa Drive/Piikea Avenue

The additional Piilani Highway counts were conducted on Tuesday, November 15 to Wednesday, November 16, 2012. The Liloa/Piikea intersection was counted on Tuesday, January 8, 2013.

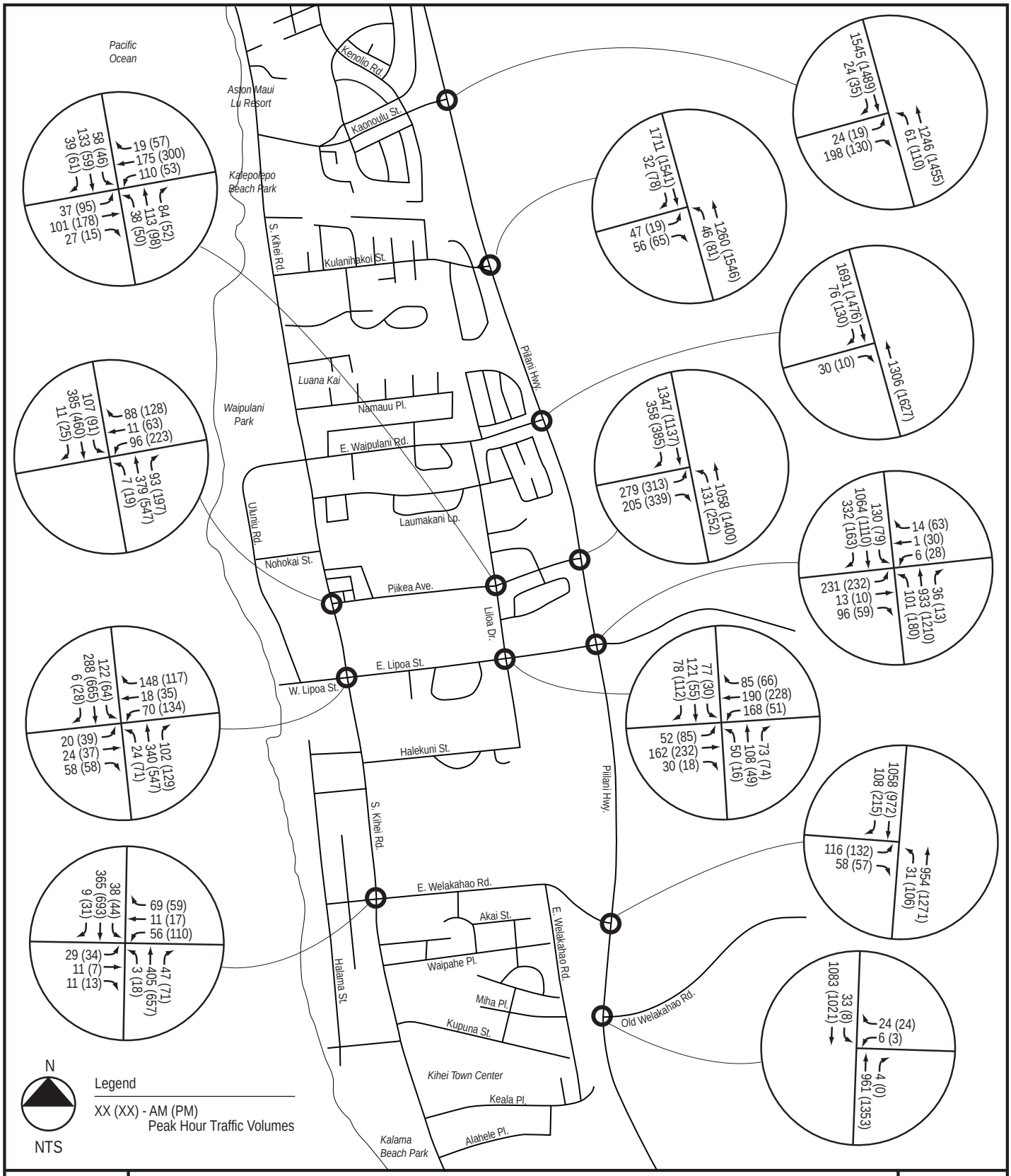
The AM and PM peak hours were found to occur from 7:15 to 8:15 AM and from 3:45 to 4:45 PM, respectively. Figure 3 shows the existing peak hour traffic volumes for each turning movement at these intersections. The existing lane configurations are shown in Figure 4. Existing traffic count data can be found in Appendix A.

## F. EXISTING TRAFFIC OPERATIONS

The intersections were analyzed using the methodologies for unsignalized and signalized intersections outlined in the 2000 Highway Capacity Manual (HCM). Operating conditions at an intersection by approach are expressed as a qualitative measure known as Level of Service (LOS) ranging from A to F. LOS A represents free-flow operations with low delay, while LOS F represents congested conditions with relatively high delay. The overall intersection LOS is a weighted average of the LOS of individual traffic movement groups. Appendix B has more detailed definitions of intersection LOS. Appendix C contains the Synchro worksheets.

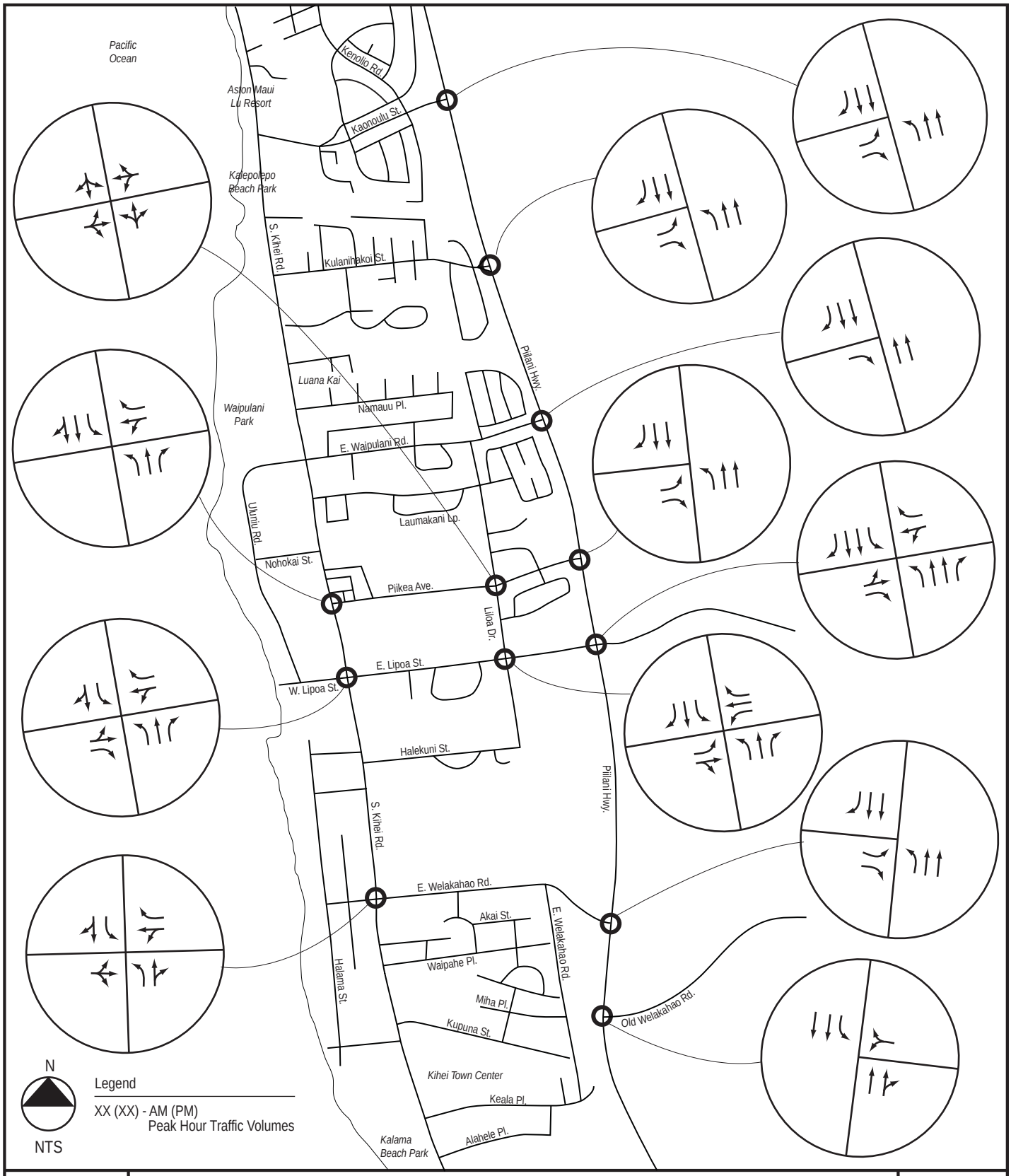
Field observations were performed at selected intersections to verify the results of the intersection analyses. Table 1 displays the existing conditions LOS for each intersection.

As shown in Table 1, Piilani Highway intersects Kaonoulu Street and forms an unsignalized tee intersection. The eastbound left turn operates at LOS F during the AM and PM peak hours. A refuge lane is provided for the Kaonoulu Street left turn, which allows the vehicles turning from the minor street to complete the left turn movement in two parts. As a result, the delay shown in Table 1 is mitigated by this refuge lane.




# Existing Peak Hour Traffic Volumes

Figure 3




# Existing Lane Configurations

Figure 4

Table 1 Existing Level of Service

| Existing | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **Kaonoulu St & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani NB Left | C | 17 | C | 18 |
| Kaonoulu EB Left | F | * | F | * |
| Kaonoulu EB Right | E | 40 | C | 25 |
| **Kulanihakoi St & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani NB Left | C | 19 | C | 19 |
| Kulanihakoi EB Left | F | * | F | * |
| Kulanihakoi EB Right | C | 22 | C | 20 |
| **E. Waipuilani Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| E. Waipuilani EB Right | C | 20 | C | 16 |
| **S. Kihei Rd & Piikea Ave** | **B** | **10** | **B** | **17** |
| S. Kihei NB Left | A | 8 | A | 10 |
| S. Kihei NB Through | B | 12 | B | 19 |
| S. Kihei NB Right | A | 9 | B | 12 |
| S. Kihei SB Left | A | 5 | A | 10 |
| S. Kihei SB Through-Right | A | 7 | B | 11 |
| Piikea WB Left-Through | B | 17 | C | 27 |
| Piikea WB Right | B | 15 | B | 20 |
| **Piikea Ave & Liloa Dr** | **A** | **6** | **A** | **7** |
| Liloa NB Approach | A | 5 | A | 7 |
| Liloa SB Approach | A | 6 | A | 7 |
| Piikea EB Approach | A | 5 | A | 7 |
| Piikea WB Approach | A | 6 | A | 8 |
| **Piikea Ave & Piilani Hwy** | **C** | **22** | **C** | **26** |
| Piilani NB Left | E | 61 | D | 54 |
| Piilani NB Through | A | 9 | B | 11 |
| Piilani SB Through | C | 26 | D | 36 |
| Piilani SB Right | B | 16 | C | 24 |
| Piikea EB Left | D | 55 | E | 69 |
| Piikea EB Right | A | 1 | A | 1 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 1 Existing Level of Service (Continued)

| Existing | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **W. Lipoa St & S. Kihei Rd** | **B** | **11** | **B** | **19** |
| S. Kihei NB Left | A | 8 | B | 11 |
| S. Kihei NB Through | B | 11 | B | 15 |
| S. Kihei NB Right | A | 8 | A | 10 |
| S. Kihei SB Left | A | 6 | A | 9 |
| S. Kihei SB Through-Right | A | 9 | C | 21 |
| W. Lipoa EB Left-Through | B | 15 | C | 25 |
| W. Lipoa EB Right | B | 15 | C | 23 |
| W. Lipoa WB Left-Through | B | 16 | C | 31 |
| W. Lipoa WB Right | B | 15 | C | 24 |
| **E. Lipoa St & Liloa Dr** | **B** | **11** | **A** | **10** |
| Liloa NB Left | B | 16 | B | 11 |
| Liloa NB Through | B | 16 | B | 12 |
| Liloa NB Right | B | 14 | B | 11 |
| Liloa SB Left | B | 17 | B | 12 |
| Liloa SB Through | B | 16 | B | 12 |
| Liloa SB Right | B | 14 | B | 11 |
| E. Lipoa EB Left | A | 9 | A | 7 |
| E. Lipoa EB Through-Right | B | 11 | A | 9 |
| E. Lipoa WB Left | A | 5 | A | 7 |
| E. Lipoa WB Through | A | 7 | A | 10 |
| E. Lipoa WB Right | A | 7 | A | 8 |
| **E. Lipoa St & Piilani Hwy** | **C** | **27** | **C** | **34** |
| Piilani NB Left | D | 47 | F | 128 |
| Piilani NB Through | C | 23 | C | 27 |
| Piilani NB Right | B | 16 | B | 15 |
| Piilani SB Left | E | 61 | E | 57 |
| Piilani SB Through | C | 26 | C | 28 |
| Piilani SB Right | B | 18 | B | 18 |
| E. Lipoa EB Left-Through | C | 35 | D | 38 |
| E. Lipoa EB Right | C | 25 | C | 26 |
| E. Lipoa WB Left-Through | C | 25 | C | 27 |
| E. Lipoa WB Right | C | 25 | C | 26 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 1 Existing Level of Service (Continued)

| Existing | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **E. Welakahao Rd & S. Kihei Rd** | **B** | **11** | **B** | **14** |
| Kihei NB Left | A | 7 | A | 7 |
| Kihei NB Through-Right | B | 13 | B | 13 |
| Kihei SB Left | A | 7 | A | 7 |
| Kihei SB Through-Right | A | 9 | B | 11 |
| W. Welakahao EB Left-Through-Right | B | 13 | C | 24 |
| E. Welakahao WB Left-Through | B | 14 | C | 34 |
| E. Welakahao WB Right | B | 12 | C | 23 |
| **E. Welakahao Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani NB Left | B | 14 | B | 14 |
| E. Welakahao EB Left | E | 47 | F | 223 |
| **Old Welakahao Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani SB Left | B | 11 | B | 13 |
| Old Welakahao WB Left-Right | C | 22 | D | 25 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Piilani Highway intersects Kulanihakoi Street and forms an unsignalized tee intersection. The eastbound left turn operates at LOS F during the AM and PM peak hours. A refuge lane is provided and utilized.

The eastbound right turn at the intersection of Piilani Highway and East Waipuilani operates at LOS C during both the AM and PM peaks. Right turns from Waipuilani are given an acceleration lane which helps them merge onto Piilani.

The intersection of South Kihei Road and Piikea Avenue operates at LOS B overall during both the AM and PM peaks. All movements operate at LOS B or better during the AM peak hour and at LOS C or better during the PM peak hour.

The intersection of Liloa Drive and Piikea Avenue is a roundabout. All approaches operate at LOS A or better during both the AM and PM peak hours.

The intersection of Piilani Highway and Piikea Avenue operates at LOS C during the AM peak. The northbound Piilani left turn to Piikea operates at LOS E. The Piikea turning movements operate at LOS A and D. During the PM peak, the intersection operates at LOS

C as well. The northbound Piilani left and southbound Piilani through operate at LOS D. The eastbound Piikea left turn operates at LOS E. This intersection has been observed to have a fairly long cycle length of approximately three minutes, which contributes to the intersection's overall delay.

The intersection of South Kihei Road and Lipoa Street operates at LOS B during both the AM and PM peak hours. All movements operate at LOS B or better during the AM peak hour and at LOS C or better during the PM peak hour.

Liloa Drive and Lipoa Street form a signalized cross intersection which operates at LOS B during the AM peak hour and LOS A during the PM peak hour.

The intersection of Piilani Highway and Lipoa Street/Lipoa Parkway operates at LOS C during the AM peak hour. The north and southbound Piilani left turns operate at LOS D and E, respectively. The Piilani through movements operate at LOS C. During the PM peak hour, the intersection also operates at LOS C. The Piilani through movements operate at LOS C. The north and southbound Piilani left turns operate at LOS F and E, respectively.

South Kihei Road forms a cross intersection with East Welakahao Road. The intersection operates at LOS B during the AM and PM peak hours. During the AM peak hour, all movements operate at LOS B or better. All movements operate at LOS C or better during the PM peak hour.

At the intersection of Piilani Highway and East Welakahao Road, the westbound approach operates at LOS E during the AM peak hour and at LOS F during the PM peak hour.

At the intersection of Piilani Highway and Old Welakahao Road, the westbound approach operates at LOS C during the AM peak hour and at LOS D during the PM peak hour.

## G. SUMMARY OF RESULTS

Overall the study area intersections operate well in the existing condition with a couple of exceptions. Two issues were identified under the existing conditions:

- Piilani Highway/Piikea Avenue - During the AM peak hour, the northbound Piilani left turn is projected to operate at LOS E. During the PM peak hour, the eastbound Piikea left turn is projected to operate at LOS E. The delay is caused by high volumes and a long cycle length which contributes to the delay.

- Piilani Highway unsignalized intersections – Eastbound left turns to Piilani Highway at unsignalized intersections are projected to operate at LOS E-F. Refuge lanes are provided to reduce the delay.

# III. YEAR 2024 TRAFFIC CONDITIONS

Phase 1 of the MRTP project is projected to be completed in the Year 2024, which was used as the basis for future traffic analysis. As described earlier, four scenarios including Scenario 1 – No Build, Scenario 2 – Build, Scenario 3 – Build with MRTP Roadway Improvements, and Scenario 4 – Build with MRTP and Regional Roadway Improvements were analyzed.

## A. SCENARIO 1 – NO BUILD

The No Build scenario represents the background conditions without MRTP development scenario. Only existing roadways and those roadways committed by other developments, the State, and the County are included.

### 1. Projected Year 2024 Background Traffic

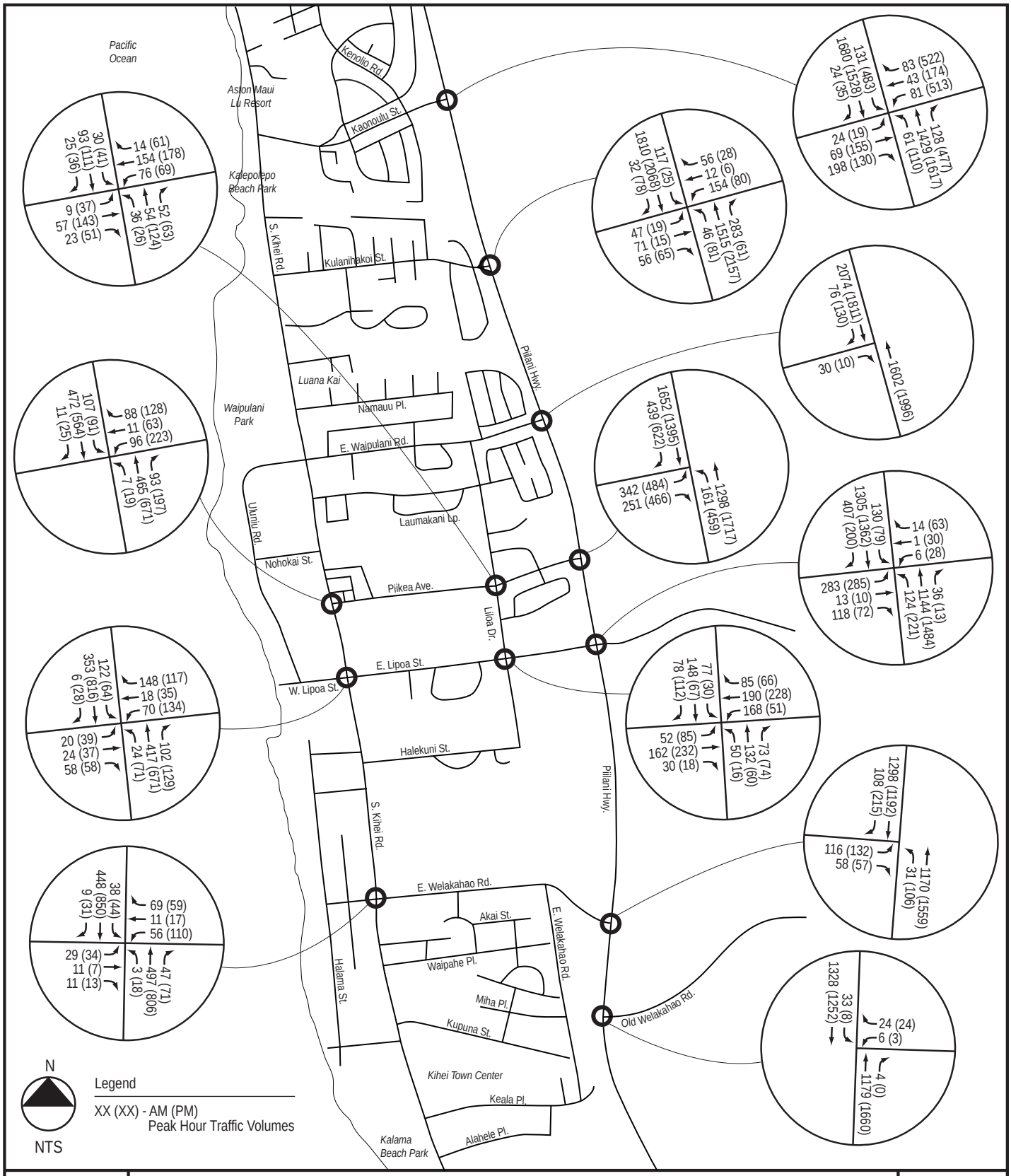
The Year 2024 background traffic volumes were derived using existing traffic along with trip generation obtained from the Maui Travel Demand Forecasting Model. The future Year 2024 background traffic assumes the presence of the following developments:

- Kihei High School
- Piilani Promenade
- Downtown Kihei
- Maui Lu Resort
- Kenolio 6
- Kaiwahine Village
- A&B N. Kihei Residential
- Honua'ula
- Wailea Resort
- Makena Resort

The projected Scenario 1 background traffic volumes are shown in Figure 5.

### 2. Scenario 1 Traffic Operations Without Project

Level of Service analysis was performed on the study area intersections. These results are shown in Table 2. Synchro 8 was used to analyze the roundabout at Liloa Drive/Piikea Avenue due to updated HCM 2010 standards.




# Year 2024 No Build Traffic Volumes

Figure 5

Table 2 Year 2024 No Build Level of Service

| Scenario 1 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **Kaonoulu St & Piilani Hwy** | **C** | **24** | **E** | **74** |
| Piilani NB Left | E | 67 | F | 164 |
| Piilani NB Through | C | 20 | F | 92 |
| Piilani NB Right | B | 11 | C | 29 |
| Piilani SB Left | D | 52 | F | 139 |
| Piilani SB Through | C | 22 | D | 36 |
| Piilani SB Right | A | 9 | B | 16 |
| Kaonoulu EB Left | D | 51 | E | 56 |
| Kaonoulu EB Through | E | 57 | F | 84 |
| Kaonoulu EB Right | A | 0 | A | 0 |
| Kaonoulu WB Left | D | 52 | F | 142 |
| Kaonoulu WB Through | D | 53 | E | 65 |
| Kaonoulu WB Right | D | 50 | D | 53 |
| **Kulanihakoi St & Piilani Hwy** | **C** | **28** | **C** | **25** |
| Piilani NB Left | E | 64 | E | 71 |
| Piilani NB Through | C | 26 | C | 22 |
| Piilani NB Right | A | 0 | A | 0 |
| Piilani SB Left | E | 66 | E | 61 |
| Piilani SB Through | C | 27 | C | 25 |
| Piilani SB Right | A | 0 | A | 0 |
| Kulanihakoi EB Left-Through | D | 46 | D | 50 |
| Kulanihakoi EB Right | A | 0 | A | 0 |
| Kulanihakoi WB Left-Through | E | 69 | E | 60 |
| Kulanihakoi WB Right | A | 0 | A | 0 |
| **E. Waipuilani Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| E. Waipuilani EB Right | D | 27 | C | 20 |
| **S. Kihei Rd & Piikea Ave** | **A** | **9** | **B** | **18** |
| S. Kihei NB Left | A | 7 | A | 9 |
| S. Kihei NB Through | B | 10 | C | 20 |
| S. Kihei NB Right | A | 7 | B | 11 |
| S. Kihei SB Left | A | 5 | B | 12 |
| S. Kihei SB Through-Right | A | 6 | B | 10 |
| Piikea WB Left-Through | C | 21 | C | 31 |
| Piikea WB Right | B | 18 | C | 23 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

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Table 2 Year 2024 No Build Level of Service (Continued)

| Scenario 1 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **Piikea Ave & Liloa Dr** | **A** | **6** | **A** | **8** |
| Liloa NB Approach | A | 5 | A | 7 |
| Liloa SB Approach | A | 6 | A | 7 |
| Piikea EB Approach | A | 5 | A | 7 |
| Piikea WB Approach | A | 6 | A | 8 |
| **Piikea Ave & Piilani Hwy** | **C** | **34** | **F** | **84** |
| Piilani NB Left | F | 127 | F | * |
| Piilani NB Through | A | 9 | B | 11 |
| Piilani SB Through | C | 30 | C | 34 |
| Piilani SB Right | B | 16 | C | 25 |
| Piikea EB Left | F | 150 | F | * |
| Piikea EB Right | A | 0 | A | 1 |
| **W. Lipoa St & S. Kihei Rd** | **B** | **12** | **C** | **21** |
| S. Kihei NB Left | A | 8 | B | 16 |
| S. Kihei NB Through | B | 13 | B | 14 |
| S. Kihei NB Right | A | 9 | A | 8 |
| S. Kihei SB Left | A | 6 | A | 10 |
| S. Kihei SB Through-Right | A | 9 | C | 23 |
| W. Lipoa EB Left-Through | B | 18 | C | 29 |
| W. Lipoa EB Right | B | 17 | C | 27 |
| W. Lipoa WB Left-Through | B | 19 | D | 36 |
| W. Lipoa WB Right | B | 18 | C | 28 |
| **E. Lipoa St & Liloa Dr** | **B** | **12** | **A** | **10** |
| Liloa NB Left | B | 13 | B | 11 |
| Liloa NB Through | B | 14 | B | 11 |
| Liloa NB Right | B | 13 | B | 11 |
| Liloa SB Left | B | 14 | B | 11 |
| Liloa SB Through | B | 14 | B | 11 |
| Liloa SB Right | B | 13 | B | 11 |
| E. Lipoa EB Left-Through | B | 10 | A | 9 |
| E. Lipoa EB Right | B | 13 | B | 10 |
| E. Lipoa WB Left | A | 6 | A | 6 |
| E. Lipoa WB Through | A | 10 | A | 9 |
| E. Lipoa WB Right | A | 9 | A | 7 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 2 Year 2024 No Build Level of Service (Continued)

| Scenario 1 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **E. Lipoa St & Piilani Hwy** | **C** | **31** | **D** | **48** |
| Piilani NB Left | E | 61 | F | 89 |
| Piilani NB Through | C | 26 | D | 37 |
| Piilani NB Right | B | 16 | B | 17 |
| Piilani SB Left | E | 62 | E | 78 |
| Piilani SB Through | C | 30 | D | 51 |
| Piilani SB Right | B | 20 | C | 26 |
| E. Lipoa EB Left-Through | E | 60 | F | 81 |
| E. Lipoa EB Right | A | 0 | A | 0 |
| E. Lipoa WB Left-Through | E | 74 | E | 78 |
| E. Lipoa WB Right | A | 0 | A | 0 |
| **E. Welakahao Rd & S. Kihei Rd** | **B** | **10** | **B** | **18** |
| S. Kihei NB Left | A | 6 | A | 9 |
| S. Kihei NB Through-Right | A | 10 | B | 16 |
| S. Kihei SB Left | A | 6 | B | 10 |
| S. Kihei SB Through-Right | A | 8 | B | 15 |
| E. Welakahao EB Left-Through-Right | B | 17 | C | 27 |
| E. Welakahao WB Left-Through | B | 18 | D | 43 |
| E. Welakahao WB Right | B | 16 | C | 26 |
| **E. Welakahao Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani NB Left | C | 17 | C | 18 |
| E. Welakahao EB Left | F | 139 | F | * |
| **Old Welakahao Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani SB Left | B | 12 | C | 16 |
| Old Welakahao WB Left-Right | D | 35 | E | 42 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

As shown in Table 2 and described earlier, Piilani Highway's intersection with Kaonoulu Street is projected to be a four-legged, signalized intersection. The intersection is projected to operate at LOS C overall during the AM peak hour. During the PM peak hour, the intersection is projected to operate at LOS E overall. Multiple movements, including the north Piilani through movement, are projected to operate at LOS F.

According to the Kihei High School Final Environmental Impact Statement (FEIS), Piilani Highway's intersection with Kulanihakoi Street is projected to be a four-legged, signalized intersection. The intersection is projected to operate at LOS C overall during the AM and PM peak hours. During both peaks, multiple movements are projected to operate at LOS E.

The eastbound right turn at the intersection of Piilani Highway and East Waipuilani is projected to operate at LOS D during the AM peak hour and at LOS C during the PM peak hour.

The intersection of South Kihei Road and Piikea Avenue is projected to operate at LOS A overall during the AM peak and at LOS B during the PM peak hour. All movements are projected to operate at LOS C or better during both peak hours.

The intersection of Liloa Drive and Piikea Avenue is a roundabout. All approaches are projected to operate at LOS A or better during both the AM and PM peak hours.

The intersection of Piilani Highway and Piikea Avenue is projected to operate at LOS C during the AM peak hour and LOS F during the PM peak hour. The northbound Piilani left turn to Piikea and the eastbound Piikea left turn to Piilani are projected to operate at LOS F during the AM and PM peak hours.

The intersection of South Kihei Road and Lipoa Street is projected to operate at LOS B during the AM peak hour and at LOS C during the PM peak hour. All movements are projected to operate at LOS B or better during the AM peak hour and at LOS D or better during the PM peak hour.

The intersection of Liloa Drive and Lipoa Street is projected to operate at LOS B during the AM peak hour and LOS A during the PM peak hour.

The intersection of Piilani Highway and Lipoa Street/Lipoa Parkway is projected to operate at LOS C during the AM peak hour and LOS D during the PM peak hour. During the AM peak hour, the north and southbound Piilani left turns are projected to operate at LOS E. The Piilani through movements are projected to operate at LOS C. During the PM peak hour, the north and southbound Piilani through movements are projected to operate at LOS D. The north and southbound Piilani left turns are projected to operate at LOS F and E, respectively.

The intersection of South Kihei Road and East Welakahao Road is projected to operate at LOS B during both the AM and PM peak hours. During the AM peak hour, all movements are projected to operate at LOS B or better. All movements are projected to operate at LOS C or better during the PM peak hour with the exception of the westbound East Welakahao left/through movement (LOS D).

At the intersection of Piilani Highway and East Welakahao Road, the eastbound Welakahao left turn is projected to operate at LOS F during both peak hours.

At the intersection of Piilani Highway and Old Welakahao Road, the westbound approach is projected to operate at LOS D during the AM peak hour and at LOS E during the PM peak hour.

## B. SCENARIO 2 – BUILD

The Build scenario adds MRTP development Phase 1 generated trips to the No Build scenario. The assumed roadway network is the same as in the No Build scenario.

As shown in Figure 2, Phase 1 consists of residential, mixed-use commercial, and the employment core. It will also contain an elementary school and business hotel. The employment will be located directly off of Lipoa Parkway. The mixed use will be located just north of the employment core. The residential will be located northwest of the mixed-use, close to Piilani Highway as well as the future Kihei High School. An elementary school is planned to be located within the northern portion of Phase 1. Finally, a business hotel is planned to be located on the fringe of the mixed-use core.

### 1. Future Roadways

The roadway network assumptions are the same as the No Build scenario.

### 2. Trip Generation

The Institute of Transportation Engineers (ITE), Trip Generation, 8th edition was used to estimate the number of trips generated by the Maui R&T development based on land uses identified in the conceptual development plan shown in Figure 2.

The conceptual development plan shows proposed development parcels within the MRTP development. Existing MRTP parcels were treated as background traffic. The site-generated traffic acknowledges only the development yet to be constructed and occupied. Phase 1 of MRTP consists of the following:

- 723,200 SF of Employment
- 100,000 SF of Retail
- 750 Residential DU broken down as follows:
    - 150 DU Mid-Rise
    - 450 DU Single Family
    - 150 DU Townhouse
- 150 Hotel Rooms
- 102,000 SF of Elementary School.

Table 3 summarizes the trips generated by Phase 1 of the proposed MRTP development. An internal capture rate was devised using ITE methodology. In addition, a 5% mode choice share was assumed for pedestrians and cyclists.

MRTP has been working with HDOT to estimate the external trips based on the assumed low, medium, and high internal capture rates in order to gauge the traffic impact by different levels of internal capture. In addition, the development will utilize the principles of new urbanism and smart growth providing diverse housing options within close proximity of the park's employment and integrating neighborhood serving retail, civic and commercial uses in a manner that encourages bicycling and walking. The residential component of the development will be targeted at the employees of the tech park that will eliminate the need for worker to drive to and from work. Conservatively, 15% of internal capture was applied to residential and office land uses.

Internal capture for local school, community shopping center, and business hotel are not clearly defined by the ITE Trip Generation Manual. The planned elementary school will be built largely for MRTP. It is not anticipated that the school will generate a significant amount of external trips. Similarly the community shopping center as currently planned is not visible from Piilani Highway and will mostly serve the MRTP itself. The planned hotel targets only those patrons who will have businesses such as meetings, seminars, and conferences in MRTP. With Kihei Elementary School nearby, other more convenient shopping centers, and plenty of hotels located makai of Piilani Highway, an internal capture rate higher than 15% rate was assumed for the planned school, community shopping center, and hotel.

## Table 3 Phase 1 Trip Generation Summary

| | | | AM Peak Hour | | | PM Peak Hour | | |
|---|---|---|---|---|---|---|---|---|
| | | | In | Out | Total | In | Out | Total |
| OFFICE | 760 | 723,200 SF | 605 | 124 | 729 | 99 | 559 | 658 |
| | | *After Mode Reductions* | *575* | *118* | *693* | *94* | *531* | *625* |
| RETAIL | 814 | 100,000 SF | 45 | 28 | 73 | 115 | 146 | 261 |
| | | *After Mode Reductions* | *43* | *27* | *70* | *109* | *139* | *248* |
| RESIDENTIAL | 223 | 150 DU | 15 | 33 | 48 | 35 | 26 | 61 |
| | 210 | 450 DU | 81 | 369 | 450 | 256 | 151 | 407 |
| | 230 | 150 DU | 11 | 55 | 66 | 52 | 26 | 78 |
| | | Residential Total | *107* | | | | | |
| | | *After Mode Reductions* | *102* | *434* | *536* | *326* | *193* | *519* |
| HOTEL | 310 | 150 Rooms | 41 | 27 | 68 | 47 | 42 | 89 |
| | | *After Mode Reductions* | *39* | *26* | *65* | *45* | *40* | *85* |
| INSTITUTION | 522 | 102,000 SF | 279 | 219 | 498 | 55 | 68 | 123 |
| | | *After Mode Reductions* | *265* | *208* | *473* | *52* | *65* | *117* |
| Subtotal Trips (Before Mode Reductions) | | | 1,077 | 855 | 1,932 | 659 | 1,018 | 1,677 |
| Subtotal Trips (After Mode Reductions) | | | 1,024 | 813 | 1,837 | 626 | 968 | 1,594 |
| *Residential Internal Capture Reduction* | | | *48* | *196* | *244* | *113* | *74* | *187* |
| *Retail Internal Capture Reduction* | | | *6* | *10* | *16* | *84* | *35* | *119* |
| *Office Internal Capture Reduction* | | | *86* | *25* | *111* | *22* | *105* | *127* |
| *Institution Internal Capture Reduction* | | | *130* | *31* | *161* | *26* | *33* | *59* |
| *Hotel Internal Capture Reduction* | | | *6* | *14* | *20* | *24* | *22* | *46* |
| Total Internal Capture Reductions | | | *276* | *276* | *552* | *269* | *269* | *538* |
| Total External Trips | | | 748 | 537 | 1,285 | 357 | 699 | 1,056 |

Trips generated expressed in vehicles per hour

Low, medium, and high internal capture rates were developed to represent the internal interactions between the different land uses for Phase 1. For the purpose of this analysis, the low internal capture that would result in highest external trips was used. Specifically,

- 220/1055 or 21% of residential trips interacted directly with the school;
- 68/1055 or 6% of residential trips interacted directly with the commercial
- 143/1318 or 11% of employment trips interacted directly with the residential;
- 47/1318 or 4% of employment trips interacted directly with the business hotel;

A more detailed explanation of internal capture assumptions is shown in Appendix D.

### 3. Trip Assignment

The traffic generated by the proposed MRTP Development was directionally distributed and assigned to the future roadway network.

A summary of regional travel patterns within the Kihei area was created from the Maui travel demand model. MRTP traffic was assigned to the projected roadway network using this distribution. Internal traffic was distributed between the residential, hotel, school, employment, and retail commercial land uses. These distributions were applied to the trips generated.

### 4. Total Traffic

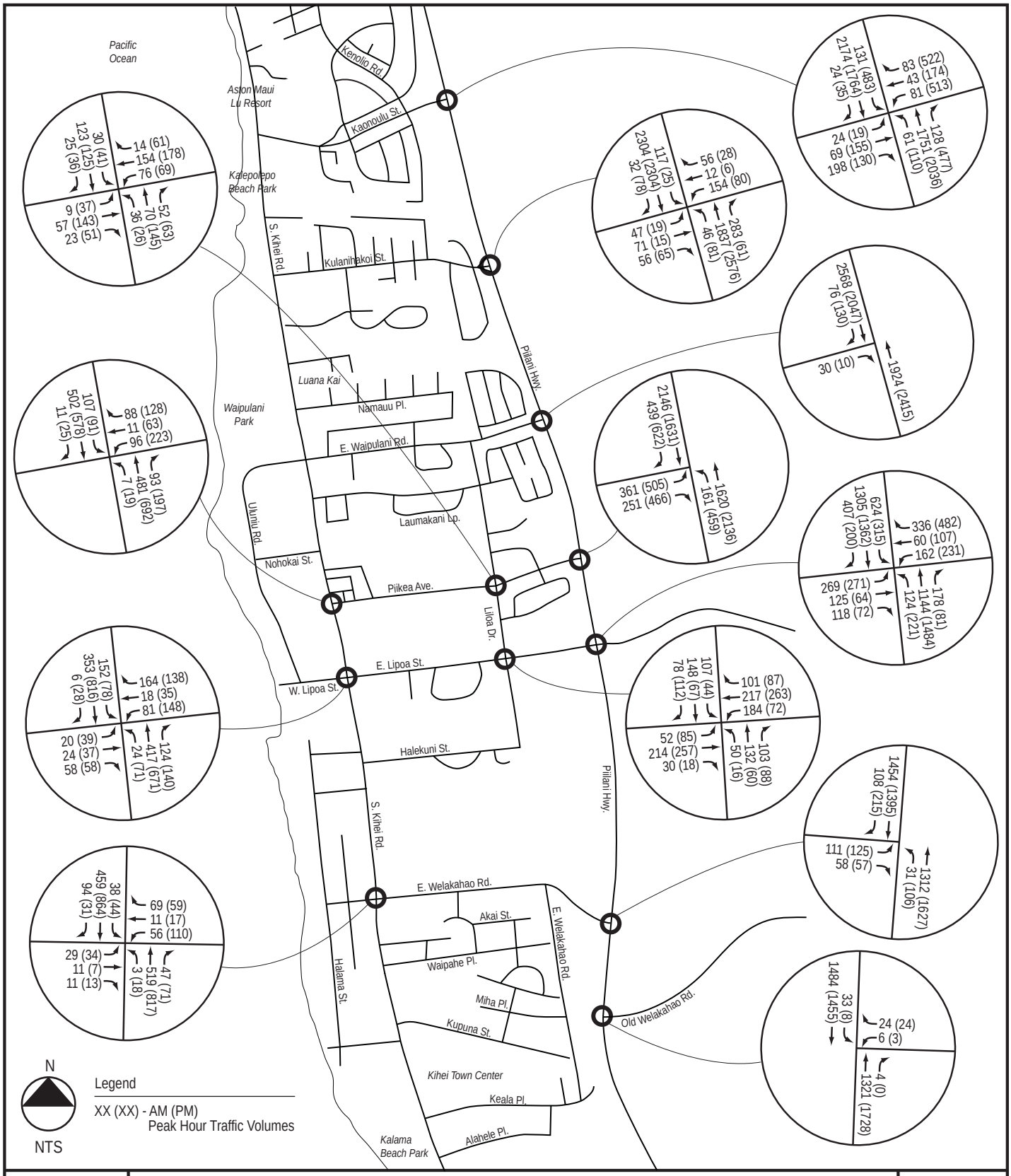
The traffic generated by the MRTP development was added to the projected background traffic to obtain the total peak hour traffic volumes shown in Figure 6.

### 5. Scenario 2 Traffic Operations With Project

Level of Service analysis was performed on the study area intersections. These results are shown in Table 4.

Piilani Highway's intersection with Kulanihakoi Street is projected to operate at LOS E overall during the AM and PM peak hours. During both peaks, multiple movements are projected to operate at LOS E or F. The eastbound right turn at the intersection of Piilani Highway and East Waipuilani is projected to operate at LOS E during the AM peak hour. It is projected to operate at LOS C during the PM peak hour.

The intersection of South Kihei Road and Piikea Avenue is projected to operate at LOS A during the AM peak hour and at LOS B during the PM peak hour. All movements are projected to operate at LOS C or better during the AM and PM peak hours.




# Year 2024 Build Traffic Volumes

Figure 6

Table 4 Year 2024 Build Level of Service

| Scenario 2 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **Kaonoulu St & Piilani Hwy** | **D** | **51** | **F** | **116** |
| Piilani NB Left | E | 68 | F | 127 |
| Piilani NB Through | C | 30 | F | 204 |
| Piilani NB Right | B | 11 | C | 29 |
| Piilani SB Left | D | 52 | F | 139 |
| Piilani SB Through | E | 74 | E | 63 |
| Piilani SB Right | A | 9 | B | 16 |
| Kaonoulu EB Left | D | 52 | E | 56 |
| Kaonoulu EB Through | E | 58 | F | 84 |
| Kaonoulu EB Right | A | 0 | A | 0 |
| Kaonoulu WB Left | D | 53 | F | 142 |
| Kaonoulu WB Through | D | 53 | E | 65 |
| Kaonoulu WB Right | D | 51 | D | 53 |
| **Kulanihakoi St & Piilani Hwy** | **E** | **63** | **E** | **61** |
| Piilani NB Left | E | 67 | E | 71 |
| Piilani NB Through | D | 41 | E | 75 |
| Piilani NB Right | A | 0 | A | 0 |
| Piilani SB Left | E | 73 | E | 61 |
| Piilani SB Through | F | 91 | D | 51 |
| Piilani SB Right | A | 0 | A | 0 |
| Kulanihakoi EB Left-Through | D | 50 | D | 50 |
| Kulanihakoi EB Right | A | 0 | A | 0 |
| Kulanihakoi WB Left-Through | F | 81 | E | 60 |
| Kulanihakoi WB Right | A | 0 | A | 0 |
| **E. Waipuilani Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| E. Waipuilani EB Right | E | 41 | C | 24 |
| **S. Kihei Rd & Piikea Ave** | **A** | **10** | **B** | **18** |
| S. Kihei NB Left | A | 7 | A | 9 |
| S. Kihei NB Through | B | 11 | C | 21 |
| S. Kihei NB Right | A | 7 | B | 11 |
| S. Kihei SB Left | A | 5 | B | 13 |
| S. Kihei SB Through-Right | A | 6 | B | 10 |
| Piikea WB Left-Through | C | 21 | C | 32 |
| Piikea WB Right | B | 19 | C | 23 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 4 Year 2024 Build Level of Service (Continued)

| Scenario 2 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **Piikea Ave & Liloa Dr** | **A** | **6** | **A** | **8** |
| Liloa NB Approach | A | 5 | A | 7 |
| Liloa SB Approach | A | 7 | A | 7 |
| Piikea EB Approach | A | 5 | A | 7 |
| Piikea WB Approach | A | 6 | A | 9 |
| **Piikea Ave & Piilani Hwy** | **D** | **54** | **F** | **95** |
| Piilani NB Left | F | 155 | F | * |
| Piilani NB Through | B | 11 | B | 15 |
| Piilani SB Through | E | 72 | D | 36 |
| Piilani SB Right | B | 15 | C | 23 |
| Piikea EB Left | F | 186 | F | * |
| Piikea EB Right | A | 0 | A | 1 |
| **W. Lipoa St & S. Kihei Rd** | **B** | **13** | **C** | **21** |
| S. Kihei NB Left | A | 9 | B | 16 |
| S. Kihei NB Through | B | 14 | B | 15 |
| S. Kihei NB Right | B | 10 | A | 8 |
| S. Kihei SB Left | A | 6 | B | 10 |
| S. Kihei SB Through-Right | A | 9 | C | 24 |
| W. Lipoa EB Left-Through | B | 20 | C | 29 |
| W. Lipoa EB Right | B | 19 | C | 27 |
| W. Lipoa WB Left-Through | C | 22 | D | 39 |
| W. Lipoa WB Right | B | 20 | C | 28 |
| **E. Lipoa St & Liloa Dr** | **B** | **13** | **B** | **10** |
| Liloa NB Left | B | 16 | B | 11 |
| Liloa NB Through | B | 17 | B | 12 |
| Liloa NB Right | B | 15 | B | 11 |
| Liloa SB Left | B | 17 | B | 12 |
| Liloa SB Through | B | 17 | B | 12 |
| Liloa SB Right | B | 15 | B | 11 |
| E. Lipoa EB Left-Through | B | 11 | A | 10 |
| E. Lipoa EB Right | B | 15 | B | 13 |
| E. Lipoa WB Left | A | 6 | A | 6 |
| E. Lipoa WB Through | A | 9 | A | 9 |
| E. Lipoa WB Right | A | 8 | A | 7 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 4 Year 2024 Build Level of Service (Continued)

| Scenario 2 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **E. Lipoa St & Piilani Hwy** | **F** | **224** | **F** | **134** |
| Piilani NB Left | F | 90 | F | 108 |
| Piilani NB Through | D | 47 | E | 58 |
| Piilani NB Right | C | 29 | C | 24 |
| Piilani SB Left | F | * | F | * |
| Piilani SB Through | E | 62 | E | 79 |
| Piilani SB Right | C | 32 | C | 32 |
| E. Lipoa EB Left-Through | F | 105 | F | 103 |
| E. Lipoa EB Right | A | 0 | A | 0 |
| E. Lipoa WB Left-Through | F | 184 | F | * |
| E. Lipoa WB Right | A | 0 | A | 1 |
| **E. Welakahao Rd & S. Kihei Rd** | **B** | **10** | **B** | **18** |
| S. Kihei NB Left | A | 6 | A | 10 |
| S. Kihei NB Through-Right | B | 10 | B | 17 |
| S. Kihei SB Left | A | 6 | B | 11 |
| S. Kihei SB Through-Right | A | 8 | B | 16 |
| E. Welakahao EB Left-Through-Right | B | 18 | C | 28 |
| E. Welakahao WB Left-Through | B | 19 | D | 44 |
| E. Welakahao WB Right | B | 17 | C | 26 |
| **E. Welakahao Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani NB Left | C | 20 | C | 24 |
| E. Welakahao EB Left | F | * | F | * |
| **Old Welakahao Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani SB Left | B | 13 | C | 17 |
| Old Welakahao WB Left-Right | F | 50 | F | 54 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

All approaches at the intersection of Liloa Drive and Piikea Avenue are projected to operate at LOS A or better during both the AM and PM peak hours.

The intersection of Piilani Highway and Piikea Avenue is projected to operate at LOS D during the AM peak hour and at LOS F during the PM peak hour. During both the AM and PM peak hours, the northbound Piilani left turn to Piikea and the eastbound Piikea left turn to Piilani are projected to operate at LOS F. The Piilani southbound through movement is

projected to operate at LOS E during the AM peak hour and at LOS D during the PM peak hour.

The intersection of South Kihei Road and Lipoa Street is projected to operate at LOS B during the AM peak hour and at LOS C during the PM peak hour. All movements are projected to operate at LOS C or better during the AM peak hour and at LOS D or better during the PM peak hour.

The intersection of Liloa Drive and Lipoa Street is projected to operate at LOS B during the both the AM and PM peak hours. All movements are projected to operate at LOS B or better during both peak hours.

With no project-related improvements, the intersection of Piilani Highway and Lipoa Street/Lipoa Parkway is projected to operate at LOS F during both the AM and PM peak hours. During the AM peak hour, the Piilani left turns are projected to operate at LOS F. The north and southbound Piilani through movements are projected to operate at LOS D and LOS E, respectively. During the PM peak hour, the Piilani through movements are projected to operate at LOS E. The north and southbound Piilani left turns are projected to operate at LOS F. The eastbound Lipoa left/through movements are projected to operate at LOS F during both peaks.

The intersection of South Kihei Road and East Welakahao Road is projected to operate at LOS B during both the AM and PM peak hours. During the AM peak hour, all movements are projected to operate at LOS B or better. All movements are projected to operate at LOS D or better during the PM peak hour.

At the intersection of Piilani Highway and East Welakahao Road, the eastbound Welakahao left turn is projected to operate at LOS F during both peak hours.

At the intersection of Piilani Highway and Old Welakahao Road, the westbound Welakahao left turn is projected to operate at LOS F during both peak hours.

## C. SCENARIO 3 – BUILD WITH MRTP ROADWAY IMPROVEMENTS

The Build with Project Roadway Improvements scenario represents the Build scenario with additional transportation improvements committed by MRTP. As described in the Build Condition, Phase 1 consists of residential, mixed-use commercial, and the employment core along with an elementary school and business hotel.

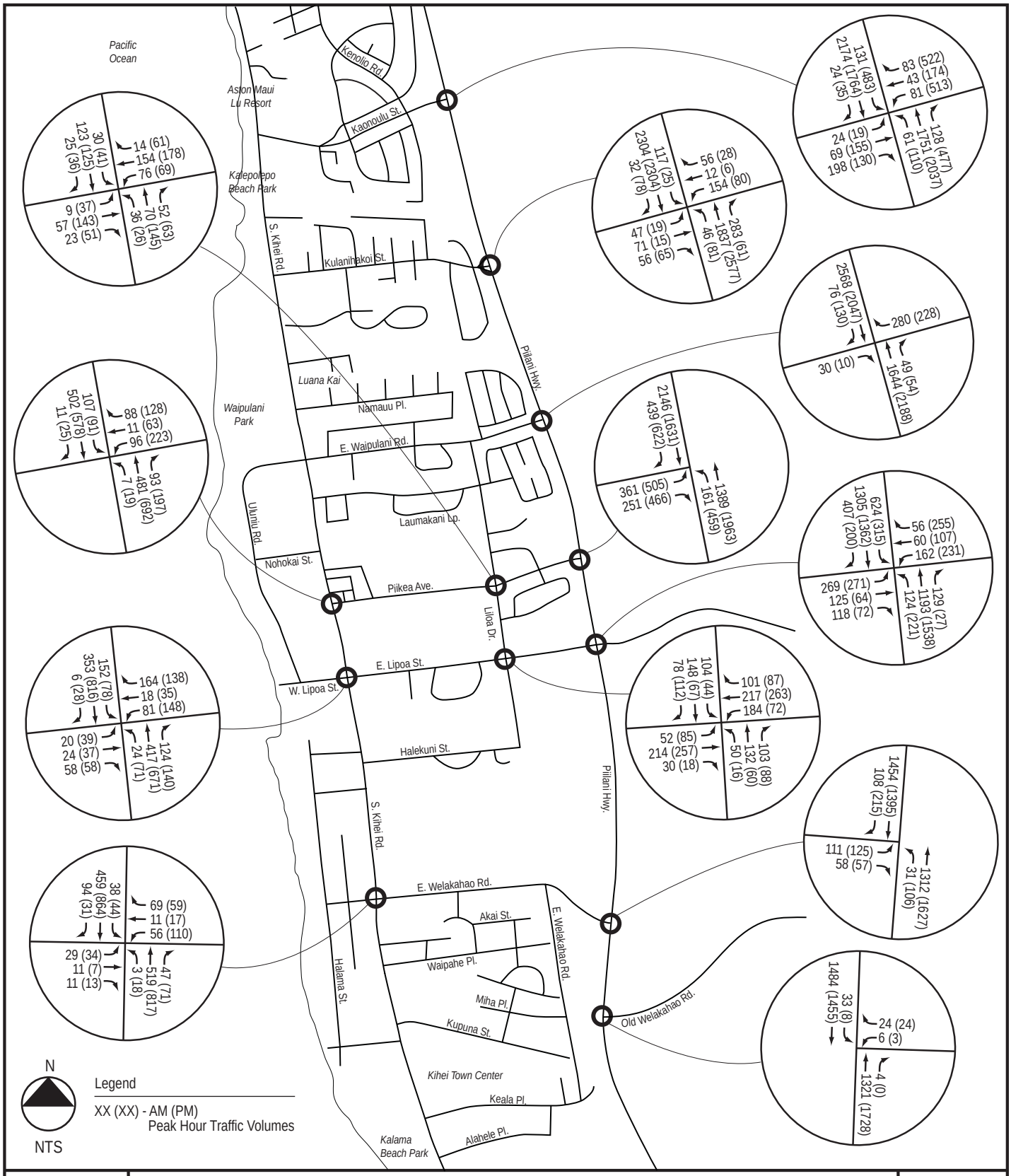
## 1. Future Roadways

The roadway network assumptions are nearly identical to Scenario 2. Additional improvements assumed to be the responsibility of MRTP are included. These are:

1. Piilani Highway/Hookena Street Access
    a. Construct 2-lane Hookena Street from within MRTP to intersect Piilani Highway across from East Waipuilani Road;
    b. Configure the westbound Hookena approach as a right-in/right-out access with stop control;
    c. Provide acceleration and deceleration lanes to and from Piilani Highway;
    d. Maintain existing delineators on Piilani Highway to prevent left turns from East Waipuilani Road or Hookena Street from crossing the center line of Piilani Highway.
2. Piilani Highway/Piikea Avenue
    a. Construct an additional eastbound Piikea Avenue left turn lane (two total);
    b. Retime the traffic signal accordingly to optimize the intersection operation.
3. Piilani Highway/Lipoa Parkway
    a. Construct an additional southbound Piilani left turn lane (two total);
    b. Widen westbound Lipoa Parkway to provide for left, through, and right turn lanes;
    c. Widen and/or restripe eastbound Lipoa Street to provide left, through, and right turn lanes;
    d. Adjust signal timing and phasing to provide leading protected left turn phases for the east and westbound Lipoa left turn movements;
    e. Add the missing crosswalk on north Piilani leg of the intersection to improve pedestrian connectivity.
4. Internal Kihei High School Access
    a. Construct an internal Kihei High School Access from within MRTP;
    b. Provide bicycle and pedestrian connectivity between the school and MRTP

## 2. Trip Generation

The trip generation for Scenario 3 is shown in Table 3.




# Year 2024 Build Traffic Volumes With MRTP Roadway Improvements

Figure 7

### 3. Trip Assignment

The traffic generated by the proposed MRTP Development was directionally distributed and assigned to the future roadway network.

### 4. Total Traffic

The traffic generated by the MRTP development was added to the projected background traffic to obtain the total peak hour traffic volumes shown in Figure 7.

### 5. Scenario 3 Traffic Operations With Project

Level of Service analysis was performed on the study area intersections. These results are shown in Table 5.

As shown in Table 5 the intersection of Piilani Highway and Kaonoulu Street is projected to operate at LOS D overall during the AM peak hour. The southbound Piilani through movement is projected to operate at LOS E. During the PM peak hour, the intersection is projected to operate at LOS F overall. Multiple movements are projected to operate at LOS F. The north and southbound Piilani through movements are projected to operate at LOS F and E, respectively.

Piilani Highway's intersection with Kulanihakoi Street is projected to operate at LOS E overall during the AM and PM peak hours. During both peaks, multiple movements are projected to operate at LOS E or worse.

The eastbound right turn at the intersection of Piilani Highway and East Waipuilani is projected to operate at LOS A during the AM and PM peak hours. The westbound right turn out of MRTP is also projected to operate at LOS A during the AM and PM peak hours.

The intersection of South Kihei Road and Piikea Avenue is projected to operate at LOS A during the AM peak hour and at LOS B during the PM peak hour. All movements are projected to operate at LOS C or better during the AM and PM peak hours.

All approaches at the intersection of Liloa Drive and Piikea Avenue are projected to operate at LOS A or better during both the AM and PM peak hours.

Table 5 Year 2024 Build With MRTP Roadway Improvements Level of Service

| Scenario 3 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **Kaonoulu St & Piilani Hwy** | **D** | **51** | **F** | **120** |
| Piilani NB Left | E | 68 | F | 164 |
| Piilani NB Through | C | 30 | F | 214 |
| Piilani NB Right | B | 11 | C | 30 |
| Piilani SB Left | D | 52 | F | 139 |
| Piilani SB Through | E | 74 | E | 63 |
| Piilani SB Right | A | 9 | B | 16 |
| Kaonoulu EB Left | D | 52 | E | 56 |
| Kaonoulu EB Through | E | 58 | F | 68 |
| Kaonoulu EB Right | A | 0 | A | 0 |
| Kaonoulu WB Left | D | 53 | F | 142 |
| Kaonoulu WB Through | D | 53 | E | 65 |
| Kaonoulu WB Right | D | 51 | D | 53 |
| **Kulanihakoi St & Piilani Hwy** | **E** | **63** | **E** | **61** |
| Piilani NB Left | E | 67 | E | 71 |
| Piilani NB Through | D | 41 | E | 76 |
| Piilani NB Right | A | 0 | A | 0 |
| Piilani SB Left | E | 73 | E | 61 |
| Piilani SB Through | F | 91 | D | 51 |
| Piilani SB Right | A | 0 | A | 0 |
| Kulanihakoi EB Left-Through | D | 50 | D | 50 |
| Kulanihakoi EB Right | A | 0 | A | 0 |
| Kulanihakoi WB Left-Through | F | 81 | E | 60 |
| Kulanihakoi WB Right | A | 0 | A | 0 |
| **E. Waipuilani Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| E. Waipuilani EB Right | A | 5 | A | 1 |
| E. Waipuilani WB Right | A | 3 | A | 2 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 5 Year 2024 Build With MRTP Roadway Improvements Level of Service (Continued)

| Scenario 3 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **S. Kihei Rd & Piikea Ave** | **A** | **10** | **B** | **18** |
| S. Kihei NB Left | A | 7 | A | 9 |
| S. Kihei NB Through | B | 11 | C | 21 |
| S. Kihei NB Right | A | 7 | B | 11 |
| S. Kihei SB Left | A | 5 | B | 13 |
| S. Kihei SB Through-Right | A | 6 | B | 10 |
| Piikea WB Left-Through | C | 21 | C | 32 |
| Piikea WB Right | B | 19 | C | 23 |
| **Piikea Ave & Liloa Dr** | **A** | **6** | **A** | **8** |
| Liloa NB Approach | A | 5 | A | 7 |
| Liloa SB Approach | A | 7 | A | 7 |
| Piikea EB Approach | A | 5 | A | 7 |
| Piikea WB Approach | A | 6 | A | 9 |
| **Piikea Ave & Piilani Hwy** | **D** | **44** | **E** | **58** |
| Piilani NB Left | F | 81 | F | 102 |
| Piilani NB Through | A | 7 | B | 14 |
| Piilani SB Through | E | 73 | F | 108 |
| Piilani SB Right | B | 14 | D | 41 |
| Piikea EB Left | E | 66 | F | 103 |
| Piikea EB Right | A | 0 | A | 1 |
| **W. Lipoa St & S. Kihei Rd** | **B** | **13** | **C** | **21** |
| S. Kihei NB Left | A | 9 | B | 16 |
| S. Kihei NB Through | B | 14 | B | 15 |
| S. Kihei NB Right | B | 10 | A | 8 |
| S. Kihei SB Left | A | 6 | B | 10 |
| S. Kihei SB Through-Right | A | 9 | C | 24 |
| W. Lipoa EB Left-Through | B | 20 | C | 29 |
| W. Lipoa EB Right | B | 19 | C | 27 |
| W. Lipoa WB Left-Through | C | 22 | D | 39 |
| W. Lipoa WB Right | B | 20 | C | 28 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 5 Year 2024 Build With MRTP Roadway Improvements Level of Service With Project (Continued)

| Scenario 3 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **E. Lipoa St & Liloa Dr** | **B** | **13** | **B** | **10** |
| Liloa NB Left | B | 16 | B | 11 |
| Liloa NB Through | B | 17 | B | 12 |
| Liloa NB Right | B | 15 | B | 11 |
| Liloa SB Left | B | 17 | B | 12 |
| Liloa SB Through | B | 17 | B | 12 |
| Liloa SB Right | B | 15 | B | 11 |
| E. Lipoa EB Left | B | 11 | A | 10 |
| E. Lipoa EB Through-Right | B | 15 | B | 13 |
| E. Lipoa WB Left | A | 6 | A | 6 |
| E. Lipoa WB Through | A | 9 | A | 9 |
| E. Lipoa WB Right | A | 8 | A | 7 |
| **E. Lipoa St & Piilani Hwy** | **D** | **53** | **F** | **92** |
| Piilani NB Left | E | 76 | E | 74 |
| Piilani NB Through | E | 57 | F | 118 |
| Piilani NB Right | C | 20 | B | 12 |
| Piilani SB Left | F | 95 | E | 74 |
| Piilani SB Through | D | 36 | F | 118 |
| Piilani SB Right | A | 9 | B | 14 |
| E. Lipoa EB Left | E | 67 | E | 67 |
| E. Lipoa EB Through | D | 52 | D | 54 |
| E. Lipoa EB Right | A | 0 | A | 0 |
| E. Lipoa WB Left | F | 152 | E | 65 |
| E. Lipoa WB Through | E | 69 | E | 61 |
| E. Lipoa WB Right | A | 0 | A | 0 |
| **E. Welakahao Rd & S. Kihei Rd** | **B** | **10** | **B** | **18** |
| S. Kihei NB Left | A | 6 | A | 10 |
| S. Kihei NB Through-Right | B | 10 | B | 17 |
| S. Kihei SB Left | A | 6 | B | 11 |
| S. Kihei SB Through-Right | A | 8 | B | 16 |
| E. Welakahao EB Left-Through-Right | B | 18 | C | 28 |
| E. Welakahao WB Left-Through | B | 19 | D | 44 |
| E. Welakahao WB Right | B | 17 | C | 26 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 5 Year 2024 Build With MRTP Roadway Improvements Level of Service With Project (Continued)

| Scenario 3 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **E. Welakahao Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani NB Left | C | 20 | C | 24 |
| E. Welakahao EB Left | F | * | F | * |
| **Old Welakahao Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani SB Left | B | 13 | C | 17 |
| Old Welakahao WB Left-Right | F | 50 | F | 54 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

The intersection of Piilani Highway and Piikea Avenue is projected to operate at LOS D during the AM peak hour and at LOS E during the PM peak hour. During both the AM and PM peak hours, the northbound Piilani left turn to Piikea is projected to operate at LOS F. With the project-related improvements, the eastbound Piikea left turn to Piilani is projected to operate at LOS F during the PM peak hour. The Piilani southbound through movement is projected to operate at LOS E during the AM peak hour and at LOS F during the PM peak hour.

The intersection of South Kihei Road and Lipoa Street is projected to operate at LOS B during the AM peak hour and at LOS C during the PM peak hour. All movements are projected to operate at LOS C or better during the AM peak hour and at LOS D or better during the PM peak hour.

The intersection of Liloa Drive and Lipoa Street is projected to operate at LOS B during the both the AM and PM peak hours. All movements are projected to operate at LOS B or better during both peak hours.

With project-related improvements, the intersection of Piilani Highway and Lipoa Street/Lipoa Parkway is projected to operate at LOS D during the AM peak hour and at LOS F during PM peak hour. During the AM peak hour, the north and southbound Piilani left turns are projected to operate at LOS E and F, respectively. The north and southbound Piilani through movements are projected to operate at LOS E and LOS D, respectively. During the PM peak hour, the Piilani through movements are projected to operate at LOS F.

The north and southbound Piilani left turns are projected to operate at LOS E. The eastbound Lipoa left turn movements are projected to operate at LOS E-F during both peaks.

The intersection of South Kihei Road and East Welakahao Road is projected to operate at LOS B during both the AM and PM peak hours. During the AM peak hour, all movements are projected to operate at LOS B or better. All movements are projected to operate at LOS D or better during the PM peak hour.

At the intersection of Piilani Highway and East Welakahao Road, the eastbound Welakahao left turn is projected to operate at LOS F during both peak hours.

At the intersection of Piilani Highway and Old Welakahao Road, the westbound Welakahao left turn is projected to operate at LOS F during both peak hours.

## D. SCENARIO 4 – BUILD SCENARIO WITH MRTP AND REGIONAL ROADWAY IMPROVEMENTS

The Build with Project and Regional Roadway Improvements scenario represents the Build scenario with additional transportation improvements committed by MRTP as well as the Liloa Drive extension. In this scenario, it is assumed that the project-related improvements described in Scenario 3 are in place along with the Liloa Drive extension between Kaonoulu Street and Kanani Road.

As described in Scenarios 2 and 3, Phase 1 consists of residential, mixed-use commercial, and the employment core along with an elementary school and business hotel.

### 1. Future Regional Roadways

It is assumed that the makai north-south collector roadway (an extension of the existing Liloa Drive) would be in place by 2024 due to its presence in the six-year Capital Program. Liloa Drive is already built between Waipuilani Road past Lokelani School. According to the Maui County 2013 Capital Improvement Program budget approved by the Maui County Council, the North South Collector Road (makai collector) is budgeted from fiscal year 2015 to 2018 at a cost of $18.2 million with two phases. An excerpt is included in Appendix E. Phase 1 will be the segment from Kaonoulu Street to Waipuilani Road and Phase 2 will be the segment from Lokelani School to Kanani Road. It is believed that the Liloa Drive Extension is committed by the County and will be placed in the next STIP.

Liloa Drive would provide additional mobility throughout the Kihei area and is necessary to divert traffic from Piilani Highway. For the purpose of this study, it is assumed that the Liloa Drive would be complete between Kaonoulu Street and Kanani Road.

### 2. Trip Generation

The trip generation for Scenario 4 is shown in Table 3.

### 3. Trip Assignment

The traffic generated by the proposed MRTP Development was directionally distributed and assigned to the future roadway network and is shown in Figure 8.

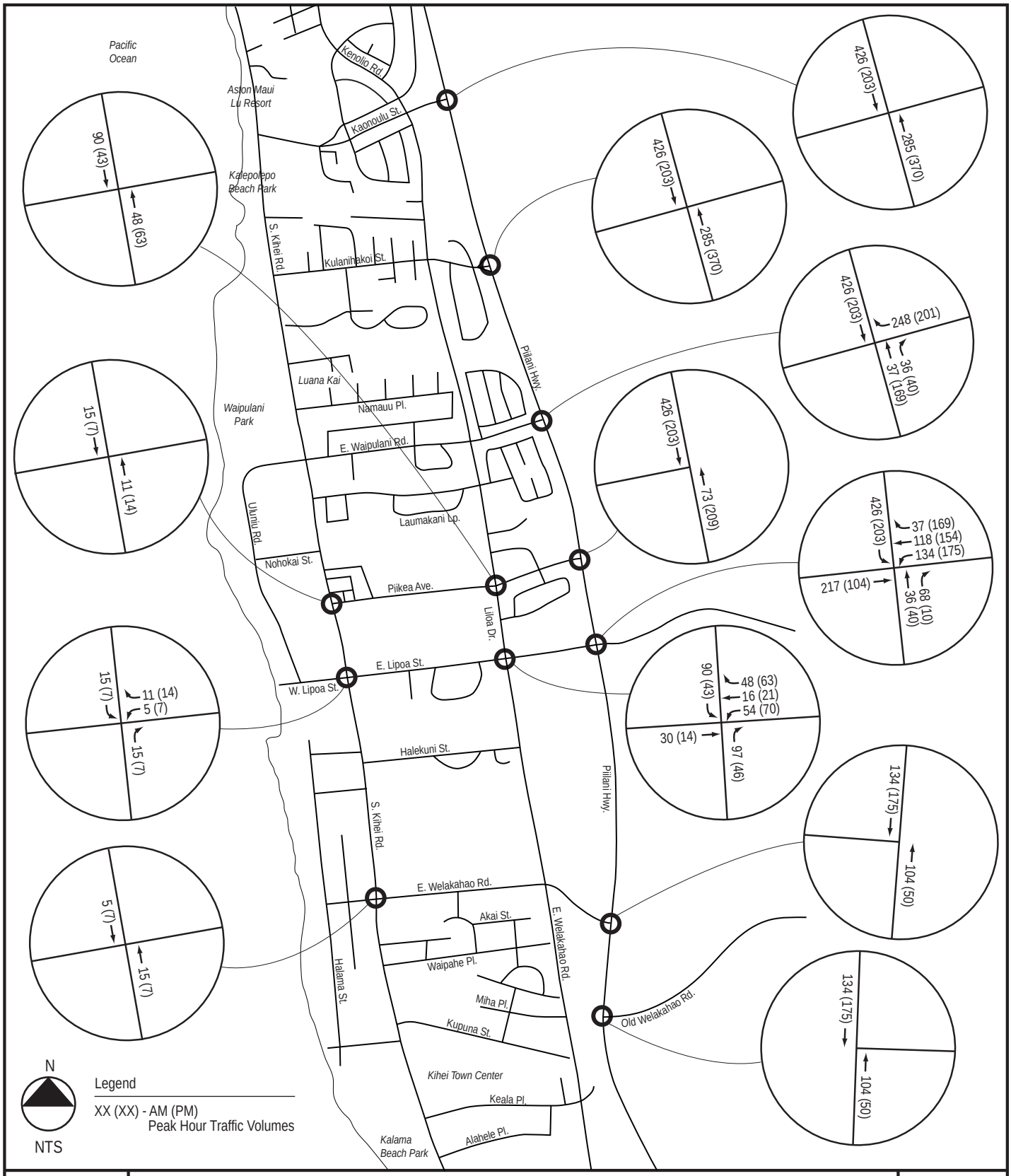
### 4. Total Traffic

The traffic generated by the MRTP development was added to the projected background traffic to obtain the total peak hour traffic volumes shown in Figure 9. The recommended lane configurations for Scenario 4 are shown in Figure 10.

### 5. Scenario 4 Traffic Operations With Project

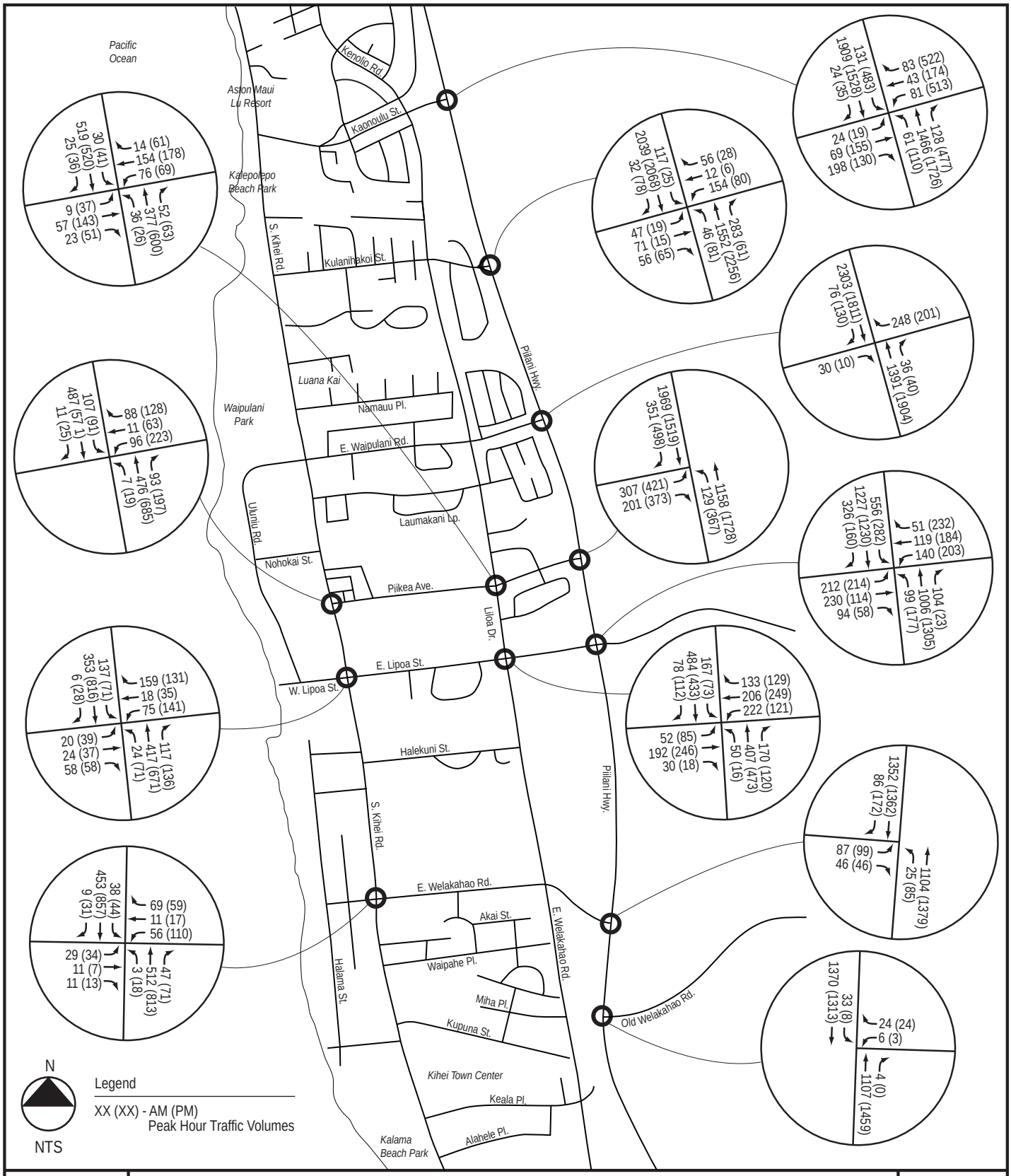
Level of Service analysis was performed on the study area intersections. These results are shown in Table 6. As shown in Table 6 the intersection of Piilani Highway and Kaonoulu Street is projected to operate at LOS C overall during the AM peak hour. The Piilani through movements are projected to operate at LOS C. During the PM peak hour, the intersection is projected to operate at LOS F overall. Multiple movements are projected to operate at LOS F. The north and southbound Piilani through movements are projected to operate at LOS F and D, respectively.

Piilani Highway's intersection with Kulanihakoi Street is projected to operate at LOS D overall during the AM peak hour and at LOS C during the PM peak hour. During both peaks, left turns and some minor street movements are projected to operate at LOS E but Piilani Highway through movements are projected to operate at LOS D or better. The eastbound right turn at the intersection of Piilani Highway and East Waipuilani is projected to operate at LOS A during the AM and PM peak hours. The westbound right turn out of MRTP is also projected to operate at LOS A during the AM and PM peak hours.



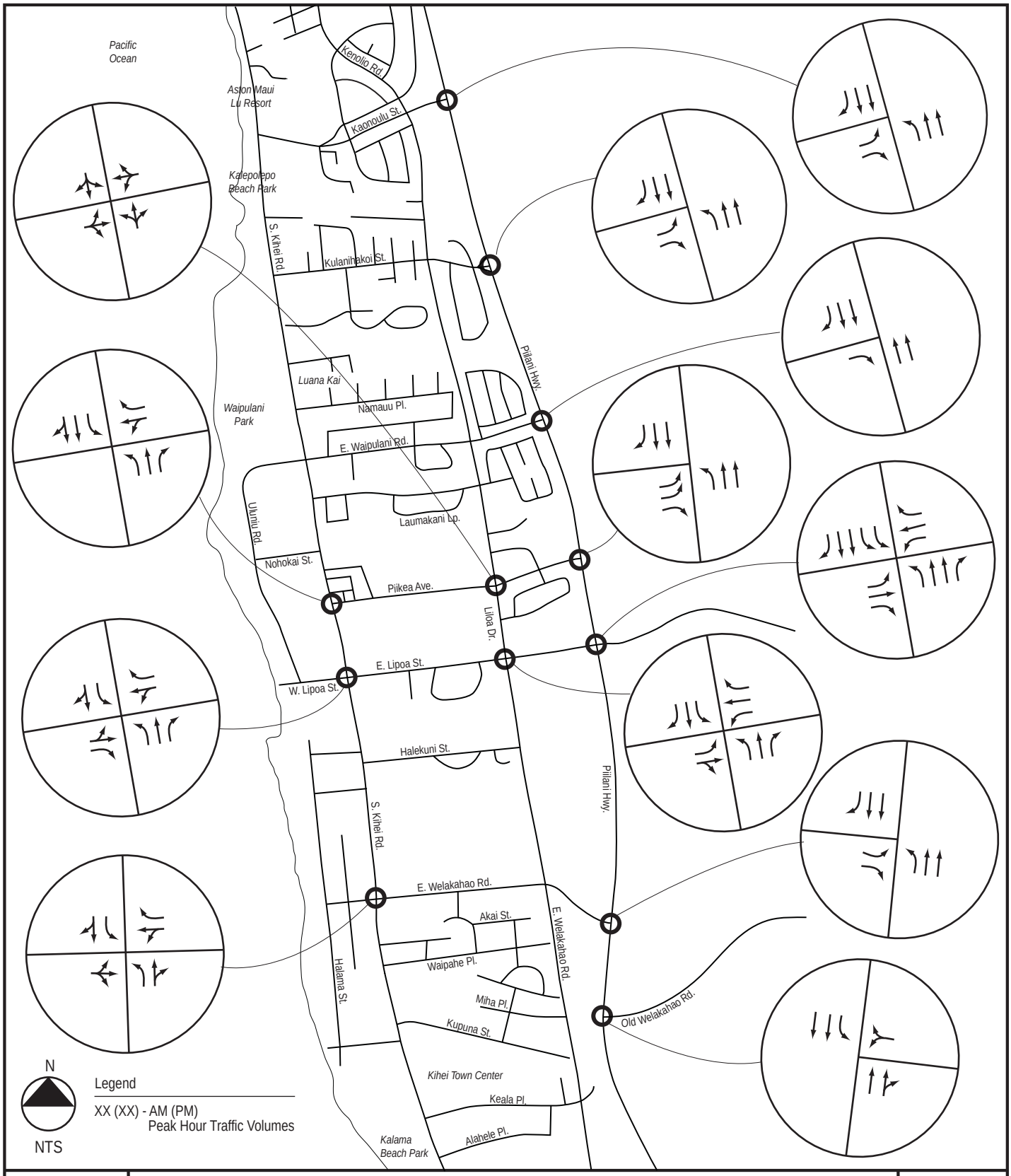

# Phase 1 Project-Generated Traffic Volumes

Figure 8




# Year 2024 Build Traffic Volumes With MRTP and Regional Roadway Improvements

Figure 9




Year 2024 Lane Configurations

Figure 10

Table 6 Build With MRTP and Regional Roadway Improvements Level of Service

| Scenario 4 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **Kaonoulu St & Piilani Hwy** | **C** | **30** | **F** | **122** |
| Piilani NB Left | E | 67 | F | 164 |
| Piilani NB Through | C | 21 | F | 122 |
| Piilani NB Right | B | 11 | C | 29 |
| Piilani SB Left | D | 52 | F | * |
| Piilani SB Through | C | 34 | D | 36 |
| Piilani SB Right | A | 9 | B | 16 |
| Kaonoulu EB Left | D | 51 | E | 56 |
| Kaonoulu EB Through | E | 57 | F | 84 |
| Kaonoulu EB Right | A | 0 | A | 0 |
| Kaonoulu WB Left | D | 52 | F | 142 |
| Kaonoulu WB Through | D | 53 | E | 65 |
| Kaonoulu WB Right | D | 50 | D | 53 |
| **Kulanihakoi St & Piilani Hwy** | **D** | **36** | **C** | **28** |
| Piilani NB Left | E | 66 | E | 71 |
| Piilani NB Through | C | 25 | C | 31 |
| Piilani NB Right | A | 0 | A | 0 |
| Piilani SB Left | E | 71 | E | 61 |
| Piilani SB Through | D | 45 | C | 25 |
| Piilani SB Right | A | 0 | A | 0 |
| Kulanihakoi EB Left-Through | D | 48 | D | 50 |
| Kulanihakoi EB Right | A | 0 | A | 0 |
| Kulanihakoi WB Left-Through | E | 79 | E | 60 |
| Kulanihakoi WB Right | A | 0 | A | 0 |
| **E. Waipuilani Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| E. Waipuilani EB Right | A | 1 | A | 1 |
| E. Waipuilani WB Right | A | 2 | A | 2 |

Delay expressed in seconds per vehicle.

* Delay greater than 300 seconds per vehicle.

Table 6 Year 2024 Build With MRTP and Regional Roadway Improvements Level of Service (Continued)

| Scenario 4 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **S. Kihei Rd & Piikea Ave** | **A** | **10** | **B** | **18** |
| S. Kihei NB Left | A | 7 | A | 9 |
| S. Kihei NB Through | B | 10 | C | 21 |
| S. Kihei NB Right | A | 7 | B | 10 |
| S. Kihei SB Left | A | 5 | B | 13 |
| S. Kihei SB Through-Right | A | 6 | B | 10 |
| Piikea WB Left-Through | C | 21 | C | 32 |
| Piikea WB Right | B | 19 | C | 23 |
| **Piikea Ave & Liloa Dr** | **B** | **14** | **C** | **23** |
| Liloa NB Approach | A | 10 | D | 28 |
| Liloa SB Approach | C | 20 | C | 23 |
| Piikea EB Approach | A | 9 | B | 14 |
| Piikea WB Approach | B | 10 | C | 21 |
| **Piikea Ave & Piilani Hwy** | **C** | **26** | **D** | **36** |
| Piilani NB Left | E | 71 | F | 86 |
| Piilani NB Through | A | 5 | A | 10 |
| Piilani SB Through | C | 35 | D | 53 |
| Piilani SB Right | B | 12 | C | 29 |
| Piikea EB Left | E | 64 | F | 84 |
| Piikea EB Right | A | 0 | A | 0 |
| **W. Lipoa St & S. Kihei Rd** | **B** | **13** | **C** | **21** |
| S. Kihei NB Left | A | 9 | B | 16 |
| S. Kihei NB Through | B | 14 | B | 14 |
| S. Kihei NB Right | A | 10 | A | 8 |
| S. Kihei SB Left | A | 6 | A | 10 |
| S. Kihei SB Through-Right | A | 9 | C | 24 |
| W. Lipoa EB Left-Through | B | 20 | C | 29 |
| W. Lipoa EB Right | B | 19 | C | 27 |
| W. Lipoa WB Left-Through | C | 22 | D | 37 |
| W. Lipoa WB Right | B | 19 | C | 28 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 6 Year 2024 Build With MRTP and Regional Roadway Improvements Level of Service (Continued)

| Scenario 4 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **E. Lipoa St & Liloa Dr** | **C** | **20** | **C** | **20** |
| Liloa NB Left | B | 17 | B | 12 |
| Liloa NB Through | B | 20 | C | 34 |
| Liloa NB Right | B | 15 | B | 12 |
| Liloa SB Left | C | 34 | B | 16 |
| Liloa SB Through | C | 23 | C | 25 |
| Liloa SB Right | B | 14 | B | 12 |
| E. Lipoa EB Left | C | 20 | B | 14 |
| E. Lipoa EB Through-Right | C | 25 | B | 18 |
| E. Lipoa WB Left | B | 13 | A | 8 |
| E. Lipoa WB Through | B | 16 | B | 12 |
| E. Lipoa WB Right | B | 14 | B | 10 |
| **E. Lipoa St & Piilani Hwy** | **D** | **46** | **D** | **51** |
| Piilani NB Left | E | 68 | E | 78 |
| Piilani NB Through | D | 46 | D | 48 |
| Piilani NB Right | B | 19 | B | 12 |
| Piilani SB Left | E | 75 | E | 77 |
| Piilani SB Through | D | 36 | D | 51 |
| Piilani SB Right | B | 12 | B | 14 |
| E. Lipoa EB Left | E | 70 | E | 75 |
| E. Lipoa EB Through | E | 60 | D | 53 |
| E. Lipoa EB Right | A | 0 | A | 0 |
| E. Lipoa WB Left | E | 71 | E | 73 |
| E. Lipoa WB Through | D | 55 | E | 64 |
| E. Lipoa WB Right | A | 0 | A | 0 |
| **E. Welakahao Rd & S. Kihei Rd** | **B** | **10** | **B** | **18** |
| S. Kihei NB Left | A | 6 | A | 9 |
| S. Kihei NB Through-Right | B | 10 | B | 17 |
| S. Kihei SB Left | A | 6 | B | 10 |
| S. Kihei SB Through-Right | A | 8 | B | 15 |
| E. Welakahao EB Left-Through-Right | B | 18 | C | 27 |
| E. Welakahao WB Left-Through | B | 78 | D | 44 |
| E. Welakahao WB Right | B | 17 | C | 26 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 6 Year 2024 Build With MRTP and Regional Roadway Improvements Level of Service (Continued)

| Scenario 4 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **E. Welakahao Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani NB Left | C | 17 | C | 19 |
| E. Welakahao EB Left | F | 75 | F | * |
| **Old Welakahao Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani SB Left | B | 12 | B | 14 |
| Old Welakahao WB Left-Right | D | 32 | E | 49 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

The intersection of South Kihei Road and Piikea Avenue is projected to operate at LOS A during the AM peak hour and at LOS B during the PM peak hour. All movements are projected to operate at LOS C or better during the AM and PM peak hours.

All approaches at the intersection of Liloa Drive and Piikea Avenue are projected to operate at LOS C or better during the AM peak hour and at LOS D or better during the PM peak hour.

The intersection of Piilani Highway and Piikea Avenue is projected to operate at LOS C during the AM peak hour and at LOS D during the PM peak hour. The northbound Piilani left turn to Piikea is projected to operate at LOS E and F during the AM and PM peak hours, respectively. With the project-related improvements, the eastbound Piikea left turn to Piilani is projected to operate at LOS E during the AM peak hour and at LOS F during the PM peak hour. The Piilani southbound through movement is projected to operate at LOS D or better during both peak hours.

The intersection of South Kihei Road and Lipoa Street is projected to operate at LOS B during the AM peak hour and at LOS C during the PM peak hour. All movements are projected to operate at LOS C or better during the AM peak hour and at LOS D or better during the PM peak hour.

The intersection of Liloa Drive and Lipoa Street is projected to operate at LOS C during the both the AM and PM peak hours. All movements are projected to operate at LOS C or better during both peak hours.

With project-related improvements, the intersection of Piilani Highway and Lipoa Street/Lipoa Parkway is projected to operate at LOS D during the both the AM and PM peak hours. All Piilani through movements are projected to operate at LOS D and all turning movements or minor street movements are projected to operate at LOS E or better.

The intersection of South Kihei Road and East Welakahao Road is projected to operate at LOS B during both the AM and PM peak hours. During the AM peak hour, all movements are projected to operate at LOS B or better. All movements are projected to operate at LOS D or better during the PM peak hour.

At the intersection of Piilani Highway and East Welakahao Road, the eastbound Welakahao left turn is projected to operate at LOS F during both peak hours.

At the intersection of Piilani Highway and Old Welakahao Road, the westbound Welakahao left turn is projected to operate at LOS D during the AM peak hour and at LOS E during the PM peak hour.

## E. SUMMARY OF RESULTS

The following issues were identified within the project study area:

- The intersection of Piilani Highway and Kaonoulu Street is projected to operate at LOS F with or without MRTP. This intersection would be signalized as part of the Piilani Promenade project located on Kaonoulu Street on the mauka side of Piilani Highway. Even with double southbound left turns and double left and right turns out of makai-bound Kaonoulu Street, many turning movements at the intersection are projected to operate at LOS F for all scenarios. Even with the makai collector in place, the intersection is projected to operate at LOS F during the PM peak.
- The construction of the Liloa Drive Extension (Makai collector) is necessary to relieve congestion on Piilani Highway. The makai collector is projected to improve the traffic operation on Piilani Highway to an acceptable LOS except at Kaonoulu Street during PM peak hour. Without makai collector, traffic operation on Piilani Highway would fail with or without MRTP.

- Along with the Makai collector, the MRTP project-related improvements are also essential to overall traffic operations on Piilani Highway especially at the intersections with Piikea Avenue and Lipoa Parkway.
    - At the intersection of Piilani Highway and Piikea Avenue, the LOS for the eastbound Piikea Avenue left turn improves is projected to improve from LOS F to C during the AM peak hour with the addition of the additional eastbound left turn lane. The left turn movement is projected to operate at LOS E or F during both peak hours, but the delay is greatly decreased and the left turn queuing is not expected to spillover with the project-related improvements.
    - At the intersection of Piilani Highway and Lipoa Parkway, project-related improvements are projected to improve the overall LOS from F to D during both AM and PM peak hour. The left turn movement is projected to operate at LOS E during both peak hours, but the delay is greatly decreased and the left turn queuing is not expected to spill over with the project-related improvements.

# IV. YEAR 2034 TRAFFIC CONDITIONS

Phase 2 of the MRTP project is projected to be completed in the Year 2034, which was used as the basis for future traffic analysis. As described earlier, four scenarios including Scenario 1 – No Build, Scenario 2 – Build, Scenario 3 – Build with MRTP Roadway Improvements, and Scenario 4 – Build with MRTP and Regional Roadway Improvements. were analyzed.

## A. SCENARIO 1 – NO BUILD

The No Build scenario represents the without project scenario. Only existing roads and regional roadways identified in the STIP are included.

### 1. Future Roadways

The roadway network assumptions are the same as the 2024 No Build scenario.

### 2. Projected Year 2034 Background Traffic

The Year 2034 background traffic volumes were derived using existing traffic along with trip generation obtained from the Maui Travel Demand Forecasting Model.

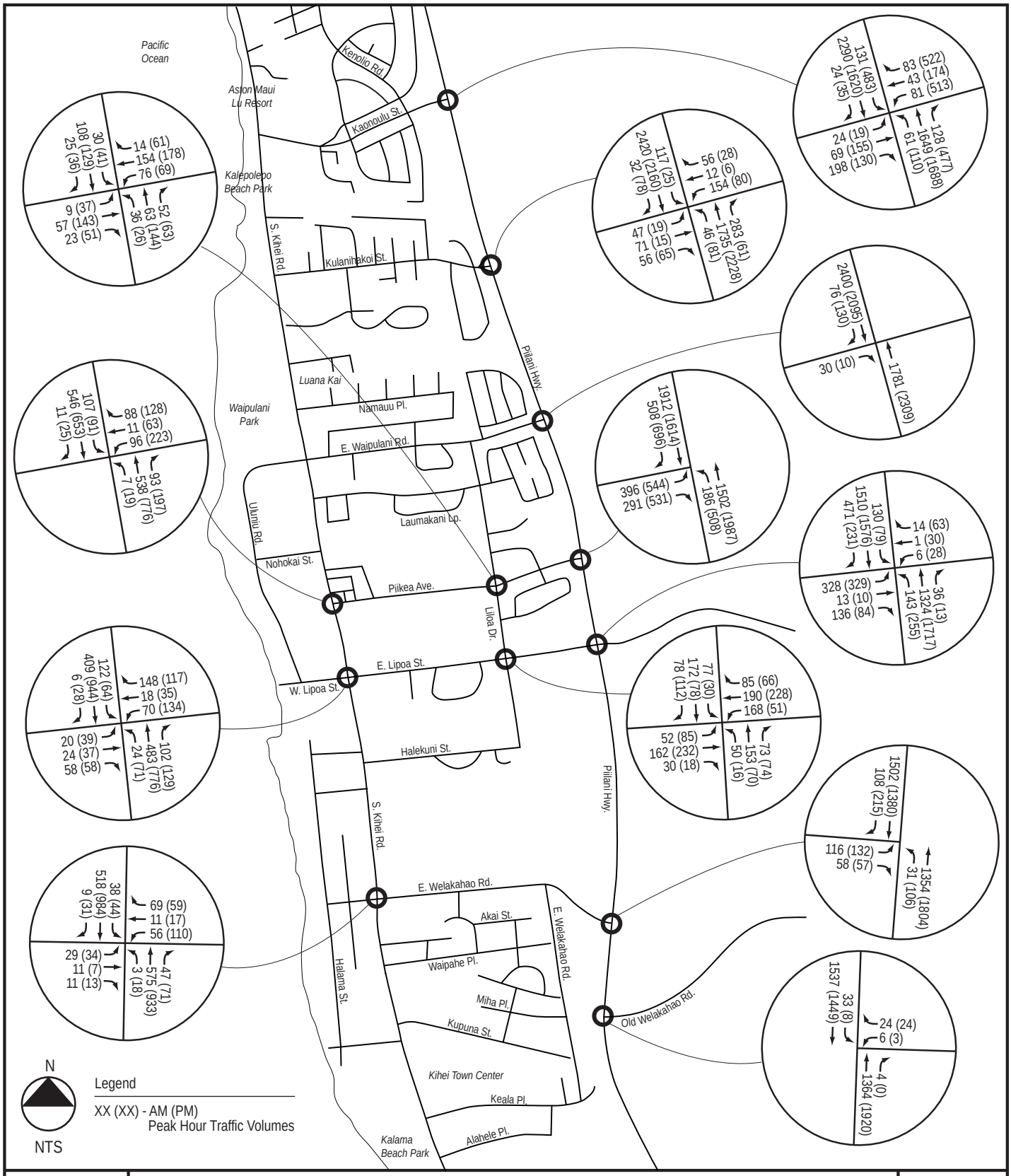
The future Year 2034 background traffic assumes the presence of the developments described in the 2024 background conditions. The projected Scenario 1 traffic volumes are shown in Figure 11.

### 3. Scenario 1 Traffic Operations

Level of Service analysis was performed on the study area intersections. These results are shown in Table 7.

As shown in Table 7, Piilani Highway's intersection with Kaonoulu Street is projected to be a four-legged, signalized intersection. The intersection is projected to operate at LOS E overall during the AM peak hour. During the PM peak hour, the intersection is projected to operate at LOS F overall. During the AM peak hour, the SB Piilani through movement is projected to operate at LOS F. During the PM peak hour, multiple movements, including the NB Piilani through movement, are projected to operate at LOS F.

Piilani Highway's intersection with Kulanihakoi Street is projected to operate at LOS E during the AM peak hour and at LOS C overall during the PM peak hour. During both peaks, multiple movements are projected to operate at LOS E. The westbound Kulanihakoi left/through movement is projected to operate at LOS F during the AM peak hour.




# Year 2034 No Build Traffic Volumes

Figure 11

Table 7 Year 2034 No Build Level of Service

| Scenario 1 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **Kaonoulu St & Piilani Hwy** | **E** | **62** | **F** | **81** |
| Piilani NB Left | E | 68 | F | 164 |
| Piilani NB Through | C | 25 | F | 111 |
| Piilani NB Right | B | 11 | C | 29 |
| Piilani SB Left | D | 52 | F | 139 |
| Piilani SB Through | F | 98 | D | 42 |
| Piilani SB Right | A | 9 | C | 16 |
| Kaonoulu EB Left | D | 52 | E | 56 |
| Kaonoulu EB Through | E | 58 | F | 84 |
| Kaonoulu EB Right | A | 0 | A | 0 |
| Kaonoulu WB Left | D | 53 | F | 142 |
| Kaonoulu WB Through | D | 53 | E | 65 |
| Kaonoulu WB Right | D | 51 | D | 53 |
| **Kulanihakoi St & Piilani Hwy** | **E** | **72** | **C** | **30** |
| Piilani NB Left | E | 67 | E | 71 |
| Piilani NB Through | C | 32 | C | 27 |
| Piilani NB Right | A | 0 | A | 0 |
| Piilani SB Left | E | 73 | E | 61 |
| Piilani SB Through | F | 115 | C | 33 |
| Piilani SB Right | A | 0 | A | 0 |
| Kulanihakoi EB Left-Through | D | 50 | D | 50 |
| Kulanihakoi EB Right | A | 0 | A | 0 |
| Kulanihakoi WB Left-Through | F | 81 | E | 60 |
| Kulanihakoi WB Right | A | 0 | A | 0 |
| **E. Waipuilani Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| E. Waipuilani EB Right | E | 35 | C | 25 |
| **S. Kihei Rd & Piikea Ave** | **A** | **10** | **B** | **20** |
| S. Kihei NB Left | A | 6 | A | 9 |
| S. Kihei NB Through | B | 11 | C | 24 |
| S. Kihei NB Right | A | 7 | B | 10 |
| S. Kihei SB Left | A | 5 | B | 16 |
| S. Kihei SB Through-Right | A | 6 | B | 10 |
| Piikea WB Left-Through | C | 23 | D | 36 |
| Piikea WB Right | B | 20 | C | 25 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 7 Year 2034 No Build Level of Service (Continued)

| Scenario 1 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **Piikea Ave & Liloa Dr** | **A** | **6** | **A** | **8** |
| Liloa NB Approach | A | 5 | A | 7 |
| Liloa SB Approach | A | 7 | A | 7 |
| Piikea EB Approach | A | 5 | A | 8 |
| Piikea WB Approach | A | 6 | A | 8 |
| **Piikea Ave & Piilani Hwy** | **D** | **45** | **F** | **113** |
| Piilani NB Left | F | 155 | F | * |
| Piilani NB Through | A | 10 | B | 13 |
| Piilani SB Through | D | 39 | D | 35 |
| Piilani SB Right | B | 15 | C | 25 |
| Piikea EB Left | F | 234 | F | * |
| Piikea EB Right | A | 0 | A | 1 |
| **W. Lipoa St & S. Kihei Rd** | **B** | **13** | **C** | **24** |
| S. Kihei NB Left | A | 8 | C | 26 |
| S. Kihei NB Through | B | 14 | B | 15 |
| S. Kihei NB Right | A | 9 | A | 8 |
| S. Kihei SB Left | A | 6 | C | 11 |
| S. Kihei SB Through-Right | A | 9 | B | 28 |
| W. Lipoa EB Left-Through | B | 20 | D | 36 |
| W. Lipoa EB Right | B | 19 | C | 33 |
| W. Lipoa WB Left-Through | C | 21 | D | 46 |
| W. Lipoa WB Right | B | 19 | C | 33 |
| **E. Lipoa St & Liloa Dr** | **B** | **13** | **A** | **10** |
| Liloa NB Left | B | 15 | B | 11 |
| Liloa NB Through | B | 16 | B | 11 |
| Liloa NB Right | B | 14 | B | 11 |
| Liloa SB Left | B | 15 | B | 11 |
| Liloa SB Through | B | 16 | B | 12 |
| Liloa SB Right | B | 14 | B | 11 |
| E. Lipoa EB Left-Through | B | 11 | A | 9 |
| E. Lipoa EB Right | B | 14 | B | 10 |
| E. Lipoa WB Left | A | 6 | A | 6 |
| E. Lipoa WB Through | A | 10 | A | 9 |
| E. Lipoa WB Right | A | 9 | A | 7 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 7 Year 2034 No Build Level of Service (Continued)

| Scenario 1 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **E. Lipoa St & Piilani Hwy** | **D** | **44** | **F** | **87** |
| Piilani NB Left | E | 75 | F | 120 |
| Piilani NB Through | C | 35 | E | 70 |
| Piilani NB Right | B | 18 | B | 19 |
| Piilani SB Left | E | 71 | F | 83 |
| Piilani SB Through | D | 53 | F | 115 |
| Piilani SB Right | C | 24 | C | 30 |
| E. Lipoa EB Left-Through | E | 65 | F | 93 |
| E. Lipoa EB Right | A | 0 | A | 0 |
| E. Lipoa WB Left-Through | F | 81 | F | 81 |
| E. Lipoa WB Right | A | 0 | A | 0 |
| **E. Welakahao Rd & S. Kihei Rd** | **B** | **11** | **C** | **23** |
| S. Kihei NB Left | A | 5 | B | 14 |
| S. Kihei NB Through-Right | B | 11 | C | 22 |
| S. Kihei SB Left | A | 6 | B | 15 |
| S. Kihei SB Through-Right | A | 8 | C | 21 |
| E. Welakahao EB Left-Through-Right | B | 19 | C | 31 |
| E. Welakahao WB Left-Through | C | 20 | D | 47 |
| E. Welakahao WB Right | B | 18 | C | 30 |
| **E. Welakahao Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani NB Left | C | 21 | C | 23 |
| E. Welakahao EB Left | F | * | F | * |
| **Old Welakahao Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani SB Left | B | 14 | C | 19 |
| Old Welakahao WB Left-Right | F | 57 | F | 79 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

The eastbound right turn at the intersection of Piilani Highway and East Waipuilani is projected to operate at LOS E during the AM peak hour and at LOS C during the PM peak hour.

The intersection of South Kihei Road and Piikea Avenue is projected to operate at LOS A overall during the AM peak and at LOS B during the PM peak hour. All movements are

projected to operate at LOS C or better during the AM peak hour and at LOS D or better during the PM peak hour.

The intersection of Liloa Drive and Piikea Avenue is a roundabout. All approaches are projected to operate at LOS A during both the AM and PM peak hours.

The intersection of Piilani Highway and Piikea Avenue is projected to operate at LOS D during the AM peak hour and LOS F during the PM peak hour. The northbound Piilani left turn to Piikea and the eastbound Piikea left turn to Piilani are projected to operate at LOS F during the AM and PM peak hours.

The intersection of South Kihei Road and Lipoa Street is projected to operate at LOS B during the AM peak hour and at LOS C during the PM peak hour. All movements are projected to operate at LOS B or better during the AM peak hour and at LOS D or better during the PM peak hour.

The intersection of Liloa Drive and Lipoa Street is projected to operate at LOS B during the AM peak hour and LOS A during the PM peak hour.

The intersection of Piilani Highway and Lipoa Street/Lipoa Parkway is projected to operate at LOS D during the AM peak hour and LOS F during the PM peak hour. During the AM peak hour, the north and southbound Piilani left turns are projected to operate at LOS E. The Piilani north and southbound through movements are projected to operate at LOS C and D respectively. The eastbound and westbound left/through movements are projected to operate at LOS E and F, respectively. During the PM peak hour, the north and southbound Piilani through movements are projected to operate at LOS E and F, respectively. Additional left turns and minor street movements are also projected to operate at LOS F.

The intersection of South Kihei Road and East Welakahao Road is projected to operate at LOS B during the AM and at LOS C during the PM peak hour. During the AM peak hour, all movements are projected to operate at LOS C or better. All movements are projected to operate at LOS D or better during the PM peak hour.

At the intersection of Piilani Highway and East Welakahao Road, the eastbound Welakahao left turn is projected to operate at LOS F during both peak hours.

At the intersection of Piilani Highway and Old Welakahao Road, the westbound approach is projected to operate at LOS F during both peak hours.

## B. SCENARIO 2 – BUILD

The Build scenario consists of the No Build scenario with Phases 1 and 2 of MRTP. The Build scenario adds MRTP development generated trips to the No Build scenario. The assumed roadway network is the same as in the No Build scenario. Building upon the residential, mixed-use, and employment land uses in Phase 1, Phase 2 is planned to consist of expansion of residential and employment land uses on either side of Lipoa Parkway as shown in Figure 2.

### 1. Future Roadways

The roadway network assumptions are the same as the No Build scenario.

### 2. Trip Generation

As with the Year 2024 scenario, the Institute of Transportation Engineers (ITE), Trip Generation, 8th edition was used to estimate the number of trips generated by the Maui R&T Park development based on land uses identified in the conceptual development plan shown in Figure 2.

The Year 2034 scenario consists of Phases 1 and 2. Building upon Phase 1, Phase 2 consists of the following:

- 1,014,800 SF of Employment
- 500 Residential DU broken down as follows:
    - 100 DU Mid-Rise
    - 300 DU Single Family
    - 100 DU Townhouse

Table 8 summarizes the trips generated by the sum of Phases 1 and 2. Similar to Phase 1, low, medium, and high internal capture rates were developed to represent the internal interactions between the different land uses when Phase 2 is added to Phase 1.

For the purpose of this analysis, the low internal capture that would result in highest external trips was used. The detailed discussion is included in Appendix D. Specifically,

- 220/1536 or 14% of residential trips interacted directly with the school;
- 68/1536 or 4% of residential trips interacted directly with the commercial

## Table 8 Phase 1 and 2 Trip Generation Summary

| | | | AM Peak Hour | | | PM Peak Hour | | |
|---|---|---|---|---|---|---|---|---|
| | | | In | Out | Total | In | Out | Total |
| OFFICE | 760 | 1,738,000 SF | 1,287 | 263 | 1,550 | 203 | 1,147 | 1,350 |
| | | *After Mode Reductions* | *1,223* | *250* | *1,473* | *193* | *1,090* | *1,283* |
| RETAIL | 814 | 100,000 SF | 45 | 28 | 73 | 115 | 146 | 261 |
| | | *After Mode Reductions* | *43* | *27* | *70* | *109* | *139* | *248* |
| RESIDENTIAL | 223 | 250 DU | 28 | 61 | 99 | 63 | 46 | 109 |
| | 210 | 750 DU | *134* | *401* | *535* | *406* | *238* | *644* |
| | 230 | 250 DU | *19* | *91* | *100* | *87* | *43* | *130* |
| | | Residential Total | *181* | *553* | *784* | *556* | *327* | *883* |
| | | *After Mode Reductions* | *172* | *525* | *697* | *528* | *311* | *839* |
| HOTEL | 310 | 150 Rooms | 41 | 27 | 68 | 47 | 42 | 89 |
| | | *After Mode Reductions* | *39* | *26* | *65* | *45* | *40* | *85* |
| INSTITUTION | 522 | 102,000 SF | 279 | 219 | 498 | 55 | 68 | 123 |
| | | *After Mode Reductions* | *265* | *208* | *473* | *52* | *65* | *117* |
| Subtotal Trips (Before Mode Reductions) | | | 1,833 | 1,090 | 2,923 | 976 | 1,730 | 2,706 |
| Subtotal Trips (After Mode Reductions) | | | 1,742 | 1,036 | 2,778 | 927 | 1,645 | 2,572 |
| *Residential Internal Capture Reduction* | | | *80* | *213* | *293* | *143* | *89* | *232* |
| *Retail Internal Capture Reduction* | | | *6* | *10* | *16* | *84* | *35* | *119* |
| *Office Internal Capture Reduction* | | | *100* | *40* | *140* | *42* | *135* | *177* |
| *Institution Internal Capture Reduction* | | | *133* | *52* | *185* | *26* | *33* | *59* |
| *Hotel Internal Capture Reduction* | | | *10* | *14* | *24* | *24* | *27* | *51* |
| Total Internal Capture Reductions | | | *329* | *329* | *658* | *319* | *319* | *638* |
| Total External Trips | | | 1,413 | 707 | 2,120 | 608 | 1,326 | 1,934 |

Trips generated expressed in vehicles per hour

- 244/2756 or 8% of employment trips interacted directly with the residential;
- 56/1318 or 2% of employment trips interacted directly with the business hotel;

### 3. Trip Assignment

The traffic generated by the proposed MRTP Development was directionally distributed and assigned to the future roadway network.

A summary of regional travel patterns within the Kihei area was created from the Maui travel demand model. MRTP traffic was assigned to the projected roadway network using this distribution. Internal traffic was distributed between the residential, hotel, school, employment, and retail commercial land uses. These distributions were applied to the trips generated.

### 4. Total Traffic

The traffic generated by the Maui R&T development was added to the projected background traffic to obtain the total peak hour traffic volumes shown in Figure 12.

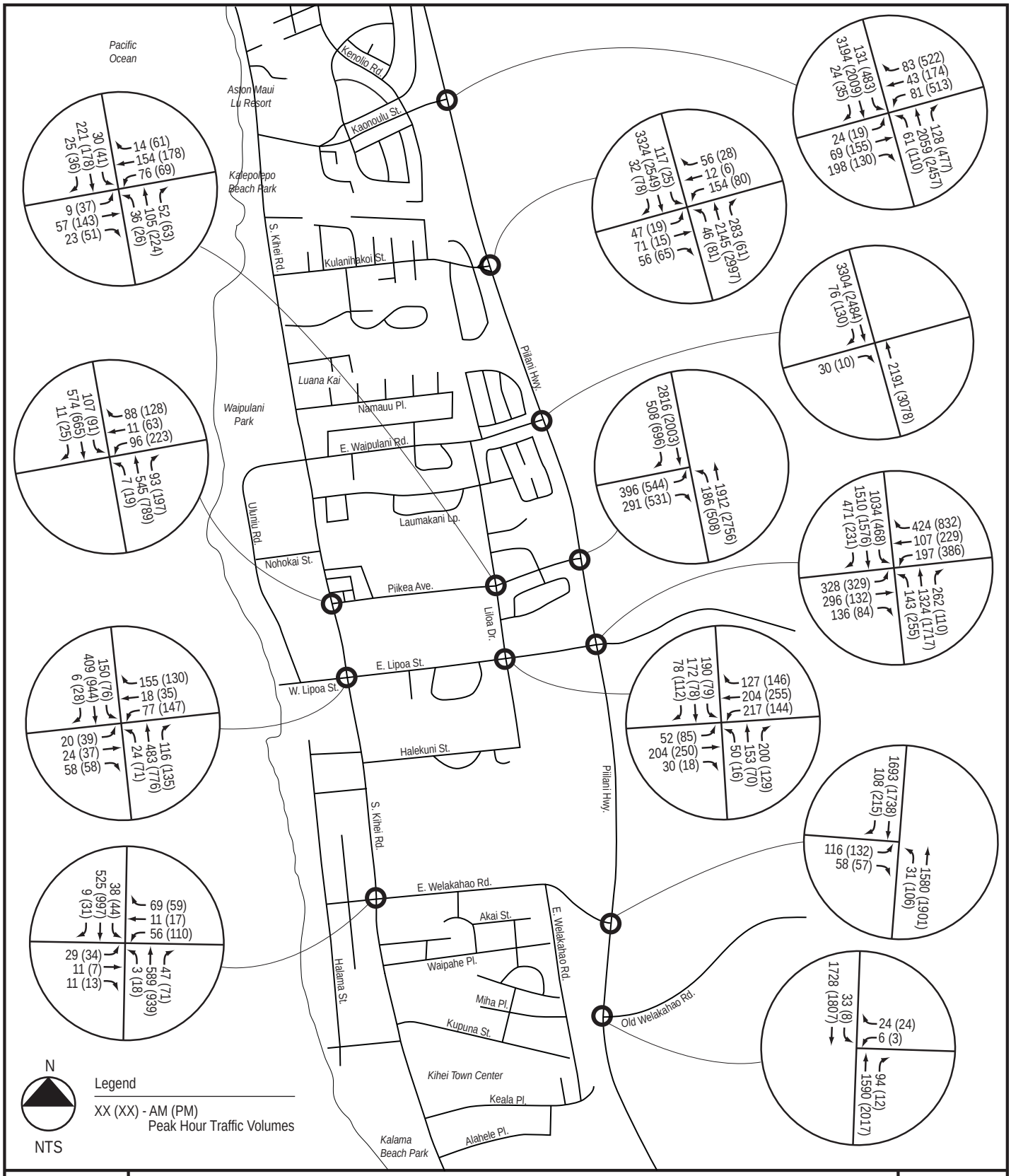
### 5. Scenario 2 Traffic Operations

Level of Service analysis was performed on the study area intersections. The results are shown in Table 9.

As shown in Table 9, Piilani Highway's intersection with Kaonoulu Street is projected to operate at LOS F overall during the AM and PM peak hours. During the AM peak hour, the southbound Piilani through movement is projected to operate at LOS F with a high delay. During PM peak hour, multiple movements, including the north and southbound Piilani through movements, are projected to operate at LOS F.

Piilani Highway's intersection with Kulanihakoi Street is projected to operate at LOS F overall during the AM and PM peak hours. During both peaks, multiple movements are projected to operate at LOS F, including the north and southbound Piilani Highway through movements.

The eastbound right turn at the intersection of Piilani Highway and East Waipuilani is projected to operate at LOS F during the AM peak hour and at LOS D during the PM peak hour.




# Year 2034 Build Traffic Volumes

Figure 12

Table 9 Year 2034 Scenario 2 Build Level of Service

| Scenario 2 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **Kaonoulu St & Piilani Hwy** | **F** | **186** | **F** | **179** |
| Piilani NB Left | E | 68 | F | 127 |
| Piilani NB Through | E | 74 | F | * |
| Piilani NB Right | B | 11 | C | 29 |
| Piilani SB Left | D | 52 | F | 139 |
| Piilani SB Through | F | 299 | F | 119 |
| Piilani SB Right | A | 9 | B | 16 |
| Kaonoulu EB Left | D | 52 | E | 56 |
| Kaonoulu EB Through | E | 58 | F | 84 |
| Kaonoulu EB Right | A | 0 | A | 0 |
| Kaonoulu WB Left | D | 53 | F | 142 |
| Kaonoulu WB Through | D | 53 | E | 65 |
| Kaonoulu WB Right | D | 51 | D | 53 |
| **Kulanihakoi St & Piilani Hwy** | **F** | **201** | **F** | **120** |
| Piilani NB Left | E | 67 | E | 71 |
| Piilani NB Through | F | 97 | F | 154 |
| Piilani NB Right | A | 0 | A | 0 |
| Piilani SB Left | E | 73 | E | 61 |
| Piilani SB Through | F | * | F | 65 |
| Piilani SB Right | A | 0 | A | 0 |
| Kulanihakoi EB Left-Through | D | 50 | D | 50 |
| Kulanihakoi EB Right | A | 0 | A | 0 |
| Kulanihakoi WB Left-Through | F | 81 | E | 60 |
| Kulanihakoi WB Right | A | 0 | A | 0 |
| **E. Waipuilani Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| E. Waipuilani EB Right | F | 96 | D | 33 |
| **S. Kihei Rd & Piikea Ave** | **A** | **10** | **B** | **20** |
| S. Kihei NB Left | A | 6 | A | 9 |
| S. Kihei NB Through | B | 11 | C | 25 |
| S. Kihei NB Right | A | 7 | B | 10 |
| S. Kihei SB Left | A | 5 | B | 17 |
| S. Kihei SB Through-Right | A | 6 | B | 10 |
| Piikea WB Left-Through | C | 23 | D | 36 |
| Piikea WB Right | B | 20 | C | 26 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 9 Year 2034 Scenario 2 Build Level of Service (Continued)

| Scenario 2 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **Piikea Ave & Liloa Dr** | **A** | **7** | **A** | **9** |
| Liloa NB Approach | A | 6 | A | 9 |
| Liloa SB Approach | A | 9 | A | 8 |
| Piikea EB Approach | A | 6 | A | 8 |
| Piikea WB Approach | A | 7 | B | 10 |
| **Piikea Ave & Piilani Hwy** | **F** | **126** | **F** | **132** |
| Piilani NB Left | F | 209 | F | * |
| Piilani NB Through | B | 14 | E | 59 |
| Piilani SB Through | F | 215 | E | 62 |
| Piilani SB Right | B | 16 | C | 24 |
| Piikea EB Left | F | 234 | F | * |
| Piikea EB Right | A | 0 | A | 1 |
| **W. Lipoa St & S. Kihei Rd** | **B** | **13** | **C** | **25** |
| S. Kihei NB Left | A | 8 | C | 27 |
| S. Kihei NB Through | B | 15 | B | 16 |
| S. Kihei NB Right | A | 10 | A | 8 |
| S. Kihei SB Left | A | 6 | B | 12 |
| S. Kihei SB Through-Right | A | 9 | C | 30 |
| W. Lipoa EB Left-Through | C | 22 | D | 36 |
| W. Lipoa EB Right | C | 21 | C | 33 |
| W. Lipoa WB Left-Through | C | 24 | D | 48 |
| W. Lipoa WB Right | C | 21 | C | 33 |
| **E. Lipoa St & Liloa Dr** | **B** | **15** | **B** | **11** |
| Liloa NB Left | B | 16 | B | 12 |
| Liloa NB Through | B | 17 | B | 13 |
| Liloa NB Right | B | 15 | B | 12 |
| Liloa SB Left | C | 21 | B | 14 |
| Liloa SB Through | B | 17 | B | 13 |
| Liloa SB Right | B | 15 | B | 12 |
| E. Lipoa EB Left-Through | B | 14 | B | 11 |
| E. Lipoa EB Right | B | 18 | B | 14 |
| E. Lipoa WB Left | A | 8 | A | 5 |
| E. Lipoa WB Through | B | 11 | A | 8 |
| E. Lipoa WB Right | B | 10 | A | 7 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 9 Year 2034 Scenario 2 Build Level of Service (Continued)

| Scenario 2 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **E. Lipoa St & Piilani Hwy** | **F** | ***** | **F** | **299** |
| Piilani NB Left | F | 107 | F | 139 |
| Piilani NB Through | E | 68 | F | 105 |
| Piilani NB Right | C | 30 | C | 25 |
| Piilani SB Left | F | * | F | * |
| Piilani SB Through | F | 114 | F | 142 |
| Piilani SB Right | C | 34 | C | 33 |
| E. Lipoa EB Left-Through | F | 339 | F | 231 |
| E. Lipoa EB Right | A | 0 | A | 0 |
| E. Lipoa WB Left-Through | F | * | F | * |
| E. Lipoa WB Right | A | 1 | A | 2 |
| **E. Welakahao Rd & S. Kihei Rd** | **B** | **11** | **C** | **24** |
| S. Kihei NB Left | A | 5 | B | 15 |
| S. Kihei NB Through-Right | B | 11 | C | 23 |
| S. Kihei SB Left | A | 6 | B | 16 |
| S. Kihei SB Through-Right | A | 8 | C | 22 |
| E. Welakahao EB Left-Through-Right | B | 19 | C | 31 |
| E. Welakahao WB Left-Through | C | 21 | D | 47 |
| E. Welakahao WB Right | B | 18 | C | 30 |
| **E. Welakahao Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani NB Left | D | 25 | E | 45 |
| E. Welakahao EB Left | F | * | F | * |
| **Old Welakahao Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani SB Left | C | 17 | C | 21 |
| Old Welakahao WB Left-Right | F | 137 | F | 142 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

The intersection of South Kihei Road and Piikea Avenue is projected to operate at LOS A overall during the AM peak hour and at LOS B during the PM peak hour. All movements are projected to operate at LOS C or better during the AM peak and at LOS D or better during the PM peak hour.

The intersection of Liloa Drive and Piikea Avenue is projected to operate at LOS A overall during both peak hours.

The intersection of Piilani Highway and Piikea Avenue is projected to operate at LOS F during the during both the AM and PM peak hours. The southbound Piilani through movement, the northbound Piilani left turn movement, and the eastbound Piikea left turn movement all are projected to operate at LOS F during the AM peak hour. Both Piilani through movements are projected to operate at LOS E during the PM peak hour.

The intersection of South Kihei Road and Lipoa Street is projected to operate at LOS B during the AM peak hour and at LOS C during the PM peak hour. All movements are projected to operate at LOS C or better during the AM peak hour and at LOS D or better during the PM peak hour.

The intersection of Liloa Drive and Lipoa Street is projected to operate at LOS B during both peak hours. All movements are projected to operate at LOS C or better during the AM peak hour. All movements are projected to operate at LOS B or better during the PM peak hour.

With no project-related improvements, the intersection of Piilani Highway and Lipoa Street/Lipoa Parkway is projected to operate at LOS F during both peak hours with a high overall delay. Most critical movements on Piilani Highway and Lipoa Parkway are projected to operate at LOS F with a high delay.

The intersection of South Kihei Road and East Welakahao Road is projected to operate at LOS B during the AM peak hour and at LOS C during the PM peak hour. During the AM peak hour, all movements are projected to operate at LOS C or better. All movements are projected to operate at LOS D or better during the PM peak hour.

At the intersection of Piilani Highway and East Welakahao Road, the eastbound Welakahao left turn is projected to operate at LOS F during both peak hours.

At the intersection of Piilani Highway and Old Welakahao Road, the westbound Welakahao left turn is projected to operate at LOS F during both peak hours.

## C. SCENARIO 3 – BUILD WITH MRTP ROADWAY IMPROVEMENTS

This scenario represents the Build scenario with additional transportation improvements committed by MRTP.

### 1. Future Roadways

The roadway network assumptions are nearly identical to Scenario 2. Additional improvements assumed to be the responsibility of MRTP are included. These are:

1. Piilani Highway/Old Welakahao Road
    a. Construct 2-lane Old Welakahao Road as MRTP's direct access to Piilani Highway;
    b. Signalize the intersection and provide a leading protected left turn phase for the southbound Piilani Highway left turn into Old Welakahao Road;
    c. Provide southbound left turning lane from Piilani Highway to Old Welakahao Road and westbound left turning lane from Old Welakahao Road to Piilani Highway;
    d. Provide acceleration and deceleration lanes to and from Piilani Highway.

### 2. Trip Generation

The trip generation for Scenario 3 is shown in Table 8.

### 3. Trip Assignment

The traffic generated by the proposed MRTP Development was directionally distributed and assigned to the future roadway network.

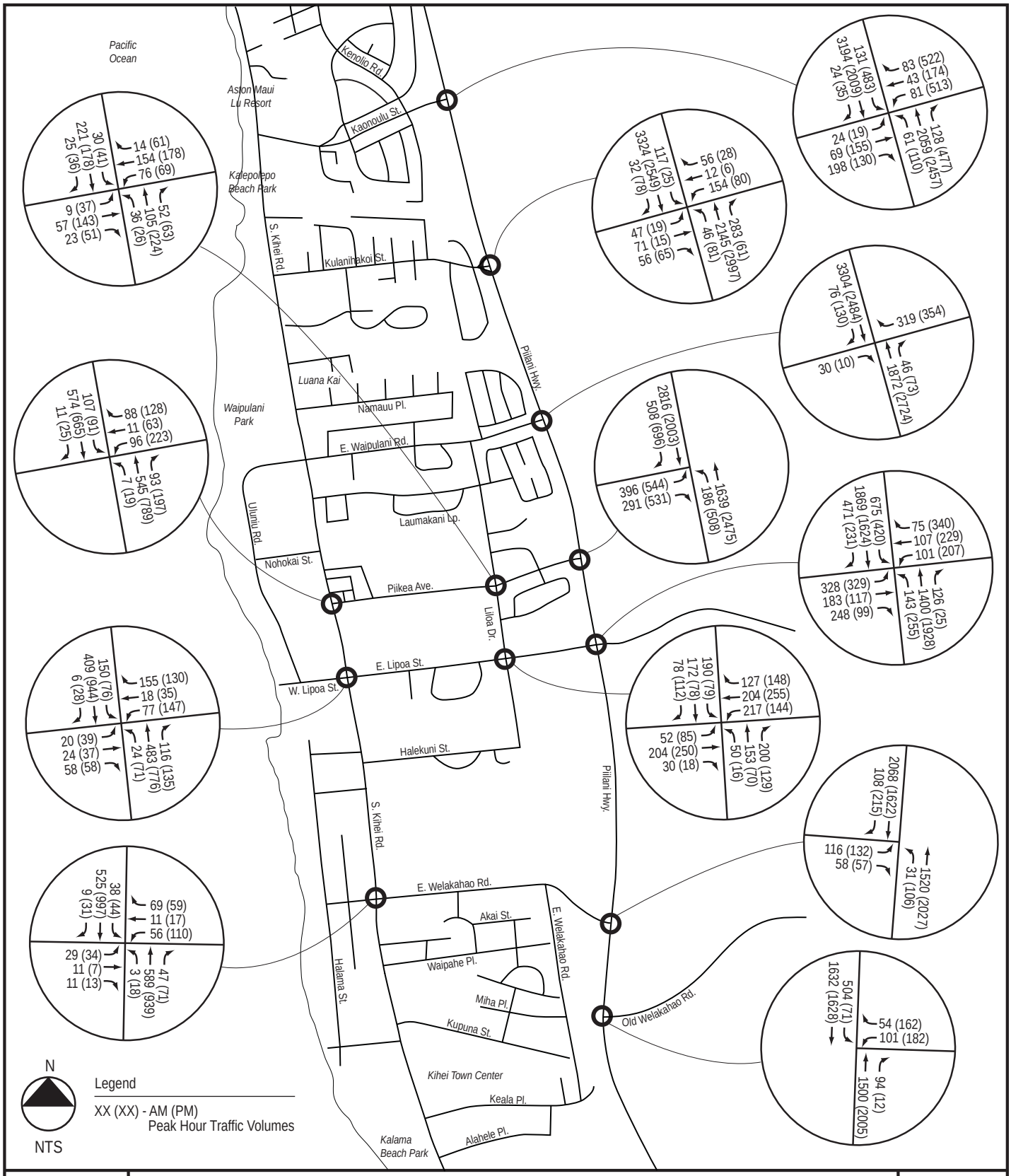
### 4. Total Traffic

The traffic generated by the MRTP development was added to the projected background traffic to obtain the total peak hour traffic volumes shown in Figure 13.

### 5. Scenario 3 Traffic Operations

Level of Service analysis was performed on the study area intersections. These results are shown in Table 10.

As shown in Table 10 the intersection of Piilani Highway and Kaonoulu Street is projected to operate at LOS F overall during both the AM and PM peak hours. The southbound Piilani through movement is projected to operate at LOS F during both peaks. During the PM peak hour, multiple movements are projected to operate at LOS F, including the north and southbound Piilani through movements.




# Year 2034 Scenario 3 Build Traffic Volumes With MRTP Roadway Improvements

Figure 13

Table 10 Year 2034 Scenario 3 Build With MRTP Roadway Improvements

Level of Service

| Scenario 3 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **Kaonoulu St & Piilani Hwy** | **F** | **186** | **F** | **184** |
| Piilani NB Left | E | 68 | F | 164 |
| Piilani NB Through | E | 74 | F | * |
| Piilani NB Right | B | 11 | C | 30 |
| Piilani SB Left | D | 52 | F | 139 |
| Piilani SB Through | F | 299 | F | 119 |
| Piilani SB Right | A | 9 | B | 16 |
| Kaonoulu EB Left | D | 52 | E | 56 |
| Kaonoulu EB Through | E | 58 | F | 84 |
| Kaonoulu EB Right | A | 0 | A | 0 |
| Kaonoulu WB Left | D | 53 | F | 142 |
| Kaonoulu WB Through | D | 53 | E | 65 |
| Kaonoulu WB Right | D | 51 | D | 54 |
| **Kulanihakoi St & Piilani Hwy** | **F** | **201** | **F** | **120** |
| Piilani NB Left | E | 67 | E | 71 |
| Piilani NB Through | F | 97 | F | 154 |
| Piilani NB Right | A | 0 | A | 0 |
| Piilani SB Left | E | 73 | E | 61 |
| Piilani SB Through | F | * | F | 95 |
| Piilani SB Right | A | 0 | A | 0 |
| Kulanihakoi EB Left-Through | D | 50 | D | 50 |
| Kulanihakoi EB Right | A | 0 | A | 0 |
| Kulanihakoi WB Left-Through | F | 81 | E | 60 |
| Kulanihakoi WB Right | A | 0 | A | 0 |
| **E. Waipuilani Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| E. Waipuilani EB Right | A | 2 | A | 1 |
| E. Waipuilani WB Right | A | 2 | A | 3 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 10 Year 2034 Scenario 3 Build With MRTP Roadway Improvements Level of Service (Continued)

| Scenario 3 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **S. Kihei Rd & Piikea Ave** | **A** | **10** | **B** | **20** |
| S. Kihei NB Left | A | 6 | A | 9 |
| S. Kihei NB Through | B | 11 | C | 25 |
| S. Kihei NB Right | A | 7 | B | 10 |
| S. Kihei SB Left | A | 5 | B | 17 |
| S. Kihei SB Through-Right | A | 6 | B | 10 |
| Piikea WB Left-Through | C | 23 | D | 36 |
| Piikea WB Right | B | 20 | C | 26 |
| **Piikea Ave & Liloa Dr** | **A** | **7** | **A** | **9** |
| Liloa NB Approach | A | 6 | A | 9 |
| Liloa SB Approach | A | 9 | A | 8 |
| Piikea EB Approach | A | 6 | A | 8 |
| Piikea WB Approach | A | 7 | B | 10 |
| **Piikea Ave & Piilani Hwy** | **F** | **125** | **F** | **102** |
| Piilani NB Left | F | 93 | F | 135 |
| Piilani NB Through | A | 9 | D | 35 |
| Piilani SB Through | F | 235 | F | 217 |
| Piilani SB Right | B | 17 | D | 49 |
| Piikea EB Left | E | 68 | F | 117 |
| Piikea EB Right | A | 0 | A | 1 |
| **W. Lipoa St & S. Kihei Rd** | **B** | **13** | **C** | **25** |
| S. Kihei NB Left | A | 8 | C | 27 |
| S. Kihei NB Through | B | 15 | B | 16 |
| S. Kihei NB Right | A | 10 | A | 8 |
| S. Kihei SB Left | A | 6 | B | 12 |
| S. Kihei SB Through-Right | A | 9 | C | 30 |
| W. Lipoa EB Left-Through | C | 22 | D | 36 |
| W. Lipoa EB Right | C | 21 | C | 33 |
| W. Lipoa WB Left-Through | C | 24 | D | 48 |
| W. Lipoa WB Right | C | 21 | C | 33 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 10 Year 2034 Scenario 3 Build With MRTP Roadway Improvements Level of Service (Continued)

| Scenario 3 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **E. Lipoa St & Liloa Dr** | **B** | **15** | **B** | **11** |
| Liloa NB Left | B | 16 | B | 12 |
| Liloa NB Through | B | 17 | B | 13 |
| Liloa NB Right | B | 15 | B | 12 |
| Liloa SB Left | C | 21 | B | 14 |
| Liloa SB Through | B | 17 | B | 13 |
| Liloa SB Right | B | 15 | B | 12 |
| E. Lipoa EB Left | B | 14 | B | 11 |
| E. Lipoa EB Through-Right | B | 18 | B | 14 |
| E. Lipoa WB Left | A | 8 | A | 5 |
| E. Lipoa WB Through | B | 11 | A | 8 |
| E. Lipoa WB Right | B | 10 | A | 7 |
| **E. Lipoa St & Piilani Hwy** | **F** | **121** | **F** | **219** |
| Piilani NB Left | F | 89 | F | 95 |
| Piilani NB Through | F | 134 | F | * |
| Piilani NB Right | C | 23 | B | 17 |
| Piilani SB Left | F | 143 | F | 184 |
| Piilani SB Through | F | 175 | F | * |
| Piilani SB Right | B | 13 | B | 18 |
| E. Lipoa EB Left | F | 108 | E | 77 |
| E. Lipoa EB Through | D | 51 | D | 48 |
| E. Lipoa EB Right | A | 0 | A | 0 |
| E. Lipoa WB Left | F | 83 | F | 90 |
| E. Lipoa WB Through | E | 71 | F | 111 |
| E. Lipoa WB Right | A | 0 | A | 0 |
| **E. Welakahao Rd & S. Kihei Rd** | **B** | **11** | **C** | **24** |
| S. Kihei NB Left | A | 5 | B | 15 |
| S. Kihei NB Through-Right | B | 11 | C | 23 |
| S. Kihei SB Left | A | 6 | B | 16 |
| S. Kihei SB Through-Right | A | 8 | C | 22 |
| E. Welakahao EB Left-Through-Right | B | 19 | C | 31 |
| E. Welakahao WB Left-Through | C | 21 | D | 47 |
| E. Welakahao WB Right | B | 18 | C | 30 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 10 Year 2034 Scenario 3 Build With MRTP Roadway Improvements Level of Service (Continued)

| Scenario 3 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **E. Welakahao Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani NB Left | E | 41 | E | 35 |
| E. Welakahao EB Left | F | * | F | * |
| **Old Welakahao Rd & Piilani Hwy** | **D** | **38** | **B** | **20** |
| Piilani NB Through | D | 37 | C | 23 |
| Piilani NB Right | B | 17 | A | 7 |
| Piilani SB Left | F | 148 | F | 89 |
| Piilani SB Through | A | 5 | A | 7 |
| Old Welakahao WB Left | E | 67 | F | 83 |
| Old Welakahao WB Right | A | 0 | A | 0 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Piilani Highway's intersection with Kulanihakoi Street is projected to operate at LOS F overall during the AM and PM peak hours. During both peaks, multiple movements are projected to operate at LOS F.

The eastbound right turn at the intersection of Piilani Highway and East Waipuilani is projected to operate at LOS A during the AM and PM peak hours. The westbound right turn out of MRTP is also projected to operate at LOS A during the AM and PM peak hours.

The intersection of South Kihei Road and Piikea Avenue is projected to operate at LOS A during the AM peak hour and at LOS B during the PM peak hour. All movements are projected to operate at LOS C or better during the AM peak hour and at LOS D or better during the PM peak hour.

All approaches at the intersection of Liloa Drive and Piikea Avenue are projected to operate at LOS A or better during the AM peak hour and at LOS B or better during the PM peak hour.

The intersection of Piilani Highway and Piikea Avenue is projected to operate at LOS F during the AM and PM peak hours. During both peak hours, the northbound Piilani left turn to Piikea is projected to operate at LOS F. With the project-related improvements, the

eastbound Piikea left turn to Piilani is projected to operate at LOS F during the PM peak hour. The Piilani southbound through movement is projected to operate at LOS F during both peak hours.

The intersection of South Kihei Road and Lipoa Street is projected to operate at LOS B during the AM peak hour and at LOS C during the PM peak hour. All movements are projected to operate at LOS C or better during the AM peak hour and at LOS D or better during the PM peak hour.

The intersection of Liloa Drive and Lipoa Street is projected to operate at LOS B during the both the AM and PM peak hours. All movements are projected to operate at LOS C or better during the AM peak hour and at LOS B or better during the PM peak hour.

With project-related improvements, the intersection of Piilani Highway and Lipoa Street/Lipoa Parkway is projected to operate at LOS F during both peak hours. During both peak hours, the north and southbound Piilani left turn and through movements are projected to operate at LOS F. The Lipoa approaches also are projected to have LOS F turning movements.

The intersection of South Kihei Road and East Welakahao Road is projected to operate at LOS B during both the AM peak hour and at LOS C during the PM peak hour. During the AM peak hour, all movements are projected to operate at LOS C or better. All movements are projected to operate at LOS D or better during the PM peak hour.

At the intersection of Piilani Highway and East Welakahao Road, the eastbound Welakahao left turn is projected to operate at LOS F during both peak hours.

As part of the project-related improvements, the intersection of Piilani Highway and Old Welakahao Road is planned to be signalized and the Old Welakahao approach widened. The intersection is projected to operate at LOS D overall during the AM peak hour and at LOS B during the PM peak hour. The southbound Piilani left turn is projected to operate at LOS F during both peak hours. The westbound Old Welakahao left is projected to operate at LOS E during the AM peak and at LOS F during the PM peak hour.

## D. SCENARIO 4 – BUILD SCENARIO WITH MRTP AND REGIONAL ROADWAY IMPROVEMENTS

The Build with MRTP and Regional Roadway Improvements scenario represents the Build scenario with additional transportation improvements committed by MRTP as well as other regional roadway improvements. In this scenario, it is assumed that the project-related improvements described in Scenario 3 are in place along with the following additional regional roadway improvements:

- Liloa Drive extension as a two-lane roadway between Kaonoulu Street and Kanani Road is completed.
- Kihei Upcountry Road as a four-lane roadway connecting Upcountry Maui to Kihei at Kaonoulu Street;
- Mauka Collector as a two-lane roadway between Mokulele Highway and Piilani Highway at a point somewhere south of MRTP and an additional two-lane in-tract roadway

### 1. Future Regional Roadways

In addition to roadways committed by MRTP, the Liloa Drive extension, are assumed to be in place as discussed in Phase 1

In addition, it is assumed that Kihei Upcountry Highway would be constructed as a four-lane roadway. This road would provide a direct connection between the Upcountry area to Piilani Highway in Kihei at Kaonoulu Street.

Furthermore, the mauka collector roadway, providing direct access to Mokulele Highway, is also assumed to be constructed. The initial configuration would be a two-lane facility connecting Mokulele Highway to Piilani Highway at a point south of MRTP. An additional two-lane in-tract roadway can be constructed later when warranted. The mauka collector is not included in the current STIP, as it is not anticipated to be necessary for many years. However, the community and county government have carefully planned for and considered the eventual need for the road.

Maui County strongly supports an interconnected Kihei Mauka transportation network as shown in an August 13, 2012 letter included in Appendix F. A North-South roadway mauka of Piilani, to be constructed as growth in the region warrants, is also identified as being supported in the 1998 Kihei-Makena Community Plan.

The Maui Island Plan, December 2012 also contemplates a future north south roadway in several sections. The directed growth chapter description of the Maui Research and Technology Park, states "the build-out of MRTP should be coordinated with the development of the neighboring Kihei Mauka planned growth area to ensure efficient intra- and inter-regional transportation connectivity for both motorized and non-motorized transportation." Similar directions are included in the project descriptions of Kihei Mauka and the North Kihei residential planned growth areas to the north of MRTP. MRTP has initiated discussions with other landowners about providing a continuous in-tract mauka collector roadway as directed by the County general plan.

The mauka collector would diverge from Piilani Highway at a point south of the MRTP development. It would proceed through MRTP and continue north, eventually providing direct access to Mokulele Highway. For the purpose of this analysis, the mauka collector was analyzed as a two-lane facility with an additional two-lane roadway in-tract. It was assumed that the mauka collector would not be used exclusively by the MRTP development, but would divert regional background traffic from Piilani Highway.

### 2. Trip Generation

The trip generation for Scenario 4 is shown in Table 8.

### 3. Trip Assignment

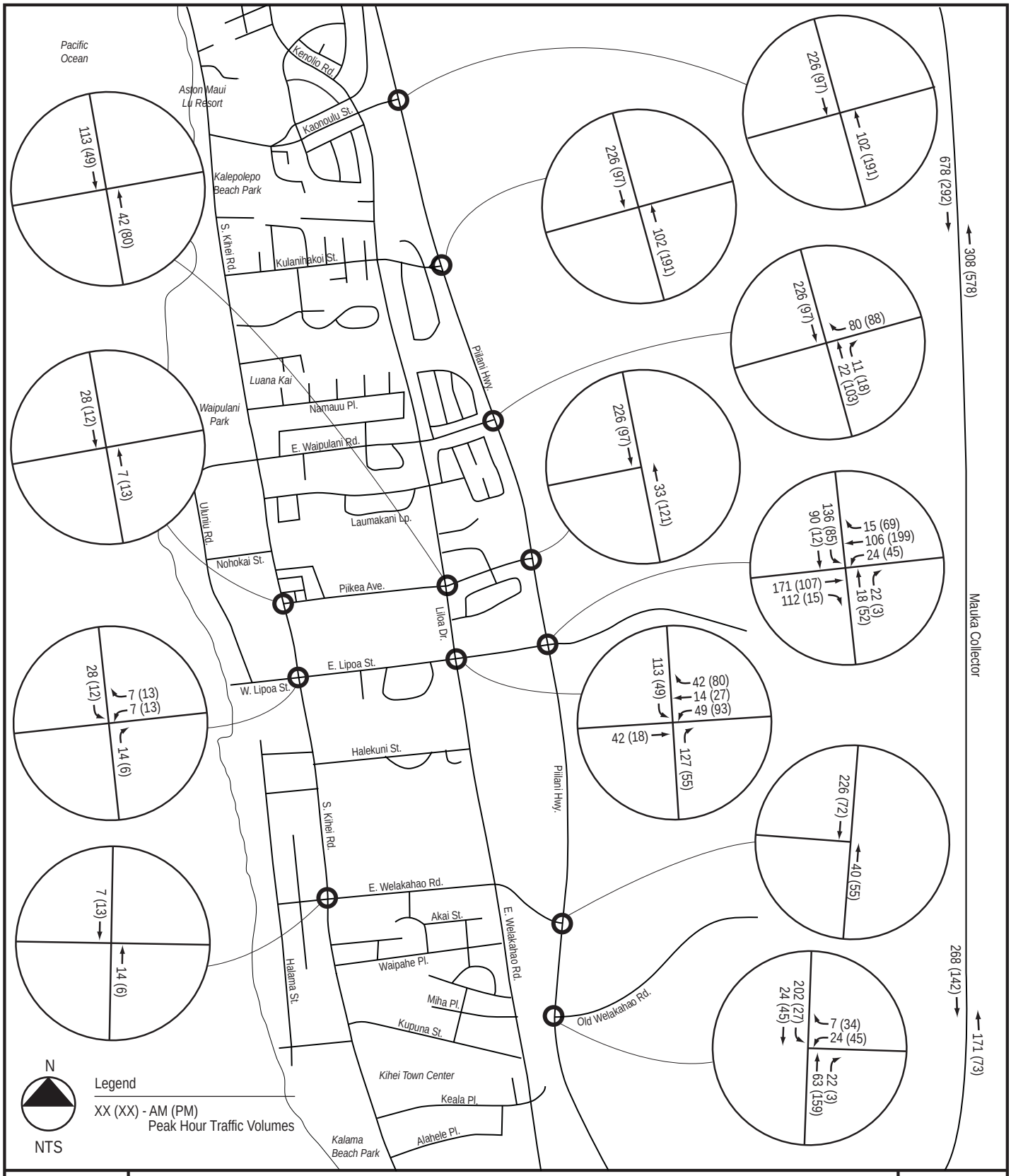
The traffic generated by the proposed MRTP Development was directionally distributed and assigned to the future roadway network and are shown in Figure 14.

### 4. Total Traffic

The traffic generated by the MRTP development was added to the projected background traffic to obtain the total peak hour traffic volumes shown in Figure 15. The recommended lane configurations for Scenario 4 are shown in Figure 16.

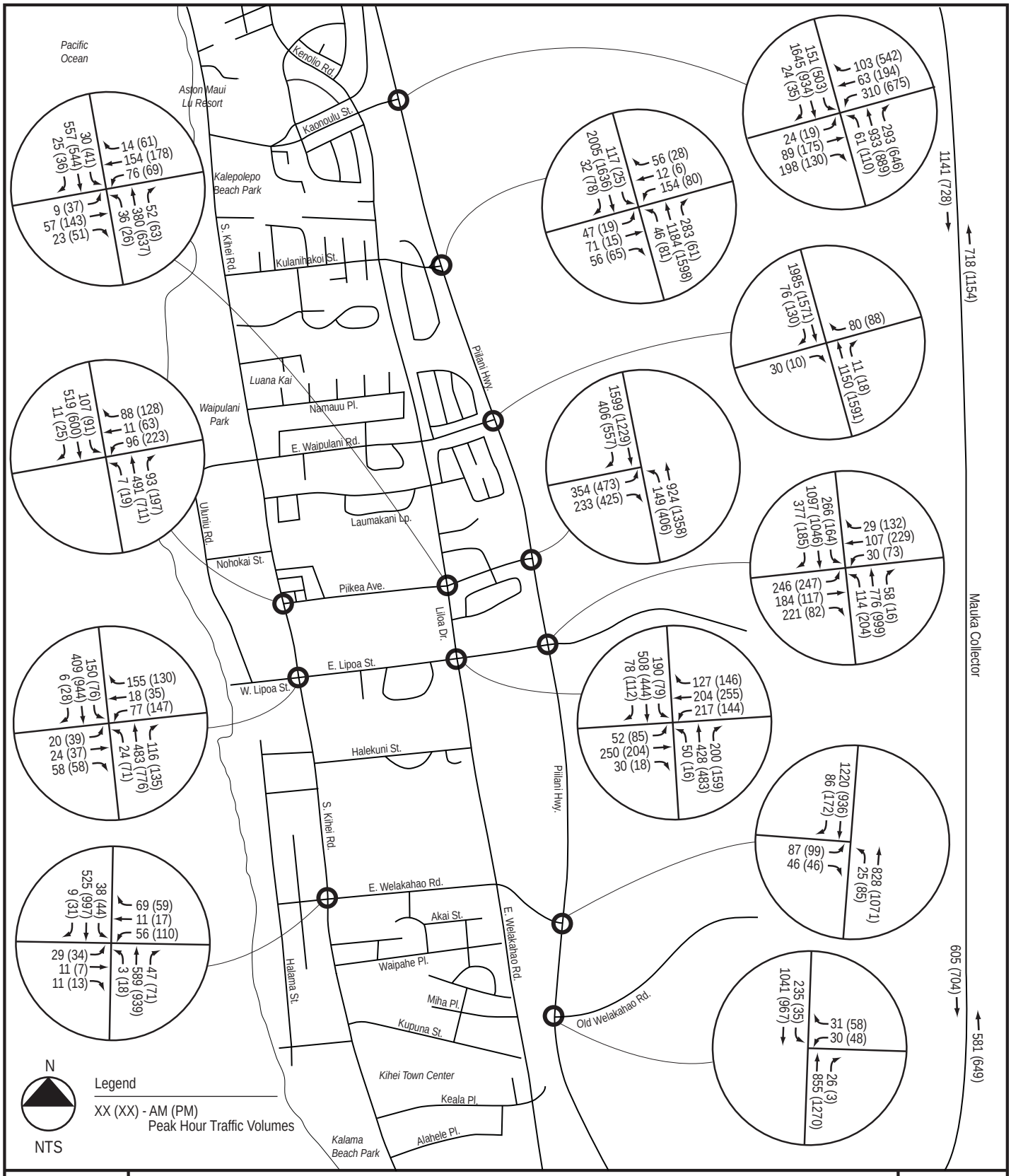
### 5. Scenario 4 Traffic Operations With Project

Level of Service analysis was performed on the study area intersections. These results are shown in Table 11.



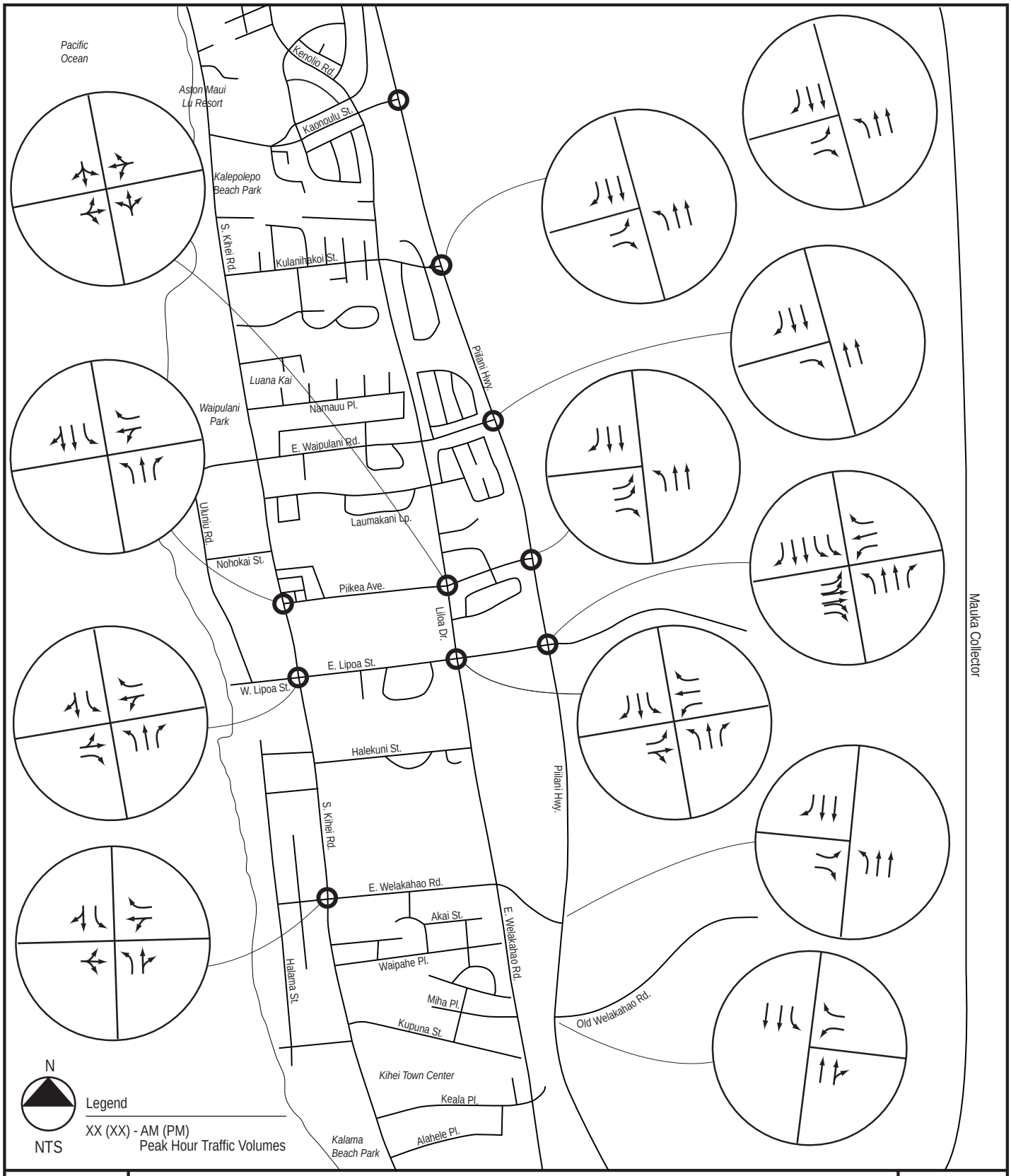

# Phase 2 Project-Generated Traffic Volumes

Figure 14




# Year 2034 Scenario 4 Build Traffic Volumes With MRTP and Regional Roadway Improvements

Figure 15




# Year 2034 Lane Configurations

Figure 16

Table 11 Year 2034 Scenario 4 Build With MRTP and Regional Roadway Improvements Level of Service

| Scenario 4 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **Kaonoulu St & Piilani Hwy** | **C** | **33** | **F** | **115** |
| Piilani NB Left | F | 81 | F | 121 |
| Piilani NB Through | C | 22 | C | 34 |
| Piilani NB Right | B | 18 | C | 34 |
| Piilani SB Left | E | 58 | F | 535 |
| Piilani SB Through | C | 35 | C | 25 |
| Piilani SB Right | B | 13 | B | 18 |
| Kaonoulu EB Left | D | 54 | D | 50 |
| Kaonoulu EB Through | E | 59 | E | 77 |
| Kaonoulu EB Right | A | 0 | A | 0 |
| Kaonoulu WB Left | E | 59 | F | 220 |
| Kaonoulu WB Through | D | 50 | E | 59 |
| Kaonoulu WB Right | D | 48 | D | 47 |
| **Kulanihakoi St & Piilani Hwy** | **C** | **33** | **B** | **15** |
| Piilani NB Left | E | 66 | E | 57 |
| Piilani NB Through | B | 19 | B | 12 |
| Piilani NB Right | A | 0 | A | 0 |
| Piilani SB Left | E | 71 | D | 55 |
| Piilani SB Through | D | 41 | B | 16 |
| Piilani SB Right | A | 0 | A | 0 |
| Kulanihakoi EB Left-Through | D | 48 | D | 44 |
| Kulanihakoi EB Right | A | 0 | A | 0 |
| Kulanihakoi WB Left-Through | E | 79 | D | 51 |
| Kulanihakoi WB Right | A | 0 | A | 0 |
| **E. Waipuilani Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| E. Waipuilani EB Right | A | 2 | A | 1 |
| E. Waipuilani WB Right | A | 1 | A | 1 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 11 Year 2034 Scenario 4 Build With MRTP and Regional Roadway Improvements Level of Service (Continued)

| Scenario 4 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **S. Kihei Rd & Piikea Ave** | **A** | **10** | **B** | **18** |
| S. Kihei NB Left | A | 7 | A | 9 |
| S. Kihei NB Through | B | 11 | C | 21 |
| S. Kihei NB Right | A | 7 | B | 10 |
| S. Kihei SB Left | A | 5 | B | 13 |
| S. Kihei SB Through-Right | A | 6 | B | 10 |
| Piikea WB Left-Through | C | 22 | C | 33 |
| Piikea WB Right | B | 19 | C | 24 |
| **Piikea Ave & Liloa Dr** | **C** | **20** | **D** | **28** |
| Liloa NB Approach | A | 10 | D | 34 |
| Liloa SB Approach | D | 32 | D | 29 |
| Piikea EB Approach | A | 10 | C | 15 |
| Piikea WB Approach | B | 10 | C | 23 |
| **Piikea Ave & Piilani Hwy** | **C** | **22** | **D** | **35** |
| Piilani NB Left | E | 66 | E | 78 |
| Piilani NB Through | A | 6 | A | 9 |
| Piilani SB Through | C | 26 | D | 46 |
| Piilani SB Right | B | 14 | C | 33 |
| Piikea EB Left | E | 57 | F | 80 |
| Piikea EB Right | A | 0 | A | 1 |
| **W. Lipoa St & S. Kihei Rd** | **B** | **13** | **C** | **25** |
| S. Kihei NB Left | A | 8 | C | 27 |
| S. Kihei NB Through | B | 15 | B | 16 |
| S. Kihei NB Right | A | 10 | A | 8 |
| S. Kihei SB Left | A | 6 | B | 12 |
| S. Kihei SB Through-Right | A | 9 | C | 30 |
| W. Lipoa EB Left-Through | C | 22 | D | 36 |
| W. Lipoa EB Right | C | 21 | C | 33 |
| W. Lipoa WB Left-Through | C | 24 | D | 48 |
| W. Lipoa WB Right | C | 21 | C | 33 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 11 Year 2034 Scenario 4 Build With MRTP and Regional Roadway Improvements Level of Service (Continued)

| Scenario 4 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **E. Lipoa St & Liloa Dr** | **C** | **21** | **C** | **22** |
| Liloa NB Left | B | 16 | B | 12 |
| Liloa NB Through | B | 19 | D | 39 |
| Liloa NB Right | B | 15 | B | 12 |
| Liloa SB Left | D | 38 | B | 18 |
| Liloa SB Through | C | 22 | C | 28 |
| Liloa SB Right | B | 14 | B | 12 |
| E. Lipoa EB Left | C | 23 | B | 15 |
| E. Lipoa EB Through-Right | C | 29 | B | 18 |
| E. Lipoa WB Left | B | 15 | A | 8 |
| E. Lipoa WB Through | B | 18 | B | 11 |
| E. Lipoa WB Right | B | 16 | B | 10 |
| **E. Lipoa St & Piilani Hwy** | **C** | **35** | **D** | **48** |
| Piilani NB Left | E | 60 | E | 79 |
| Piilani NB Through | C | 32 | D | 37 |
| Piilani NB Right | C | 20 | B | 18 |
| Piilani SB Left | D | 53 | E | 64 |
| Piilani SB Through | D | 38 | D | 54 |
| Piilani SB Right | B | 13 | B | 17 |
| E. Lipoa EB Left | E | 59 | E | 80 |
| E. Lipoa EB Through | D | 38 | D | 41 |
| E. Lipoa EB Right | A | 0 | A | 0 |
| E. Lipoa WB Left | E | 58 | E | 65 |
| E. Lipoa WB Through | D | 53 | E | 67 |
| E. Lipoa WB Right | A | 0 | A | 0 |
| **E. Welakahao Rd & S. Kihei Rd** | **B** | **11** | **C** | **24** |
| S. Kihei NB Left | A | 5 | B | 15 |
| S. Kihei NB Through-Right | B | 11 | C | 24 |
| S. Kihei SB Left | A | 6 | B | 16 |
| S. Kihei SB Through-Right | A | 8 | C | 22 |
| E. Welakahao EB Left-Through-Right | B | 20 | B | 31 |
| E. Welakahao WB Left-Through | C | 21 | D | 47 |
| E. Welakahao WB Right | B | 19 | B | 30 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

Table 11 Year 2034 Scenario 4 Build With MRTP and Regional Roadway Improvements Level of Service (Continued)

| Scenario 4 | AM | | PM | |
|---|---|---|---|---|
| | LOS | Delay | LOS | Delay |
| **E. Welakahao Rd & Piilani Hwy** | **Unsignalized** | | **Unsignalized** | |
| Piilani NB Left | C | 15 | B | 13 |
| E. Welakahao EB Left | E | 36 | E | 44 |
| **Old Welakahao Rd & Piilani Hwy** | **B** | **10** | **A** | **7** |
| Piilani NB Through | B | 15 | A | 9 |
| Piilani NB Right | B | 11 | A | 5 |
| Piilani SB Left | C | 24 | C | 35 |
| Piilani SB Through | A | 3 | A | 3 |
| Old Welakahao WB Left | C | 31 | C | 32 |
| Old Welakahao WB Right | A | 0 | A | 0 |

Delay expressed in seconds per vehicle.
* Delay greater than 300 seconds per vehicle.

As shown in Table 11 the intersection of Piilani Highway and Kaonoulu Street is projected to operate at LOS C overall during the AM peak hour. The Piilani through movements are projected to operate at LOS C. Left turns and certain minor street movements are projected to operate at LOS E or F. During the PM peak hour, the intersection is projected to operate at LOS F overall. Multiple movements are projected to operate at LOS F. The north and southbound Piilani through movements are projected to operate at LOS C.

Piilani Highway's intersection with Kulanihakoi Street is projected to operate at LOS C overall during the AM peak hour and at LOS B during the PM peak hour. During both peaks, left turns and minor street movements are projected to operate at LOS E, but Piilani Highway through movements are projected to operate at LOS D or better.

The eastbound right turn at the intersection of Piilani Highway and East Waipuilani is projected to operate at LOS A during the AM and PM peak hours. The westbound right turn out of MRTP is also projected to operate at LOS A during the AM and PM peak hours.

The intersection of South Kihei Road and Piikea Avenue is projected to operate at LOS A during the AM peak hour and at LOS B during the PM peak hour. All movements are projected to operate at LOS C or better during the AM and PM peak hours.

All approaches at the intersection of Liloa Drive and Piikea Avenue are projected to operate at LOS D or better during both peak hours.

The intersection of Piilani Highway and Piikea Avenue is projected to operate at LOS C during the AM peak hour and at LOS D during the PM peak hour. The northbound Piilani left turn to Piikea is projected to operate at LOS E during the AM and PM peak hours. With the project-related improvements, the eastbound Piikea left turn to Piilani is projected to operate at LOS E during the AM peak hour and at LOS F during the PM peak hour. The Piilani southbound through movement is projected to operate at LOS D or better during both peak hours.

The intersection of South Kihei Road and Lipoa Street is projected to operate at LOS B during the AM peak hour and at LOS C during the PM peak hour. All movements are projected to operate at LOS C or better during the AM peak hour and at LOS D or better during the PM peak hour.

The intersection of Liloa Drive and Lipoa Street is projected to operate at LOS C during the both the AM and PM peak hours. All movements are projected to operate at LOS D or better during both peak hours.

With project-related improvements, the intersection of Piilani Highway and Lipoa Street/Lipoa Parkway is projected to operate at LOS C during the AM peak hour and at LOS D during the PM peak hour. The intersection benefits from project-related traffic being diverted to the mauka collector. All Piilani through movements are projected to operate at LOS D or better and all turning movements or minor street movements are projected to operate at LOS E or better.

The intersection of South Kihei Road and East Welakahao Road is projected to operate at LOS B during the AM peak hour and at LOS C during the PM peak hour. During the AM peak hour, all movements are projected to operate at LOS B or better. All movements are projected to operate at LOS D or better during the PM peak hour.

At the intersection of Piilani Highway and East Welakahao Road, the eastbound Welakahao left turn is projected to operate at LOS E during both peak hours.

The intersection of Piilani Highway and Old Welakahao Road is projected to operate at LOS B during the AM peak hour and at LOS A during the PM peak hour.

## E. SUMMARY OF RESULTS

The following issues were identified within the project study area:

- The intersection of Piilani Highway and Kaonoulu Street is projected to operate at LOS F during PM peak hour with or without MRTP. The construction of the Mauka Collector is necessary to relieve congestion on Piilani Highway. The addition of the Mauka Collector is projected to improve the overall intersection LOS to an acceptable level on Piilani Highway except for at the intersection with Kaonoulu Street during PM peak hour.
- The addition of MRTP project-related improvements at the intersection of Piilani Highway and Old Welakahao Road results in better LOS. Specifically,
    - At the intersection of Piilani Highway and Piikea Avenue, the overall LOS is projected to improve from F to C in the AM peak hour and from F to D in the PM peak hour.
    - At the intersection of Piilani Highway and Lipoa Parkway, the overall LOS is projected to improve from F to C in the AM peak hour and from F to D in the PM peak hour.

# V. CONCLUSIONS & RECOMMENDATIONS

## A. PHASE 1 IN YEAR 2024

Phase 1 will be located directly off of Lipoa Parkway and will consist of residential, mixed-use commercial, civic, and employment core land uses. Phase 1 will consist of 723,200 SF of Employment, 100,000 SF of Retail, 750 Residential Dwelling Units, 150 Hotel Rooms, 102,000 SF of Elementary School. The planned MRTP Phase 1 will generate 1,285 trips during AM peak hour and 1,056 during PM peak hour.

Based on the intersection operational analyses, it is recommended that MRTP construct the following necessary transportation improvements to mitigate Phase 1 project generated impacts along Piilani Highway:

1. Piilani Highway/Hookena Street Access
    a. Construct 2-lane Hookena Street from within MRTP to intersect Piilani Highway across from East Waipuilani Road;
    b. Configure the westbound Hookena approach as a right-in/right-out access with stop control;
    c. Provide acceleration and deceleration lanes to and from Piilani Highway;
    d. Maintain existing delineators on Piilani Highway to prevent left turns from East Waipuilani Road or Hookena Street from crossing the center line of Piilani Highway.
2. Piilani Highway/Piikea Avenue
    a. Construct an additional eastbound Piikea Avenue left turn lane (two total);
    b. Retime the traffic signal accordingly to optimize the intersection operation.
3. Piilani Highway/Lipoa Parkway
    a. Construct an additional southbound Piilani left turn lane (two total);
    b. Widen westbound Lipoa Parkway to provide for left, through, and right turn lanes;
    c. Widen and/or restripe eastbound Lipoa Street to provide left, through, and right turn lanes;
    d. Adjust signal timing and phasing to provide leading protected left turn phases for the east and westbound Lipoa left turn movements;

e. Add the missing crosswalk on north Piilani leg of the intersection to improve pedestrian connectivity.

4. Internal Kihei High School Access
    a. Construct an internal Kihei High School Access from within MRTP;
    b. Provide bicycle and pedestrian connectivity between the school and MRTP

In addition, the background traffic growth from planned future developments including developments in the Kihei/Wailea/Makena areas warrants extending Liloa Drive as a two-lane facility to provide a direct connection between Kaonoulu Street and Kanani Road. It is essential that the Liloa Drive Extension be constructed as the added capacity as the area continues to grow. Without Liloa Drive extension, the traffic conditions along Piilani Highway would be adversely affected and generally deteriorate to Level of Services E or F with and without MRTP.

The County of Maui has included Liloa Drive Extension in its Fiscal Year (FY) 2013 Capital Improvement Project Proposal. $18.2 million was budgeted for design and construction from FY 2015 to 2018. The project is not, however, included in Hawaii State DOT's current Statewide Transportation Improvement Program (STIP). Extensive consultation and discussions with the County indicated that Liloa Drive Extension project will be the County's priority and will be programmed into future STIP.

## B. PHASE 2 IN YEAR 2034

Building upon the land uses in Phase 1, Phase 2 will consist of 1,014,800 SF of Employment and 500 Residential DU. In addition to the trips generated by Phase1, the planned MRTP Phase 2 will generate 835 trips during AM peak hour and 878 during PM peak hour.

Based on the intersection operational analyses, it is recommended that MRTP construct the following necessary transportation improvements to mitigate Phase 2 project generated impacts along Piilani Highway:

1. Piilani Highway/Old Welakahao Road
    a. Construct 2-lane Old Welakahao Road as MRTP's direct access to Piilani Highway;

b. Signalize the intersection and provide a leading protected left turn phase for the southbound Piilani Highway left turn into Old Welakahao Road;
c. Provide southbound left turning lane from Piilani Highway to Old Welakahao Road and westbound left turning lane from Old Welakahao Road to Piilani Highway;
d. Provide acceleration and deceleration lanes to and from Piilani Highway.

2. Mauka collector within MRTP property
    a. Construct the two-lane mauka collector within MRTP property and additional two-lane in-tract roadway when warranted;
    b. Construct three mauka-bound access points to the mauka collector with proper intersection spacing within MRTP property;

Piilani Highway will continue to encounter conditions of congestion and excessive delays with and without MRTP by Year 2034 due to regional growth. The construction of the Mauka collector between Mokulele Highway and a point somewhere south of MRTP on Piilani Highway will be critical to north-south mobility in Kihei because it would provide much needed additional capacity and divert regional trips away from Piilani Highway. The issues associated with the operating condition of the intersections along Piilani Highway would become an element of the overall regional transportation planning issue associated with all the major arterials in Kihei. Because these issues are long range and of a regional nature, they must be addressed collectively by the State, the County, the land owners, and other stakeholders as part of the long-range highway planning documents.

Maui County strongly supports an interconnected Kihei Mauka transportation network as growth in the region warrants. The 1998 Kihei-Makena Community Plan also echoed the need for a North-South roadway mauka of Piilani. The Maui Island Plan, December 2012 contemplates a future north south roadway in several sections and depicts the preferred road alignment. Similar directions are included in the project descriptions of Kihei Mauka and the North Kihei residential planned growth areas to the north of MRTP. MRTP has initiated discussions with other landowners about providing a continuous in-tract mauka collector roadway as directed by the County general plan. MRTP is willing to work with other land owners located mauka of Piilani Highway to coordinate on Mauka collector cost sharing and alignment.

# APPENDICES

# Appendix A Traffic Count Data

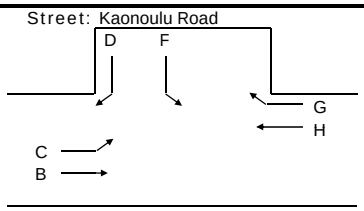
AM COUNT SHEET

Intersection: Piilani & Kaonoulu

Date: Tuesday, 11/15/2012

By: Phil

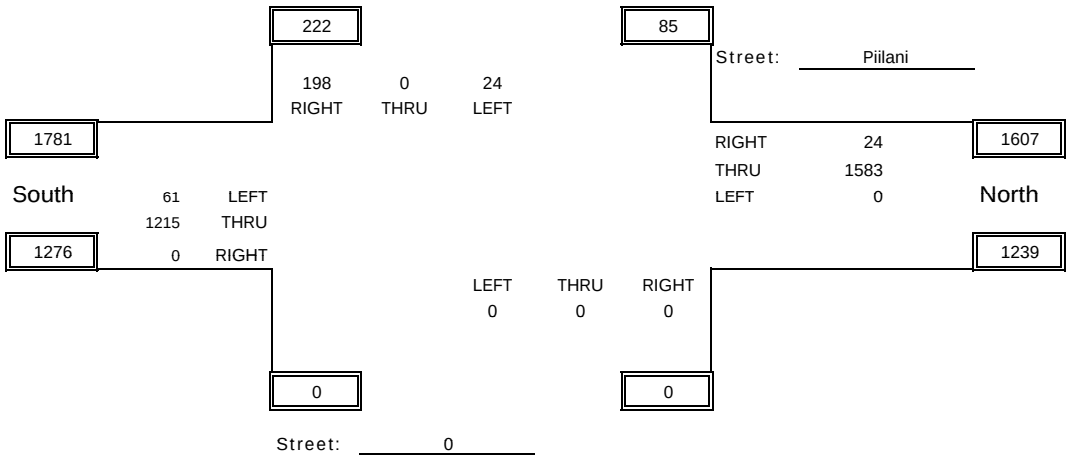
Weather: Clear




| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6:30 AM - 6:45 AM | 0 | 211 | 3 | 27 | 0 | 8 | 5 | 242 | 0 | 0 | 0 | 0 | 496 | 1986 |
| 6:45 AM - 7:00 AM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2324 |
| 7:00 AM - 7:15 AM | 0 | 297 | 12 | 37 | 0 | 8 | 2 | 324 | 0 | 0 | 0 | 0 | 680 | 3082 |
| 7:15 AM - 7:30 AM | 0 | 311 | 13 | 59 | 0 | 6 | 8 | 413 | 0 | 0 | 0 | 0 | 810 | 3105 |
| 7:30 AM - 7:45 AM | 0 | 328 | 17 | 62 | 0 | 7 | 5 | 415 | 0 | 0 | 0 | 0 | 834 | 2918 |
| 7:45 AM - 8:00 AM | 0 | 315 | 21 | 34 | 0 | 5 | 6 | 377 | 0 | 0 | 0 | 0 | 758 | |
| 8:00 AM - 8:15 AM | 0 | 261 | 10 | 43 | 0 | 6 | 5 | 378 | 0 | 0 | 0 | 0 | 703 | |
| 8:15 AM - 8:30 AM | 0 | 266 | 7 | 21 | 0 | 8 | 3 | 318 | 0 | 0 | 0 | 0 | 623 | |
| | | | | | | | | | | | | | | |
| Phf | #DIV/0! | 0.926 | 0.726 | 0.798 | #DIV/0! | 0.857 | 0.750 | 0.954 | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | Peak | Phf |
| 7:15 AM - 8:15 AM | 0 | 1215 | 61 | 198 | 0 | 24 | 24 | 1583 | 0 | 0 | 0 | 0 | 3105 | 0.931 |

## Peak Hour

7:15 AM - 8:15 AM




PARSONS
BRINCKERHOFF

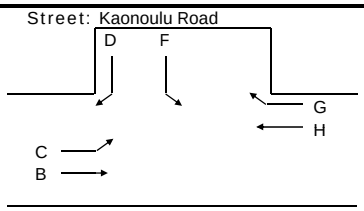
PM COUNT SHEET

Intersection: Piilani & Kaonoulu

Date: Wednesday, 11/16/2012

By: Phil

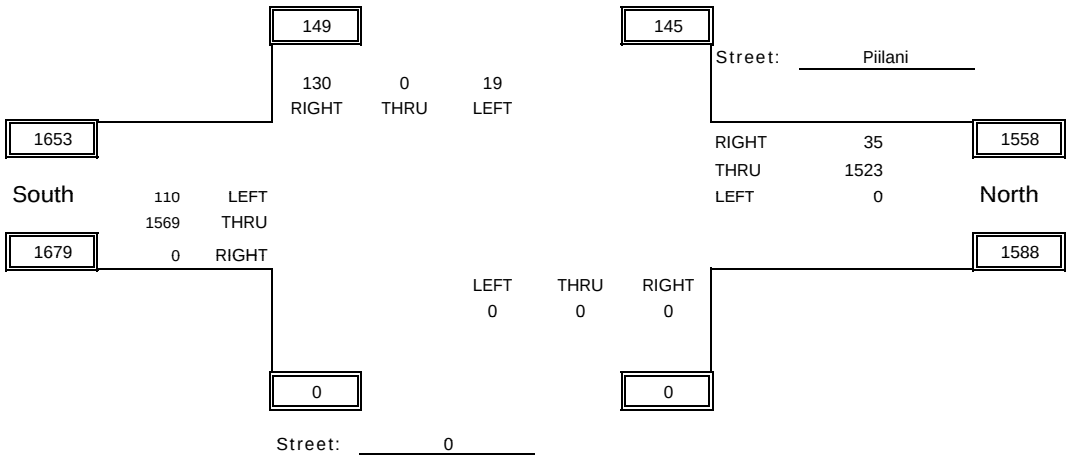
Weather: Clear




| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3:15 PM - 3:30 PM | 0 | 361 | 24 | 30 | 0 | 4 | 8 | 339 | 0 | 0 | 0 | 0 | 766 | 3258 |
| 3:30 PM - 3:45 PM | 0 | 383 | 23 | 25 | 0 | 6 | 15 | 386 | 0 | 0 | 0 | 0 | 838 | 3369 |
| 3:45 PM - 4:00 PM | 0 | 331 | 22 | 34 | 0 | 6 | 10 | 412 | 0 | 0 | 0 | 0 | 815 | 3386 |
| 4:00 PM - 4:15 PM | 0 | 394 | 32 | 35 | 0 | 7 | 7 | 364 | 0 | 0 | 0 | 0 | 839 | 3359 |
| 4:15 PM - 4:30 PM | 0 | 445 | 21 | 28 | 0 | 5 | 7 | 371 | 0 | 0 | 0 | 0 | 877 | 3222 |
| 4:30 PM - 4:45 PM | 0 | 399 | 35 | 33 | 0 | 1 | 11 | 376 | 0 | 0 | 0 | 0 | 855 | |
| 4:45 PM - 5:00 PM | 0 | 331 | 24 | 30 | 0 | 8 | 14 | 381 | 0 | 0 | 0 | 0 | 788 | |
| 5:00 PM - 5:15 PM | 0 | 305 | 25 | 18 | 0 | 6 | 15 | 333 | 0 | 0 | 0 | 0 | 702 | |
| | | | | | | | | | | | | | | |
| Phf | #DIV/0! | 0.881 | 0.786 | 0.929 | #DIV/0! | 0.679 | 0.795 | 0.924 | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | Peak | Phf |
| 3:45 PM - 4:45 PM | 0 | 1569 | 110 | 130 | 0 | 19 | 35 | 1523 | 0 | 0 | 0 | 0 | 3386 | 0.965 |

## Peak Hour

3:45 PM - 4:45 PM




PARSONS
BRINCKERHOFF

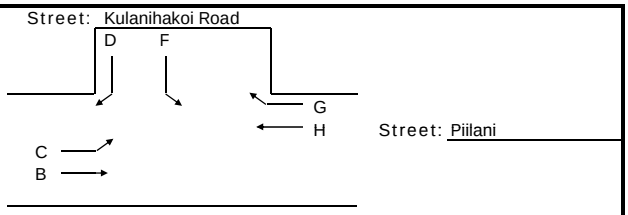
AM COUNT SHEET

Intersection: Piilani & Kulanihakoi

Date: Tuesday, 11/15/2012

By: Phil

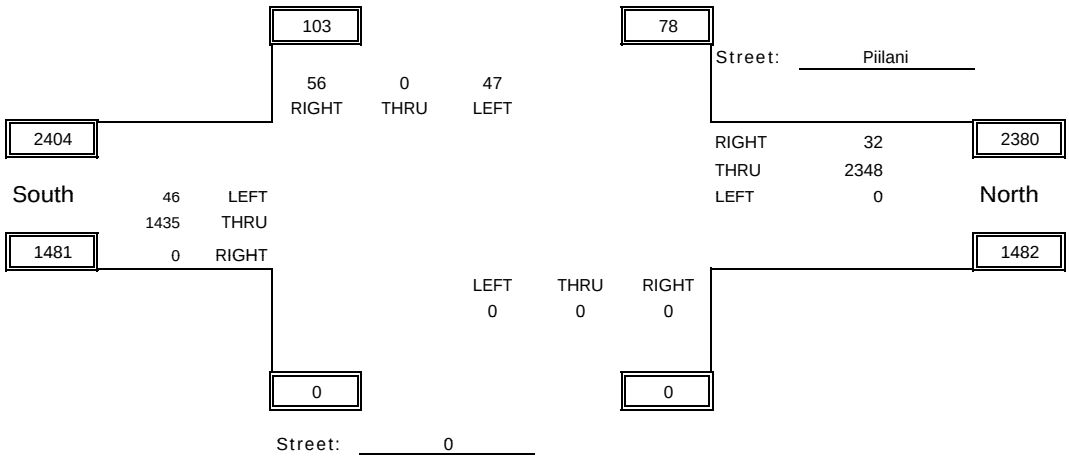
Weather: Clear




| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6:30 AM - 6:45 AM | 0 | 193 | 2 | 16 | 0 | 14 | 9 | 279 | 0 | 0 | 0 | 0 | 513 | 2724 |
| 6:45 AM - 7:00 AM | 0 | 214 | 12 | 16 | 0 | 19 | 7 | 299 | 0 | 0 | 0 | 0 | 567 | 3205 |
| 7:00 AM - 7:15 AM | 0 | 277 | 6 | 16 | 0 | 18 | 4 | 338 | 0 | 0 | 0 | 0 | 659 | 3670 |
| 7:15 AM - 7:30 AM | 0 | 333 | 6 | 18 | 0 | 13 | 2 | 613 | 0 | 0 | 0 | 0 | 985 | 3964 |
| 7:30 AM - 7:45 AM | 0 | 353 | 6 | 11 | 0 | 9 | 8 | 607 | 0 | 0 | 0 | 0 | 994 | 3770 |
| 7:45 AM - 8:00 AM | 0 | 410 | 12 | 10 | 0 | 13 | 8 | 579 | 0 | 0 | 0 | 0 | 1032 | |
| 8:00 AM - 8:15 AM | 0 | 339 | 22 | 17 | 0 | 12 | 14 | 549 | 0 | 0 | 0 | 0 | 953 | |
| 8:15 AM - 8:30 AM | 0 | 303 | 9 | 8 | 0 | 7 | 7 | 457 | 0 | 0 | 0 | 0 | 791 | |
| | | | | | | | | | | | | | | |
| Phf | #DIV/0! | 0.875 | 0.523 | 0.778 | #DIV/0! | 0.904 | 0.571 | 0.958 | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | Peak | Phf |
| 7:15 AM - 8:15 AM | 0 | 1435 | 46 | 56 | 0 | 47 | 32 | 2348 | 0 | 0 | 0 | 0 | 3964 | 0.960 |

## Peak Hour

7:15 AM - 8:15 AM




PARSONS
BRINCKERHOFF

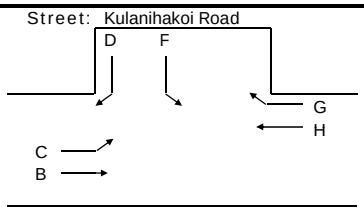
PM COUNT SHEET

Intersection: Piilani & Kulanihakoi

Date: Wednesday, 11/16/2012

By: Phil

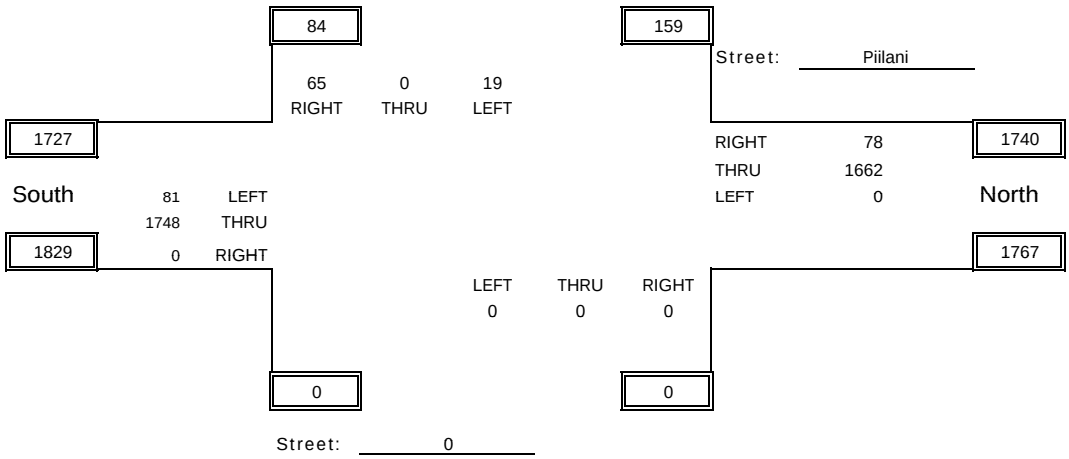
Weather: Clear




| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3:15 PM - 3:30 PM | 0 | 396 | 17 | 14 | 0 | 7 | 21 | 383 | 0 | 0 | 0 | 0 | 838 | 3612 |
| 3:30 PM - 3:45 PM | 0 | 476 | 11 | 13 | 0 | 10 | 7 | 446 | 0 | 0 | 0 | 0 | 963 | 3708 |
| 3:45 PM - 4:00 PM | 0 | 409 | 18 | 17 | 0 | 13 | 20 | 434 | 0 | 0 | 0 | 0 | 911 | 3653 |
| 4:00 PM - 4:15 PM | 0 | 463 | 13 | 8 | 0 | 3 | 19 | 394 | 0 | 0 | 0 | 0 | 900 | 3593 |
| 4:15 PM - 4:30 PM | 0 | 458 | 18 | 17 | 0 | 3 | 23 | 415 | 0 | 0 | 0 | 0 | 934 | 3392 |
| 4:30 PM - 4:45 PM | 0 | 418 | 32 | 23 | 0 | 0 | 16 | 419 | 0 | 0 | 0 | 0 | 908 | |
| 4:45 PM - 5:00 PM | 0 | 368 | 18 | 32 | 0 | 10 | 13 | 410 | 0 | 0 | 0 | 0 | 851 | |
| 5:00 PM - 5:15 PM | 0 | 313 | 20 | 19 | 0 | 3 | 18 | 326 | 0 | 0 | 0 | 0 | 699 | |
| | | | | | | | | | | | | | | |
| Phf | #DIV/0! | 0.944 | 0.633 | 0.707 | #DIV/0! | 0.365 | 0.848 | 0.957 | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | Peak | Phf |
| 3:45 PM - 4:45 PM | 0 | 1748 | 81 | 65 | 0 | 19 | 78 | 1662 | 0 | 0 | 0 | 0 | 3653 | 0.978 |

## Peak Hour

3:45 PM - 4:45 PM




PARSONS
BRINCKERHOFF

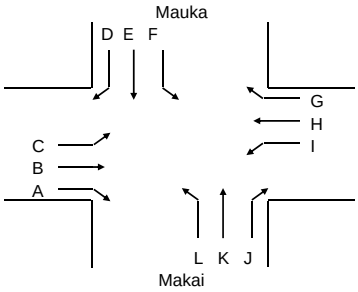
AM COUNT SHEET

Intersection: Piilani Hwy & Waipuilani Rd

Date: 11/17/2010

By: 0

Weather: 0



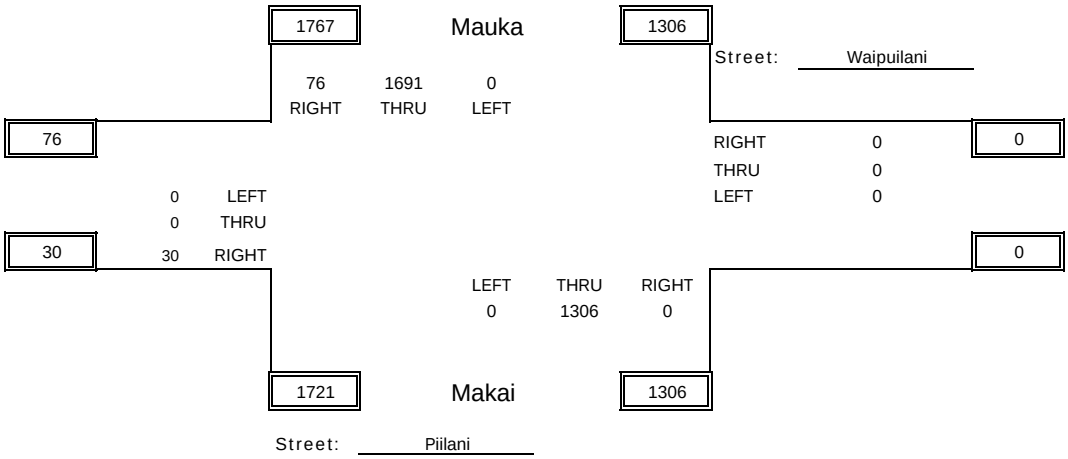

Street: Waipuilani

Street: Piilani

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6:30 AM - 6:45 AM | 8 | 0 | 0 | 4 | 220 | 0 | 0 | 0 | 0 | 0 | 194 | 0 | 426 | 2312 |
| 6:45 AM - 7:00 AM | 5 | 0 | 0 | 7 | 253 | 0 | 0 | 0 | 0 | 0 | 288 | 0 | 553 | 2718 |
| 7:00 AM - 7:15 AM | 4 | 0 | 0 | 10 | 305 | 0 | 0 | 0 | 0 | 0 | 247 | 0 | 566 | 3004 |
| 7:15 AM - 7:30 AM | 7 | 0 | 0 | 14 | 397 | 0 | 0 | 0 | 0 | 0 | 349 | 0 | 767 | 3103 |
| 7:30 AM - 7:45 AM | 3 | 0 | 0 | 24 | 476 | 0 | 0 | 0 | 0 | 0 | 329 | 0 | 832 | 2982 |
| 7:45 AM - 8:00 AM | 13 | 0 | 0 | 22 | 467 | 0 | 0 | 0 | 0 | 0 | 337 | 0 | 839 | |
| 8:00 AM - 8:15 AM | 7 | 0 | 0 | 16 | 351 | 0 | 0 | 0 | 0 | 0 | 291 | 0 | 665 | |
| 8:15 AM - 8:30 AM | 15 | 0 | 0 | 20 | 353 | 0 | 0 | 0 | 0 | 0 | 258 | 0 | 646 | |
| 8:30 AM - 8:45 AM | | | | | | | | | | | | | | |
| 8:45 AM - 9:00 AM | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| Phf | 0.577 | #DIV/0! | #DIV/0! | 0.792 | 0.888 | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0.936 | #DIV/0! | Peak | Phf |
| 7:15 AM - 8:15 AM | 30 | 0 | 0 | 76 | 1691 | 0 | 0 | 0 | 0 | 0 | 1306 | 0 | 3103 | 0.925 |

## Peak Hour

7:15 AM - 8:15 AM




PARSONS
BRINCKERHOFF

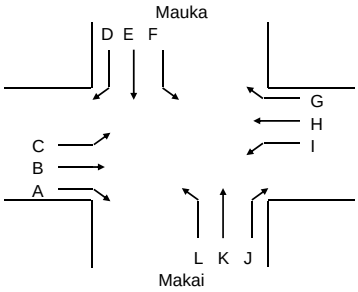
PM COUNT SHEET

Intersection: Piilani Hwy & Waipuilani Rd

Date: 11/16/2010

By: 0

Weather: 0



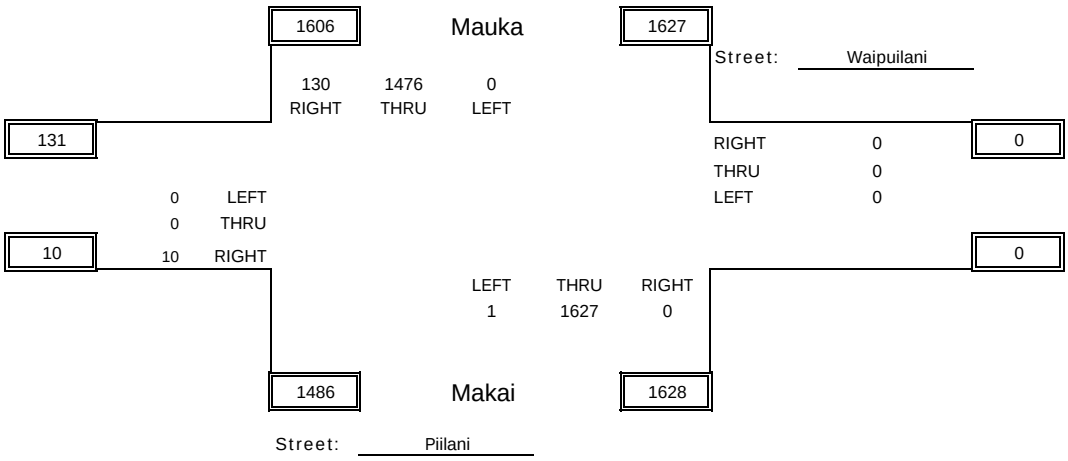

Street: Waipuilani

Street: Piilani

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3:30 PM - 3:45 PM | 2 | 0 | 0 | 33 | 373 | 0 | 0 | 0 | 0 | 0 | 353 | 0 | 761 | 3213 |
| 3:45 PM - 4:00 PM | 2 | 0 | 0 | 36 | 375 | 0 | 0 | 0 | 0 | 0 | 364 | 1 | 778 | 3244 |
| 4:00 PM - 4:15 PM | 2 | 0 | 0 | 22 | 369 | 0 | 0 | 0 | 0 | 0 | 348 | 0 | 741 | 3125 |
| 4:15 PM - 4:30 PM | 5 | 0 | 0 | 32 | 387 | 0 | 0 | 0 | 0 | 0 | 509 | 0 | 933 | 3041 |
| 4:30 PM - 4:45 PM | 1 | 0 | 0 | 40 | 345 | 0 | 0 | 0 | 0 | 0 | 406 | 0 | 792 | 2872 |
| 4:45 PM - 5:00 PM | 5 | 0 | 0 | 28 | 334 | 0 | 0 | 0 | 0 | 0 | 292 | 0 | 659 | |
| 5:00 PM - 5:15 PM | 3 | 0 | 0 | 25 | 343 | 0 | 0 | 0 | 0 | 0 | 286 | 0 | 657 | |
| 5:00 PM - 5:15 PM | 7 | 0 | 0 | 22 | 336 | 0 | 0 | 0 | 0 | 0 | 399 | 0 | 764 | |
| 5:15 PM - 5:30 PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | |
| Phf | 0.500 | #DIV/0! | #DIV/0! | 0.813 | 0.953 | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0.799 | 0.250 | Peak | Phf |
| 3:45 PM - 4:45 PM | 10 | 0 | 0 | 130 | 1476 | 0 | 0 | 0 | 0 | 0 | 1627 | 1 | 3244 | 0.869 |

## Peak Hour

3:45 PM - 4:45 PM




PARSONS
BRINCKERHOFF

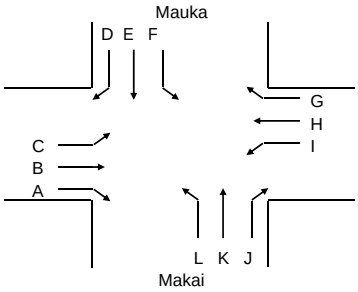
AM COUNT SHEET

Intersection: Piilani Hwy & Piikea Ave

Date: 11/17/2010

By: 0

Weather: 0



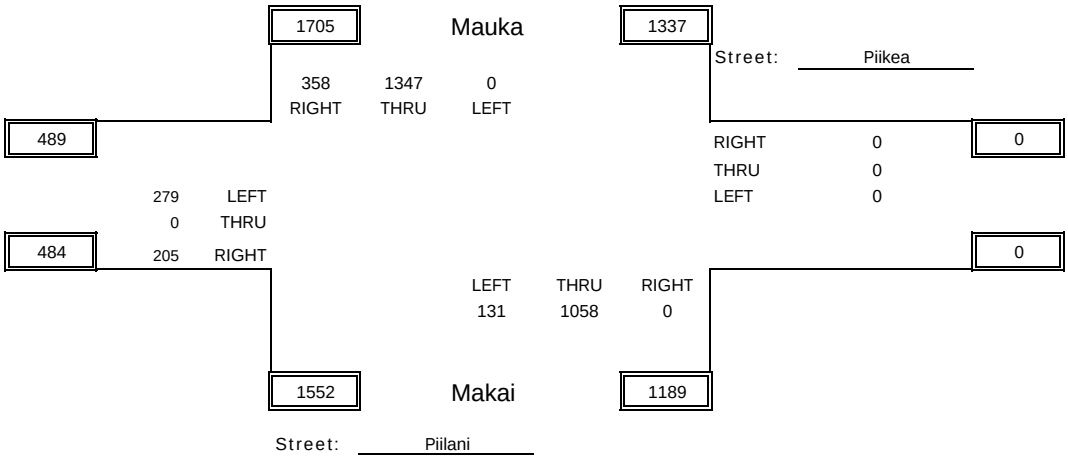

Street: Piikea

Street: Piilani

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6:30 AM - 6:45 AM | 26 | 0 | 38 | 31 | 187 | 0 | 0 | 0 | 0 | 0 | 161 | 6 | 449 | 2474 |
| 6:45 AM - 7:00 AM | 33 | 0 | 37 | 57 | 221 | 0 | 0 | 0 | 0 | 1 | 225 | 17 | 591 | 2942 |
| 7:00 AM - 7:15 AM | 37 | 0 | 53 | 61 | 244 | 1 | 0 | 0 | 0 | 0 | 198 | 20 | 614 | 3271 |
| 7:15 AM - 7:30 AM | 52 | 0 | 58 | 88 | 324 | 0 | 0 | 0 | 0 | 0 | 273 | 25 | 820 | 3378 |
| 7:30 AM - 7:45 AM | 47 | 0 | 78 | 112 | 364 | 0 | 0 | 0 | 0 | 0 | 282 | 34 | 917 | 3232 |
| 7:45 AM - 8:00 AM | 66 | 0 | 90 | 99 | 363 | 0 | 0 | 0 | 0 | 0 | 268 | 34 | 920 | |
| 8:00 AM - 8:15 AM | 40 | 0 | 53 | 59 | 296 | 0 | 0 | 0 | 0 | 0 | 235 | 38 | 721 | |
| 8:15 AM - 8:30 AM | 47 | 0 | 45 | 60 | 294 | 0 | 0 | 0 | 0 | 0 | 189 | 39 | 674 | |
| 8:30 AM - 8:45 AM | | | | | | | | | | | | | | |
| 8:45 AM - 9:00 AM | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| Phf | 0.777 | #DIV/0! | 0.775 | 0.799 | 0.925 | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0.938 | 0.862 | Peak | Phf |
| 7:15 AM - 8:15 AM | 205 | 0 | 279 | 358 | 1347 | 0 | 0 | 0 | 0 | 0 | 1058 | 131 | 3378 | 0.918 |

## Peak Hour

7:15 AM - 8:15 AM




PARSONS
BRINCKERHOFF

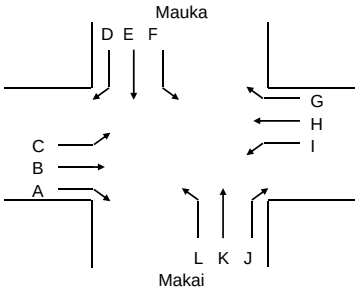
PM COUNT SHEET

Intersection: Piilani Hwy & Piikea Ave

Date: 116/16/2010

By: 0

Weather: 0



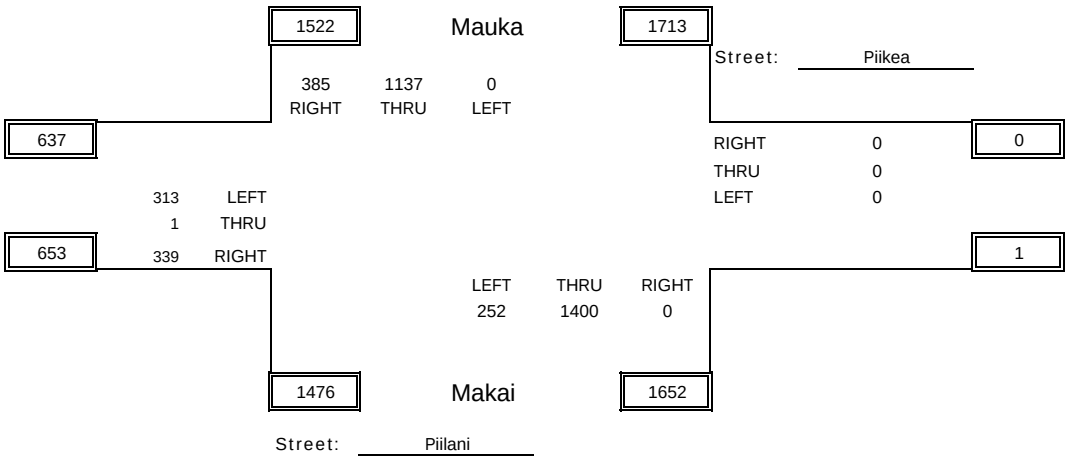

Street: Piikea

Street: Piilani

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3:30 PM - 3:45 PM | 54 | 5 | 70 | 97 | 279 | 0 | 0 | 0 | 0 | 0 | 323 | 57 | 885 | 3727 |
| 3:45 PM - 4:00 PM | 81 | 0 | 83 | 91 | 310 | 0 | 0 | 0 | 0 | 0 | 356 | 62 | 983 | 3827 |
| 4:00 PM - 4:15 PM | 89 | 1 | 82 | 90 | 267 | 0 | 0 | 0 | 0 | 0 | 306 | 68 | 903 | 3732 |
| 4:15 PM - 4:30 PM | 92 | 0 | 70 | 104 | 261 | 0 | 0 | 0 | 0 | 0 | 370 | 59 | 956 | 3623 |
| 4:30 PM - 4:45 PM | 77 | 0 | 78 | 100 | 299 | 0 | 0 | 0 | 0 | 0 | 368 | 63 | 985 | 3559 |
| 4:45 PM - 5:00 PM | 84 | 0 | 78 | 122 | 235 | 0 | 0 | 0 | 0 | 0 | 307 | 62 | 888 | |
| 5:00 PM - 5:15 PM | 84 | 0 | 85 | 87 | 233 | 0 | 0 | 0 | 0 | 0 | 261 | 44 | 794 | |
| 5:00 PM - 5:15 PM | 82 | 0 | 74 | 101 | 271 | 0 | 0 | 0 | 0 | 0 | 302 | 62 | 892 | |
| 5:15 PM - 5:30 PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | |
| Phf | 0.921 | 0.250 | 0.943 | 0.925 | 0.917 | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0.946 | 0.926 | Peak | Phf |
| 3:45 PM - 4:45 PM | 339 | 1 | 313 | 385 | 1137 | 0 | 0 | 0 | 0 | 0 | 1400 | 252 | 3827 | 0.973 |

## Peak Hour

3:45 PM - 4:45 PM




PARSONS
BRINCKERHOFF

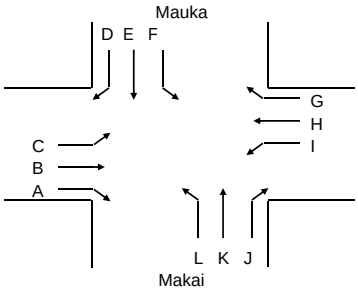
AM COUNT SHEET

Intersection: Piilani Hwy & Lipoa St

Date: 11/17/2010

By: 0

Weather: 0



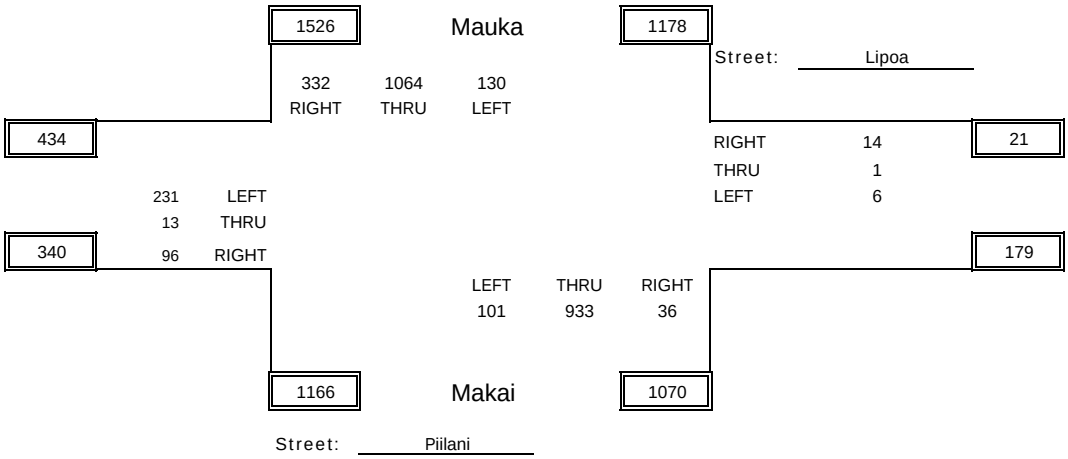

Street: Lipoa

Street: Piilani

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6:30 AM - 6:45 AM | 10 | 0 | 34 | 36 | 186 | 8 | 1 | 0 | 1 | 6 | 161 | 23 | 466 | 2347 |
| 6:45 AM - 7:00 AM | 9 | 1 | 45 | 53 | 199 | 6 | 3 | 0 | 0 | 7 | 186 | 26 | 535 | 2701 |
| 7:00 AM - 7:15 AM | 19 | 2 | 37 | 66 | 212 | 12 | 3 | 0 | 1 | 6 | 205 | 20 | 583 | 2906 |
| 7:15 AM - 7:30 AM | 25 | 1 | 61 | 112 | 246 | 32 | 2 | 0 | 2 | 6 | 247 | 29 | 763 | 2957 |
| 7:30 AM - 7:45 AM | 31 | 5 | 73 | 125 | 270 | 26 | 4 | 0 | 0 | 10 | 240 | 36 | 820 | 2841 |
| 7:45 AM - 8:00 AM | 24 | 4 | 69 | 57 | 294 | 32 | 3 | 0 | 3 | 8 | 224 | 22 | 740 | |
| 8:00 AM - 8:15 AM | 16 | 3 | 28 | 38 | 254 | 40 | 5 | 1 | 1 | 12 | 222 | 14 | 634 | |
| 8:15 AM - 8:30 AM | 22 | 5 | 34 | 25 | 277 | 31 | 5 | 1 | 6 | 9 | 212 | 20 | 647 | |
| 8:30 AM - 8:45 AM | | | | | | | | | | | | | | |
| 8:45 AM - 9:00 AM | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| Phf | 0.774 | 0.650 | 0.791 | 0.664 | 0.905 | 0.813 | 0.700 | 0.250 | 0.500 | 0.750 | 0.944 | 0.701 | Peak | Phf |
| 7:15 AM - 8:15 AM | 96 | 13 | 231 | 332 | 1064 | 130 | 14 | 1 | 6 | 36 | 933 | 101 | 2957 | 0.902 |

## Peak Hour

7:15 AM - 8:15 AM




PARSONS
BRINCKERHOFF

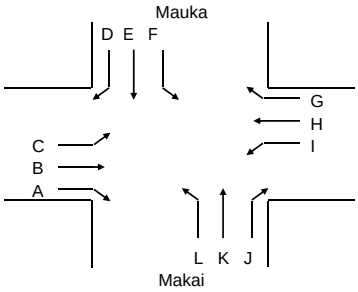
PM COUNT SHEET

Intersection: Piilani Hwy & Lipoa St

Date: 116/16/2010

By: 0

Weather: 0



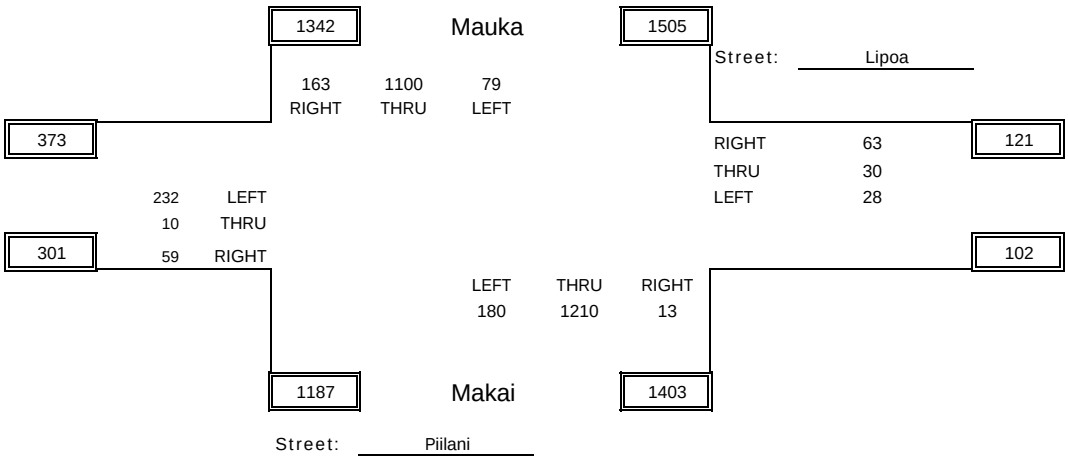

Street: Lipoa

Street: Piilani

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3:30 PM - 3:45 PM | 8 | 2 | 76 | 55 | 303 | 6 | 3 | 8 | 3 | 2 | 289 | 45 | 800 | 3143 |
| 3:45 PM - 4:00 PM | 11 | 7 | 58 | 50 | 264 | 11 | 14 | 5 | 4 | 5 | 250 | 39 | 718 | 3167 |
| 4:00 PM - 4:15 PM | 19 | 1 | 67 | 48 | 283 | 19 | 16 | 6 | 8 | 4 | 279 | 39 | 789 | 3138 |
| 4:15 PM - 4:30 PM | 3 | 1 | 54 | 30 | 251 | 45 | 11 | 9 | 4 | 2 | 364 | 62 | 836 | 3050 |
| 4:30 PM - 4:45 PM | 26 | 1 | 53 | 35 | 302 | 4 | 22 | 10 | 12 | 2 | 317 | 40 | 824 | 2937 |
| 4:45 PM - 5:00 PM | 36 | 1 | 51 | 39 | 276 | 6 | 22 | 0 | 10 | 1 | 224 | 23 | 689 | |
| 5:00 PM - 5:15 PM | 18 | 2 | 56 | 30 | 259 | 3 | 17 | 7 | 10 | 1 | 269 | 29 | 701 | |
| 5:00 PM - 5:15 PM | 15 | 1 | 35 | 36 | 303 | 9 | 21 | 7 | 14 | 3 | 249 | 30 | 723 | |
| 5:15 PM - 5:30 PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | |
| Phf | 0.567 | 0.357 | 0.866 | 0.815 | 0.911 | 0.439 | 0.716 | 0.750 | 0.583 | 0.650 | 0.831 | 0.726 | Peak | Phf |
| 3:45 PM - 4:45 PM | 59 | 10 | 232 | 163 | 1100 | 79 | 63 | 30 | 28 | 13 | 1210 | 180 | 3167 | 0.947 |

## Peak Hour

3:45 PM - 4:45 PM




PARSONS
BRINCKERHOFF

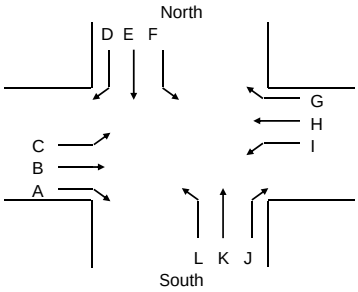
AM COUNT SHEET

Intersection: Piilani Highway and Welakahao Road (North)

Date: 11/17/2010

By: 0

Weather: 0



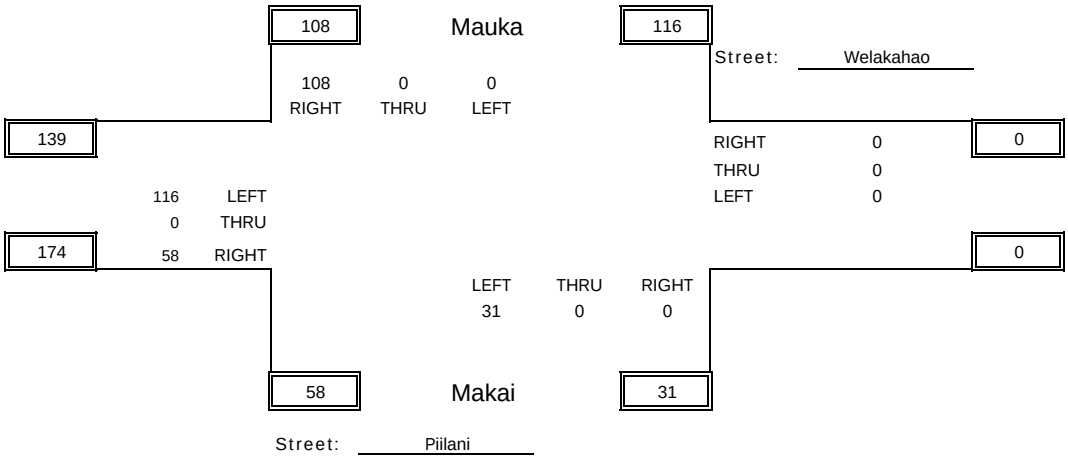

Street: Welakahao

Street: Piilani

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6:30 AM - 6:45 AM | 10 | 0 | 17 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 45 | 216 |
| 6:45 AM - 7:00 AM | 4 | 0 | 20 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 44 | 244 |
| 7:00 AM - 7:15 AM | 3 | 0 | 28 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 53 | 291 |
| 7:15 AM - 7:30 AM | 17 | 0 | 27 | 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 74 | 313 |
| 7:30 AM - 7:45 AM | 10 | 0 | 31 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 73 | 319 |
| 7:45 AM - 8:00 AM | 20 | 0 | 26 | 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 91 | |
| 8:00 AM - 8:15 AM | 11 | 0 | 32 | 27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 75 | |
| 8:15 AM - 8:30 AM | 14 | 0 | 26 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 80 | |
| 8:30 AM - 8:45 AM | | | | | | | | | | | | | | |
| 8:45 AM - 9:00 AM | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| Phf | 0.725 | #DIV/0! | 0.906 | 0.771 | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0.775 | Peak | Phf |
| 7:15 AM - 8:15 AM | 58 | 0 | 116 | 108 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 31 | 313 | 0.860 |

## Peak Hour

7:15 AM - 8:15 AM




PARSONS
BRINCKERHOFF

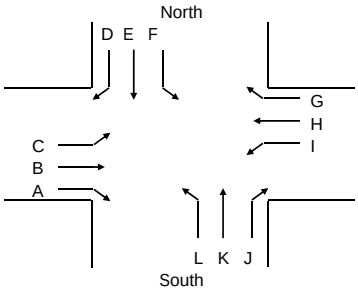
PM COUNT SHEET

Intersection: Piilani Highway and Welakahao Road (North)

Date: 11/16/2010

By: 0

Weather: 0



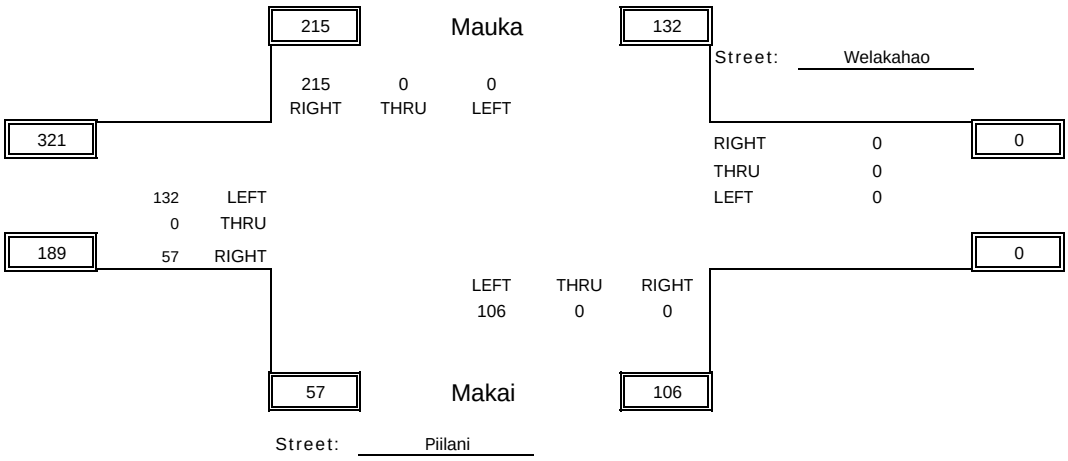

Street: Welakahao

Street: Piilani

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3:30 PM - 3:45 PM | 17 | 0 | 35 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 23 | 115 | 504 |
| 3:45 PM - 4:00 PM | 11 | 0 | 35 | 55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 131 | 510 |
| 4:00 PM - 4:15 PM | 15 | 0 | 32 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 122 | 494 |
| 4:15 PM - 4:30 PM | 15 | 0 | 40 | 55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26 | 136 | 481 |
| 4:30 PM - 4:45 PM | 16 | 0 | 25 | 55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 121 | 436 |
| 4:45 PM - 5:00 PM | 13 | 0 | 26 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 115 | 412 |
| 5:00 PM - 5:15 PM | 13 | 0 | 25 | 55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 109 | |
| 5:15 PM - 5:30 PM | 8 | 0 | 24 | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 91 | |
| 5:30 PM - 5:45 PM | 12 | 0 | 26 | 49 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 97 | |
| 5:45 PM - 6:00 PM | 8 | 0 | 20 | 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | | |
| Phf | 0.891 | #DIV/0! | 0.825 | 0.977 | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0.883 | Peak | Phf |
| 3:45 PM - 4:45 PM | 57 | 0 | 132 | 215 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 106 | 510 | 0.938 |

## Peak Hour

3:45 PM - 4:45 PM




PARSONS
BRINCKERHOFF

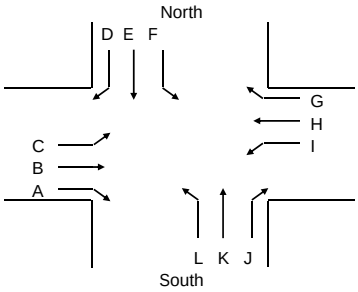
AM COUNT SHEET

Intersection: Piilani Highway and Welakahao Road (South)

Date: 11/18/2010

By: 0

Weather: 0



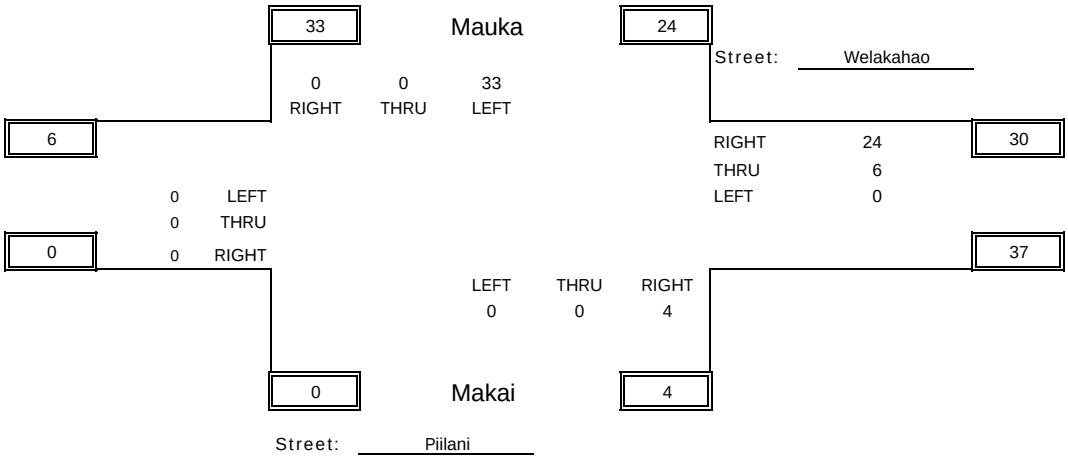

Street: Welakahao

Street: Piilani

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6:30 AM - 6:45 AM | 0 | 0 | 0 | 0 | 0 | 12 | 2 | 0 | 0 | 4 | 0 | 0 | 18 | 79 |
| 6:45 AM - 7:00 AM | 0 | 0 | 0 | 0 | 0 | 16 | 7 | 0 | 0 | 1 | 0 | 0 | 24 | 75 |
| 7:00 AM - 7:15 AM | 0 | 0 | 0 | 0 | 0 | 13 | 3 | 0 | 0 | 3 | 0 | 0 | 19 | 65 |
| 7:15 AM - 7:30 AM | 0 | 0 | 0 | 0 | 0 | 9 | 7 | 1 | 0 | 1 | 0 | 0 | 18 | 67 |
| 7:30 AM - 7:45 AM | 0 | 0 | 0 | 0 | 0 | 9 | 4 | 1 | 0 | 0 | 0 | 0 | 14 | 75 |
| 7:45 AM - 8:00 AM | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 2 | 0 | 2 | 0 | 0 | 14 | |
| 8:00 AM - 8:15 AM | 0 | 0 | 0 | 0 | 0 | 10 | 8 | 2 | 0 | 1 | 0 | 0 | 21 | |
| 8:15 AM - 8:30 AM | 0 | 0 | 0 | 0 | 0 | 8 | 12 | 2 | 0 | 4 | 0 | 0 | 26 | |
| 8:30 AM - 8:45 AM | | | | | | | | | | | | | | |
| 8:45 AM - 9:00 AM | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| Phf | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0.825 | 0.750 | 0.750 | #DIV/0! | 0.500 | #DIV/0! | #DIV/0! | Peak | Phf |
| 7:15 AM - 8:15 AM | 0 | 0 | 0 | 0 | 0 | 33 | 24 | 6 | 0 | 4 | 0 | 0 | 67 | 0.798 |

## Peak Hour

7:15 AM - 8:15 AM




PARSONS
BRINCKERHOFF

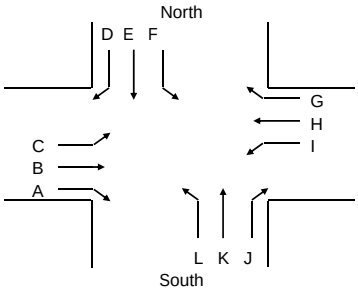
PM COUNT SHEET

Intersection: Piilani Highway and Welakahao Road (South)

Date: 11/17/2010

By: 0

Weather: 0



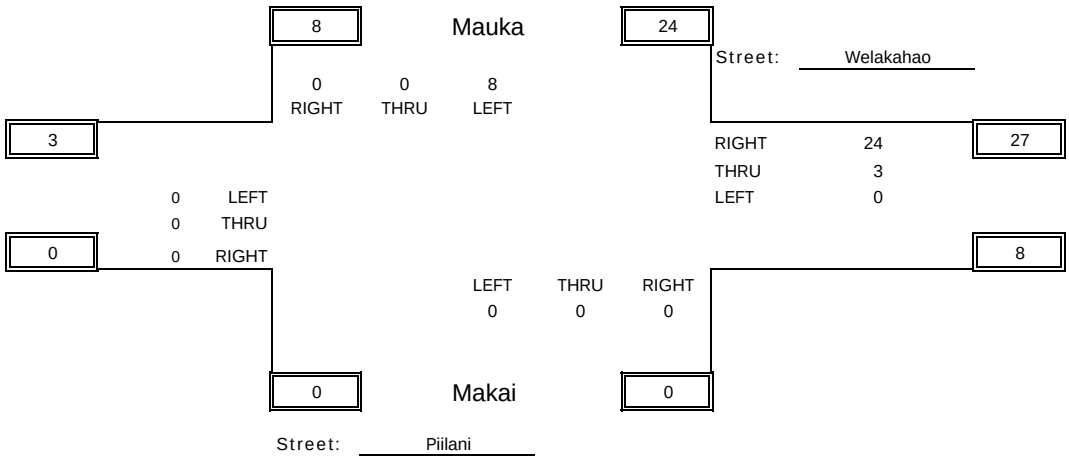

Street: Welakahao

Street: Piilani

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3:30 PM - 3:45 PM | 0 | 0 | 0 | 0 | 0 | 2 | 13 | 4 | 0 | 2 | 0 | 0 | 21 | 47 |
| 3:45 PM - 4:00 PM | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 6 | 35 |
| 4:00 PM - 4:15 PM | 0 | 0 | 0 | 0 | 0 | 2 | 12 | 2 | 0 | 0 | 0 | 0 | 16 | 32 |
| 4:15 PM - 4:30 PM | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | 24 |
| 4:30 PM - 4:45 PM | 0 | 0 | 0 | 0 | 0 | 3 | 5 | 1 | 0 | 0 | 0 | 0 | 9 | 24 |
| 4:45 PM - 5:00 PM | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 3 | |
| 5:00 PM - 5:15 PM | 0 | 0 | 0 | 0 | 0 | 3 | 4 | 0 | 0 | 1 | 0 | 0 | 8 | |
| 5:15 PM - 5:30 PM | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 4 | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| Phf | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | 0.667 | 0.500 | 0.375 | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | Peak | Phf |
| 3:45 PM - 4:45 PM | 0 | 0 | 0 | 0 | 0 | 8 | 24 | 3 | 0 | 0 | 0 | 0 | 35 | 0.417 |

## Peak Hour

3:45 PM - 4:45 PM




PARSONS
BRINCKERHOFF

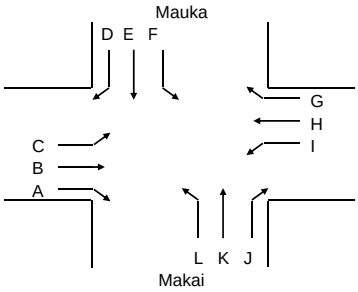
AM COUNT SHEET

Intersection: South Kihei Rd & Piikea

Date: 11/17/2010

By: 0

Weather: 0



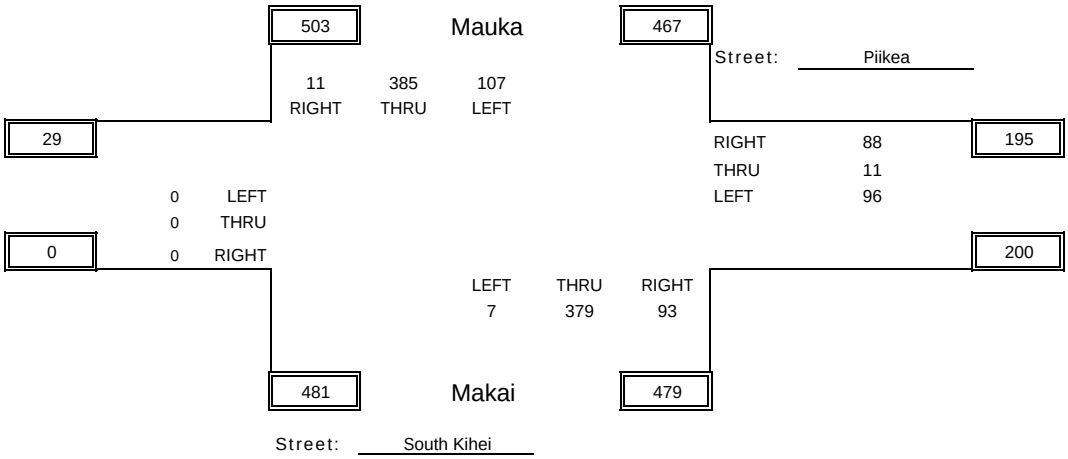

Street: Piikea

Street: South Kihei

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6:30 AM - 6:45 AM | 0 | 0 | 0 | 0 | 46 | 12 | 6 | 0 | 6 | 9 | 51 | 3 | 133 | 814 |
| 6:45 AM - 7:00 AM | 0 | 0 | 0 | 4 | 68 | 18 | 12 | 1 | 13 | 17 | 67 | 0 | 200 | 1005 |
| 7:00 AM - 7:15 AM | 0 | 0 | 0 | 3 | 82 | 21 | 19 | 0 | 14 | 13 | 59 | 3 | 214 | 1141 |
| 7:15 AM - 7:30 AM | 0 | 0 | 0 | 3 | 96 | 26 | 18 | 1 | 13 | 21 | 88 | 1 | 267 | 1177 |
| 7:30 AM - 7:45 AM | 0 | 0 | 0 | 3 | 112 | 35 | 27 | 1 | 25 | 28 | 93 | 0 | 324 | 1177 |
| 7:45 AM - 8:00 AM | 0 | 0 | 0 | 4 | 97 | 29 | 25 | 5 | 34 | 26 | 114 | 2 | 336 | |
| 8:00 AM - 8:15 AM | 0 | 0 | 0 | 1 | 80 | 17 | 18 | 4 | 24 | 18 | 84 | 4 | 250 | |
| 8:15 AM - 8:30 AM | 0 | 0 | 0 | 7 | 94 | 15 | 15 | 2 | 26 | 28 | 79 | 1 | 267 | |
| 8:30 AM - 8:45 AM | | | | | | | | | | | | | | |
| 8:45 AM - 9:00 AM | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| Phf | #DIV/0! | #DIV/0! | #DIV/0! | 0.688 | 0.859 | 0.764 | 0.815 | 0.550 | 0.706 | 0.830 | 0.831 | 0.438 | Peak | Phf |
| 7:15 AM - 8:15 AM | 0 | 0 | 0 | 11 | 385 | 107 | 88 | 11 | 96 | 93 | 379 | 7 | 1177 | 0.876 |

## Peak Hour

7:15 AM - 8:15 AM




PARSONS
BRINCKERHOFF

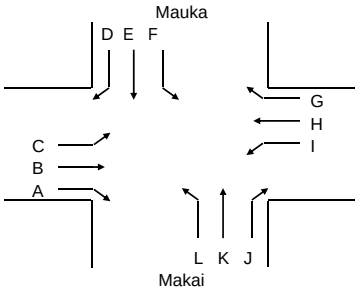
PM COUNT SHEET

Intersection: South Kihei Rd & Piikea

Date: 11/16/2010

By: 0

Weather: 0



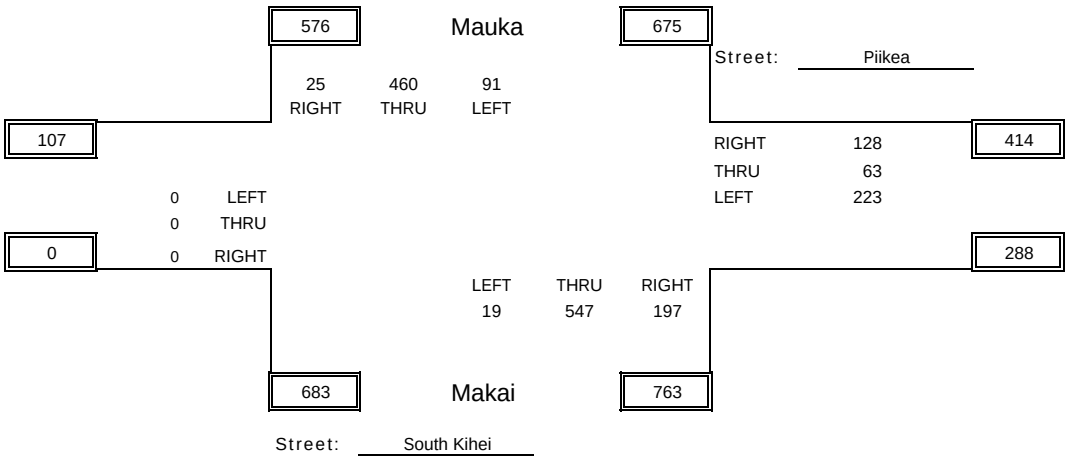

Street: Piikea

Street: South Kihei

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3:30 PM - 3:45 PM | 0 | 0 | 0 | 2 | 120 | 28 | 36 | 10 | 55 | 44 | 137 | 2 | 434 | 1749 |
| 3:45 PM - 4:00 PM | 0 | 0 | 0 | 7 | 97 | 22 | 34 | 30 | 49 | 49 | 130 | 8 | 426 | 1753 |
| 4:00 PM - 4:15 PM | 0 | 0 | 0 | 5 | 130 | 27 | 36 | 6 | 59 | 42 | 140 | 4 | 449 | 1736 |
| 4:15 PM - 4:30 PM | 0 | 0 | 0 | 8 | 107 | 17 | 32 | 19 | 54 | 56 | 144 | 3 | 440 | 1653 |
| 4:30 PM - 4:45 PM | 0 | 0 | 0 | 5 | 126 | 25 | 26 | 8 | 61 | 50 | 133 | 4 | 438 | 1643 |
| 4:45 PM - 5:00 PM | 0 | 0 | 0 | 4 | 122 | 20 | 33 | 8 | 37 | 48 | 135 | 2 | 409 | 1563 |
| 5:00 PM - 5:15 PM | 0 | 0 | 0 | 2 | 114 | 15 | 28 | 2 | 37 | 37 | 131 | 0 | 366 | |
| 5:00 PM - 5:15 PM | 0 | 0 | 0 | 5 | 124 | 28 | 26 | 5 | 67 | 50 | 124 | 1 | 430 | |
| 5:15 PM - 5:30 PM | 0 | 0 | 0 | 5 | 100 | 17 | 24 | 3 | 55 | 28 | 125 | 1 | 358 | |
| | | | | | | | | | | | | | | |
| Phf | #DIV/0! | #DIV/0! | #DIV/0! | 0.781 | 0.885 | 0.843 | 0.889 | 0.525 | 0.914 | 0.879 | 0.950 | 0.594 | Peak | Phf |
| 3:45 PM - 4:45 PM | 0 | 0 | 0 | 25 | 460 | 91 | 128 | 63 | 223 | 197 | 547 | 19 | 1753 | 0.976 |

## Peak Hour

3:45 PM - 4:45 PM




PARSONS
BRINCKERHOFF

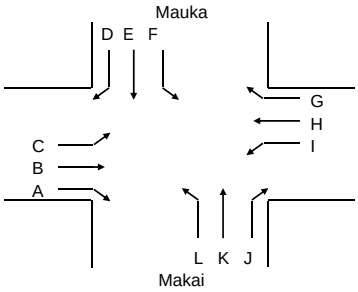
AM COUNT SHEET

Intersection: South Kihei Rd & East Lipoa St

Date: 11/18/2010

By: 0

Weather: 0



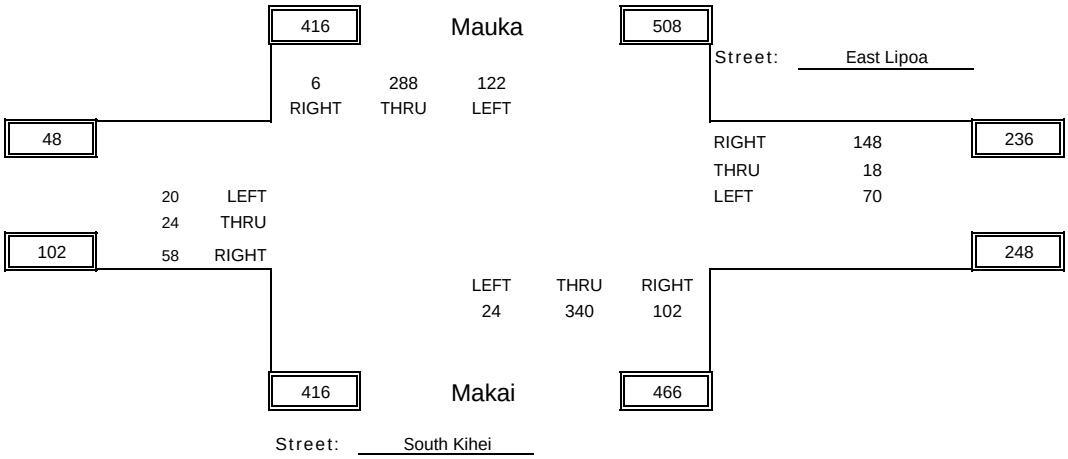

Street: East Lipoa

Street: South Kihei

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6:30 AM - 6:45 AM | 4 | 3 | 1 | 4 | 35 | 13 | 11 | 3 | 7 | 17 | 56 | 3 | 157 | 834 |
| 6:45 AM - 7:00 AM | 7 | 3 | 2 | 4 | 51 | 17 | 6 | 9 | 11 | 19 | 59 | 17 | 205 | 996 |
| 7:00 AM - 7:15 AM | 3 | 4 | 3 | 3 | 44 | 16 | 15 | 6 | 6 | 25 | 62 | 6 | 193 | 1119 |
| 7:15 AM - 7:30 AM | 7 | 3 | 2 | 2 | 58 | 32 | 28 | 2 | 20 | 30 | 91 | 4 | 279 | 1220 |
| 7:30 AM - 7:45 AM | 22 | 10 | 7 | 1 | 68 | 42 | 48 | 3 | 16 | 27 | 67 | 8 | 319 | 1259 |
| 7:45 AM - 8:00 AM | 19 | 4 | 7 | 1 | 76 | 25 | 49 | 8 | 21 | 26 | 88 | 4 | 328 | |
| 8:00 AM - 8:15 AM | 10 | 7 | 4 | 2 | 86 | 23 | 23 | 5 | 13 | 19 | 94 | 8 | 294 | |
| 8:15 AM - 8:30 AM | 17 | 6 | 5 | 3 | 89 | 31 | 15 | 5 | 23 | 25 | 96 | 3 | 318 | |
| 8:30 AM - 8:45 AM | | | | | | | | | | | | | | |
| 8:45 AM - 9:00 AM | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| Phf | 0.659 | 0.600 | 0.714 | 0.750 | 0.837 | 0.726 | 0.755 | 0.563 | 0.833 | 0.850 | 0.904 | 0.750 | Peak | Phf |
| 7:15 AM - 8:15 AM | 58 | 24 | 20 | 6 | 288 | 122 | 148 | 18 | 70 | 102 | 340 | 24 | 1220 | 0.930 |

## Peak Hour

7:15 AM - 8:15 AM




PARSONS
BRINCKERHOFF

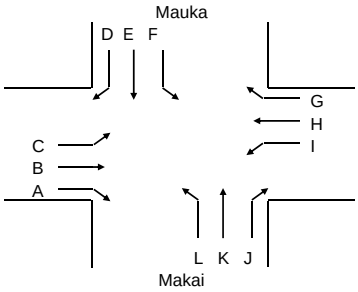
PM COUNT SHEET

Intersection: South Kihei Rd & East Lipoa St

Date: 11/17/2010

By: 0

Weather: 0



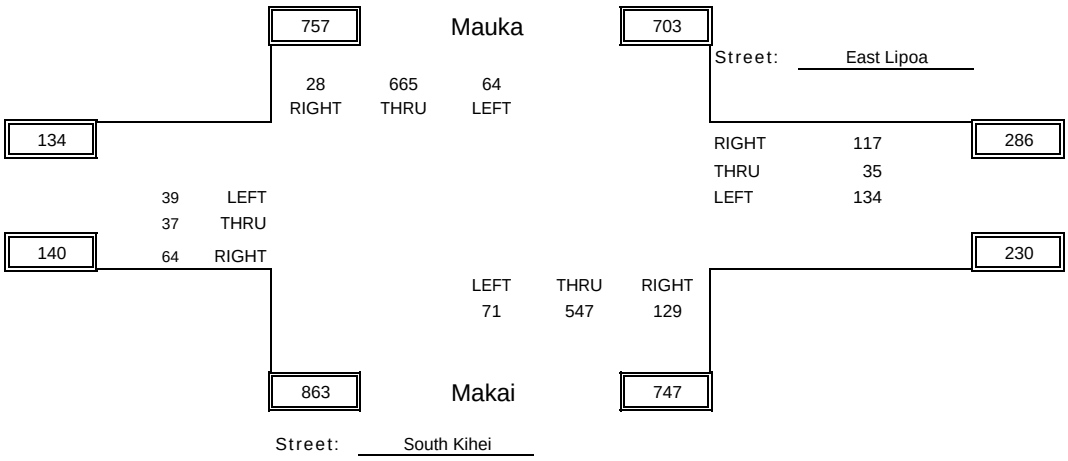

Street: East Lipoa

Street: South Kihei

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3:30 PM - 3:45 PM | 20 | 5 | 14 | 7 | 136 | 32 | 37 | 12 | 29 | 40 | 139 | 7 | 478 | 1933 |
| 3:45 PM - 4:00 PM | 8 | 7 | 8 | 11 | 189 | 25 | 33 | 6 | 34 | 37 | 136 | 10 | 504 | 1930 |
| 4:00 PM - 4:15 PM | 14 | 9 | 9 | 5 | 161 | 11 | 32 | 8 | 27 | 39 | 142 | 15 | 472 | 1922 |
| 4:15 PM - 4:30 PM | 19 | 11 | 15 | 8 | 150 | 20 | 28 | 9 | 43 | 24 | 133 | 19 | 479 | 1926 |
| 4:30 PM - 4:45 PM | 23 | 10 | 7 | 4 | 165 | 8 | 24 | 12 | 30 | 29 | 136 | 27 | 475 | 1931 |
| 4:45 PM - 5:00 PM | 24 | 19 | 15 | 5 | 155 | 23 | 31 | 8 | 39 | 40 | 123 | 14 | 496 | |
| 5:00 PM - 5:15 PM | 18 | 11 | 7 | 5 | 158 | 14 | 37 | 11 | 17 | 20 | 163 | 15 | 476 | |
| 5:00 PM - 5:15 PM | 22 | 8 | 17 | 9 | 181 | 19 | 19 | 11 | 20 | 36 | 112 | 30 | 484 | |
| 5:15 PM - 5:30 PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | |
| Phf | 0.696 | 0.841 | 0.650 | 0.636 | 0.880 | 0.640 | 0.886 | 0.729 | 0.779 | 0.827 | 0.963 | 0.657 | Peak | Phf |
| 3:45 PM - 4:45 PM | 64 | 37 | 39 | 28 | 665 | 64 | 117 | 35 | 134 | 129 | 547 | 71 | 1930 | 0.957 |

## Peak Hour

3:45 PM - 4:45 PM




PARSONS
BRINCKERHOFF

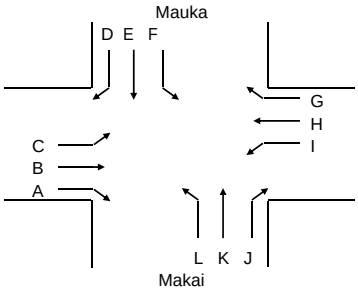
AM COUNT SHEET

Intersection: South Kihei Rd & Welakahao

Date: 11/18/2010

By: 0

Weather: 0



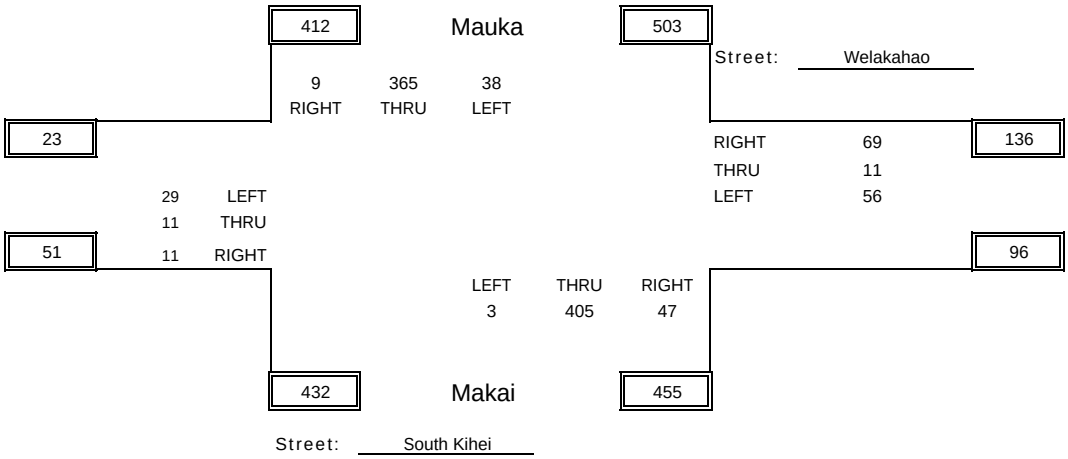

Street: Welakahao

Street: South Kihei

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6:30 AM - 6:45 AM | 1 | 2 | 4 | 0 | 18 | 2 | 2 | 0 | 4 | 3 | 27 | 1 | 64 | 662 |
| 6:45 AM - 7:00 AM | 1 | 8 | 6 | 6 | 47 | 2 | 5 | 3 | 11 | 17 | 76 | 0 | 182 | 861 |
| 7:00 AM - 7:15 AM | 0 | 3 | 5 | 1 | 66 | 2 | 6 | 1 | 9 | 8 | 90 | 2 | 193 | 987 |
| 7:15 AM - 7:30 AM | 2 | 2 | 5 | 0 | 60 | 3 | 14 | 1 | 11 | 17 | 108 | 0 | 223 | 1054 |
| 7:30 AM - 7:45 AM | 4 | 3 | 11 | 4 | 88 | 13 | 17 | 4 | 11 | 6 | 100 | 2 | 263 | 1124 |
| 7:45 AM - 8:00 AM | 1 | 3 | 6 | 2 | 124 | 12 | 28 | 3 | 12 | 16 | 101 | 0 | 308 | |
| 8:00 AM - 8:15 AM | 4 | 3 | 7 | 3 | 93 | 10 | 10 | 3 | 22 | 8 | 96 | 1 | 260 | |
| 8:15 AM - 8:30 AM | 4 | 3 | 5 | 3 | 115 | 7 | 10 | 2 | 10 | 16 | 115 | 3 | 293 | |
| 8:30 AM - 8:45 AM | | | | | | | | | | | | | | |
| 8:45 AM - 9:00 AM | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| Phf | 0.688 | 0.917 | 0.659 | 0.563 | 0.736 | 0.731 | 0.616 | 0.688 | 0.636 | 0.691 | 0.938 | 0.375 | Peak | Phf |
| 7:15 AM - 8:15 AM | 11 | 11 | 29 | 9 | 365 | 38 | 69 | 11 | 56 | 47 | 405 | 3 | 1054 | 0.856 |

## Peak Hour

7:15 AM - 8:15 AM




PARSONS
BRINCKERHOFF

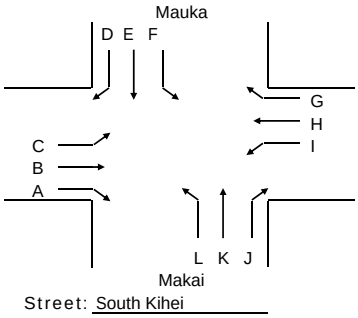
PM COUNT SHEET

Intersection: South Kihei Rd & Welakahao

Date: 11/17/2010

By: 0

Weather: 0

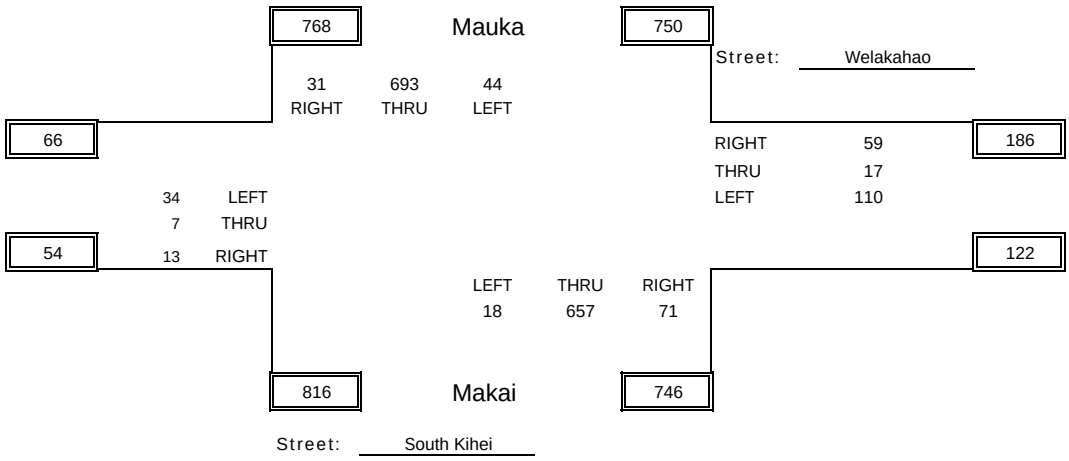



Street: Welakahao

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3:30 PM - 3:45 PM | 2 | 2 | 6 | 3 | 170 | 8 | 17 | 3 | 26 | 19 | 157 | 6 | 419 | 1723 |
| 3:45 PM - 4:00 PM | 6 | 1 | 13 | 5 | 166 | 13 | 9 | 5 | 30 | 19 | 154 | 4 | 425 | 1754 |
| 4:00 PM - 4:15 PM | 3 | 0 | 6 | 7 | 181 | 10 | 17 | 6 | 31 | 24 | 165 | 4 | 454 | 1808 |
| 4:15 PM - 4:30 PM | 2 | 2 | 7 | 9 | 169 | 11 | 16 | 3 | 24 | 11 | 165 | 6 | 425 | 1770 |
| 4:30 PM - 4:45 PM | 2 | 4 | 8 | 10 | 177 | 10 | 17 | 3 | 25 | 17 | 173 | 4 | 450 | 1676 |
| 4:45 PM - 5:00 PM | 6 | 1 | 5 | 14 | 207 | 13 | 13 | 3 | 29 | 9 | 175 | 4 | 479 | |
| 5:00 PM - 5:15 PM | 3 | 3 | 11 | 5 | 149 | 10 | 17 | 4 | 25 | 18 | 169 | 2 | 416 | |
| 5:00 PM - 5:15 PM | 3 | 3 | 3 | 5 | 146 | 8 | 11 | 6 | 19 | 10 | 115 | 2 | 331 | |
| 5:15 PM - 5:30 PM | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| Phf | 0.542 | 0.438 | 0.654 | 0.775 | 0.957 | 0.846 | 0.868 | 0.708 | 0.887 | 0.740 | 0.949 | 0.750 | Peak | Phf |
| 3:45 PM - 4:45 PM | 13 | 7 | 34 | 31 | 693 | 44 | 59 | 17 | 110 | 71 | 657 | 18 | 1754 | 0.966 |

## Peak Hour

3:45 PM - 4:45 PM




PARSONS
BRINCKERHOFF

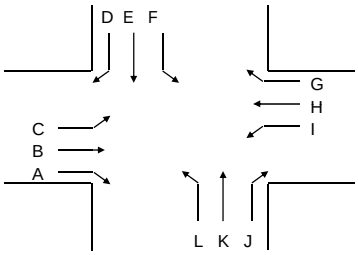
AM COUNT SHEET

Intersection: Liloa St & Piikea Ave

Date: 1/8/2013

By: Linda McLain

Weather: 0



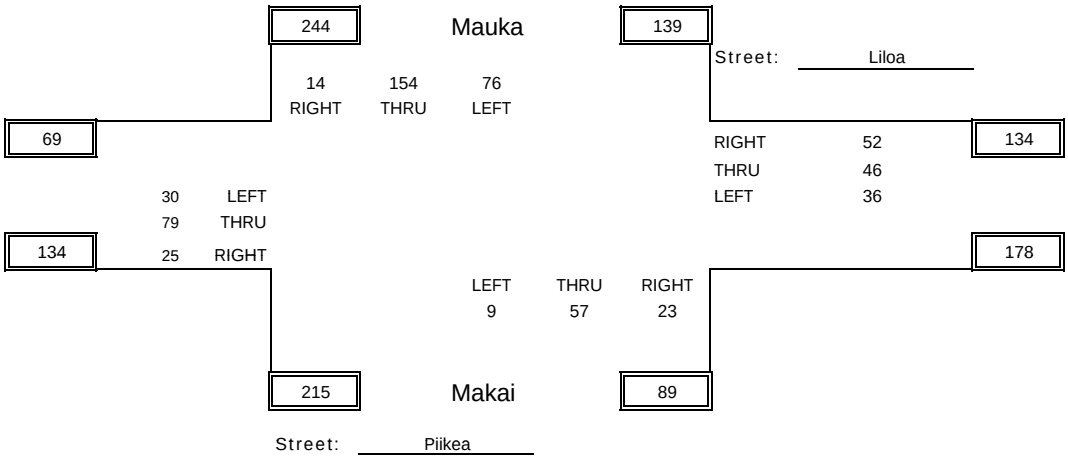

Street: Liloa

Street: Piikea

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6:30 AM - 6:45 AM | 7 | 10 | 10 | 5 | 20 | 4 | 8 | 4 | 1 | 2 | 22 | 2 | 95 | 492 |
| 6:45 AM - 7:00 AM | 10 | 15 | 14 | 2 | 33 | 7 | 6 | 6 | 2 | 5 | 16 | 2 | 118 | 610 |
| 7:00 AM - 7:15 AM | 4 | 13 | 10 | 3 | 30 | 24 | 4 | 5 | 3 | 1 | 10 | 2 | 109 | 611 |
| 7:15 AM - 7:30 AM | 11 | 30 | 9 | 3 | 40 | 21 | 15 | 8 | 4 | 7 | 22 | 0 | 170 | 601 |
| 7:30 AM - 7:45 AM | 8 | 32 | 11 | 2 | 38 | 36 | 24 | 19 | 15 | 10 | 13 | 5 | 213 | 544 |
| 7:45 AM - 8:00 AM | 2 | 10 | 9 | 4 | 33 | 12 | 9 | 15 | 10 | 1 | 11 | 3 | 119 | |
| 8:00 AM - 8:15 AM | 4 | 7 | 1 | 5 | 43 | 7 | 4 | 4 | 7 | 5 | 11 | 1 | 99 | |
| 8:15 AM - 8:30 AM | 7 | 8 | 8 | 7 | 38 | 9 | 3 | 7 | 1 | 5 | 18 | 2 | 113 | |
| 8:30 AM - 8:45 AM | | | | | | | | | | | | | | |
| 8:45 AM - 9:00 AM | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| Phf | 0.568 | 0.617 | 0.682 | 0.700 | 0.895 | 0.528 | 0.542 | 0.605 | 0.600 | 0.575 | 0.648 | 0.450 | Peak | Phf |
| 7:15 AM - 8:15 AM | 25 | 79 | 30 | 14 | 154 | 76 | 52 | 46 | 36 | 23 | 57 | 9 | 601 | 0.705 |

## Peak Hour

7:15 AM - 8:15 AM




PARSONS
BRINCKERHOFF

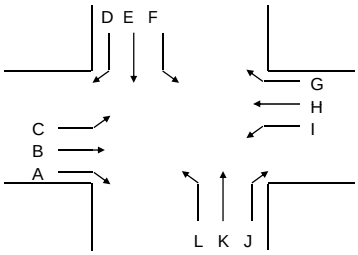
PM COUNT SHEET

Intersection: Liloa St & Piikea Ave

Date: 1/8/2013

By: Linda McLain

Weather: 0



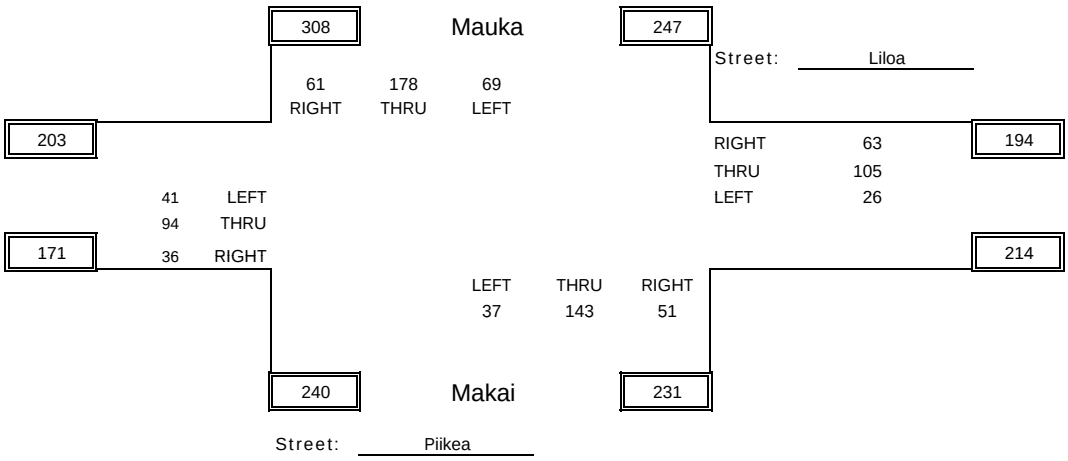

Street: Liloa

Street: Piikea

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3:15 PM - 3:30 PM | 8 | 30 | 2 | 5 | 50 | 5 | 10 | 27 | 1 | 10 | 53 | 17 | 218 | 944 |
| 3:30 PM - 3:45 PM | 2 | 17 | 8 | 11 | 65 | 12 | 8 | 28 | 2 | 16 | 38 | 13 | 220 | 952 |
| 3:45 PM - 4:00 PM | 17 | 32 | 1 | 23 | 53 | 20 | 23 | 33 | 10 | 16 | 46 | 21 | 295 | 904 |
| 4:00 PM - 4:15 PM | 8 | 21 | 11 | 13 | 48 | 15 | 17 | 25 | 6 | 2 | 35 | 10 | 211 | 759 |
| 4:15 PM - 4:30 PM | 9 | 20 | 17 | 17 | 43 | 17 | 10 | 24 | 5 | 20 | 40 | 4 | 226 | 672 |
| 4:30 PM - 4:45 PM | 2 | 21 | 12 | 8 | 34 | 17 | 13 | 23 | 5 | 13 | 22 | 2 | 172 | |
| 4:45 PM - 5:00 PM | 7 | 13 | 4 | 6 | 35 | 13 | 8 | 23 | 7 | 6 | 25 | 3 | 150 | |
| 5:00 PM - 5:15 PM | 3 | 17 | 8 | 5 | 31 | 1 | 11 | 18 | 2 | 2 | 20 | 6 | 124 | |
| 5:15 PM - 5:30 PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | |
| Phf | 0.529 | 0.734 | 0.603 | 0.663 | 0.840 | 0.863 | 0.685 | 0.795 | 0.650 | 0.638 | 0.777 | 0.440 | Peak | Phf |
| 3:45 PM - 4:45 PM | 36 | 94 | 41 | 61 | 178 | 69 | 63 | 105 | 26 | 51 | 143 | 37 | 904 | 0.766 |

## Peak Hour

3:45 PM - 4:45 PM




PARSONS
BRINCKERHOFF

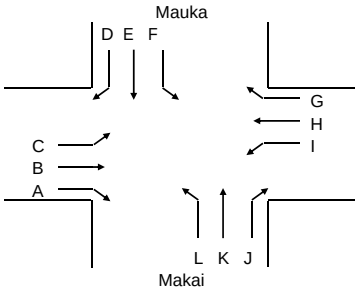
AM COUNT SHEET

Intersection: Liloa Dr & Liloa St

Date: 11/17/2010

By: 0

Weather: 0



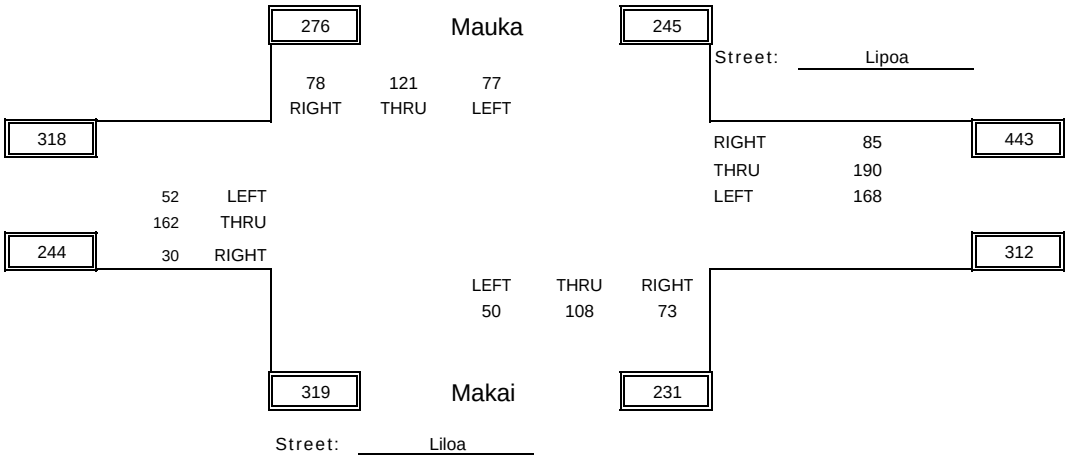

Street: Lipoa

Street: Liloa

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6:30 AM - 6:45 AM | 1 | 25 | 5 | 3 | 10 | 11 | 7 | 18 | 17 | 12 | 1 | 2 | 112 | 736 |
| 6:45 AM - 7:00 AM | 5 | 29 | 4 | 10 | 13 | 9 | 9 | 32 | 24 | 8 | 1 | 0 | 144 | 1033 |
| 7:00 AM - 7:15 AM | 8 | 23 | 12 | 10 | 19 | 12 | 5 | 19 | 38 | 21 | 15 | 6 | 188 | 1224 |
| 7:15 AM - 7:30 AM | 18 | 43 | 9 | 14 | 14 | 34 | 21 | 42 | 47 | 23 | 17 | 10 | 292 | 1194 |
| 7:30 AM - 7:45 AM | 7 | 48 | 17 | 17 | 67 | 28 | 20 | 44 | 84 | 24 | 44 | 9 | 409 | 1037 |
| 7:45 AM - 8:00 AM | 3 | 42 | 14 | 27 | 32 | 11 | 36 | 63 | 28 | 14 | 35 | 30 | 335 | |
| 8:00 AM - 8:15 AM | 2 | 29 | 12 | 20 | 8 | 4 | 8 | 41 | 9 | 12 | 12 | 1 | 158 | |
| 8:15 AM - 8:30 AM | 3 | 23 | 9 | 15 | 11 | 2 | 4 | 38 | 14 | 7 | 5 | 4 | 135 | |
| 8:30 AM - 8:45 AM | | | | | | | | | | | | | | |
| 8:45 AM - 9:00 AM | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| Phf | 0.417 | 0.844 | 0.765 | 0.722 | 0.451 | 0.566 | 0.590 | 0.754 | 0.500 | 0.760 | 0.614 | 0.417 | Peak | Phf |
| 7:15 AM - 8:15 AM | 30 | 162 | 52 | 78 | 121 | 77 | 85 | 190 | 168 | 73 | 108 | 50 | 1194 | 0.730 |

## Peak Hour

7:15 AM - 8:15 AM




PARSONS
BRINCKERHOFF

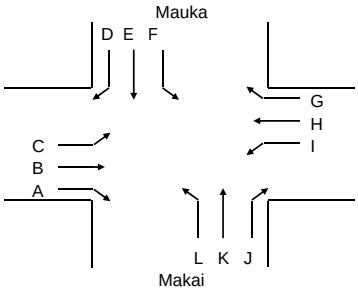
PM COUNT SHEET

Intersection: Liloa Dr & Liloa St

Date: 11/17/2010

By: 0

Weather: 0



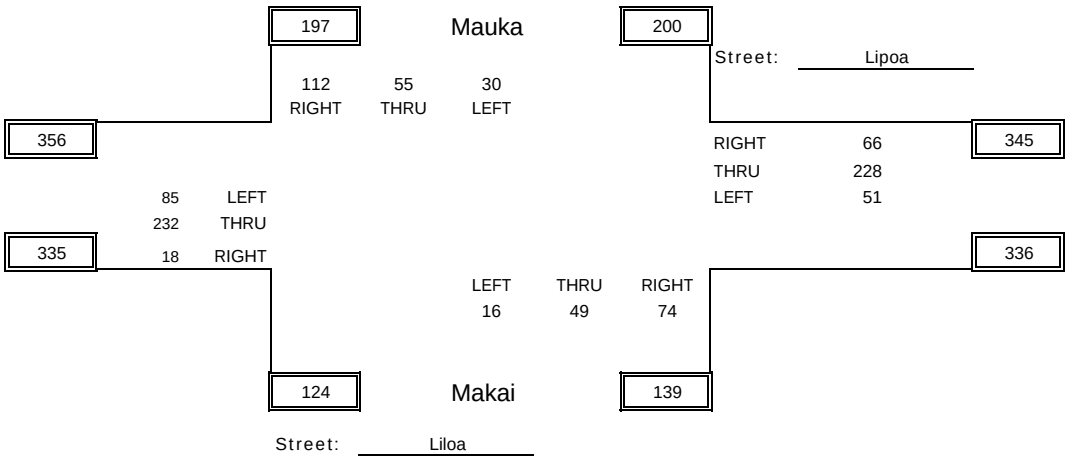

Street: Lipoa

Street: Liloa

| TIME | A | B | C | D | E | F | G | H | I | J | K | L | Total Mvmt | Total Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3:30 PM - 3:45 PM | 3 | 58 | 15 | 27 | 9 | 6 | 27 | 52 | 18 | 31 | 26 | 3 | 275 | 1071 |
| 3:45 PM - 4:00 PM | 4 | 55 | 31 | 25 | 17 | 4 | 14 | 57 | 10 | 28 | 17 | 4 | 266 | 1016 |
| 4:00 PM - 4:15 PM | 9 | 60 | 23 | 35 | 13 | 8 | 15 | 58 | 15 | 13 | 9 | 3 | 261 | 1008 |
| 4:15 PM - 4:30 PM | 1 | 80 | 15 | 23 | 6 | 8 | 18 | 65 | 16 | 21 | 10 | 6 | 269 | 970 |
| 4:30 PM - 4:45 PM | 4 | 37 | 16 | 29 | 19 | 10 | 19 | 48 | 10 | 12 | 13 | 3 | 220 | 919 |
| 4:45 PM - 5:00 PM | 1 | 70 | 16 | 24 | 11 | 7 | 20 | 62 | 10 | 12 | 18 | 7 | 258 | |
| 5:00 PM - 5:15 PM | 3 | 68 | 19 | 14 | 8 | 10 | 12 | 41 | 13 | 16 | 15 | 4 | 223 | |
| 5:00 PM - 5:15 PM | 4 | 54 | 15 | 26 | 2 | 5 | 21 | 45 | 12 | 20 | 10 | 4 | 218 | |
| 5:15 PM - 5:30 PM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | |
| Phf | 0.500 | 0.725 | 0.685 | 0.800 | 0.724 | 0.750 | 0.868 | 0.877 | 0.797 | 0.661 | 0.721 | 0.667 | Peak | Phf |
| 3:45 PM - 4:45 PM | 18 | 232 | 85 | 112 | 55 | 30 | 66 | 228 | 51 | 74 | 49 | 16 | 1016 | 0.924 |

## Peak Hour

3:45 PM - 4:45 PM




PARSONS
BRINCKERHOFF

# Appendix B Level of Service Definitions

The Highway Capacity Manual defines six Intersection Levels of Service (LOS), labeled A through F, from free flow to congested conditions.

Levels of Service for signalized intersections is defined in terms of control delay, which is a measure of driver discomfort, frustration, fuel consumption, and increased travel time. The delay experienced by a motorist is made up of a number of factors that relate to control, geometrics, traffic, and incidents. Total delay is the difference between the travel time actually experienced and the reference travel time that would result during base conditions: in the absence of traffic control, geometric delay, any incidents, and any other vehicles. Specifically, LOS criteria for traffic signals are stated in terms of the average control delay per vehicle, typically for a 15-minute analysis period. Delay is a complex measure and depends on a number of variables, including the quality of progression, the cycle length, the green ratio, and the v/c ratio for the lane group.

LEVEL-OF-SERVICE A: Low control delay, up to 10 s/veh. This LOS occurs when progression is extremely favorable and most vehicles arrive during the green phase. Many vehicles do not stop at all. Short cycle lengths may tend to contribute to low delay values.

LEVEL-OF-SERVICE B: Control delay greater than 10 and up to 20 s/veh. This level generally occurs with good progression, short cycle lengths, or both. More vehicles stop than with LOS A, causing higher levels of delay.

LEVEL-OF-SERVICE C: Control delay greater than 20 and up to 35 s/veh. These higher delays may result from only fair progression, longer cycle lengths, or both. Individual cycle failures may begin to appear at this level. Cycle failure occurs when a given green phase does not serve queued vehicles, and overflows occur. The number of vehicles stopping is significant at this level, though many still pass through the intersection without stopping.

LEVEL-OF-SERVICE D: Control delay greater than 35 and up to 55 s/veh. At LOS D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, and high v/c ratios.

Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

LEVEL-OF-SERVICE E: Control delay greater than 55 and up to 80 s/veh. These high delay values generally indicate poor progression, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent.

LEVEL-OF-SERVICE F: Control delay in excess of 80 s/veh. This level, considered unacceptable to most drivers, often occurs with oversaturation, that is when arrival flow rates exceed the capacity of lane groups. It may also occur at high v/c ratios with many individual cycle failures. Poor progression and long cycle lengths may also contribute significantly to high delay levels.

For unsignalized intersections, the Highway Capacity Manual evaluates gaps in the major street traffic flow and calculates available gaps for left-turns across oncoming traffic and for the left and right-turns onto the major roadway from the minor street. Average control delay, based on these factors, is still used to define the levels of service.

LEVEL-OF-SERVICE A: Low control delay, up to 10 s/veh.

LEVEL-OF-SERVICE B: Control delay greater than 10 and up to 15 s/veh.

LEVEL-OF-SERVICE C: Control delay greater than 15 and up to 25 s/veh.

LEVEL-OF-SERVICE D: Control delay greater than 25 and up to 35 s/veh.

LEVEL-OF-SERVICE E: Control delay greater than 35 and up to 50 s/veh.

LEVEL-OF-SERVICE F: Control delay in excess of 50 s/veh.

# Appendix C Intersection Capacity Analysis Worksheets

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 6 | 24 | 961 | 4 | 33 | 1083 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 7 | 26 | 1045 | 4 | 36 | 1177 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 1707 | 524 | | | 1049 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1707 | 524 | | | 1049 | |
| tC, single (s) | 6.8 | 6.9 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 92 | 95 | | | 95 | |
| cM capacity (veh/h) | 78 | 498 | | | 659 | |

| Direction, Lane # | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 33 | 696 | 353 | 36 | 589 | 589 |
| Volume Left | 7 | 0 | 0 | 36 | 0 | 0 |
| Volume Right | 26 | 0 | 4 | 0 | 0 | 0 |
| cSH | 239 | 1700 | 1700 | 659 | 1700 | 1700 |
| Volume to Capacity | 0.14 | 0.41 | 0.21 | 0.05 | 0.35 | 0.35 |
| Queue Length 95th (ft) | 12 | 0 | 0 | 4 | 0 | 0 |
| Control Delay (s) | 22.4 | 0.0 | 0.0 | 10.8 | 0.0 | 0.0 |
| Lane LOS | C | | | B | | |
| Approach Delay (s) | 22.4 | 0.0 | | 0.3 | | |
| Approach LOS | C | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.5 | | |
| Intersection Capacity Utilization | 39.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 116 | 58 | 31 | 954 | 1058 | 108 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 126 | 63 | 34 | 1037 | 1150 | 117 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 1736 | 575 | 1150 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1736 | 575 | 1150 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 29 | 90 | 93 | | | |
| cM capacity (veh/h) | 177 | 629 | 458 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 189 | 34 | 518 | 518 | 575 | 575 | 117 |
| Volume Left | 126 | 34 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 63 | 0 | 0 | 0 | 0 | 0 | 117 |
| cSH | 265 | 458 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.71 | 0.07 | 0.30 | 0.30 | 0.34 | 0.34 | 0.07 |
| Queue Length 95th (ft) | 123 | 6 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 46.7 | 13.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | E | B | | | | | |
| Approach Delay (s) | 46.7 | 0.4 | | | 0.0 | | |
| Approach LOS | E | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.7 | | |
| Intersection Capacity Utilization | 42.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 29 | 11 | 11 | 56 | 11 | 69 | 3 | 405 | 47 | 38 | 365 | 9 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.98 | | 1.00 | 1.00 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1759 | | | 1788 | 1583 | 1770 | 1834 | | 1770 | 1856 | |
| Flt Permitted | | 0.78 | | | 0.72 | 1.00 | 0.49 | 1.00 | | 0.35 | 1.00 | |
| Satd. Flow (perm) | | 1415 | | | 1345 | 1583 | 922 | 1834 | | 645 | 1856 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 32 | 12 | 12 | 61 | 12 | 75 | 3 | 440 | 51 | 41 | 397 | 10 |
| RTOR Reduction (vph) | 0 | 10 | 0 | 0 | 0 | 62 | 0 | 6 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 46 | 0 | 0 | 73 | 13 | 3 | 485 | 0 | 41 | 406 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 6.1 | | | 6.1 | 6.1 | 13.7 | 13.2 | | 14.9 | 13.8 | |
| Effective Green, g (s) | | 6.1 | | | 6.1 | 6.1 | 13.7 | 13.2 | | 14.9 | 13.8 | |
| Actuated g/C Ratio | | 0.17 | | | 0.17 | 0.17 | 0.39 | 0.37 | | 0.42 | 0.39 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 244 | | | 232 | 273 | 369 | 684 | | 306 | 724 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.26 | | c0.00 | 0.22 | |
| v/s Ratio Perm | | 0.03 | | | c0.05 | 0.01 | 0.00 | | | 0.05 | | |
| v/c Ratio | | 0.19 | | | 0.31 | 0.05 | 0.01 | 0.71 | | 0.13 | 0.56 | |
| Uniform Delay, d1 | | 12.5 | | | 12.8 | 12.2 | 6.7 | 9.5 | | 6.3 | 8.4 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.4 | | | 0.8 | 0.1 | 0.0 | 3.4 | | 0.2 | 1.0 | |
| Delay (s) | | 12.9 | | | 13.6 | 12.3 | 6.7 | 12.8 | | 6.5 | 9.4 | |
| Level of Service | | B | | | B | B | A | B | | A | A | |
| Approach Delay (s) | | 12.9 | | | 12.9 | | | 12.8 | | | 9.2 | |
| Approach LOS | | B | | | B | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 11.4 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.56 | | |
| Actuated Cycle Length (s) | 35.4 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 49.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 231 | 13 | 96 | 6 | 1 | 14 | 101 | 933 | 36 | 130 | 1064 | 332 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.95 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1779 | 1583 | | 1785 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.95 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1779 | 1583 | | 1785 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 251 | 14 | 104 | 7 | 1 | 15 | 110 | 1014 | 39 | 141 | 1157 | 361 |
| RTOR Reduction (vph) | 0 | 0 | 81 | 0 | 0 | 15 | 0 | 0 | 23 | 0 | 0 | 170 |
| Lane Group Flow (vph) | 0 | 265 | 23 | 0 | 8 | 0 | 110 | 1014 | 16 | 141 | 1157 | 191 |
| Turn Type | Split | | Perm | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | 4 | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | | 23.0 | 23.0 | | 3.3 | 3.3 | 12.1 | 43.9 | 43.9 | 13.8 | 45.6 | 45.6 |
| Effective Green, g (s) | | 23.0 | 23.0 | | 3.3 | 3.3 | 12.1 | 43.9 | 43.9 | 13.8 | 45.6 | 45.6 |
| Actuated g/C Ratio | | 0.22 | 0.22 | | 0.03 | 0.03 | 0.11 | 0.41 | 0.41 | 0.13 | 0.43 | 0.43 |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 386 | 343 | | 56 | 49 | 202 | 1466 | 656 | 230 | 1522 | 681 |
| v/s Ratio Prot | | c0.15 | | | c0.00 | | 0.06 | 0.29 | | c0.08 | c0.33 | |
| v/s Ratio Perm | | | 0.01 | | | 0.00 | | | 0.01 | | | 0.12 |
| v/c Ratio | | 0.69 | 0.07 | | 0.14 | 0.01 | 0.54 | 0.69 | 0.02 | 0.61 | 0.76 | 0.28 |
| Uniform Delay, d1 | | 38.2 | 33.0 | | 50.0 | 49.8 | 44.3 | 25.5 | 18.4 | 43.6 | 25.6 | 19.6 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 5.0 | 0.1 | | 1.2 | 0.1 | 3.0 | 1.4 | 0.0 | 4.8 | 2.3 | 0.2 |
| Delay (s) | | 43.2 | 33.0 | | 51.1 | 49.8 | 47.3 | 26.9 | 18.4 | 48.4 | 27.9 | 19.8 |
| Level of Service | | D | C | | D | D | D | C | B | D | C | B |
| Approach Delay (s) | | 40.3 | | | 50.3 | | | 28.6 | | | 27.8 | |
| Approach LOS | | D | | | D | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 29.7 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.66 | | |
| Actuated Cycle Length (s) | 106.0 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 69.3% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 20 | 24 | 58 | 70 | 18 | 148 | 24 | 340 | 102 | 122 | 288 | 6 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1821 | 1583 | | 1792 | 1583 | 1770 | 1863 | 1583 | 1770 | 1857 | |
| Flt Permitted | | 0.83 | 1.00 | | 0.74 | 1.00 | 0.57 | 1.00 | 1.00 | 0.43 | 1.00 | |
| Satd. Flow (perm) | | 1542 | 1583 | | 1375 | 1583 | 1055 | 1863 | 1583 | 809 | 1857 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 26 | 63 | 76 | 20 | 161 | 26 | 370 | 111 | 133 | 313 | 7 |
| RTOR Reduction (vph) | 0 | 0 | 51 | 0 | 0 | 130 | 0 | 0 | 67 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 48 | 12 | 0 | 96 | 31 | 26 | 370 | 44 | 133 | 319 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 8.7 | 8.7 | | 8.7 | 8.7 | 18.8 | 17.8 | 17.8 | 22.8 | 19.8 | |
| Effective Green, g (s) | | 8.7 | 8.7 | | 8.7 | 8.7 | 18.8 | 17.8 | 17.8 | 22.8 | 19.8 | |
| Actuated g/C Ratio | | 0.20 | 0.20 | | 0.20 | 0.20 | 0.42 | 0.40 | 0.40 | 0.51 | 0.44 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 301 | 309 | | 269 | 309 | 462 | 745 | 633 | 479 | 826 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.20 | | c0.02 | 0.17 | |
| v/s Ratio Perm | | 0.03 | 0.01 | | c0.07 | 0.02 | 0.02 | | 0.03 | 0.12 | | |
| v/c Ratio | | 0.16 | 0.04 | | 0.36 | 0.10 | 0.06 | 0.50 | 0.07 | 0.28 | 0.39 | |
| Uniform Delay, d1 | | 14.9 | 14.5 | | 15.5 | 14.7 | 7.5 | 10.0 | 8.2 | 5.9 | 8.3 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.2 | 0.1 | | 0.8 | 0.1 | 0.1 | 0.5 | 0.0 | 0.3 | 0.3 | |
| Delay (s) | | 15.1 | 14.6 | | 16.3 | 14.8 | 7.6 | 10.5 | 8.3 | 6.2 | 8.6 | |
| Level of Service | | B | B | | B | B | A | B | A | A | A | |
| Approach Delay (s) | | 14.8 | | | 15.4 | | | 9.9 | | | 7.9 | |
| Approach LOS | | B | | | B | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.7 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 44.5 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 48.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 279 | 205 | 131 | 1058 | 1347 | 358 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 303 | 223 | 142 | 1150 | 1464 | 389 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 184 |
| Lane Group Flow (vph) | 303 | 223 | 142 | 1150 | 1464 | 205 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 26.6 | 121.7 | 14.1 | 84.1 | 64.0 | 64.0 |
| Effective Green, g (s) | 26.6 | 121.7 | 14.1 | 84.1 | 64.0 | 64.0 |
| Actuated g/C Ratio | 0.22 | 1.00 | 0.12 | 0.69 | 0.53 | 0.53 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 387 | 1583 | 205 | 2446 | 1861 | 832 |
| v/s Ratio Prot | c0.17 | | c0.08 | 0.32 | c0.41 | |
| v/s Ratio Perm | | 0.14 | | | | 0.13 |
| v/c Ratio | 0.78 | 0.14 | 0.69 | 0.47 | 0.79 | 0.25 |
| Uniform Delay, d1 | 44.8 | 0.0 | 51.7 | 8.6 | 23.3 | 15.7 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 9.9 | 0.2 | 9.7 | 0.1 | 2.3 | 0.2 |
| Delay (s) | 54.8 | 0.2 | 61.4 | 8.7 | 25.6 | 15.9 |
| Level of Service | D | A | E | A | C | B |
| Approach Delay (s) | 31.6 | | | 14.5 | 23.6 | |
| Approach LOS | C | | | B | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 21.5 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.77 | | |
| Actuated Cycle Length (s) | 121.7 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 74.1% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 96 | 11 | 88 | 7 | 379 | 93 | 107 | 385 | 11 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1783 | 1583 | 1770 | 1863 | 1583 | 1770 | 3524 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.50 | 1.00 | 1.00 | 0.33 | 1.00 | |
| Satd. Flow (perm) | | | | | 1783 | 1583 | 934 | 1863 | 1583 | 619 | 3524 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 104 | 12 | 96 | 8 | 412 | 101 | 116 | 418 | 12 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 81 | 0 | 0 | 64 | 0 | 3 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 116 | 15 | 8 | 412 | 37 | 116 | 427 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 6.4 | 6.4 | 15.8 | 15.0 | 15.0 | 24.0 | 19.1 | |
| Effective Green, g (s) | | | | | 6.4 | 6.4 | 15.8 | 15.0 | 15.0 | 24.0 | 19.1 | |
| Actuated g/C Ratio | | | | | 0.15 | 0.15 | 0.38 | 0.36 | 0.36 | 0.58 | 0.46 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 276 | 245 | 374 | 677 | 575 | 496 | 1630 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.22 | | c0.03 | 0.12 | |
| v/s Ratio Perm | | | | | 0.07 | 0.01 | 0.01 | | 0.02 | 0.11 | | |
| v/c Ratio | | | | | 0.42 | 0.06 | 0.02 | 0.61 | 0.06 | 0.23 | 0.26 | |
| Uniform Delay, d1 | | | | | 15.8 | 14.9 | 7.9 | 10.8 | 8.6 | 4.5 | 6.8 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 1.0 | 0.1 | 0.0 | 1.6 | 0.0 | 0.2 | 0.1 | |
| Delay (s) | | | | | 16.8 | 15.0 | 7.9 | 12.3 | 8.6 | 4.8 | 6.9 | |
| Level of Service | | | | | B | B | A | B | A | A | A | |
| Approach Delay (s) | | 0.0 | | | 16.0 | | | 11.5 | | | 6.4 | |
| Approach LOS | | A | | | B | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.1 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.61 | | |
| Actuated Cycle Length (s) | 41.3 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 44.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 30 | 0 | 1306 | 1691 | 76 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 33 | 0 | 1420 | 1838 | 83 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2548 | 919 | 1838 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2548 | 919 | 1838 | | | |
| tC, single (s) | 6.8 | 6.9 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 100 | 88 | 100 | | | |
| cM capacity (veh/h) | 22 | 273 | 327 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 33 | 710 | 710 | 919 | 919 | 83 |
| Volume Left | 0 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 33 | 0 | 0 | 0 | 0 | 83 |
| cSH | 273 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.12 | 0.42 | 0.42 | 0.54 | 0.54 | 0.05 |
| Queue Length 95th (ft) | 10 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 19.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | C | | | | | |
| Approach Delay (s) | 19.9 | 0.0 | | 0.0 | | |
| Approach LOS | C | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.2 | | |
| Intersection Capacity Utilization | 56.7% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 52 | 162 | 30 | 168 | 190 | 85 | 50 | 108 | 73 | 77 | 121 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.98 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1819 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.63 | 1.00 | | 0.47 | 1.00 | 1.00 | 0.67 | 1.00 | 1.00 | 0.68 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1170 | 1819 | | 884 | 1863 | 1583 | 1253 | 1863 | 1583 | 1270 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 57 | 176 | 33 | 183 | 207 | 92 | 54 | 117 | 79 | 84 | 132 | 85 |
| RTOR Reduction (vph) | 0 | 7 | 0 | 0 | 0 | 52 | 0 | 0 | 66 | 0 | 0 | 71 |
| Lane Group Flow (vph) | 57 | 202 | 0 | 183 | 207 | 40 | 54 | 117 | 13 | 84 | 132 | 14 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 14.7 | 13.4 | | 23.3 | 17.7 | 17.7 | 6.6 | 6.6 | 6.6 | 6.6 | 6.6 | 6.6 |
| Effective Green, g (s) | 14.7 | 13.4 | | 23.3 | 17.7 | 17.7 | 6.6 | 6.6 | 6.6 | 6.6 | 6.6 | 6.6 |
| Actuated g/C Ratio | 0.36 | 0.33 | | 0.57 | 0.44 | 0.44 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 443 | 600 | | 630 | 812 | 690 | 204 | 303 | 257 | 206 | 303 | 257 |
| v/s Ratio Prot | 0.00 | 0.11 | | c0.04 | 0.11 | | | 0.06 | | | c0.07 | |
| v/s Ratio Perm | 0.04 | | | c0.13 | | 0.03 | 0.04 | | 0.01 | 0.07 | | 0.01 |
| v/c Ratio | 0.13 | 0.34 | | 0.29 | 0.25 | 0.06 | 0.26 | 0.39 | 0.05 | 0.41 | 0.44 | 0.05 |
| Uniform Delay, d1 | 8.5 | 10.2 | | 4.4 | 7.3 | 6.6 | 14.9 | 15.2 | 14.4 | 15.2 | 15.3 | 14.4 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.1 | 0.3 | | 0.3 | 0.2 | 0.0 | 0.7 | 0.8 | 0.1 | 1.3 | 1.0 | 0.1 |
| Delay (s) | 8.7 | 10.6 | | 4.6 | 7.4 | 6.7 | 15.6 | 16.0 | 14.4 | 16.6 | 16.3 | 14.4 |
| Level of Service | A | B | | A | A | A | B | B | B | B | B | B |
| Approach Delay (s) | | 10.2 | | | 6.2 | | | 15.4 | | | 15.9 | |
| Approach LOS | | B | | | A | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 11.0 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.37 | | |
| Actuated Cycle Length (s) | 40.6 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 46.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 5.8 |
| Intersection LOS | A |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 97 | 265 | 146 | 146 |
| Demand Flow Rate, veh/h | 99 | 270 | 149 | 150 |
| Vehicles Circulating, veh/h | 207 | 101 | 107 | 295 |
| Vehicles Exiting, veh/h | 238 | 155 | 198 | 76 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 5.0 | 6.2 | 5.0 | 6.2 |
| Approach LOS | A | A | A | A |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 99 | 270 | 149 | 150 |
| Cap Entry Lane, veh/h | 919 | 1021 | 1015 | 841 |
| Entry HV Adj Factor | 0.977 | 0.980 | 0.980 | 0.975 |
| Flow Entry, veh/h | 97 | 265 | 146 | 146 |
| Cap Entry, veh/h | 898 | 1001 | 995 | 820 |
| V/C Ratio | 1.08 | 2.64 | 1.47 | 1.78 |
| Control Delay, s/veh | 5.0 | 6.2 | 5.0 | 6.2 |
| LOS | A | A | A | A |
| 95th %tile Queue, veh | 0.0 | 0.1 | 0.1 | 0.1 |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 47 | 56 | 46 | 1260 | 1711 | 32 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 51 | 61 | 50 | 1370 | 1860 | 35 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2645 | 930 | 1895 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2645 | 930 | 1895 | | | |
| tC, single (s) | 6.8 | 6.9 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 77 | 84 | | | |
| cM capacity (veh/h) | 16 | 269 | 311 | | | |

| Direction, Lane # | EB 1 | EB 2 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|---|
| Volume Total | 51 | 61 | 50 | 685 | 685 | 930 | 930 | 35 |
| Volume Left | 51 | 0 | 50 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 61 | 0 | 0 | 0 | 0 | 0 | 35 |
| cSH | 16 | 269 | 311 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 3.24 | 0.23 | 0.16 | 0.40 | 0.40 | 0.55 | 0.55 | 0.02 |
| Queue Length 95th (ft) | Err | 21 | 14 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | Err | 22.3 | 18.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | C | C | | | | | |
| Approach Delay (s) | 4574.8 | | 0.7 | | | 0.0 | | |
| Approach LOS | F | | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 149.8 | | |
| Intersection Capacity Utilization | 57.4% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 24 | 198 | 61 | 1246 | 1545 | 24 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 26 | 215 | 66 | 1354 | 1679 | 26 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2489 | 840 | 1679 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2489 | 840 | 1679 | | | |
| tC, single (s) | 6.8 | 6.9 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 30 | 82 | | | |
| cM capacity (veh/h) | 20 | 309 | 377 | | | |

| Direction, Lane # | EB 1 | EB 2 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|---|
| Volume Total | 26 | 215 | 66 | 677 | 677 | 840 | 840 | 26 |
| Volume Left | 26 | 0 | 66 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 215 | 0 | 0 | 0 | 0 | 0 | 26 |
| cSH | 20 | 309 | 377 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 1.31 | 0.70 | 0.18 | 0.40 | 0.40 | 0.49 | 0.49 | 0.02 |
| Queue Length 95th (ft) | 89 | 122 | 16 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 591.5 | 39.6 | 16.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | E | C | | | | | |
| Approach Delay (s) | 99.3 | | 0.8 | | | 0.0 | | |
| Approach LOS | F | | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 7.4 | | |
| Intersection Capacity Utilization | 61.6% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 3 | 24 | 1353 | 0 | 8 | 1021 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 3 | 26 | 1471 | 0 | 9 | 1110 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2043 | 735 | | | 1471 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2043 | 735 | | | 1471 | |
| tC, single (s) | 6.8 | 6.9 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 93 | 93 | | | 98 | |
| cM capacity (veh/h) | 48 | 362 | | | 455 | |

| Direction, Lane # | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 29 | 980 | 490 | 9 | 555 | 555 |
| Volume Left | 3 | 0 | 0 | 9 | 0 | 0 |
| Volume Right | 26 | 0 | 0 | 0 | 0 | 0 |
| cSH | 209 | 1700 | 1700 | 455 | 1700 | 1700 |
| Volume to Capacity | 0.14 | 0.58 | 0.29 | 0.02 | 0.33 | 0.33 |
| Queue Length 95th (ft) | 12 | 0 | 0 | 1 | 0 | 0 |
| Control Delay (s) | 25.0 | 0.0 | 0.0 | 13.1 | 0.0 | 0.0 |
| Lane LOS | D | | | B | | |
| Approach Delay (s) | 25.0 | 0.0 | | 0.1 | | |
| Approach LOS | D | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.3 | | |
| Intersection Capacity Utilization | 47.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 132 | 57 | 106 | 1271 | 972 | 215 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 143 | 62 | 115 | 1382 | 1057 | 234 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 1978 | 528 | 1057 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1978 | 528 | 1057 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 91 | 77 | | | |
| cM capacity (veh/h) | 115 | 658 | 509 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 205 | 115 | 691 | 691 | 528 | 528 | 234 |
| Volume Left | 143 | 115 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 62 | 0 | 0 | 0 | 0 | 0 | 234 |
| cSH | 160 | 509 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 1.29 | 0.23 | 0.41 | 0.41 | 0.31 | 0.31 | 0.14 |
| Queue Length 95th (ft) | 302 | 22 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 223.4 | 14.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | B | | | | | |
| Approach Delay (s) | 223.4 | 1.1 | | | 0.0 | | |
| Approach LOS | F | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 15.9 | | |
| Intersection Capacity Utilization | 50.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 34 | 7 | 13 | 110 | 17 | 59 | 18 | 657 | 71 | 44 | 693 | 31 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 0.99 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1748 | | | 1785 | 1583 | 1770 | 1836 | | 1770 | 1851 | |
| Flt Permitted | | 0.73 | | | 0.71 | 1.00 | 0.24 | 1.00 | | 0.19 | 1.00 | |
| Satd. Flow (perm) | | 1315 | | | 1327 | 1583 | 439 | 1836 | | 354 | 1851 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 37 | 8 | 14 | 120 | 18 | 64 | 20 | 714 | 77 | 48 | 753 | 34 |
| RTOR Reduction (vph) | 0 | 12 | 0 | 0 | 0 | 54 | 0 | 3 | 0 | 0 | 2 | 0 |
| Lane Group Flow (vph) | 0 | 47 | 0 | 0 | 138 | 10 | 20 | 788 | 0 | 48 | 785 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 9.5 | | | 9.5 | 9.5 | 36.0 | 35.4 | | 39.6 | 37.2 | |
| Effective Green, g (s) | | 9.5 | | | 9.5 | 9.5 | 36.0 | 35.4 | | 39.6 | 37.2 | |
| Actuated g/C Ratio | | 0.15 | | | 0.15 | 0.15 | 0.58 | 0.57 | | 0.64 | 0.60 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 201 | | | 202 | 241 | 266 | 1043 | | 280 | 1105 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.43 | | c0.01 | 0.42 | |
| v/s Ratio Perm | | 0.04 | | | c0.10 | 0.01 | 0.04 | | | 0.10 | | |
| v/c Ratio | | 0.23 | | | 0.68 | 0.04 | 0.08 | 0.76 | | 0.17 | 0.71 | |
| Uniform Delay, d1 | | 23.2 | | | 25.0 | 22.5 | 6.9 | 10.2 | | 7.0 | 8.8 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.6 | | | 9.2 | 0.1 | 0.1 | 3.2 | | 0.3 | 2.2 | |
| Delay (s) | | 23.8 | | | 34.1 | 22.6 | 7.1 | 13.3 | | 7.3 | 11.0 | |
| Level of Service | | C | | | C | C | A | B | | A | B | |
| Approach Delay (s) | | 23.8 | | | 30.5 | | | 13.2 | | | 10.8 | |
| Approach LOS | | C | | | C | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 14.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.71 | | |
| Actuated Cycle Length (s) | 62.3 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 58.4% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 232 | 10 | 59 | 28 | 30 | 63 | 180 | 1210 | 13 | 79 | 1110 | 163 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.95 | 1.00 | | 0.98 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1778 | 1583 | | 1819 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.95 | 1.00 | | 0.98 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1778 | 1583 | | 1819 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 252 | 11 | 64 | 30 | 33 | 68 | 196 | 1315 | 14 | 86 | 1207 | 177 |
| RTOR Reduction (vph) | 0 | 0 | 51 | 0 | 0 | 62 | 0 | 0 | 6 | 0 | 0 | 81 |
| Lane Group Flow (vph) | 0 | 263 | 13 | 0 | 63 | 6 | 196 | 1315 | 8 | 86 | 1207 | 96 |
| Turn Type | Split | | Perm | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | 4 | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | | 24.1 | 24.1 | | 10.0 | 10.0 | 14.5 | 54.3 | 54.3 | 11.1 | 50.9 | 50.9 |
| Effective Green, g (s) | | 24.1 | 24.1 | | 10.0 | 10.0 | 14.5 | 54.3 | 54.3 | 11.1 | 50.9 | 50.9 |
| Actuated g/C Ratio | | 0.20 | 0.20 | | 0.08 | 0.08 | 0.12 | 0.45 | 0.45 | 0.09 | 0.42 | 0.42 |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 353 | 314 | | 150 | 130 | 211 | 1582 | 707 | 162 | 1483 | 663 |
| v/s Ratio Prot | | c0.15 | | | c0.03 | | c0.11 | c0.37 | | 0.05 | 0.34 | |
| v/s Ratio Perm | | | 0.01 | | | 0.00 | | | 0.00 | | | 0.06 |
| v/c Ratio | | 0.75 | 0.04 | | 0.42 | 0.04 | 0.93 | 0.83 | 0.01 | 0.53 | 0.81 | 0.14 |
| Uniform Delay, d1 | | 45.8 | 39.4 | | 53.0 | 51.3 | 53.0 | 29.6 | 18.7 | 52.7 | 31.1 | 21.8 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 8.3 | 0.1 | | 1.9 | 0.1 | 42.0 | 3.9 | 0.0 | 3.3 | 3.5 | 0.1 |
| Delay (s) | | 54.1 | 39.4 | | 54.9 | 51.5 | 95.0 | 33.4 | 18.7 | 56.0 | 34.7 | 21.9 |
| Level of Service | | D | D | | D | D | F | C | B | E | C | C |
| Approach Delay (s) | | 51.2 | | | 53.1 | | | 41.2 | | | 34.4 | |
| Approach LOS | | D | | | D | | | D | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 39.7 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.81 | | |
| Actuated Cycle Length (s) | 121.5 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 74.9% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 39 | 37 | 58 | 134 | 35 | 117 | 71 | 547 | 129 | 64 | 665 | 28 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1816 | 1583 | | 1792 | 1583 | 1770 | 1863 | 1583 | 1770 | 1852 | |
| Flt Permitted | | 0.78 | 1.00 | | 0.72 | 1.00 | 0.16 | 1.00 | 1.00 | 0.30 | 1.00 | |
| Satd. Flow (perm) | | 1461 | 1583 | | 1333 | 1583 | 289 | 1863 | 1583 | 554 | 1852 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 42 | 40 | 63 | 146 | 38 | 127 | 77 | 595 | 140 | 70 | 723 | 30 |
| RTOR Reduction (vph) | 0 | 0 | 49 | 0 | 0 | 99 | 0 | 0 | 68 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 82 | 14 | 0 | 184 | 28 | 77 | 595 | 72 | 70 | 752 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 17.1 | 17.1 | | 17.1 | 17.1 | 45.4 | 39.4 | 39.4 | 43.6 | 38.5 | |
| Effective Green, g (s) | | 17.1 | 17.1 | | 17.1 | 17.1 | 45.4 | 39.4 | 39.4 | 43.6 | 38.5 | |
| Actuated g/C Ratio | | 0.22 | 0.22 | | 0.22 | 0.22 | 0.59 | 0.51 | 0.51 | 0.57 | 0.50 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 326 | 353 | | 298 | 353 | 287 | 958 | 814 | 396 | 931 | |
| v/s Ratio Prot | | | | | | | c0.02 | 0.32 | | 0.01 | c0.41 | |
| v/s Ratio Perm | | 0.06 | 0.01 | | c0.14 | 0.02 | 0.14 | | 0.05 | 0.09 | | |
| v/c Ratio | | 0.25 | 0.04 | | 0.62 | 0.08 | 0.27 | 0.62 | 0.09 | 0.18 | 0.81 | |
| Uniform Delay, d1 | | 24.5 | 23.3 | | 26.8 | 23.5 | 10.6 | 13.3 | 9.5 | 8.5 | 15.9 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.4 | 0.0 | | 3.8 | 0.1 | 0.5 | 1.3 | 0.0 | 0.2 | 5.2 | |
| Delay (s) | | 24.9 | 23.4 | | 30.6 | 23.6 | 11.1 | 14.5 | 9.5 | 8.7 | 21.1 | |
| Level of Service | | C | C | | C | C | B | B | A | A | C | |
| Approach Delay (s) | | 24.2 | | | 27.7 | | | 13.3 | | | 20.1 | |
| Approach LOS | | C | | | C | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 18.9 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.70 | | |
| Actuated Cycle Length (s) | 76.6 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 69.1% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 313 | 339 | 252 | 1400 | 1137 | 385 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 340 | 368 | 274 | 1522 | 1236 | 418 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 236 |
| Lane Group Flow (vph) | 340 | 368 | 274 | 1522 | 1236 | 182 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 29.2 | 132.9 | 28.9 | 92.7 | 57.8 | 57.8 |
| Effective Green, g (s) | 29.2 | 132.9 | 28.9 | 92.7 | 57.8 | 57.8 |
| Actuated g/C Ratio | 0.22 | 1.00 | 0.22 | 0.70 | 0.43 | 0.43 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 389 | 1583 | 385 | 2469 | 1539 | 688 |
| v/s Ratio Prot | c0.19 | | c0.15 | 0.43 | c0.35 | |
| v/s Ratio Perm | | 0.23 | | | | 0.11 |
| v/c Ratio | 0.87 | 0.23 | 0.71 | 0.62 | 0.80 | 0.26 |
| Uniform Delay, d1 | 50.1 | 0.0 | 48.1 | 10.7 | 32.6 | 24.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 19.0 | 0.3 | 6.1 | 0.5 | 3.1 | 0.2 |
| Delay (s) | 69.1 | 0.3 | 54.2 | 11.1 | 35.7 | 24.2 |
| Level of Service | E | A | D | B | D | C |
| Approach Delay (s) | 33.4 | | | 17.7 | 32.8 | |
| Approach LOS | C | | | B | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 26.4 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.80 | | |
| Actuated Cycle Length (s) | 132.9 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 76.9% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 223 | 63 | 128 | 19 | 547 | 197 | 91 | 460 | 25 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1793 | 1583 | 1770 | 1863 | 1583 | 1770 | 3512 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.46 | 1.00 | 1.00 | 0.22 | 1.00 | |
| Satd. Flow (perm) | | | | | 1793 | 1583 | 850 | 1863 | 1583 | 406 | 3512 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 242 | 68 | 139 | 21 | 595 | 214 | 99 | 500 | 27 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 103 | 0 | 0 | 118 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 310 | 36 | 21 | 595 | 96 | 99 | 524 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 18.3 | 18.3 | 33.7 | 31.7 | 31.7 | 40.9 | 35.3 | |
| Effective Green, g (s) | | | | | 18.3 | 18.3 | 33.7 | 31.7 | 31.7 | 40.9 | 35.3 | |
| Actuated g/C Ratio | | | | | 0.26 | 0.26 | 0.48 | 0.45 | 0.45 | 0.58 | 0.50 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 465 | 410 | 432 | 837 | 711 | 343 | 1756 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.32 | | c0.02 | 0.15 | |
| v/s Ratio Perm | | | | | 0.17 | 0.02 | 0.02 | | 0.06 | 0.14 | | |
| v/c Ratio | | | | | 0.67 | 0.09 | 0.05 | 0.71 | 0.14 | 0.29 | 0.30 | |
| Uniform Delay, d1 | | | | | 23.4 | 19.8 | 9.8 | 15.7 | 11.4 | 9.2 | 10.4 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 3.6 | 0.1 | 0.0 | 2.9 | 0.1 | 0.5 | 0.1 | |
| Delay (s) | | | | | 27.0 | 19.9 | 9.8 | 18.6 | 11.5 | 9.6 | 10.5 | |
| Level of Service | | | | | C | B | A | B | B | A | B | |
| Approach Delay (s) | | 0.0 | | | 24.8 | | | 16.6 | | | 10.3 | |
| Approach LOS | | A | | | C | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 16.5 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.72 | | |
| Actuated Cycle Length (s) | 70.6 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 62.0% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 10 | 0 | 1627 | 1476 | 130 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 11 | 0 | 1768 | 1604 | 141 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2489 | 802 | 1604 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2489 | 802 | 1604 | | | |
| tC, single (s) | 6.8 | 6.9 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 100 | 97 | 100 | | | |
| cM capacity (veh/h) | 24 | 327 | 404 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 11 | 884 | 884 | 802 | 802 | 141 |
| Volume Left | 0 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 11 | 0 | 0 | 0 | 0 | 141 |
| cSH | 327 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.03 | 0.52 | 0.52 | 0.47 | 0.47 | 0.08 |
| Queue Length 95th (ft) | 3 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 16.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | C | | | | | |
| Approach Delay (s) | 16.4 | 0.0 | | 0.0 | | |
| Approach LOS | C | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.1 | | |
| Intersection Capacity Utilization | 50.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 85 | 232 | 18 | 51 | 228 | 66 | 16 | 49 | 74 | 30 | 55 | 112 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.99 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1842 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.58 | 1.00 | | 0.59 | 1.00 | 1.00 | 0.77 | 1.00 | 1.00 | 0.77 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1081 | 1842 | | 1103 | 1863 | 1583 | 1433 | 1863 | 1583 | 1433 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 92 | 252 | 20 | 55 | 248 | 72 | 17 | 53 | 80 | 33 | 60 | 122 |
| RTOR Reduction (vph) | 0 | 6 | 0 | 0 | 0 | 51 | 0 | 0 | 67 | 0 | 0 | 102 |
| Lane Group Flow (vph) | 92 | 266 | 0 | 55 | 248 | 21 | 17 | 53 | 13 | 33 | 60 | 20 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 11.7 | 9.8 | | 10.9 | 9.4 | 9.4 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 |
| Effective Green, g (s) | 11.7 | 9.8 | | 10.9 | 9.4 | 9.4 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 |
| Actuated g/C Ratio | 0.37 | 0.31 | | 0.35 | 0.30 | 0.30 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 443 | 573 | | 413 | 556 | 472 | 237 | 308 | 261 | 237 | 308 | 261 |
| v/s Ratio Prot | c0.01 | c0.14 | | 0.01 | 0.13 | | | 0.03 | | | c0.03 | |
| v/s Ratio Perm | 0.06 | | | 0.04 | | 0.01 | 0.01 | | 0.01 | 0.02 | | 0.01 |
| v/c Ratio | 0.21 | 0.46 | | 0.13 | 0.45 | 0.05 | 0.07 | 0.17 | 0.05 | 0.14 | 0.19 | 0.08 |
| Uniform Delay, d1 | 6.6 | 8.7 | | 7.0 | 8.9 | 7.9 | 11.1 | 11.3 | 11.1 | 11.2 | 11.3 | 11.1 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.2 | 0.6 | | 0.1 | 0.6 | 0.0 | 0.1 | 0.3 | 0.1 | 0.3 | 0.3 | 0.1 |
| Delay (s) | 6.8 | 9.3 | | 7.1 | 9.5 | 7.9 | 11.2 | 11.6 | 11.2 | 11.5 | 11.7 | 11.2 |
| Level of Service | A | A | | A | A | A | B | B | B | B | B | B |
| Approach Delay (s) | | 8.7 | | | 8.9 | | | 11.3 | | | 11.4 | |
| Approach LOS | | A | | | A | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.6 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.28 | | |
| Actuated Cycle Length (s) | 31.5 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 37.5% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 7.2 |
| Intersection LOS | A |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 250 | 334 | 210 | 186 |
| Demand Flow Rate, veh/h | 255 | 340 | 214 | 190 |
| Vehicles Circulating, veh/h | 226 | 186 | 245 | 302 |
| Vehicles Exiting, veh/h | 266 | 273 | 236 | 224 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 7.1 | 7.9 | 6.7 | 6.8 |
| Approach LOS | A | A | A | A |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 255 | 340 | 214 | 190 |
| Cap Entry Lane, veh/h | 901 | 938 | 884 | 835 |
| Entry HV Adj Factor | 0.980 | 0.983 | 0.980 | 0.979 |
| Flow Entry, veh/h | 250 | 334 | 210 | 186 |
| Cap Entry, veh/h | 883 | 922 | 867 | 818 |
| V/C Ratio | 2.83 | 3.62 | 2.42 | 2.27 |
| Control Delay, s/veh | 7.1 | 7.9 | 6.7 | 6.8 |
| LOS | A | A | A | A |
| 95th %tile Queue, veh | 0.1 | 0.2 | 0.1 | 0.1 |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 19 | 65 | 81 | 1546 | 1541 | 78 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 21 | 71 | 88 | 1680 | 1675 | 85 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2691 | 838 | 1760 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2691 | 838 | 1760 | | | |
| tC, single (s) | 6.8 | 6.9 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 77 | 75 | | | |
| cM capacity (veh/h) | 13 | 310 | 351 | | | |

| Direction, Lane # | EB 1 | EB 2 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|---|
| Volume Total | 21 | 71 | 88 | 840 | 840 | 838 | 838 | 85 |
| Volume Left | 21 | 0 | 88 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 71 | 0 | 0 | 0 | 0 | 0 | 85 |
| cSH | 13 | 310 | 351 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 1.58 | 0.23 | 0.25 | 0.49 | 0.49 | 0.49 | 0.49 | 0.05 |
| Queue Length 95th (ft) | 82 | 22 | 24 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 872.3 | 20.0 | 18.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | C | C | | | | | |
| Approach Delay (s) | 212.8 | | 0.9 | | | 0.0 | | |
| Approach LOS | F | | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 5.8 | | |
| Intersection Capacity Utilization | 60.4% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 19 | 130 | 110 | 1455 | 1489 | 35 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 21 | 141 | 120 | 1582 | 1618 | 38 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2648 | 809 | 1618 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2648 | 809 | 1618 | | | |
| tC, single (s) | 6.8 | 6.9 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 56 | 70 | | | |
| cM capacity (veh/h) | 13 | 323 | 399 | | | |

| Direction, Lane # | EB 1 | EB 2 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|---|
| Volume Total | 21 | 141 | 120 | 791 | 791 | 809 | 809 | 38 |
| Volume Left | 21 | 0 | 120 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 141 | 0 | 0 | 0 | 0 | 0 | 38 |
| cSH | 13 | 323 | 399 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 1.58 | 0.44 | 0.30 | 0.47 | 0.47 | 0.48 | 0.48 | 0.02 |
| Queue Length 95th (ft) | 82 | 53 | 31 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 871.4 | 24.5 | 17.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | C | C | | | | | |
| Approach Delay (s) | 132.5 | | 1.3 | | | 0.0 | | |
| Approach LOS | F | | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 6.7 | | |
| Intersection Capacity Utilization | 60.6% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 47 | 71 | 56 | 154 | 12 | 56 | 46 | 1515 | 283 | 117 | 1810 | 32 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 4.0 | 6.0 | 6.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1826 | 1583 | | 1780 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.69 | 1.00 | | 0.58 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1291 | 1583 | | 1087 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 51 | 77 | 61 | 167 | 13 | 61 | 50 | 1647 | 308 | 127 | 1967 | 35 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 128 | 61 | 0 | 180 | 61 | 50 | 1647 | 308 | 127 | 1967 | 35 |
| Turn Type | Perm | | Free | Perm | | Free | Prot | | Free | Prot | | Free |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | Free | 8 | | Free | | | Free | | | Free |
| Actuated Green, G (s) | | 25.1 | 124.7 | | 25.1 | 124.7 | 6.4 | 69.9 | 124.7 | 12.7 | 76.2 | 124.7 |
| Effective Green, g (s) | | 25.1 | 124.7 | | 25.1 | 124.7 | 6.4 | 69.9 | 124.7 | 12.7 | 76.2 | 124.7 |
| Actuated g/C Ratio | | 0.20 | 1.00 | | 0.20 | 1.00 | 0.05 | 0.56 | 1.00 | 0.10 | 0.61 | 1.00 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 260 | 1583 | | 219 | 1583 | 91 | 1984 | 1583 | 180 | 2163 | 1583 |
| v/s Ratio Prot | | | | | | | 0.03 | 0.47 | | c0.07 | c0.56 | |
| v/s Ratio Perm | | 0.10 | 0.04 | | c0.17 | 0.04 | | | 0.19 | | | 0.02 |
| v/c Ratio | | 0.49 | 0.04 | | 0.82 | 0.04 | 0.55 | 0.83 | 0.19 | 0.71 | 0.91 | 0.02 |
| Uniform Delay, d1 | | 44.2 | 0.0 | | 47.7 | 0.0 | 57.7 | 22.5 | 0.0 | 54.2 | 21.2 | 0.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 1.5 | 0.0 | | 21.3 | 0.0 | 6.6 | 3.1 | 0.3 | 11.9 | 6.1 | 0.0 |
| Delay (s) | | 45.6 | 0.0 | | 69.0 | 0.0 | 64.4 | 25.6 | 0.3 | 66.1 | 27.3 | 0.0 |
| Level of Service | | D | A | | E | A | E | C | A | E | C | A |
| Approach Delay (s) | | 30.9 | | | 51.5 | | | 22.7 | | | 29.2 | |
| Approach LOS | | C | | | D | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 27.6 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.90 | | |
| Actuated Cycle Length (s) | 124.7 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 83.4% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 6 | 24 | 1179 | 4 | 33 | 1328 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 7 | 26 | 1282 | 4 | 36 | 1443 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2077 | 643 | | | 1286 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2077 | 643 | | | 1286 | |
| tC, single (s) | 6.8 | 6.9 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 85 | 94 | | | 93 | |
| cM capacity (veh/h) | 43 | 416 | | | 535 | |

| Direction, Lane # | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 33 | 854 | 432 | 36 | 722 | 722 |
| Volume Left | 7 | 0 | 0 | 36 | 0 | 0 |
| Volume Right | 26 | 0 | 4 | 0 | 0 | 0 |
| cSH | 152 | 1700 | 1700 | 535 | 1700 | 1700 |
| Volume to Capacity | 0.21 | 0.50 | 0.25 | 0.07 | 0.42 | 0.42 |
| Queue Length 95th (ft) | 19 | 0 | 0 | 5 | 0 | 0 |
| Control Delay (s) | 34.9 | 0.0 | 0.0 | 12.2 | 0.0 | 0.0 |
| Lane LOS | D | | | B | | |
| Approach Delay (s) | 34.9 | 0.0 | | 0.3 | | |
| Approach LOS | D | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.6 | | |
| Intersection Capacity Utilization | 46.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 111 | 58 | 31 | 1170 | 1298 | 108 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 121 | 63 | 34 | 1272 | 1411 | 117 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2114 | 705 | 1411 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2114 | 705 | 1411 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 89 | 90 | | | |
| cM capacity (veh/h) | 116 | 554 | 342 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 184 | 34 | 636 | 636 | 705 | 705 | 117 |
| Volume Left | 121 | 34 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 63 | 0 | 0 | 0 | 0 | 0 | 117 |
| cSH | 174 | 342 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 1.06 | 0.10 | 0.37 | 0.37 | 0.41 | 0.41 | 0.07 |
| Queue Length 95th (ft) | 224 | 8 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 138.6 | 16.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | C | | | | | |
| Approach Delay (s) | 138.6 | 0.4 | | | 0.0 | | |
| Approach LOS | F | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 8.6 | | |
| Intersection Capacity Utilization | 48.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 29 | 11 | 11 | 56 | 11 | 69 | 3 | 497 | 47 | 38 | 448 | 9 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1759 | | | 1788 | 1583 | 1770 | 1839 | | 1770 | 1857 | |
| Flt Permitted | | 0.78 | | | 0.72 | 1.00 | 0.42 | 1.00 | | 0.31 | 1.00 | |
| Satd. Flow (perm) | | 1415 | | | 1345 | 1583 | 784 | 1839 | | 580 | 1857 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 32 | 12 | 12 | 61 | 12 | 75 | 3 | 540 | 51 | 41 | 487 | 10 |
| RTOR Reduction (vph) | 0 | 10 | 0 | 0 | 0 | 64 | 0 | 5 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 46 | 0 | 0 | 73 | 11 | 3 | 586 | 0 | 41 | 496 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 6.3 | | | 6.3 | 6.3 | 22.1 | 21.6 | | 23.3 | 22.2 | |
| Effective Green, g (s) | | 6.3 | | | 6.3 | 6.3 | 22.1 | 21.6 | | 23.3 | 22.2 | |
| Actuated g/C Ratio | | 0.14 | | | 0.14 | 0.14 | 0.50 | 0.49 | | 0.53 | 0.50 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 203 | | | 193 | 227 | 405 | 903 | | 337 | 937 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.32 | | c0.00 | 0.27 | |
| v/s Ratio Perm | | 0.03 | | | c0.05 | 0.01 | 0.00 | | | 0.06 | | |
| v/c Ratio | | 0.23 | | | 0.38 | 0.05 | 0.01 | 0.65 | | 0.12 | 0.53 | |
| Uniform Delay, d1 | | 16.7 | | | 17.1 | 16.3 | 5.5 | 8.4 | | 5.5 | 7.4 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.6 | | | 1.2 | 0.1 | 0.0 | 1.6 | | 0.2 | 0.5 | |
| Delay (s) | | 17.3 | | | 18.3 | 16.3 | 5.6 | 10.0 | | 5.7 | 7.9 | |
| Level of Service | | B | | | B | B | A | A | | A | A | |
| Approach Delay (s) | | 17.3 | | | 17.3 | | | 10.0 | | | 7.7 | |
| Approach LOS | | B | | | B | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.2 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.57 | | |
| Actuated Cycle Length (s) | 44.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 49.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 269 | 13 | 118 | 6 | 1 | 14 | 124 | 1144 | 36 | 130 | 1305 | 407 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.95 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1778 | 1583 | | 1785 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.95 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1778 | 1583 | | 1785 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 292 | 14 | 128 | 7 | 1 | 15 | 135 | 1243 | 39 | 141 | 1418 | 442 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 148 |
| Lane Group Flow (vph) | 0 | 306 | 128 | 0 | 8 | 15 | 135 | 1243 | 23 | 141 | 1418 | 294 |
| Turn Type | Split | | Free | Split | | Free | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | Free | | | 2 | | | 6 |
| Actuated Green, G (s) | | 25.2 | 121.0 | | 1.3 | 121.0 | 13.5 | 58.7 | 58.7 | 13.8 | 59.0 | 59.0 |
| Effective Green, g (s) | | 25.2 | 121.0 | | 1.3 | 121.0 | 13.5 | 58.7 | 58.7 | 13.8 | 59.0 | 59.0 |
| Actuated g/C Ratio | | 0.21 | 1.00 | | 0.01 | 1.00 | 0.11 | 0.49 | 0.49 | 0.11 | 0.49 | 0.49 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 370 | 1583 | | 19 | 1583 | 197 | 1717 | 768 | 202 | 1726 | 772 |
| v/s Ratio Prot | | c0.17 | | | c0.00 | | 0.08 | 0.35 | | c0.08 | c0.40 | |
| v/s Ratio Perm | | | c0.08 | | | 0.01 | | | 0.01 | | | 0.19 |
| v/c Ratio | | 0.83 | 0.08 | | 0.42 | 0.01 | 0.69 | 0.72 | 0.03 | 0.70 | 0.82 | 0.38 |
| Uniform Delay, d1 | | 45.8 | 0.0 | | 59.5 | 0.0 | 51.7 | 24.7 | 16.3 | 51.6 | 26.5 | 19.5 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 14.0 | 0.1 | | 14.4 | 0.0 | 9.5 | 1.5 | 0.0 | 10.0 | 3.3 | 0.3 |
| Delay (s) | | 59.8 | 0.1 | | 73.8 | 0.0 | 61.2 | 26.3 | 16.3 | 61.6 | 29.8 | 19.8 |
| Level of Service | | E | A | | E | A | E | C | B | E | C | B |
| Approach Delay (s) | | 42.2 | | | 25.7 | | | 29.3 | | | 29.8 | |
| Approach LOS | | D | | | C | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 31.0 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.76 | | |
| Actuated Cycle Length (s) | 121.0 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 79.4% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 20 | 24 | 58 | 70 | 18 | 148 | 24 | 417 | 102 | 122 | 353 | 6 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1821 | 1583 | | 1792 | 1583 | 1770 | 1863 | 1583 | 1770 | 1858 | |
| Flt Permitted | | 0.83 | 1.00 | | 0.74 | 1.00 | 0.53 | 1.00 | 1.00 | 0.32 | 1.00 | |
| Satd. Flow (perm) | | 1554 | 1583 | | 1375 | 1583 | 989 | 1863 | 1583 | 600 | 1858 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 26 | 63 | 76 | 20 | 161 | 26 | 453 | 111 | 133 | 384 | 7 |
| RTOR Reduction (vph) | 0 | 0 | 51 | 0 | 0 | 131 | 0 | 0 | 65 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 48 | 12 | 0 | 96 | 30 | 26 | 453 | 46 | 133 | 390 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 9.7 | 9.7 | | 9.7 | 9.7 | 23.3 | 21.4 | 21.4 | 30.9 | 25.2 | |
| Effective Green, g (s) | | 9.7 | 9.7 | | 9.7 | 9.7 | 23.3 | 21.4 | 21.4 | 30.9 | 25.2 | |
| Actuated g/C Ratio | | 0.19 | 0.19 | | 0.19 | 0.19 | 0.45 | 0.41 | 0.41 | 0.60 | 0.49 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 291 | 296 | | 257 | 296 | 474 | 770 | 654 | 487 | 904 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.24 | | c0.03 | c0.21 | |
| v/s Ratio Perm | | 0.03 | 0.01 | | c0.07 | 0.02 | 0.02 | | 0.03 | 0.13 | | |
| v/c Ratio | | 0.16 | 0.04 | | 0.37 | 0.10 | 0.05 | 0.59 | 0.07 | 0.27 | 0.43 | |
| Uniform Delay, d1 | | 17.7 | 17.2 | | 18.4 | 17.4 | 8.0 | 11.8 | 9.2 | 5.5 | 8.6 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.3 | 0.1 | | 0.9 | 0.2 | 0.0 | 1.2 | 0.0 | 0.3 | 0.3 | |
| Delay (s) | | 17.9 | 17.3 | | 19.3 | 17.6 | 8.0 | 12.9 | 9.2 | 5.8 | 9.0 | |
| Level of Service | | B | B | | B | B | A | B | A | A | A | |
| Approach Delay (s) | | 17.6 | | | 18.2 | | | 12.0 | | | 8.2 | |
| Approach LOS | | B | | | B | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 12.2 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.57 | | |
| Actuated Cycle Length (s) | 51.8 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 52.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 361 | 251 | 161 | 1298 | 1652 | 439 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 392 | 273 | 175 | 1411 | 1796 | 477 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 196 |
| Lane Group Flow (vph) | 392 | 273 | 175 | 1411 | 1796 | 281 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 29.2 | 149.3 | 15.1 | 109.1 | 88.0 | 88.0 |
| Effective Green, g (s) | 29.2 | 149.3 | 15.1 | 109.1 | 88.0 | 88.0 |
| Actuated g/C Ratio | 0.20 | 1.00 | 0.10 | 0.73 | 0.59 | 0.59 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 346 | 1583 | 179 | 2586 | 2086 | 933 |
| v/s Ratio Prot | c0.22 | | c0.10 | 0.40 | c0.51 | |
| v/s Ratio Perm | | 0.17 | | | | 0.18 |
| v/c Ratio | 1.13 | 0.17 | 0.98 | 0.55 | 0.86 | 0.30 |
| Uniform Delay, d1 | 60.1 | 0.0 | 66.9 | 9.0 | 25.6 | 15.3 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 89.5 | 0.2 | 60.1 | 0.2 | 3.9 | 0.2 |
| Delay (s) | 149.5 | 0.2 | 127.0 | 9.2 | 29.5 | 15.5 |
| Level of Service | F | A | F | A | C | B |
| Approach Delay (s) | 88.2 | | | 22.2 | 26.5 | |
| Approach LOS | F | | | C | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 34.1 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.93 | | |
| Actuated Cycle Length (s) | 149.3 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 88.8% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 96 | 11 | 88 | 7 | 465 | 93 | 107 | 472 | 11 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1783 | 1583 | 1770 | 1863 | 1583 | 1770 | 3527 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.46 | 1.00 | 1.00 | 0.32 | 1.00 | |
| Satd. Flow (perm) | | | | | 1783 | 1583 | 852 | 1863 | 1583 | 595 | 3527 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 104 | 12 | 96 | 8 | 505 | 101 | 116 | 513 | 12 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 0 | 54 | 0 | 2 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 116 | 13 | 8 | 505 | 47 | 116 | 523 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 6.5 | 6.5 | 23.1 | 22.6 | 22.6 | 30.5 | 26.3 | |
| Effective Green, g (s) | | | | | 6.5 | 6.5 | 23.1 | 22.6 | 22.6 | 30.5 | 26.3 | |
| Actuated g/C Ratio | | | | | 0.13 | 0.13 | 0.48 | 0.47 | 0.47 | 0.63 | 0.54 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 240 | 213 | 417 | 872 | 741 | 478 | 1920 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.27 | | c0.02 | 0.15 | |
| v/s Ratio Perm | | | | | 0.07 | 0.01 | 0.01 | | 0.03 | 0.13 | | |
| v/c Ratio | | | | | 0.48 | 0.06 | 0.02 | 0.58 | 0.06 | 0.24 | 0.27 | |
| Uniform Delay, d1 | | | | | 19.3 | 18.2 | 6.6 | 9.4 | 7.0 | 4.4 | 5.9 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 1.5 | 0.1 | 0.0 | 0.9 | 0.0 | 0.3 | 0.1 | |
| Delay (s) | | | | | 20.9 | 18.4 | 6.6 | 10.3 | 7.1 | 4.7 | 6.0 | |
| Level of Service | | | | | C | B | A | B | A | A | A | |
| Approach Delay (s) | | 0.0 | | | 19.7 | | | 9.7 | | | 5.7 | |
| Approach LOS | | A | | | B | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.4 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.61 | | |
| Actuated Cycle Length (s) | 48.3 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 48.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 30 | 0 | 1602 | 2074 | 76 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 33 | 0 | 1741 | 2254 | 83 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 3125 | 1127 | 2254 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 3125 | 1127 | 2254 | | | |
| tC, single (s) | 6.8 | 6.9 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 100 | 84 | 100 | | | |
| cM capacity (veh/h) | 9 | 199 | 225 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 33 | 871 | 871 | 1127 | 1127 | 83 |
| Volume Left | 0 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 33 | 0 | 0 | 0 | 0 | 83 |
| cSH | 199 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.16 | 0.51 | 0.51 | 0.66 | 0.66 | 0.05 |
| Queue Length 95th (ft) | 14 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 26.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | D | | | | | |
| Approach Delay (s) | 26.7 | 0.0 | | 0.0 | | |
| Approach LOS | D | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.2 | | |
| Intersection Capacity Utilization | 67.3% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 52 | 162 | 30 | 168 | 190 | 85 | 50 | 132 | 73 | 77 | 148 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.98 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1819 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.63 | 1.00 | | 0.47 | 1.00 | 1.00 | 0.66 | 1.00 | 1.00 | 0.67 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1170 | 1819 | | 874 | 1863 | 1583 | 1220 | 1863 | 1583 | 1240 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 57 | 176 | 33 | 183 | 207 | 92 | 54 | 143 | 79 | 84 | 161 | 85 |
| RTOR Reduction (vph) | 0 | 7 | 0 | 0 | 0 | 58 | 0 | 0 | 61 | 0 | 0 | 65 |
| Lane Group Flow (vph) | 57 | 202 | 0 | 183 | 207 | 34 | 54 | 143 | 18 | 84 | 161 | 20 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 13.7 | 11.6 | | 21.5 | 15.5 | 15.5 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 |
| Effective Green, g (s) | 13.7 | 11.6 | | 21.5 | 15.5 | 15.5 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 |
| Actuated g/C Ratio | 0.32 | 0.27 | | 0.51 | 0.36 | 0.36 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 407 | 496 | | 569 | 679 | 577 | 284 | 434 | 369 | 289 | 434 | 369 |
| v/s Ratio Prot | 0.01 | c0.11 | | c0.05 | 0.11 | | | 0.08 | | | c0.09 | |
| v/s Ratio Perm | 0.04 | | | 0.12 | | 0.02 | 0.04 | | 0.01 | 0.07 | | 0.01 |
| v/c Ratio | 0.14 | 0.41 | | 0.32 | 0.30 | 0.06 | 0.19 | 0.33 | 0.05 | 0.29 | 0.37 | 0.05 |
| Uniform Delay, d1 | 10.1 | 12.6 | | 6.0 | 9.6 | 8.8 | 13.1 | 13.5 | 12.7 | 13.4 | 13.7 | 12.7 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.2 | 0.5 | | 0.3 | 0.3 | 0.0 | 0.3 | 0.4 | 0.1 | 0.6 | 0.5 | 0.1 |
| Delay (s) | 10.2 | 13.2 | | 6.3 | 9.9 | 8.8 | 13.4 | 14.0 | 12.7 | 14.0 | 14.2 | 12.7 |
| Level of Service | B | B | | A | A | A | B | B | B | B | B | B |
| Approach Delay (s) | | 12.6 | | | 8.3 | | | 13.5 | | | 13.8 | |
| Approach LOS | | B | | | A | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 11.5 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.47 | | |
| Actuated Cycle Length (s) | 42.5 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 47.5% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 5.9 |
| Intersection LOS | A |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 97 | 265 | 155 | 161 |
| Demand Flow Rate, veh/h | 99 | 270 | 158 | 165 |
| Vehicles Circulating, veh/h | 222 | 110 | 107 | 295 |
| Vehicles Exiting, veh/h | 238 | 155 | 213 | 85 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 5.1 | 6.3 | 5.1 | 6.4 |
| Approach LOS | A | A | A | A |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 99 | 270 | 158 | 165 |
| Cap Entry Lane, veh/h | 905 | 1012 | 1015 | 841 |
| Entry HV Adj Factor | 0.977 | 0.980 | 0.980 | 0.976 |
| Flow Entry, veh/h | 97 | 265 | 155 | 161 |
| Cap Entry, veh/h | 885 | 992 | 995 | 821 |
| V/C Ratio | 1.09 | 2.67 | 1.56 | 1.96 |
| Control Delay, s/veh | 5.1 | 6.3 | 5.1 | 6.4 |
| LOS | A | A | A | A |
| 95th %tile Queue, veh | 0.0 | 0.1 | 0.1 | 0.1 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 24 | 69 | 198 | 81 | 43 | 83 | 61 | 1429 | 128 | 131 | 1680 | 24 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.88 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 26 | 75 | 215 | 88 | 47 | 90 | 66 | 1553 | 139 | 142 | 1826 | 26 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 0 | 31 | 0 | 0 | 5 |
| Lane Group Flow (vph) | 26 | 75 | 215 | 88 | 47 | 7 | 66 | 1553 | 108 | 142 | 1826 | 21 |
| Turn Type | Split | | Free | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 8.4 | 8.4 | 116.0 | 8.6 | 8.6 | 8.6 | 6.7 | 66.8 | 66.8 | 10.2 | 70.3 | 70.3 |
| Effective Green, g (s) | 8.4 | 8.4 | 116.0 | 8.6 | 8.6 | 8.6 | 6.7 | 66.8 | 66.8 | 10.2 | 70.3 | 70.3 |
| Actuated g/C Ratio | 0.07 | 0.07 | 1.00 | 0.07 | 0.07 | 0.07 | 0.06 | 0.58 | 0.58 | 0.09 | 0.61 | 0.61 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 128 | 135 | 1583 | 255 | 138 | 207 | 102 | 2038 | 912 | 302 | 2145 | 959 |
| v/s Ratio Prot | 0.01 | c0.04 | | c0.03 | 0.03 | | 0.04 | 0.44 | | c0.04 | c0.52 | |
| v/s Ratio Perm | | | 0.14 | | | 0.00 | | | 0.07 | | | 0.01 |
| v/c Ratio | 0.20 | 0.56 | 0.14 | 0.35 | 0.34 | 0.03 | 0.65 | 0.76 | 0.12 | 0.47 | 0.85 | 0.02 |
| Uniform Delay, d1 | 50.6 | 52.0 | 0.0 | 51.0 | 51.0 | 49.8 | 53.5 | 18.6 | 11.2 | 50.3 | 18.6 | 9.1 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.8 | 4.9 | 0.2 | 0.8 | 1.5 | 0.1 | 13.3 | 1.7 | 0.1 | 1.2 | 3.5 | 0.0 |
| Delay (s) | 51.4 | 56.9 | 0.2 | 51.8 | 52.5 | 49.9 | 66.8 | 20.3 | 11.3 | 51.5 | 22.1 | 9.1 |
| Level of Service | D | E | A | D | D | D | E | C | B | D | C | A |
| Approach Delay (s) | | 17.9 | | | 51.2 | | | 21.4 | | | 24.0 | |
| Approach LOS | | B | | | D | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 23.9 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.77 | | |
| Actuated Cycle Length (s) | 116.0 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 73.0% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 15 | 65 | 80 | 6 | 28 | 81 | 2157 | 61 | 25 | 2068 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 4.0 | 6.0 | 6.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.97 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1811 | 1583 | | 1780 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.80 | 1.00 | | 0.71 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1495 | 1583 | | 1332 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 21 | 16 | 71 | 87 | 7 | 30 | 88 | 2345 | 66 | 27 | 2248 | 85 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 37 | 71 | 0 | 94 | 30 | 88 | 2345 | 66 | 27 | 2248 | 85 |
| Turn Type | Perm | | Free | Perm | | Free | Prot | | Free | Prot | | Free |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | Free | 8 | | Free | | | Free | | | Free |
| Actuated Green, G (s) | | 13.7 | 122.5 | | 13.7 | 122.5 | 8.8 | 87.0 | 122.5 | 4.8 | 83.0 | 122.5 |
| Effective Green, g (s) | | 13.7 | 122.5 | | 13.7 | 122.5 | 8.8 | 87.0 | 122.5 | 4.8 | 83.0 | 122.5 |
| Actuated g/C Ratio | | 0.11 | 1.00 | | 0.11 | 1.00 | 0.07 | 0.71 | 1.00 | 0.04 | 0.68 | 1.00 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 167 | 1583 | | 149 | 1583 | 127 | 2513 | 1583 | 69 | 2398 | 1583 |
| v/s Ratio Prot | | | | | | | c0.05 | c0.66 | | 0.02 | 0.64 | |
| v/s Ratio Perm | | 0.02 | 0.04 | | c0.07 | 0.02 | | | 0.04 | | | 0.05 |
| v/c Ratio | | 0.22 | 0.04 | | 0.63 | 0.02 | 0.69 | 0.93 | 0.04 | 0.39 | 0.94 | 0.05 |
| Uniform Delay, d1 | | 49.5 | 0.0 | | 52.0 | 0.0 | 55.5 | 15.3 | 0.0 | 57.4 | 17.5 | 0.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 0.7 | 0.1 | | 8.4 | 0.0 | 15.1 | 7.2 | 0.0 | 3.6 | 7.8 | 0.1 |
| Delay (s) | | 50.2 | 0.1 | | 60.4 | 0.0 | 70.6 | 22.4 | 0.0 | 61.1 | 25.3 | 0.1 |
| Level of Service | | D | A | | E | A | E | C | A | E | C | A |
| Approach Delay (s) | | 17.2 | | | 45.8 | | | 23.5 | | | 24.8 | |
| Approach LOS | | B | | | D | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 24.5 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.91 | | |
| Actuated Cycle Length (s) | 122.5 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 87.9% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 3 | 24 | 1660 | 0 | 8 | 1252 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 3 | 26 | 1804 | 0 | 9 | 1361 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2502 | 902 | | | 1804 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2502 | 902 | | | 1804 | |
| tC, single (s) | 6.8 | 6.9 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 86 | 91 | | | 97 | |
| cM capacity (veh/h) | 23 | 281 | | | 337 | |

| Direction, Lane # | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 29 | 1203 | 601 | 9 | 680 | 680 |
| Volume Left | 3 | 0 | 0 | 9 | 0 | 0 |
| Volume Right | 26 | 0 | 0 | 0 | 0 | 0 |
| cSH | 125 | 1700 | 1700 | 337 | 1700 | 1700 |
| Volume to Capacity | 0.23 | 0.71 | 0.35 | 0.03 | 0.40 | 0.40 |
| Queue Length 95th (ft) | 21 | 0 | 0 | 2 | 0 | 0 |
| Control Delay (s) | 42.4 | 0.0 | 0.0 | 15.9 | 0.0 | 0.0 |
| Lane LOS | E | | | C | | |
| Approach Delay (s) | 42.4 | 0.0 | | 0.1 | | |
| Approach LOS | E | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.4 | | |
| Intersection Capacity Utilization | 55.9% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 125 | 57 | 106 | 1559 | 1192 | 215 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 136 | 62 | 115 | 1695 | 1296 | 234 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2373 | 648 | 1296 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2373 | 648 | 1296 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 89 | 70 | | | |
| cM capacity (veh/h) | 69 | 586 | 389 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 198 | 115 | 847 | 847 | 648 | 648 | 234 |
| Volume Left | 136 | 115 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 62 | 0 | 0 | 0 | 0 | 0 | 234 |
| cSH | 96 | 389 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 2.06 | 0.30 | 0.50 | 0.50 | 0.38 | 0.38 | 0.14 |
| Queue Length 95th (ft) | 426 | 30 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 582.6 | 18.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | C | | | | | |
| Approach Delay (s) | 582.6 | 1.2 | | | 0.0 | | |
| Approach LOS | F | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 33.2 | | |
| Intersection Capacity Utilization | 56.7% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 34 | 7 | 13 | 110 | 17 | 59 | 18 | 806 | 71 | 44 | 850 | 31 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 0.99 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1748 | | | 1785 | 1583 | 1770 | 1840 | | 1770 | 1853 | |
| Flt Permitted | | 0.73 | | | 0.71 | 1.00 | 0.14 | 1.00 | | 0.13 | 1.00 | |
| Satd. Flow (perm) | | 1315 | | | 1327 | 1583 | 254 | 1840 | | 239 | 1853 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 37 | 8 | 14 | 120 | 18 | 64 | 20 | 876 | 77 | 48 | 924 | 34 |
| RTOR Reduction (vph) | 0 | 12 | 0 | 0 | 0 | 55 | 0 | 3 | 0 | 0 | 2 | 0 |
| Lane Group Flow (vph) | 0 | 47 | 0 | 0 | 138 | 9 | 20 | 950 | 0 | 48 | 956 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 9.7 | | | 9.7 | 9.7 | 43.8 | 42.5 | | 45.0 | 43.1 | |
| Effective Green, g (s) | | 9.7 | | | 9.7 | 9.7 | 43.8 | 42.5 | | 45.0 | 43.1 | |
| Actuated g/C Ratio | | 0.14 | | | 0.14 | 0.14 | 0.63 | 0.62 | | 0.65 | 0.62 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 185 | | | 186 | 222 | 190 | 1132 | | 198 | 1156 | |
| v/s Ratio Prot | | | | | | | 0.00 | 0.52 | | c0.01 | c0.52 | |
| v/s Ratio Perm | | 0.04 | | | c0.10 | 0.01 | 0.06 | | | 0.15 | | |
| v/c Ratio | | 0.25 | | | 0.74 | 0.04 | 0.11 | 0.84 | | 0.24 | 0.83 | |
| Uniform Delay, d1 | | 26.5 | | | 28.5 | 25.7 | 9.0 | 10.6 | | 9.5 | 10.1 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.7 | | | 14.7 | 0.1 | 0.2 | 5.6 | | 0.6 | 5.0 | |
| Delay (s) | | 27.2 | | | 43.2 | 25.8 | 9.2 | 16.2 | | 10.1 | 15.1 | |
| Level of Service | | C | | | D | C | A | B | | B | B | |
| Approach Delay (s) | | 27.2 | | | 37.7 | | | 16.0 | | | 14.9 | |
| Approach LOS | | C | | | D | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 17.8 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.73 | | |
| Actuated Cycle Length (s) | 69.1 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 66.2% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 271 | 10 | 72 | 28 | 30 | 63 | 221 | 1484 | 13 | 79 | 1362 | 200 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.95 | 1.00 | | 0.98 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1777 | 1583 | | 1819 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.95 | 1.00 | | 0.98 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1777 | 1583 | | 1819 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 295 | 11 | 78 | 30 | 33 | 68 | 240 | 1613 | 14 | 86 | 1480 | 217 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 67 |
| Lane Group Flow (vph) | 0 | 306 | 78 | 0 | 63 | 68 | 240 | 1613 | 10 | 86 | 1480 | 150 |
| Turn Type | Split | | Free | Split | | Free | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | Free | | | 2 | | | 6 |
| Actuated Green, G (s) | | 30.1 | 153.7 | | 9.1 | 153.7 | 23.7 | 80.7 | 80.7 | 11.8 | 68.8 | 68.8 |
| Effective Green, g (s) | | 30.1 | 153.7 | | 9.1 | 153.7 | 23.7 | 80.7 | 80.7 | 11.8 | 68.8 | 68.8 |
| Actuated g/C Ratio | | 0.20 | 1.00 | | 0.06 | 1.00 | 0.15 | 0.53 | 0.53 | 0.08 | 0.45 | 0.45 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 348 | 1583 | | 108 | 1583 | 273 | 1858 | 831 | 136 | 1584 | 709 |
| v/s Ratio Prot | | c0.17 | | | c0.03 | | c0.14 | c0.46 | | 0.05 | c0.42 | |
| v/s Ratio Perm | | | 0.05 | | | 0.04 | | | 0.01 | | | 0.09 |
| v/c Ratio | | 0.88 | 0.05 | | 0.58 | 0.04 | 0.88 | 0.87 | 0.01 | 0.63 | 0.93 | 0.21 |
| Uniform Delay, d1 | | 60.0 | 0.0 | | 70.5 | 0.0 | 63.6 | 31.9 | 17.4 | 68.8 | 40.3 | 25.9 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 21.4 | 0.1 | | 7.8 | 0.1 | 25.8 | 4.6 | 0.0 | 9.2 | 10.6 | 0.1 |
| Delay (s) | | 81.4 | 0.1 | | 78.2 | 0.1 | 89.4 | 36.5 | 17.4 | 78.1 | 50.9 | 26.0 |
| Level of Service | | F | A | | E | A | F | D | B | E | D | C |
| Approach Delay (s) | | 64.9 | | | 37.7 | | | 43.1 | | | 49.2 | |
| Approach LOS | | E | | | D | | | D | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 47.5 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.94 | | |
| Actuated Cycle Length (s) | 153.7 | Sum of lost time (s) | 28.0 |
| Intersection Capacity Utilization | 86.3% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 39 | 37 | 58 | 134 | 35 | 117 | 71 | 671 | 129 | 64 | 816 | 28 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1816 | 1583 | | 1792 | 1583 | 1770 | 1863 | 1583 | 1770 | 1854 | |
| Flt Permitted | | 0.78 | 1.00 | | 0.72 | 1.00 | 0.10 | 1.00 | 1.00 | 0.24 | 1.00 | |
| Satd. Flow (perm) | | 1457 | 1583 | | 1333 | 1583 | 193 | 1863 | 1583 | 447 | 1854 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 42 | 40 | 63 | 146 | 38 | 127 | 77 | 729 | 140 | 70 | 887 | 30 |
| RTOR Reduction (vph) | 0 | 0 | 50 | 0 | 0 | 100 | 0 | 0 | 59 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 82 | 13 | 0 | 184 | 27 | 77 | 729 | 81 | 70 | 916 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 18.5 | 18.5 | | 18.5 | 18.5 | 54.2 | 50.5 | 50.5 | 52.6 | 49.7 | |
| Effective Green, g (s) | | 18.5 | 18.5 | | 18.5 | 18.5 | 54.2 | 50.5 | 50.5 | 52.6 | 49.7 | |
| Actuated g/C Ratio | | 0.21 | 0.21 | | 0.21 | 0.21 | 0.62 | 0.58 | 0.58 | 0.61 | 0.57 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 310 | 337 | | 284 | 337 | 188 | 1083 | 920 | 315 | 1060 | |
| v/s Ratio Prot | | | | | | | c0.02 | 0.39 | | 0.01 | c0.49 | |
| v/s Ratio Perm | | 0.06 | 0.01 | | c0.14 | 0.02 | 0.24 | | 0.05 | 0.13 | | |
| v/c Ratio | | 0.26 | 0.04 | | 0.65 | 0.08 | 0.41 | 0.67 | 0.09 | 0.22 | 0.86 | |
| Uniform Delay, d1 | | 28.5 | 27.1 | | 31.2 | 27.4 | 14.2 | 12.5 | 8.0 | 9.3 | 15.7 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.5 | 0.0 | | 5.0 | 0.1 | 1.5 | 1.7 | 0.0 | 0.4 | 7.5 | |
| Delay (s) | | 29.0 | 27.2 | | 36.2 | 27.5 | 15.7 | 14.2 | 8.1 | 9.7 | 23.2 | |
| Level of Service | | C | C | | D | C | B | B | A | A | C | |
| Approach Delay (s) | | 28.2 | | | 32.7 | | | 13.4 | | | 22.2 | |
| Approach LOS | | C | | | C | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 20.5 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.78 | | |
| Actuated Cycle Length (s) | 86.9 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 77.0% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 505 | 466 | 459 | 1717 | 1395 | 622 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 549 | 507 | 499 | 1866 | 1516 | 676 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 255 |
| Lane Group Flow (vph) | 549 | 507 | 499 | 1866 | 1516 | 421 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 29.3 | 163.3 | 30.4 | 123.0 | 86.6 | 86.6 |
| Effective Green, g (s) | 29.3 | 163.3 | 30.4 | 123.0 | 86.6 | 86.6 |
| Actuated g/C Ratio | 0.18 | 1.00 | 0.19 | 0.75 | 0.53 | 0.53 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 318 | 1583 | 330 | 2666 | 1877 | 839 |
| v/s Ratio Prot | c0.31 | | c0.28 | 0.53 | c0.43 | |
| v/s Ratio Perm | | 0.32 | | | | 0.27 |
| v/c Ratio | 1.73 | 0.32 | 1.51 | 0.70 | 0.81 | 0.50 |
| Uniform Delay, d1 | 67.0 | 0.0 | 66.5 | 10.5 | 31.5 | 24.5 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 339.8 | 0.5 | 245.6 | 0.8 | 2.7 | 0.5 |
| Delay (s) | 406.8 | 0.5 | 312.0 | 11.3 | 34.2 | 25.0 |
| Level of Service | F | A | F | B | C | C |
| Approach Delay (s) | 211.8 | | | 74.8 | 31.3 | |
| Approach LOS | F | | | E | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 83.6 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.14 | | |
| Actuated Cycle Length (s) | 163.3 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 106.1% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 223 | 63 | 128 | 19 | 671 | 197 | 91 | 564 | 25 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1793 | 1583 | 1770 | 1863 | 1583 | 1770 | 3517 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.41 | 1.00 | 1.00 | 0.16 | 1.00 | |
| Satd. Flow (perm) | | | | | 1793 | 1583 | 761 | 1863 | 1583 | 301 | 3517 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 242 | 68 | 139 | 21 | 729 | 214 | 99 | 613 | 27 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 104 | 0 | 0 | 107 | 0 | 3 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 310 | 35 | 21 | 729 | 107 | 99 | 637 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 19.5 | 19.5 | 40.3 | 39.1 | 39.1 | 46.7 | 42.3 | |
| Effective Green, g (s) | | | | | 19.5 | 19.5 | 40.3 | 39.1 | 39.1 | 46.7 | 42.3 | |
| Actuated g/C Ratio | | | | | 0.25 | 0.25 | 0.52 | 0.50 | 0.50 | 0.60 | 0.54 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 448 | 396 | 409 | 934 | 794 | 263 | 1907 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.39 | | c0.02 | 0.18 | |
| v/s Ratio Perm | | | | | 0.17 | 0.02 | 0.03 | | 0.07 | 0.20 | | |
| v/c Ratio | | | | | 0.69 | 0.09 | 0.05 | 0.78 | 0.14 | 0.38 | 0.33 | |
| Uniform Delay, d1 | | | | | 26.5 | 22.4 | 9.2 | 15.9 | 10.4 | 11.2 | 10.0 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 4.6 | 0.1 | 0.1 | 4.3 | 0.1 | 0.9 | 0.1 | |
| Delay (s) | | | | | 31.1 | 22.5 | 9.3 | 20.2 | 10.5 | 12.1 | 10.1 | |
| Level of Service | | | | | C | C | A | C | B | B | B | |
| Approach Delay (s) | | 0.0 | | | 28.4 | | | 17.8 | | | 10.3 | |
| Approach LOS | | A | | | C | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 17.5 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.79 | | |
| Actuated Cycle Length (s) | 78.0 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 68.5% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 10 | 0 | 1996 | 1811 | 130 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 11 | 0 | 2170 | 1968 | 141 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 3053 | 984 | 1968 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 3053 | 984 | 1968 | | | |
| tC, single (s) | 6.8 | 6.9 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 100 | 96 | 100 | | | |
| cM capacity (veh/h) | 10 | 247 | 291 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 11 | 1085 | 1085 | 984 | 984 | 141 |
| Volume Left | 0 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 11 | 0 | 0 | 0 | 0 | 141 |
| cSH | 247 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.04 | 0.64 | 0.64 | 0.58 | 0.58 | 0.08 |
| Queue Length 95th (ft) | 3 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 20.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | C | | | | | |
| Approach Delay (s) | 20.2 | 0.0 | | 0.0 | | |
| Approach LOS | C | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.1 | | |
| Intersection Capacity Utilization | 60.1% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 85 | 232 | 18 | 51 | 228 | 66 | 16 | 60 | 74 | 30 | 67 | 112 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.99 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1842 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.61 | 1.00 | | 0.51 | 1.00 | 1.00 | 0.74 | 1.00 | 1.00 | 0.74 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1127 | 1842 | | 951 | 1863 | 1583 | 1380 | 1863 | 1583 | 1380 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 92 | 252 | 20 | 55 | 248 | 72 | 17 | 65 | 80 | 33 | 73 | 122 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 0 | 48 | 0 | 0 | 66 | 0 | 0 | 101 |
| Lane Group Flow (vph) | 92 | 267 | 0 | 55 | 248 | 24 | 17 | 65 | 14 | 33 | 73 | 21 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 9.3 | 8.8 | | 12.1 | 10.2 | 10.2 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 |
| Effective Green, g (s) | 9.3 | 8.8 | | 12.1 | 10.2 | 10.2 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 |
| Actuated g/C Ratio | 0.30 | 0.28 | | 0.39 | 0.33 | 0.33 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 347 | 521 | | 420 | 611 | 519 | 240 | 323 | 275 | 240 | 323 | 275 |
| v/s Ratio Prot | 0.00 | c0.14 | | c0.01 | 0.13 | | | 0.03 | | | c0.04 | |
| v/s Ratio Perm | 0.07 | | | 0.04 | | 0.01 | 0.01 | | 0.01 | 0.02 | | 0.01 |
| v/c Ratio | 0.27 | 0.51 | | 0.13 | 0.41 | 0.05 | 0.07 | 0.20 | 0.05 | 0.14 | 0.23 | 0.08 |
| Uniform Delay, d1 | 8.1 | 9.4 | | 6.0 | 8.1 | 7.1 | 10.8 | 11.0 | 10.7 | 10.9 | 11.1 | 10.8 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.4 | 0.9 | | 0.1 | 0.4 | 0.0 | 0.1 | 0.3 | 0.1 | 0.3 | 0.4 | 0.1 |
| Delay (s) | 8.6 | 10.2 | | 6.2 | 8.5 | 7.2 | 10.9 | 11.3 | 10.8 | 11.1 | 11.4 | 10.9 |
| Level of Service | A | B | | A | A | A | B | B | B | B | B | B |
| Approach Delay (s) | | 9.8 | | | 7.9 | | | 11.0 | | | 11.1 | |
| Approach LOS | | A | | | A | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.6 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.37 | | |
| Actuated Cycle Length (s) | 31.1 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 37.5% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 7.5 |
| Intersection LOS | A |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 250 | 334 | 231 | 205 |
| Demand Flow Rate, veh/h | 255 | 340 | 236 | 209 |
| Vehicles Circulating, veh/h | 245 | 208 | 245 | 302 |
| Vehicles Exiting, veh/h | 266 | 273 | 255 | 246 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 7.3 | 8.2 | 7.0 | 7.1 |
| Approach LOS | A | A | A | A |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 255 | 340 | 236 | 209 |
| Cap Entry Lane, veh/h | 884 | 918 | 884 | 835 |
| Entry HV Adj Factor | 0.980 | 0.983 | 0.980 | 0.979 |
| Flow Entry, veh/h | 250 | 334 | 231 | 205 |
| Cap Entry, veh/h | 867 | 902 | 867 | 818 |
| V/C Ratio | 2.88 | 3.70 | 2.67 | 2.50 |
| Control Delay, s/veh | 7.3 | 8.2 | 7.0 | 7.1 |
| LOS | A | A | A | A |
| 95th %tile Queue, veh | 0.1 | 0.2 | 0.1 | 0.1 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 155 | 130 | 513 | 174 | 522 | 110 | 1617 | 477 | 483 | 1528 | 35 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.88 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 21 | 168 | 141 | 558 | 189 | 567 | 120 | 1758 | 518 | 525 | 1661 | 38 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 463 | 0 | 0 | 129 | 0 | 0 | 10 |
| Lane Group Flow (vph) | 21 | 168 | 141 | 558 | 189 | 104 | 120 | 1758 | 389 | 525 | 1661 | 28 |
| Turn Type | Split | | Free | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 15.2 | 15.2 | 139.2 | 20.0 | 20.0 | 20.0 | 9.0 | 63.0 | 63.0 | 19.0 | 73.0 | 73.0 |
| Effective Green, g (s) | 15.2 | 15.2 | 139.2 | 20.0 | 20.0 | 20.0 | 9.0 | 63.0 | 63.0 | 19.0 | 73.0 | 73.0 |
| Actuated g/C Ratio | 0.11 | 0.11 | 1.00 | 0.14 | 0.14 | 0.14 | 0.06 | 0.45 | 0.45 | 0.14 | 0.52 | 0.52 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 193 | 203 | 1583 | 493 | 268 | 400 | 114 | 1602 | 716 | 469 | 1856 | 830 |
| v/s Ratio Prot | 0.01 | c0.09 | | c0.16 | 0.10 | | 0.07 | c0.50 | | c0.15 | 0.47 | |
| v/s Ratio Perm | | | 0.09 | | | 0.04 | | | 0.25 | | | 0.02 |
| v/c Ratio | 0.11 | 0.83 | 0.09 | 1.13 | 0.71 | 0.26 | 1.05 | 1.10 | 0.54 | 1.12 | 0.89 | 0.03 |
| Uniform Delay, d1 | 55.9 | 60.7 | 0.0 | 59.6 | 56.8 | 53.0 | 65.1 | 38.1 | 27.7 | 60.1 | 29.7 | 16.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.3 | 23.3 | 0.1 | 82.0 | 8.2 | 0.3 | 99.1 | 54.1 | 0.8 | 78.4 | 6.0 | 0.0 |
| Delay (s) | 56.1 | 84.0 | 0.1 | 141.6 | 65.0 | 53.4 | 164.2 | 92.2 | 28.5 | 138.5 | 35.7 | 16.0 |
| Level of Service | E | F | A | F | E | D | F | F | C | F | D | B |
| Approach Delay (s) | | 46.4 | | | 92.5 | | | 82.0 | | | 59.6 | |
| Approach LOS | | D | | | F | | | F | | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 74.4 | HCM Level of Service | E |
| HCM Volume to Capacity ratio | 1.07 | | |
| Actuated Cycle Length (s) | 139.2 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 99.6% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 47 | 71 | 56 | 154 | 12 | 56 | 46 | 1837 | 283 | 117 | 2304 | 32 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 4.0 | 6.0 | 6.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1826 | 1583 | | 1780 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.67 | 1.00 | | 0.57 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1242 | 1583 | | 1068 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 51 | 77 | 61 | 167 | 13 | 61 | 50 | 1997 | 308 | 127 | 2504 | 35 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 128 | 61 | 0 | 180 | 61 | 50 | 1997 | 308 | 127 | 2504 | 35 |
| Turn Type | Perm | | Free | Perm | | Free | Prot | | Free | Prot | | Free |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | Free | 8 | | Free | | | Free | | | Free |
| Actuated Green, G (s) | | 25.4 | 130.8 | | 25.4 | 130.8 | 6.7 | 75.7 | 130.8 | 12.7 | 81.7 | 130.8 |
| Effective Green, g (s) | | 25.4 | 130.8 | | 25.4 | 130.8 | 6.7 | 75.7 | 130.8 | 12.7 | 81.7 | 130.8 |
| Actuated g/C Ratio | | 0.19 | 1.00 | | 0.19 | 1.00 | 0.05 | 0.58 | 1.00 | 0.10 | 0.62 | 1.00 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 241 | 1583 | | 207 | 1583 | 91 | 2048 | 1583 | 172 | 2211 | 1583 |
| v/s Ratio Prot | | | | | | | 0.03 | 0.56 | | c0.07 | c0.71 | |
| v/s Ratio Perm | | 0.10 | 0.04 | | c0.17 | 0.04 | | | 0.19 | | | 0.02 |
| v/c Ratio | | 0.53 | 0.04 | | 0.87 | 0.04 | 0.55 | 0.98 | 0.19 | 0.74 | 1.13 | 0.02 |
| Uniform Delay, d1 | | 47.3 | 0.0 | | 51.1 | 0.0 | 60.6 | 26.6 | 0.0 | 57.4 | 24.6 | 0.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 2.2 | 0.0 | | 29.8 | 0.0 | 6.6 | 14.4 | 0.3 | 15.2 | 65.9 | 0.0 |
| Delay (s) | | 49.6 | 0.0 | | 80.9 | 0.0 | 67.2 | 41.0 | 0.3 | 72.7 | 90.5 | 0.0 |
| Level of Service | | D | A | | F | A | E | D | A | E | F | A |
| Approach Delay (s) | | 33.6 | | | 60.5 | | | 36.2 | | | 88.4 | |
| Approach LOS | | C | | | E | | | D | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 62.7 | HCM Level of Service | E |
| HCM Volume to Capacity ratio | 1.07 | | |
| Actuated Cycle Length (s) | 130.8 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 97.0% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 6 | 24 | 1321 | 4 | 33 | 1484 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 7 | 26 | 1436 | 4 | 36 | 1613 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2316 | 720 | | | 1440 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2316 | 720 | | | 1440 | |
| tC, single (s) | 6.8 | 6.9 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 78 | 93 | | | 92 | |
| cM capacity (veh/h) | 29 | 370 | | | 467 | |

| Direction, Lane # | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 33 | 957 | 483 | 36 | 807 | 807 |
| Volume Left | 7 | 0 | 0 | 36 | 0 | 0 |
| Volume Right | 26 | 0 | 4 | 0 | 0 | 0 |
| cSH | 111 | 1700 | 1700 | 467 | 1700 | 1700 |
| Volume to Capacity | 0.29 | 0.56 | 0.28 | 0.08 | 0.47 | 0.47 |
| Queue Length 95th (ft) | 28 | 0 | 0 | 6 | 0 | 0 |
| Control Delay (s) | 50.3 | 0.0 | 0.0 | 13.3 | 0.0 | 0.0 |
| Lane LOS | F | | | B | | |
| Approach Delay (s) | 50.3 | 0.0 | | 0.3 | | |
| Approach LOS | F | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.7 | | |
| Intersection Capacity Utilization | 51.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 111 | 58 | 31 | 1312 | 1454 | 108 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 121 | 63 | 34 | 1426 | 1580 | 117 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2361 | 790 | 1580 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2361 | 790 | 1580 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 88 | 88 | | | |
| cM capacity (veh/h) | 87 | 510 | 283 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 184 | 34 | 713 | 713 | 790 | 790 | 117 |
| Volume Left | 121 | 34 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 63 | 0 | 0 | 0 | 0 | 0 | 117 |
| cSH | 127 | 283 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 1.45 | 0.12 | 0.42 | 0.42 | 0.46 | 0.46 | 0.07 |
| Queue Length 95th (ft) | 314 | 10 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 302.8 | 19.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | C | | | | | |
| Approach Delay (s) | 302.8 | 0.4 | | | 0.0 | | |
| Approach LOS | F | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 16.8 | | |
| Intersection Capacity Utilization | 53.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 29 | 11 | 11 | 56 | 11 | 69 | 3 | 519 | 47 | 38 | 459 | 9 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1759 | | | 1788 | 1583 | 1770 | 1840 | | 1770 | 1857 | |
| Flt Permitted | | 0.78 | | | 0.72 | 1.00 | 0.41 | 1.00 | | 0.30 | 1.00 | |
| Satd. Flow (perm) | | 1415 | | | 1345 | 1583 | 767 | 1840 | | 551 | 1857 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 32 | 12 | 12 | 61 | 12 | 75 | 3 | 564 | 51 | 41 | 499 | 10 |
| RTOR Reduction (vph) | 0 | 10 | 0 | 0 | 0 | 64 | 0 | 5 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 46 | 0 | 0 | 73 | 11 | 3 | 611 | 0 | 41 | 508 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 6.4 | | | 6.4 | 6.4 | 23.0 | 22.5 | | 24.2 | 23.1 | |
| Effective Green, g (s) | | 6.4 | | | 6.4 | 6.4 | 23.0 | 22.5 | | 24.2 | 23.1 | |
| Actuated g/C Ratio | | 0.14 | | | 0.14 | 0.14 | 0.51 | 0.50 | | 0.54 | 0.51 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 201 | | | 191 | 225 | 403 | 920 | | 326 | 953 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.33 | | c0.00 | 0.27 | |
| v/s Ratio Perm | | 0.03 | | | c0.05 | 0.01 | 0.00 | | | 0.06 | | |
| v/c Ratio | | 0.23 | | | 0.38 | 0.05 | 0.01 | 0.66 | | 0.13 | 0.53 | |
| Uniform Delay, d1 | | 17.1 | | | 17.5 | 16.7 | 5.5 | 8.4 | | 5.5 | 7.3 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.6 | | | 1.3 | 0.1 | 0.0 | 1.8 | | 0.2 | 0.6 | |
| Delay (s) | | 17.7 | | | 18.8 | 16.8 | 5.5 | 10.2 | | 5.7 | 7.9 | |
| Level of Service | | B | | | B | B | A | B | | A | A | |
| Approach Delay (s) | | 17.7 | | | 17.8 | | | 10.2 | | | 7.7 | |
| Approach LOS | | B | | | B | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.58 | | |
| Actuated Cycle Length (s) | 45.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 50.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 269 | 125 | 118 | 162 | 60 | 336 | 124 | 1144 | 178 | 624 | 1305 | 407 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.97 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1801 | 1583 | | 1797 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.97 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1801 | 1583 | | 1797 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 292 | 136 | 128 | 176 | 65 | 365 | 135 | 1243 | 193 | 678 | 1418 | 442 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 92 | 0 | 0 | 170 |
| Lane Group Flow (vph) | 0 | 428 | 128 | 0 | 241 | 365 | 135 | 1243 | 101 | 678 | 1418 | 272 |
| Turn Type | Split | | Free | Split | | Free | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | Free | | | 2 | | | 6 |
| Actuated Green, G (s) | | 35.0 | 149.2 | | 17.0 | 149.2 | 14.2 | 60.2 | 60.2 | 15.0 | 61.0 | 61.0 |
| Effective Green, g (s) | | 35.0 | 149.2 | | 17.0 | 149.2 | 14.2 | 60.2 | 60.2 | 15.0 | 61.0 | 61.0 |
| Actuated g/C Ratio | | 0.23 | 1.00 | | 0.11 | 1.00 | 0.10 | 0.40 | 0.40 | 0.10 | 0.41 | 0.41 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 422 | 1583 | | 205 | 1583 | 168 | 1428 | 639 | 178 | 1447 | 647 |
| v/s Ratio Prot | | c0.24 | | | c0.13 | | 0.08 | 0.35 | | c0.38 | c0.40 | |
| v/s Ratio Perm | | | 0.08 | | | c0.23 | | | 0.06 | | | 0.17 |
| v/c Ratio | | 1.01 | 0.08 | | 1.18 | 0.23 | 0.80 | 0.87 | 0.16 | 3.81 | 0.98 | 0.42 |
| Uniform Delay, d1 | | 57.1 | 0.0 | | 66.1 | 0.0 | 66.1 | 40.9 | 28.3 | 67.1 | 43.5 | 31.5 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 47.4 | 0.1 | | 118.3 | 0.3 | 23.5 | 6.1 | 0.1 | 1277.6 | 18.8 | 0.4 |
| Delay (s) | | 104.5 | 0.1 | | 184.4 | 0.3 | 89.7 | 47.0 | 28.5 | 1344.7 | 62.3 | 31.9 |
| Level of Service | | F | A | | F | A | F | D | C | F | E | C |
| Approach Delay (s) | | 80.5 | | | 73.5 | | | 48.4 | | | 399.6 | |
| Approach LOS | | F | | | E | | | D | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 223.8 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.30 | | |
| Actuated Cycle Length (s) | 149.2 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 118.1% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 20 | 24 | 58 | 81 | 18 | 164 | 24 | 417 | 124 | 152 | 353 | 6 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1821 | 1583 | | 1790 | 1583 | 1770 | 1863 | 1583 | 1770 | 1858 | |
| Flt Permitted | | 0.83 | 1.00 | | 0.73 | 1.00 | 0.53 | 1.00 | 1.00 | 0.30 | 1.00 | |
| Satd. Flow (perm) | | 1549 | 1583 | | 1365 | 1583 | 989 | 1863 | 1583 | 563 | 1858 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 26 | 63 | 88 | 20 | 178 | 26 | 453 | 135 | 165 | 384 | 7 |
| RTOR Reduction (vph) | 0 | 0 | 52 | 0 | 0 | 146 | 0 | 0 | 80 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 48 | 11 | 0 | 108 | 32 | 26 | 453 | 55 | 165 | 391 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 10.2 | 10.2 | | 10.2 | 10.2 | 25.2 | 23.2 | 23.2 | 36.3 | 29.3 | |
| Effective Green, g (s) | | 10.2 | 10.2 | | 10.2 | 10.2 | 25.2 | 23.2 | 23.2 | 36.3 | 29.3 | |
| Actuated g/C Ratio | | 0.18 | 0.18 | | 0.18 | 0.18 | 0.45 | 0.41 | 0.41 | 0.64 | 0.52 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 280 | 286 | | 246 | 286 | 469 | 765 | 650 | 535 | 964 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.24 | | c0.04 | c0.21 | |
| v/s Ratio Perm | | 0.03 | 0.01 | | c0.08 | 0.02 | 0.02 | | 0.04 | 0.15 | | |
| v/c Ratio | | 0.17 | 0.04 | | 0.44 | 0.11 | 0.06 | 0.59 | 0.09 | 0.31 | 0.41 | |
| Uniform Delay, d1 | | 19.6 | 19.1 | | 20.6 | 19.4 | 8.8 | 13.0 | 10.2 | 5.3 | 8.3 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.3 | 0.1 | | 1.3 | 0.2 | 0.0 | 1.2 | 0.1 | 0.3 | 0.3 | |
| Delay (s) | | 19.9 | 19.2 | | 21.9 | 19.5 | 8.8 | 14.2 | 10.2 | 5.7 | 8.6 | |
| Level of Service | | B | B | | C | B | A | B | B | A | A | |
| Approach Delay (s) | | 19.5 | | | 20.4 | | | 13.1 | | | 7.7 | |
| Approach LOS | | B | | | C | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 13.0 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.58 | | |
| Actuated Cycle Length (s) | 56.5 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 55.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 361 | 251 | 161 | 1620 | 2146 | 439 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 392 | 273 | 175 | 1761 | 2333 | 477 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 150 |
| Lane Group Flow (vph) | 392 | 273 | 175 | 1761 | 2333 | 327 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 29.0 | 159.0 | 15.0 | 119.0 | 98.0 | 98.0 |
| Effective Green, g (s) | 29.0 | 159.0 | 15.0 | 119.0 | 98.0 | 98.0 |
| Actuated g/C Ratio | 0.18 | 1.00 | 0.09 | 0.75 | 0.62 | 0.62 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 323 | 1583 | 167 | 2649 | 2181 | 976 |
| v/s Ratio Prot | c0.22 | | c0.10 | 0.50 | c0.66 | |
| v/s Ratio Perm | | 0.17 | | | | 0.21 |
| v/c Ratio | 1.21 | 0.17 | 1.05 | 0.66 | 1.07 | 0.34 |
| Uniform Delay, d1 | 65.0 | 0.0 | 72.0 | 10.0 | 30.5 | 14.8 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 121.2 | 0.2 | 82.9 | 0.6 | 41.0 | 0.2 |
| Delay (s) | 186.2 | 0.2 | 154.9 | 10.7 | 71.5 | 15.0 |
| Level of Service | F | A | F | B | E | B |
| Approach Delay (s) | 109.9 | | | 23.7 | 61.9 | |
| Approach LOS | F | | | C | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 54.1 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 1.10 | | |
| Actuated Cycle Length (s) | 159.0 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 102.4% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 96 | 11 | 88 | 7 | 481 | 93 | 107 | 502 | 11 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1783 | 1583 | 1770 | 1863 | 1583 | 1770 | 3528 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.44 | 1.00 | 1.00 | 0.31 | 1.00 | |
| Satd. Flow (perm) | | | | | 1783 | 1583 | 825 | 1863 | 1583 | 574 | 3528 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 104 | 12 | 96 | 8 | 523 | 101 | 116 | 546 | 12 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 0 | 53 | 0 | 2 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 116 | 13 | 8 | 523 | 48 | 116 | 556 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 6.6 | 6.6 | 23.7 | 23.2 | 23.2 | 31.1 | 26.9 | |
| Effective Green, g (s) | | | | | 6.6 | 6.6 | 23.7 | 23.2 | 23.2 | 31.1 | 26.9 | |
| Actuated g/C Ratio | | | | | 0.13 | 0.13 | 0.48 | 0.47 | 0.47 | 0.63 | 0.55 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 240 | 213 | 409 | 882 | 750 | 467 | 1937 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.28 | | c0.02 | 0.16 | |
| v/s Ratio Perm | | | | | 0.07 | 0.01 | 0.01 | | 0.03 | 0.14 | | |
| v/c Ratio | | | | | 0.48 | 0.06 | 0.02 | 0.59 | 0.06 | 0.25 | 0.29 | |
| Uniform Delay, d1 | | | | | 19.6 | 18.5 | 6.6 | 9.4 | 7.0 | 4.5 | 5.9 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 1.5 | 0.1 | 0.0 | 1.1 | 0.0 | 0.3 | 0.1 | |
| Delay (s) | | | | | 21.2 | 18.6 | 6.6 | 10.5 | 7.0 | 4.8 | 6.0 | |
| Level of Service | | | | | C | B | A | B | A | A | A | |
| Approach Delay (s) | | 0.0 | | | 20.0 | | | 9.9 | | | 5.8 | |
| Approach LOS | | A | | | C | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.5 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.62 | | |
| Actuated Cycle Length (s) | 49.0 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 49.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 30 | 0 | 1924 | 2568 | 76 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 33 | 0 | 2091 | 2791 | 83 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 3837 | 1396 | 2791 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 3837 | 1396 | 2791 | | | |
| tC, single (s) | 6.8 | 6.9 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 100 | 75 | 100 | | | |
| cM capacity (veh/h) | 3 | 131 | 137 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 33 | 1046 | 1046 | 1396 | 1396 | 83 |
| Volume Left | 0 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 33 | 0 | 0 | 0 | 0 | 83 |
| cSH | 131 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.25 | 0.62 | 0.62 | 0.82 | 0.82 | 0.05 |
| Queue Length 95th (ft) | 23 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 41.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | E | | | | | |
| Approach Delay (s) | 41.4 | 0.0 | | 0.0 | | |
| Approach LOS | E | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.3 | | |
| Intersection Capacity Utilization | 81.0% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 52 | 214 | 30 | 184 | 217 | 101 | 50 | 132 | 103 | 107 | 148 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.98 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1828 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.61 | 1.00 | | 0.42 | 1.00 | 1.00 | 0.66 | 1.00 | 1.00 | 0.67 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1140 | 1828 | | 774 | 1863 | 1583 | 1220 | 1863 | 1583 | 1240 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 57 | 233 | 33 | 200 | 236 | 110 | 54 | 143 | 112 | 116 | 161 | 85 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 0 | 63 | 0 | 0 | 87 | 0 | 0 | 66 |
| Lane Group Flow (vph) | 57 | 261 | 0 | 200 | 236 | 47 | 54 | 143 | 25 | 116 | 161 | 19 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 16.8 | 14.6 | | 28.0 | 20.8 | 20.8 | 10.7 | 10.7 | 10.7 | 10.7 | 10.7 | 10.7 |
| Effective Green, g (s) | 16.8 | 14.6 | | 28.0 | 20.8 | 20.8 | 10.7 | 10.7 | 10.7 | 10.7 | 10.7 | 10.7 |
| Actuated g/C Ratio | 0.34 | 0.30 | | 0.57 | 0.43 | 0.43 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 422 | 548 | | 617 | 796 | 676 | 268 | 409 | 348 | 272 | 409 | 348 |
| v/s Ratio Prot | 0.01 | c0.14 | | c0.06 | 0.13 | | | 0.08 | | | 0.09 | |
| v/s Ratio Perm | 0.04 | | | 0.13 | | 0.03 | 0.04 | | 0.02 | c0.09 | | 0.01 |
| v/c Ratio | 0.14 | 0.48 | | 0.32 | 0.30 | 0.07 | 0.20 | 0.35 | 0.07 | 0.43 | 0.39 | 0.05 |
| Uniform Delay, d1 | 10.8 | 13.9 | | 5.4 | 9.2 | 8.2 | 15.5 | 16.1 | 15.1 | 16.4 | 16.2 | 15.0 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.1 | 0.7 | | 0.3 | 0.2 | 0.0 | 0.4 | 0.5 | 0.1 | 1.1 | 0.6 | 0.1 |
| Delay (s) | 10.9 | 14.6 | | 5.7 | 9.4 | 8.3 | 15.9 | 16.6 | 15.1 | 17.4 | 16.9 | 15.1 |
| Level of Service | B | B | | A | A | A | B | B | B | B | B | B |
| Approach Delay (s) | | 13.9 | | | 7.8 | | | 15.9 | | | 16.6 | |
| Approach LOS | | B | | | A | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 12.8 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 48.7 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 52.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 6.1 |
| Intersection LOS | A |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 97 | 265 | 172 | 194 |
| Demand Flow Rate, veh/h | 99 | 270 | 176 | 199 |
| Vehicles Circulating, veh/h | 256 | 128 | 107 | 295 |
| Vehicles Exiting, veh/h | 238 | 155 | 247 | 103 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 5.3 | 6.4 | 5.2 | 6.9 |
| Approach LOS | A | A | A | A |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 99 | 270 | 176 | 199 |
| Cap Entry Lane, veh/h | 875 | 994 | 1015 | 841 |
| Entry HV Adj Factor | 0.977 | 0.980 | 0.980 | 0.976 |
| Flow Entry, veh/h | 97 | 265 | 172 | 194 |
| Cap Entry, veh/h | 855 | 975 | 995 | 821 |
| V/C Ratio | 1.13 | 2.72 | 1.73 | 2.37 |
| Control Delay, s/veh | 5.3 | 6.4 | 5.2 | 6.9 |
| LOS | A | A | A | A |
| 95th %tile Queue, veh | 0.0 | 0.1 | 0.1 | 0.1 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 24 | 69 | 198 | 81 | 43 | 83 | 61 | 1751 | 128 | 131 | 2174 | 24 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.88 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 26 | 75 | 215 | 88 | 47 | 90 | 66 | 1903 | 139 | 142 | 2363 | 26 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 0 | 25 | 0 | 0 | 4 |
| Lane Group Flow (vph) | 26 | 75 | 215 | 88 | 47 | 7 | 66 | 1903 | 114 | 142 | 2363 | 22 |
| Turn Type | Split | | Free | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 8.5 | 8.5 | 117.6 | 8.6 | 8.6 | 8.6 | 6.8 | 68.3 | 68.3 | 10.2 | 71.7 | 71.7 |
| Effective Green, g (s) | 8.5 | 8.5 | 117.6 | 8.6 | 8.6 | 8.6 | 6.8 | 68.3 | 68.3 | 10.2 | 71.7 | 71.7 |
| Actuated g/C Ratio | 0.07 | 0.07 | 1.00 | 0.07 | 0.07 | 0.07 | 0.06 | 0.58 | 0.58 | 0.09 | 0.61 | 0.61 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 128 | 135 | 1583 | 251 | 136 | 204 | 102 | 2055 | 919 | 298 | 2158 | 965 |
| v/s Ratio Prot | 0.01 | c0.04 | | c0.03 | 0.03 | | 0.04 | 0.54 | | c0.04 | c0.67 | |
| v/s Ratio Perm | | | 0.14 | | | 0.00 | | | 0.07 | | | 0.01 |
| v/c Ratio | 0.20 | 0.56 | 0.14 | 0.35 | 0.35 | 0.03 | 0.65 | 0.93 | 0.12 | 0.48 | 1.09 | 0.02 |
| Uniform Delay, d1 | 51.4 | 52.7 | 0.0 | 51.8 | 51.8 | 50.6 | 54.2 | 22.4 | 11.1 | 51.2 | 22.9 | 9.1 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.8 | 4.9 | 0.2 | 0.8 | 1.5 | 0.1 | 13.3 | 7.8 | 0.1 | 1.2 | 50.8 | 0.0 |
| Delay (s) | 52.1 | 57.6 | 0.2 | 52.7 | 53.4 | 50.7 | 67.5 | 30.1 | 11.2 | 52.4 | 73.8 | 9.1 |
| Level of Service | D | E | A | D | D | D | E | C | B | D | E | A |
| Approach Delay (s) | | 18.1 | | | 52.0 | | | 30.0 | | | 71.9 | |
| Approach LOS | | B | | | D | | | C | | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 50.7 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.95 | | |
| Actuated Cycle Length (s) | 117.6 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 78.2% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 15 | 65 | 80 | 6 | 28 | 81 | 2576 | 61 | 25 | 2304 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 4.0 | 6.0 | 6.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.97 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1811 | 1583 | | 1780 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.80 | 1.00 | | 0.71 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1495 | 1583 | | 1332 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 21 | 16 | 71 | 87 | 7 | 30 | 88 | 2800 | 66 | 27 | 2504 | 85 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 37 | 71 | 0 | 94 | 30 | 88 | 2800 | 66 | 27 | 2504 | 85 |
| Turn Type | Perm | | Free | Perm | | Free | Prot | | Free | Prot | | Free |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | Free | 8 | | Free | | | Free | | | Free |
| Actuated Green, G (s) | | 13.7 | 122.5 | | 13.7 | 122.5 | 8.8 | 87.0 | 122.5 | 4.8 | 83.0 | 122.5 |
| Effective Green, g (s) | | 13.7 | 122.5 | | 13.7 | 122.5 | 8.8 | 87.0 | 122.5 | 4.8 | 83.0 | 122.5 |
| Actuated g/C Ratio | | 0.11 | 1.00 | | 0.11 | 1.00 | 0.07 | 0.71 | 1.00 | 0.04 | 0.68 | 1.00 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 167 | 1583 | | 149 | 1583 | 127 | 2513 | 1583 | 69 | 2398 | 1583 |
| v/s Ratio Prot | | | | | | | c0.05 | c0.79 | | 0.02 | 0.71 | |
| v/s Ratio Perm | | 0.02 | 0.04 | | c0.07 | 0.02 | | | 0.04 | | | 0.05 |
| v/c Ratio | | 0.22 | 0.04 | | 0.63 | 0.02 | 0.69 | 1.11 | 0.04 | 0.39 | 1.04 | 0.05 |
| Uniform Delay, d1 | | 49.5 | 0.0 | | 52.0 | 0.0 | 55.5 | 17.8 | 0.0 | 57.4 | 19.8 | 0.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 0.7 | 0.1 | | 8.4 | 0.0 | 15.1 | 57.6 | 0.0 | 3.6 | 31.2 | 0.1 |
| Delay (s) | | 50.2 | 0.1 | | 60.4 | 0.0 | 70.6 | 75.4 | 0.0 | 61.1 | 50.9 | 0.1 |
| Level of Service | | D | A | | E | A | E | E | A | E | D | A |
| Approach Delay (s) | | 17.2 | | | 45.8 | | | 73.6 | | | 49.4 | |
| Approach LOS | | B | | | D | | | E | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 61.0 | HCM Level of Service | E |
| HCM Volume to Capacity ratio | 1.06 | | |
| Actuated Cycle Length (s) | 122.5 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 91.8% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 3 | 24 | 1728 | 0 | 8 | 1455 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 3 | 26 | 1878 | 0 | 9 | 1582 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2686 | 939 | | | 1878 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2686 | 939 | | | 1878 | |
| tC, single (s) | 6.8 | 6.9 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 81 | 90 | | | 97 | |
| cM capacity (veh/h) | 17 | 265 | | | 316 | |

| Direction, Lane # | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 29 | 1252 | 626 | 9 | 791 | 791 |
| Volume Left | 3 | 0 | 0 | 9 | 0 | 0 |
| Volume Right | 26 | 0 | 0 | 0 | 0 | 0 |
| cSH | 102 | 1700 | 1700 | 316 | 1700 | 1700 |
| Volume to Capacity | 0.29 | 0.74 | 0.37 | 0.03 | 0.47 | 0.47 |
| Queue Length 95th (ft) | 27 | 0 | 0 | 2 | 0 | 0 |
| Control Delay (s) | 54.3 | 0.0 | 0.0 | 16.7 | 0.0 | 0.0 |
| Lane LOS | F | | | C | | |
| Approach Delay (s) | 54.3 | 0.0 | | 0.1 | | |
| Approach LOS | F | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.5 | | |
| Intersection Capacity Utilization | 57.8% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 125 | 57 | 106 | 1627 | 1395 | 215 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 136 | 62 | 115 | 1768 | 1516 | 234 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2631 | 758 | 1516 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2631 | 758 | 1516 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 88 | 62 | | | |
| cM capacity (veh/h) | 46 | 526 | 304 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 198 | 115 | 884 | 884 | 758 | 758 | 234 |
| Volume Left | 136 | 115 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 62 | 0 | 0 | 0 | 0 | 0 | 234 |
| cSH | 64 | 304 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 3.07 | 0.38 | 0.52 | 0.52 | 0.45 | 0.45 | 0.14 |
| Queue Length 95th (ft) | Err | 43 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | Err | 23.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | C | | | | | |
| Approach Delay (s) | Err | 1.5 | | | 0.0 | | |
| Approach LOS | F | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 517.0 | | |
| Intersection Capacity Utilization | 61.4% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 34 | 7 | 13 | 110 | 17 | 59 | 18 | 817 | 71 | 44 | 864 | 31 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 0.99 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1748 | | | 1785 | 1583 | 1770 | 1840 | | 1770 | 1853 | |
| Flt Permitted | | 0.73 | | | 0.71 | 1.00 | 0.13 | 1.00 | | 0.12 | 1.00 | |
| Satd. Flow (perm) | | 1315 | | | 1327 | 1583 | 240 | 1840 | | 229 | 1853 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 37 | 8 | 14 | 120 | 18 | 64 | 20 | 888 | 77 | 48 | 939 | 34 |
| RTOR Reduction (vph) | 0 | 12 | 0 | 0 | 0 | 55 | 0 | 3 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 47 | 0 | 0 | 138 | 9 | 20 | 962 | 0 | 48 | 972 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 9.8 | | | 9.8 | 9.8 | 44.4 | 43.1 | | 45.6 | 43.7 | |
| Effective Green, g (s) | | 9.8 | | | 9.8 | 9.8 | 44.4 | 43.1 | | 45.6 | 43.7 | |
| Actuated g/C Ratio | | 0.14 | | | 0.14 | 0.14 | 0.64 | 0.62 | | 0.65 | 0.63 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 185 | | | 186 | 222 | 181 | 1136 | | 192 | 1160 | |
| v/s Ratio Prot | | | | | | | 0.00 | 0.52 | | c0.01 | c0.52 | |
| v/s Ratio Perm | | 0.04 | | | c0.10 | 0.01 | 0.07 | | | 0.16 | | |
| v/c Ratio | | 0.25 | | | 0.74 | 0.04 | 0.11 | 0.85 | | 0.25 | 0.84 | |
| Uniform Delay, d1 | | 26.7 | | | 28.8 | 25.9 | 9.4 | 10.7 | | 9.8 | 10.3 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.7 | | | 14.7 | 0.1 | 0.3 | 6.0 | | 0.7 | 5.4 | |
| Delay (s) | | 27.5 | | | 43.5 | 26.0 | 9.6 | 16.7 | | 10.5 | 15.7 | |
| Level of Service | | C | | | D | C | A | B | | B | B | |
| Approach Delay (s) | | 27.5 | | | 38.0 | | | 16.5 | | | 15.4 | |
| Approach LOS | | C | | | D | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 18.2 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.74 | | |
| Actuated Cycle Length (s) | 69.8 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 66.8% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 271 | 64 | 72 | 231 | 107 | 482 | 221 | 1484 | 81 | 315 | 1362 | 200 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | | 0.97 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1790 | 1583 | | 1801 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.96 | 1.00 | | 0.97 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1790 | 1583 | | 1801 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 295 | 70 | 78 | 251 | 116 | 524 | 240 | 1613 | 88 | 342 | 1480 | 217 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 0 | 0 | 72 |
| Lane Group Flow (vph) | 0 | 365 | 78 | 0 | 367 | 524 | 240 | 1613 | 59 | 342 | 1480 | 145 |
| Turn Type | Split | | Free | Split | | Free | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | Free | | | 2 | | | 6 |
| Actuated Green, G (s) | | 35.0 | 166.4 | | 17.0 | 166.4 | 24.3 | 78.4 | 78.4 | 14.0 | 68.1 | 68.1 |
| Effective Green, g (s) | | 35.0 | 166.4 | | 17.0 | 166.4 | 24.3 | 78.4 | 78.4 | 14.0 | 68.1 | 68.1 |
| Actuated g/C Ratio | | 0.21 | 1.00 | | 0.10 | 1.00 | 0.15 | 0.47 | 0.47 | 0.08 | 0.41 | 0.41 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 377 | 1583 | | 184 | 1583 | 258 | 1667 | 746 | 149 | 1448 | 648 |
| v/s Ratio Prot | | c0.20 | | | c0.20 | | 0.14 | c0.46 | | c0.19 | c0.42 | |
| v/s Ratio Perm | | | 0.05 | | | 0.33 | | | 0.04 | | | 0.09 |
| v/c Ratio | | 0.97 | 0.05 | | 1.99 | 0.33 | 0.93 | 0.97 | 0.08 | 2.30 | 1.02 | 0.22 |
| Uniform Delay, d1 | | 65.1 | 0.0 | | 74.7 | 0.0 | 70.2 | 42.8 | 24.2 | 76.2 | 49.2 | 32.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 37.5 | 0.1 | | 466.4 | 0.6 | 37.6 | 14.9 | 0.0 | 603.6 | 29.4 | 0.2 |
| Delay (s) | | 102.7 | 0.1 | | 541.1 | 0.6 | 107.8 | 57.7 | 24.2 | 679.8 | 78.5 | 32.1 |
| Level of Service | | F | A | | F | A | F | E | C | F | E | C |
| Approach Delay (s) | | 84.6 | | | 223.2 | | | 62.4 | | | 174.4 | |
| Approach LOS | | F | | | F | | | E | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 134.2 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.28 | | |
| Actuated Cycle Length (s) | 166.4 | Sum of lost time (s) | 28.0 |
| Intersection Capacity Utilization | 97.7% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 39 | 37 | 58 | 148 | 35 | 138 | 71 | 671 | 140 | 78 | 816 | 28 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1816 | 1583 | | 1790 | 1583 | 1770 | 1863 | 1583 | 1770 | 1854 | |
| Flt Permitted | | 0.76 | 1.00 | | 0.71 | 1.00 | 0.10 | 1.00 | 1.00 | 0.24 | 1.00 | |
| Satd. Flow (perm) | | 1411 | 1583 | | 1325 | 1583 | 190 | 1863 | 1583 | 443 | 1854 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 42 | 40 | 63 | 161 | 38 | 150 | 77 | 729 | 152 | 85 | 887 | 30 |
| RTOR Reduction (vph) | 0 | 0 | 49 | 0 | 0 | 117 | 0 | 0 | 64 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 82 | 14 | 0 | 199 | 33 | 77 | 729 | 88 | 85 | 916 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 19.5 | 19.5 | | 19.5 | 19.5 | 55.3 | 51.6 | 51.6 | 53.7 | 50.8 | |
| Effective Green, g (s) | | 19.5 | 19.5 | | 19.5 | 19.5 | 55.3 | 51.6 | 51.6 | 53.7 | 50.8 | |
| Actuated g/C Ratio | | 0.22 | 0.22 | | 0.22 | 0.22 | 0.62 | 0.58 | 0.58 | 0.60 | 0.57 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 309 | 347 | | 290 | 347 | 184 | 1080 | 918 | 311 | 1058 | |
| v/s Ratio Prot | | | | | | | c0.02 | 0.39 | | 0.01 | c0.49 | |
| v/s Ratio Perm | | 0.06 | 0.01 | | c0.15 | 0.02 | 0.24 | | 0.06 | 0.16 | | |
| v/c Ratio | | 0.27 | 0.04 | | 0.69 | 0.09 | 0.42 | 0.68 | 0.10 | 0.27 | 0.87 | |
| Uniform Delay, d1 | | 28.8 | 27.4 | | 31.9 | 27.7 | 14.8 | 12.9 | 8.3 | 9.8 | 16.2 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.5 | 0.0 | | 6.6 | 0.1 | 1.5 | 1.7 | 0.0 | 0.5 | 7.6 | |
| Delay (s) | | 29.3 | 27.4 | | 38.5 | 27.8 | 16.3 | 14.6 | 8.4 | 10.3 | 23.8 | |
| Level of Service | | C | C | | D | C | B | B | A | B | C | |
| Approach Delay (s) | | 28.5 | | | 33.9 | | | 13.7 | | | 22.6 | |
| Approach LOS | | C | | | C | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 21.1 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.80 | | |
| Actuated Cycle Length (s) | 89.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 77.8% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 505 | 466 | 459 | 2136 | 1631 | 622 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 549 | 507 | 499 | 2322 | 1773 | 676 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 227 |
| Lane Group Flow (vph) | 549 | 507 | 499 | 2322 | 1773 | 449 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 29.2 | 182.6 | 30.2 | 142.4 | 106.2 | 106.2 |
| Effective Green, g (s) | 29.2 | 182.6 | 30.2 | 142.4 | 106.2 | 106.2 |
| Actuated g/C Ratio | 0.16 | 1.00 | 0.17 | 0.78 | 0.58 | 0.58 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 283 | 1583 | 293 | 2760 | 2058 | 921 |
| v/s Ratio Prot | c0.31 | | c0.28 | 0.66 | c0.50 | |
| v/s Ratio Perm | | 0.32 | | | | 0.28 |
| v/c Ratio | 1.94 | 0.32 | 1.70 | 0.84 | 0.86 | 0.49 |
| Uniform Delay, d1 | 76.7 | 0.0 | 76.2 | 12.9 | 32.0 | 22.3 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 435.7 | 0.5 | 330.6 | 2.5 | 4.0 | 0.4 |
| Delay (s) | 512.4 | 0.5 | 406.8 | 15.4 | 36.0 | 22.7 |
| Level of Service | F | A | F | B | D | C |
| Approach Delay (s) | 266.7 | | | 84.6 | 32.3 | |
| Approach LOS | F | | | F | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 94.8 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.21 | | |
| Actuated Cycle Length (s) | 182.6 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 112.7% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 223 | 63 | 128 | 19 | 692 | 197 | 91 | 578 | 25 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1793 | 1583 | 1770 | 1863 | 1583 | 1770 | 3517 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.40 | 1.00 | 1.00 | 0.15 | 1.00 | |
| Satd. Flow (perm) | | | | | 1793 | 1583 | 744 | 1863 | 1583 | 279 | 3517 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 242 | 68 | 139 | 21 | 752 | 214 | 99 | 628 | 27 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 104 | 0 | 0 | 106 | 0 | 3 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 310 | 35 | 21 | 752 | 108 | 99 | 652 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 19.8 | 19.8 | 41.5 | 40.3 | 40.3 | 47.9 | 43.5 | |
| Effective Green, g (s) | | | | | 19.8 | 19.8 | 41.5 | 40.3 | 40.3 | 47.9 | 43.5 | |
| Actuated g/C Ratio | | | | | 0.25 | 0.25 | 0.52 | 0.51 | 0.51 | 0.60 | 0.55 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 447 | 394 | 404 | 944 | 802 | 251 | 1924 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.40 | | c0.02 | 0.19 | |
| v/s Ratio Perm | | | | | 0.17 | 0.02 | 0.03 | | 0.07 | 0.22 | | |
| v/c Ratio | | | | | 0.69 | 0.09 | 0.05 | 0.80 | 0.14 | 0.39 | 0.34 | |
| Uniform Delay, d1 | | | | | 27.1 | 22.9 | 9.2 | 16.2 | 10.4 | 11.7 | 10.0 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 4.6 | 0.1 | 0.1 | 4.7 | 0.1 | 1.0 | 0.1 | |
| Delay (s) | | | | | 31.7 | 23.0 | 9.2 | 20.9 | 10.5 | 12.7 | 10.1 | |
| Level of Service | | | | | C | C | A | C | B | B | B | |
| Approach Delay (s) | | 0.0 | | | 29.0 | | | 18.4 | | | 10.5 | |
| Approach LOS | | A | | | C | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 17.9 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.80 | | |
| Actuated Cycle Length (s) | 79.5 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 69.6% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 10 | 0 | 2415 | 2047 | 130 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 11 | 0 | 2625 | 2225 | 141 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 3538 | 1112 | 2225 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 3538 | 1112 | 2225 | | | |
| tC, single (s) | 6.8 | 6.9 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 100 | 95 | 100 | | | |
| cM capacity (veh/h) | 4 | 203 | 231 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 11 | 1312 | 1312 | 1112 | 1112 | 141 |
| Volume Left | 0 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 11 | 0 | 0 | 0 | 0 | 141 |
| cSH | 203 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.05 | 0.77 | 0.77 | 0.65 | 0.65 | 0.08 |
| Queue Length 95th (ft) | 4 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 23.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | C | | | | | |
| Approach Delay (s) | 23.7 | 0.0 | | 0.0 | | |
| Approach LOS | C | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.1 | | |
| Intersection Capacity Utilization | 70.1% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 85 | 257 | 18 | 72 | 263 | 87 | 16 | 60 | 88 | 44 | 67 | 112 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.99 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1844 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.58 | 1.00 | | 0.44 | 1.00 | 1.00 | 0.74 | 1.00 | 1.00 | 0.74 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1089 | 1844 | | 814 | 1863 | 1583 | 1380 | 1863 | 1583 | 1380 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 92 | 279 | 20 | 78 | 286 | 95 | 17 | 65 | 96 | 48 | 73 | 122 |
| RTOR Reduction (vph) | 0 | 4 | 0 | 0 | 0 | 63 | 0 | 0 | 80 | 0 | 0 | 101 |
| Lane Group Flow (vph) | 92 | 295 | 0 | 78 | 286 | 32 | 17 | 65 | 16 | 48 | 73 | 21 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 8.6 | 8.1 | | 13.8 | 10.7 | 10.7 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 |
| Effective Green, g (s) | 8.6 | 8.1 | | 13.8 | 10.7 | 10.7 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 |
| Actuated g/C Ratio | 0.27 | 0.26 | | 0.44 | 0.34 | 0.34 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 307 | 473 | | 449 | 631 | 536 | 236 | 318 | 271 | 236 | 318 | 271 |
| v/s Ratio Prot | 0.00 | c0.16 | | c0.02 | c0.15 | | | 0.03 | | | c0.04 | |
| v/s Ratio Perm | 0.08 | | | 0.06 | | 0.02 | 0.01 | | 0.01 | 0.03 | | 0.01 |
| v/c Ratio | 0.30 | 0.62 | | 0.17 | 0.45 | 0.06 | 0.07 | 0.20 | 0.06 | 0.20 | 0.23 | 0.08 |
| Uniform Delay, d1 | 8.9 | 10.4 | | 5.4 | 8.2 | 7.1 | 11.0 | 11.3 | 11.0 | 11.3 | 11.3 | 11.0 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.6 | 2.5 | | 0.2 | 0.5 | 0.0 | 0.1 | 0.3 | 0.1 | 0.4 | 0.4 | 0.1 |
| Delay (s) | 9.5 | 12.9 | | 5.5 | 8.7 | 7.1 | 11.1 | 11.6 | 11.1 | 11.7 | 11.7 | 11.1 |
| Level of Service | A | B | | A | A | A | B | B | B | B | B | B |
| Approach Delay (s) | | 12.1 | | | 7.8 | | | 11.3 | | | 11.4 | |
| Approach LOS | | B | | | A | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.59 | | |
| Actuated Cycle Length (s) | 31.6 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 40.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 7.7 |
| Intersection LOS | A |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 250 | 334 | 254 | 220 |
| Demand Flow Rate, veh/h | 255 | 340 | 259 | 225 |
| Vehicles Circulating, veh/h | 261 | 231 | 245 | 302 |
| Vehicles Exiting, veh/h | 266 | 273 | 271 | 269 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 7.4 | 8.5 | 7.3 | 7.4 |
| Approach LOS | A | A | A | A |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 255 | 340 | 259 | 225 |
| Cap Entry Lane, veh/h | 870 | 897 | 884 | 835 |
| Entry HV Adj Factor | 0.980 | 0.983 | 0.980 | 0.979 |
| Flow Entry, veh/h | 250 | 334 | 254 | 220 |
| Cap Entry, veh/h | 853 | 881 | 867 | 818 |
| V/C Ratio | 2.93 | 3.79 | 2.93 | 2.69 |
| Control Delay, s/veh | 7.4 | 8.5 | 7.3 | 7.4 |
| LOS | A | A | A | A |
| 95th %tile Queue, veh | 0.1 | 0.2 | 0.1 | 0.1 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 155 | 130 | 513 | 174 | 522 | 110 | 2036 | 477 | 483 | 1764 | 35 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.88 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 21 | 168 | 141 | 558 | 189 | 567 | 120 | 2213 | 518 | 525 | 1917 | 38 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 473 | 0 | 0 | 103 | 0 | 0 | 9 |
| Lane Group Flow (vph) | 21 | 168 | 141 | 558 | 189 | 94 | 120 | 2213 | 415 | 525 | 1917 | 29 |
| Turn Type | Split | | Free | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 15.2 | 15.2 | 139.2 | 20.0 | 20.0 | 20.0 | 10.0 | 64.0 | 64.0 | 19.0 | 73.0 | 73.0 |
| Effective Green, g (s) | 15.2 | 15.2 | 139.2 | 20.0 | 20.0 | 20.0 | 10.0 | 64.0 | 64.0 | 19.0 | 73.0 | 73.0 |
| Actuated g/C Ratio | 0.11 | 0.11 | 1.00 | 0.14 | 0.14 | 0.14 | 0.07 | 0.46 | 0.46 | 0.14 | 0.52 | 0.52 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 193 | 203 | 1583 | 493 | 268 | 400 | 127 | 1627 | 728 | 469 | 1856 | 830 |
| v/s Ratio Prot | 0.01 | c0.09 | | c0.16 | 0.10 | | 0.07 | c0.63 | | c0.15 | c0.54 | |
| v/s Ratio Perm | | | 0.09 | | | 0.03 | | | 0.26 | | | 0.02 |
| v/c Ratio | 0.11 | 0.83 | 0.09 | 1.13 | 0.71 | 0.24 | 0.94 | 1.36 | 0.57 | 1.12 | 1.03 | 0.04 |
| Uniform Delay, d1 | 55.9 | 60.7 | 0.0 | 59.6 | 56.8 | 52.8 | 64.3 | 37.6 | 27.5 | 60.1 | 33.1 | 16.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.3 | 23.3 | 0.1 | 82.0 | 8.2 | 0.3 | 62.4 | 166.2 | 1.1 | 78.4 | 29.9 | 0.0 |
| Delay (s) | 56.1 | 84.0 | 0.1 | 141.6 | 65.0 | 53.1 | 126.8 | 203.8 | 28.6 | 138.5 | 63.0 | 16.1 |
| Level of Service | E | F | A | F | E | D | F | F | C | F | E | B |
| Approach Delay (s) | | 46.4 | | | 92.4 | | | 168.7 | | | 78.2 | |
| Approach LOS | | D | | | F | | | F | | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 116.4 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.28 | | |
| Actuated Cycle Length (s) | 139.2 | Sum of lost time (s) | 27.0 |
| Intersection Capacity Utilization | 110.4% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 47 | 71 | 56 | 154 | 12 | 56 | 46 | 1837 | 283 | 117 | 2304 | 32 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 4.0 | 6.0 | 6.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1826 | 1583 | | 1780 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.67 | 1.00 | | 0.57 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1242 | 1583 | | 1068 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 51 | 77 | 61 | 167 | 13 | 61 | 50 | 1997 | 308 | 127 | 2504 | 35 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 128 | 61 | 0 | 180 | 61 | 50 | 1997 | 308 | 127 | 2504 | 35 |
| Turn Type | Perm | | Free | Perm | | Free | Prot | | Free | Prot | | Free |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | Free | 8 | | Free | | | Free | | | Free |
| Actuated Green, G (s) | | 25.4 | 130.8 | | 25.4 | 130.8 | 6.7 | 75.7 | 130.8 | 12.7 | 81.7 | 130.8 |
| Effective Green, g (s) | | 25.4 | 130.8 | | 25.4 | 130.8 | 6.7 | 75.7 | 130.8 | 12.7 | 81.7 | 130.8 |
| Actuated g/C Ratio | | 0.19 | 1.00 | | 0.19 | 1.00 | 0.05 | 0.58 | 1.00 | 0.10 | 0.62 | 1.00 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 241 | 1583 | | 207 | 1583 | 91 | 2048 | 1583 | 172 | 2211 | 1583 |
| v/s Ratio Prot | | | | | | | 0.03 | 0.56 | | c0.07 | c0.71 | |
| v/s Ratio Perm | | 0.10 | 0.04 | | c0.17 | 0.04 | | | 0.19 | | | 0.02 |
| v/c Ratio | | 0.53 | 0.04 | | 0.87 | 0.04 | 0.55 | 0.98 | 0.19 | 0.74 | 1.13 | 0.02 |
| Uniform Delay, d1 | | 47.3 | 0.0 | | 51.1 | 0.0 | 60.6 | 26.6 | 0.0 | 57.4 | 24.6 | 0.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 2.2 | 0.0 | | 29.8 | 0.0 | 6.6 | 14.4 | 0.3 | 15.2 | 65.9 | 0.0 |
| Delay (s) | | 49.6 | 0.0 | | 80.9 | 0.0 | 67.2 | 41.0 | 0.3 | 72.7 | 90.5 | 0.0 |
| Level of Service | | D | A | | F | A | E | D | A | E | F | A |
| Approach Delay (s) | | 33.6 | | | 60.5 | | | 36.2 | | | 88.4 | |
| Approach LOS | | C | | | E | | | D | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 62.7 | HCM Level of Service | E |
| HCM Volume to Capacity ratio | 1.07 | | |
| Actuated Cycle Length (s) | 130.8 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 97.0% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 6 | 24 | 1321 | 4 | 33 | 1484 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 7 | 26 | 1436 | 4 | 36 | 1613 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2316 | 720 | | | 1440 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2316 | 720 | | | 1440 | |
| tC, single (s) | 6.8 | 6.9 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 78 | 93 | | | 92 | |
| cM capacity (veh/h) | 29 | 370 | | | 467 | |

| Direction, Lane # | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 33 | 957 | 483 | 36 | 807 | 807 |
| Volume Left | 7 | 0 | 0 | 36 | 0 | 0 |
| Volume Right | 26 | 0 | 4 | 0 | 0 | 0 |
| cSH | 111 | 1700 | 1700 | 467 | 1700 | 1700 |
| Volume to Capacity | 0.29 | 0.56 | 0.28 | 0.08 | 0.47 | 0.47 |
| Queue Length 95th (ft) | 28 | 0 | 0 | 6 | 0 | 0 |
| Control Delay (s) | 50.3 | 0.0 | 0.0 | 13.3 | 0.0 | 0.0 |
| Lane LOS | F | | | B | | |
| Approach Delay (s) | 50.3 | 0.0 | | 0.3 | | |
| Approach LOS | F | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.7 | | |
| Intersection Capacity Utilization | 51.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 111 | 58 | 31 | 1312 | 1454 | 108 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 121 | 63 | 34 | 1426 | 1580 | 117 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2361 | 790 | 1580 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2361 | 790 | 1580 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 88 | 88 | | | |
| cM capacity (veh/h) | 87 | 510 | 283 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 184 | 34 | 713 | 713 | 790 | 790 | 117 |
| Volume Left | 121 | 34 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 63 | 0 | 0 | 0 | 0 | 0 | 117 |
| cSH | 127 | 283 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 1.45 | 0.12 | 0.42 | 0.42 | 0.46 | 0.46 | 0.07 |
| Queue Length 95th (ft) | 314 | 10 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 302.8 | 19.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | C | | | | | |
| Approach Delay (s) | 302.8 | 0.4 | | | 0.0 | | |
| Approach LOS | F | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 16.8 | | |
| Intersection Capacity Utilization | 53.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 29 | 11 | 11 | 56 | 11 | 69 | 3 | 519 | 47 | 38 | 459 | 9 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1759 | | | 1788 | 1583 | 1770 | 1840 | | 1770 | 1857 | |
| Flt Permitted | | 0.78 | | | 0.72 | 1.00 | 0.41 | 1.00 | | 0.30 | 1.00 | |
| Satd. Flow (perm) | | 1415 | | | 1345 | 1583 | 767 | 1840 | | 551 | 1857 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 32 | 12 | 12 | 61 | 12 | 75 | 3 | 564 | 51 | 41 | 499 | 10 |
| RTOR Reduction (vph) | 0 | 10 | 0 | 0 | 0 | 64 | 0 | 5 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 46 | 0 | 0 | 73 | 11 | 3 | 611 | 0 | 41 | 508 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 6.4 | | | 6.4 | 6.4 | 23.0 | 22.5 | | 24.2 | 23.1 | |
| Effective Green, g (s) | | 6.4 | | | 6.4 | 6.4 | 23.0 | 22.5 | | 24.2 | 23.1 | |
| Actuated g/C Ratio | | 0.14 | | | 0.14 | 0.14 | 0.51 | 0.50 | | 0.54 | 0.51 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 201 | | | 191 | 225 | 403 | 920 | | 326 | 953 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.33 | | c0.00 | 0.27 | |
| v/s Ratio Perm | | 0.03 | | | c0.05 | 0.01 | 0.00 | | | 0.06 | | |
| v/c Ratio | | 0.23 | | | 0.38 | 0.05 | 0.01 | 0.66 | | 0.13 | 0.53 | |
| Uniform Delay, d1 | | 17.1 | | | 17.5 | 16.7 | 5.5 | 8.4 | | 5.5 | 7.3 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.6 | | | 1.3 | 0.1 | 0.0 | 1.8 | | 0.2 | 0.6 | |
| Delay (s) | | 17.7 | | | 18.8 | 16.8 | 5.5 | 10.2 | | 5.7 | 7.9 | |
| Level of Service | | B | | | B | B | A | B | | A | A | |
| Approach Delay (s) | | 17.7 | | | 17.8 | | | 10.2 | | | 7.7 | |
| Approach LOS | | B | | | B | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.58 | | |
| Actuated Cycle Length (s) | 45.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 50.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 269 | 125 | 118 | 162 | 60 | 56 | 124 | 1193 | 129 | 624 | 1305 | 407 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 4.0 | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frpb, ped/bikes | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Flpb, ped/bikes | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1541 | 1770 | 1863 | 1583 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1541 | 1770 | 1863 | 1583 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 292 | 136 | 128 | 176 | 65 | 61 | 135 | 1297 | 140 | 678 | 1418 | 442 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 65 | 0 | 0 | 130 |
| Lane Group Flow (vph) | 292 | 136 | 128 | 176 | 65 | 61 | 135 | 1297 | 75 | 678 | 1418 | 312 |
| Confl. Peds. (#/hr) | | | 50 | 50 | | | | | | | | |
| Turn Type | Prot | | Free | Prot | | Free | Prot | | pm+ov | Prot | | pm+ov |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | 3 | 1 | 6 | 7 |
| Permitted Phases | | | Free | | | Free | | | 2 | | | 6 |
| Actuated Green, G (s) | 28.1 | 23.9 | 139.2 | 13.0 | 8.8 | 139.2 | 14.3 | 53.2 | 66.2 | 27.1 | 66.0 | 94.1 |
| Effective Green, g (s) | 28.1 | 23.9 | 139.2 | 13.0 | 8.8 | 139.2 | 14.3 | 53.2 | 66.2 | 27.1 | 66.0 | 94.1 |
| Actuated g/C Ratio | 0.20 | 0.17 | 1.00 | 0.09 | 0.06 | 1.00 | 0.10 | 0.38 | 0.48 | 0.19 | 0.47 | 0.68 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 357 | 320 | 1541 | 165 | 118 | 1583 | 182 | 1353 | 753 | 668 | 1678 | 1070 |
| v/s Ratio Prot | c0.17 | 0.07 | | c0.10 | c0.03 | | 0.08 | c0.37 | 0.01 | c0.20 | 0.40 | 0.06 |
| v/s Ratio Perm | | | 0.08 | | | 0.04 | | | 0.04 | | | 0.14 |
| v/c Ratio | 0.82 | 0.42 | 0.08 | 1.07 | 0.55 | 0.04 | 0.74 | 0.96 | 0.10 | 1.01 | 0.85 | 0.29 |
| Uniform Delay, d1 | 53.1 | 51.5 | 0.0 | 63.1 | 63.3 | 0.0 | 60.7 | 41.9 | 20.1 | 56.0 | 32.1 | 9.1 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 13.5 | 0.9 | 0.1 | 88.9 | 5.5 | 0.0 | 15.0 | 15.5 | 0.1 | 38.6 | 4.1 | 0.2 |
| Delay (s) | 66.6 | 52.4 | 0.1 | 152.0 | 68.7 | 0.0 | 75.7 | 57.4 | 20.2 | 94.7 | 36.2 | 9.3 |
| Level of Service | E | D | A | F | E | A | E | E | C | F | D | A |
| Approach Delay (s) | | 47.8 | | | 103.4 | | | 55.7 | | | 47.1 | |
| Approach LOS | | D | | | F | | | E | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 53.3 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.92 | | |
| Actuated Cycle Length (s) | 139.2 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 90.1% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 20 | 24 | 58 | 81 | 18 | 164 | 24 | 417 | 124 | 152 | 353 | 6 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1821 | 1583 | | 1790 | 1583 | 1770 | 1863 | 1583 | 1770 | 1858 | |
| Flt Permitted | | 0.83 | 1.00 | | 0.73 | 1.00 | 0.53 | 1.00 | 1.00 | 0.30 | 1.00 | |
| Satd. Flow (perm) | | 1549 | 1583 | | 1365 | 1583 | 989 | 1863 | 1583 | 563 | 1858 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 26 | 63 | 88 | 20 | 178 | 26 | 453 | 135 | 165 | 384 | 7 |
| RTOR Reduction (vph) | 0 | 0 | 52 | 0 | 0 | 146 | 0 | 0 | 80 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 48 | 11 | 0 | 108 | 32 | 26 | 453 | 55 | 165 | 391 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 10.2 | 10.2 | | 10.2 | 10.2 | 25.2 | 23.2 | 23.2 | 36.3 | 29.3 | |
| Effective Green, g (s) | | 10.2 | 10.2 | | 10.2 | 10.2 | 25.2 | 23.2 | 23.2 | 36.3 | 29.3 | |
| Actuated g/C Ratio | | 0.18 | 0.18 | | 0.18 | 0.18 | 0.45 | 0.41 | 0.41 | 0.64 | 0.52 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 280 | 286 | | 246 | 286 | 469 | 765 | 650 | 535 | 964 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.24 | | c0.04 | c0.21 | |
| v/s Ratio Perm | | 0.03 | 0.01 | | c0.08 | 0.02 | 0.02 | | 0.04 | 0.15 | | |
| v/c Ratio | | 0.17 | 0.04 | | 0.44 | 0.11 | 0.06 | 0.59 | 0.09 | 0.31 | 0.41 | |
| Uniform Delay, d1 | | 19.6 | 19.1 | | 20.6 | 19.4 | 8.8 | 13.0 | 10.2 | 5.3 | 8.3 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.3 | 0.1 | | 1.3 | 0.2 | 0.0 | 1.2 | 0.1 | 0.3 | 0.3 | |
| Delay (s) | | 19.9 | 19.2 | | 21.9 | 19.5 | 8.8 | 14.2 | 10.2 | 5.7 | 8.6 | |
| Level of Service | | B | B | | C | B | A | B | B | A | A | |
| Approach Delay (s) | | 19.5 | | | 20.4 | | | 13.1 | | | 7.7 | |
| Approach LOS | | B | | | C | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 13.0 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.58 | | |
| Actuated Cycle Length (s) | 56.5 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 55.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 361 | 251 | 161 | 1389 | 2146 | 439 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 0.97 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 392 | 273 | 175 | 1510 | 2333 | 477 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 132 |
| Lane Group Flow (vph) | 392 | 273 | 175 | 1510 | 2333 | 345 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 21.9 | 146.1 | 18.0 | 113.2 | 89.2 | 89.2 |
| Effective Green, g (s) | 21.9 | 146.1 | 18.0 | 113.2 | 89.2 | 89.2 |
| Actuated g/C Ratio | 0.15 | 1.00 | 0.12 | 0.77 | 0.61 | 0.61 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 515 | 1583 | 218 | 2742 | 2161 | 966 |
| v/s Ratio Prot | c0.11 | | c0.10 | 0.43 | c0.66 | |
| v/s Ratio Perm | | 0.17 | | | | 0.22 |
| v/c Ratio | 0.76 | 0.17 | 0.80 | 0.55 | 1.08 | 0.36 |
| Uniform Delay, d1 | 59.6 | 0.0 | 62.3 | 6.5 | 28.4 | 14.2 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 6.6 | 0.2 | 18.8 | 0.2 | 44.8 | 0.2 |
| Delay (s) | 66.1 | 0.2 | 81.2 | 6.7 | 73.3 | 14.4 |
| Level of Service | E | A | F | A | E | B |
| Approach Delay (s) | 39.1 | | | 14.4 | 63.3 | |
| Approach LOS | D | | | B | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 44.2 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.99 | | |
| Actuated Cycle Length (s) | 146.1 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 92.7% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 96 | 11 | 88 | 7 | 481 | 93 | 107 | 502 | 11 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1783 | 1583 | 1770 | 1863 | 1583 | 1770 | 3528 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.44 | 1.00 | 1.00 | 0.31 | 1.00 | |
| Satd. Flow (perm) | | | | | 1783 | 1583 | 825 | 1863 | 1583 | 574 | 3528 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 104 | 12 | 96 | 8 | 523 | 101 | 116 | 546 | 12 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 0 | 53 | 0 | 2 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 116 | 13 | 8 | 523 | 48 | 116 | 556 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 6.6 | 6.6 | 23.7 | 23.2 | 23.2 | 31.1 | 26.9 | |
| Effective Green, g (s) | | | | | 6.6 | 6.6 | 23.7 | 23.2 | 23.2 | 31.1 | 26.9 | |
| Actuated g/C Ratio | | | | | 0.13 | 0.13 | 0.48 | 0.47 | 0.47 | 0.63 | 0.55 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 240 | 213 | 409 | 882 | 750 | 467 | 1937 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.28 | | c0.02 | 0.16 | |
| v/s Ratio Perm | | | | | 0.07 | 0.01 | 0.01 | | 0.03 | 0.14 | | |
| v/c Ratio | | | | | 0.48 | 0.06 | 0.02 | 0.59 | 0.06 | 0.25 | 0.29 | |
| Uniform Delay, d1 | | | | | 19.6 | 18.5 | 6.6 | 9.4 | 7.0 | 4.5 | 5.9 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 1.5 | 0.1 | 0.0 | 1.1 | 0.0 | 0.3 | 0.1 | |
| Delay (s) | | | | | 21.2 | 18.6 | 6.6 | 10.5 | 7.0 | 4.8 | 6.0 | |
| Level of Service | | | | | C | B | A | B | A | A | A | |
| Approach Delay (s) | | 0.0 | | | 20.0 | | | 9.9 | | | 5.8 | |
| Approach LOS | | A | | | C | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.5 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.62 | | |
| Actuated Cycle Length (s) | 49.0 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 49.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

## 19: East Waipuilani Road & Pi'ilani Highway Performance by movement

| Movement | EBR | WBR | NBT | NBR | SBT | SBR | All |
|---|---|---|---|---|---|---|---|
| Total Delay (hr) | 0.0 | 0.1 | 0.3 | 0.0 | 0.3 | 0.0 | 0.7 |
| Delay / Veh (s) | 5.4 | 2.8 | 2.7 | 5.6 | 1.7 | 1.5 | 2.2 |
| Total Stops | 1 | 1 | 1 | 0 | 0 | 0 | 3 |
| Travel Dist (mi) | 1.0 | 9.9 | 86.4 | 1.5 | 68.9 | 0.9 | 168.6 |
| Travel Time (hr) | 0.0 | 0.5 | 2.3 | 0.1 | 1.9 | 0.0 | 4.8 |
| Avg Speed (mph) | 21 | 22 | 39 | 34 | 37 | 27 | 36 |
| Fuel Used (gal) | 0.0 | 0.3 | 2.6 | 0.0 | 2.0 | 0.0 | 5.0 |
| HC Emissions (g) | 2 | 2 | 52 | 0 | 25 | 0 | 81 |
| CO Emissions (g) | 30 | 87 | 1692 | 32 | 806 | 7 | 2654 |
| NOx Emissions (g) | 5 | 6 | 179 | 2 | 100 | 0 | 292 |
| Vehicles Entered | 5 | 90 | 403 | 7 | 655 | 10 | 1170 |
| Vehicles Exited | 5 | 91 | 402 | 7 | 654 | 9 | 1168 |
| Hourly Exit Rate | 20 | 364 | 1608 | 28 | 2616 | 36 | 4672 |
| Input Volume | 30 | 280 | 1644 | 49 | 2568 | 76 | 4647 |
| % of Volume | 67 | 130 | 98 | 57 | 102 | 47 | 101 |
| Denied Entry Before | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Denied Entry After | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## Total Network Performance

| | |
|---|---|
| Total Delay (hr) | 2.9 |
| Delay / Veh (s) | 9.0 |
| Total Stops | 101 |
| Travel Dist (mi) | 689.3 |
| Travel Time (hr) | 19.0 |
| Avg Speed (mph) | 37 |
| Fuel Used (gal) | 23.1 |
| HC Emissions (g) | 329 |
| CO Emissions (g) | 11947 |
| NOx Emissions (g) | 1297 |
| Vehicles Entered | 1168 |
| Vehicles Exited | 1167 |
| Hourly Exit Rate | 4668 |
| Input Volume | 13862 |
| % of Volume | 34 |
| Denied Entry Before | 1 |
| Denied Entry After | 2 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 52 | 214 | 30 | 184 | 217 | 101 | 50 | 132 | 103 | 107 | 148 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.98 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1828 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.61 | 1.00 | | 0.42 | 1.00 | 1.00 | 0.66 | 1.00 | 1.00 | 0.67 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1140 | 1828 | | 774 | 1863 | 1583 | 1220 | 1863 | 1583 | 1240 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 57 | 233 | 33 | 200 | 236 | 110 | 54 | 143 | 112 | 116 | 161 | 85 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 0 | 63 | 0 | 0 | 87 | 0 | 0 | 66 |
| Lane Group Flow (vph) | 57 | 261 | 0 | 200 | 236 | 47 | 54 | 143 | 25 | 116 | 161 | 19 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 16.8 | 14.6 | | 28.0 | 20.8 | 20.8 | 10.7 | 10.7 | 10.7 | 10.7 | 10.7 | 10.7 |
| Effective Green, g (s) | 16.8 | 14.6 | | 28.0 | 20.8 | 20.8 | 10.7 | 10.7 | 10.7 | 10.7 | 10.7 | 10.7 |
| Actuated g/C Ratio | 0.34 | 0.30 | | 0.57 | 0.43 | 0.43 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 422 | 548 | | 617 | 796 | 676 | 268 | 409 | 348 | 272 | 409 | 348 |
| v/s Ratio Prot | 0.01 | c0.14 | | c0.06 | 0.13 | | | 0.08 | | | 0.09 | |
| v/s Ratio Perm | 0.04 | | | 0.13 | | 0.03 | 0.04 | | 0.02 | c0.09 | | 0.01 |
| v/c Ratio | 0.14 | 0.48 | | 0.32 | 0.30 | 0.07 | 0.20 | 0.35 | 0.07 | 0.43 | 0.39 | 0.05 |
| Uniform Delay, d1 | 10.8 | 13.9 | | 5.4 | 9.2 | 8.2 | 15.5 | 16.1 | 15.1 | 16.4 | 16.2 | 15.0 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.1 | 0.7 | | 0.3 | 0.2 | 0.0 | 0.4 | 0.5 | 0.1 | 1.1 | 0.6 | 0.1 |
| Delay (s) | 10.9 | 14.6 | | 5.7 | 9.4 | 8.3 | 15.9 | 16.6 | 15.1 | 17.4 | 16.9 | 15.1 |
| Level of Service | B | B | | A | A | A | B | B | B | B | B | B |
| Approach Delay (s) | | 13.9 | | | 7.8 | | | 15.9 | | | 16.6 | |
| Approach LOS | | B | | | A | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 12.8 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 48.7 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 52.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 6.1 |
| Intersection LOS | A |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 97 | 265 | 172 | 194 |
| Demand Flow Rate, veh/h | 99 | 270 | 176 | 199 |
| Vehicles Circulating, veh/h | 256 | 128 | 107 | 295 |
| Vehicles Exiting, veh/h | 238 | 155 | 247 | 103 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 5.3 | 6.4 | 5.2 | 6.9 |
| Approach LOS | A | A | A | A |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 99 | 270 | 176 | 199 |
| Cap Entry Lane, veh/h | 875 | 994 | 1015 | 841 |
| Entry HV Adj Factor | 0.977 | 0.980 | 0.980 | 0.976 |
| Flow Entry, veh/h | 97 | 265 | 172 | 194 |
| Cap Entry, veh/h | 855 | 975 | 995 | 821 |
| V/C Ratio | 1.13 | 2.72 | 1.73 | 2.37 |
| Control Delay, s/veh | 5.3 | 6.4 | 5.2 | 6.9 |
| LOS | A | A | A | A |
| 95th %tile Queue, veh | 0.0 | 0.1 | 0.1 | 0.1 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 24 | 69 | 198 | 81 | 43 | 83 | 61 | 1751 | 128 | 131 | 2174 | 24 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.88 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 26 | 75 | 215 | 88 | 47 | 90 | 66 | 1903 | 139 | 142 | 2363 | 26 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 0 | 25 | 0 | 0 | 4 |
| Lane Group Flow (vph) | 26 | 75 | 215 | 88 | 47 | 7 | 66 | 1903 | 114 | 142 | 2363 | 22 |
| Turn Type | Split | | Free | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 8.5 | 8.5 | 117.6 | 8.6 | 8.6 | 8.6 | 6.8 | 68.3 | 68.3 | 10.2 | 71.7 | 71.7 |
| Effective Green, g (s) | 8.5 | 8.5 | 117.6 | 8.6 | 8.6 | 8.6 | 6.8 | 68.3 | 68.3 | 10.2 | 71.7 | 71.7 |
| Actuated g/C Ratio | 0.07 | 0.07 | 1.00 | 0.07 | 0.07 | 0.07 | 0.06 | 0.58 | 0.58 | 0.09 | 0.61 | 0.61 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 128 | 135 | 1583 | 251 | 136 | 204 | 102 | 2055 | 919 | 298 | 2158 | 965 |
| v/s Ratio Prot | 0.01 | c0.04 | | c0.03 | 0.03 | | 0.04 | 0.54 | | c0.04 | c0.67 | |
| v/s Ratio Perm | | | 0.14 | | | 0.00 | | | 0.07 | | | 0.01 |
| v/c Ratio | 0.20 | 0.56 | 0.14 | 0.35 | 0.35 | 0.03 | 0.65 | 0.93 | 0.12 | 0.48 | 1.09 | 0.02 |
| Uniform Delay, d1 | 51.4 | 52.7 | 0.0 | 51.8 | 51.8 | 50.6 | 54.2 | 22.4 | 11.1 | 51.2 | 22.9 | 9.1 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.8 | 4.9 | 0.2 | 0.8 | 1.5 | 0.1 | 13.3 | 7.8 | 0.1 | 1.2 | 50.8 | 0.0 |
| Delay (s) | 52.1 | 57.6 | 0.2 | 52.7 | 53.4 | 50.7 | 67.5 | 30.1 | 11.2 | 52.4 | 73.8 | 9.1 |
| Level of Service | D | E | A | D | D | D | E | C | B | D | E | A |
| Approach Delay (s) | | 18.1 | | | 52.0 | | | 30.0 | | | 71.9 | |
| Approach LOS | | B | | | D | | | C | | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 50.7 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.95 | | |
| Actuated Cycle Length (s) | 117.6 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 78.2% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 15 | 65 | 80 | 6 | 28 | 81 | 2577 | 61 | 25 | 2304 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 4.0 | 6.0 | 6.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.97 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1811 | 1583 | | 1780 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.80 | 1.00 | | 0.71 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1495 | 1583 | | 1332 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 21 | 16 | 71 | 87 | 7 | 30 | 88 | 2801 | 66 | 27 | 2504 | 85 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 37 | 71 | 0 | 94 | 30 | 88 | 2801 | 66 | 27 | 2504 | 85 |
| Turn Type | Perm | | Free | Perm | | Free | Prot | | Free | Prot | | Free |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | Free | 8 | | Free | | | Free | | | Free |
| Actuated Green, G (s) | | 13.7 | 122.5 | | 13.7 | 122.5 | 8.8 | 87.0 | 122.5 | 4.8 | 83.0 | 122.5 |
| Effective Green, g (s) | | 13.7 | 122.5 | | 13.7 | 122.5 | 8.8 | 87.0 | 122.5 | 4.8 | 83.0 | 122.5 |
| Actuated g/C Ratio | | 0.11 | 1.00 | | 0.11 | 1.00 | 0.07 | 0.71 | 1.00 | 0.04 | 0.68 | 1.00 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 167 | 1583 | | 149 | 1583 | 127 | 2513 | 1583 | 69 | 2398 | 1583 |
| v/s Ratio Prot | | | | | | | c0.05 | c0.79 | | 0.02 | 0.71 | |
| v/s Ratio Perm | | 0.02 | 0.04 | | c0.07 | 0.02 | | | 0.04 | | | 0.05 |
| v/c Ratio | | 0.22 | 0.04 | | 0.63 | 0.02 | 0.69 | 1.11 | 0.04 | 0.39 | 1.04 | 0.05 |
| Uniform Delay, d1 | | 49.5 | 0.0 | | 52.0 | 0.0 | 55.5 | 17.8 | 0.0 | 57.4 | 19.8 | 0.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 0.7 | 0.1 | | 8.4 | 0.0 | 15.1 | 57.8 | 0.0 | 3.6 | 31.2 | 0.1 |
| Delay (s) | | 50.2 | 0.1 | | 60.4 | 0.0 | 70.6 | 75.5 | 0.0 | 61.1 | 50.9 | 0.1 |
| Level of Service | | D | A | | E | A | E | E | A | E | D | A |
| Approach Delay (s) | | 17.2 | | | 45.8 | | | 73.7 | | | 49.4 | |
| Approach LOS | | B | | | D | | | E | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 61.1 | HCM Level of Service | E |
| HCM Volume to Capacity ratio | 1.06 | | |
| Actuated Cycle Length (s) | 122.5 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 91.8% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 3 | 24 | 1728 | 0 | 8 | 1455 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 3 | 26 | 1878 | 0 | 9 | 1582 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2686 | 939 | | | 1878 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2686 | 939 | | | 1878 | |
| tC, single (s) | 6.8 | 6.9 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 81 | 90 | | | 97 | |
| cM capacity (veh/h) | 17 | 265 | | | 316 | |

| Direction, Lane # | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 29 | 1252 | 626 | 9 | 791 | 791 |
| Volume Left | 3 | 0 | 0 | 9 | 0 | 0 |
| Volume Right | 26 | 0 | 0 | 0 | 0 | 0 |
| cSH | 102 | 1700 | 1700 | 316 | 1700 | 1700 |
| Volume to Capacity | 0.29 | 0.74 | 0.37 | 0.03 | 0.47 | 0.47 |
| Queue Length 95th (ft) | 27 | 0 | 0 | 2 | 0 | 0 |
| Control Delay (s) | 54.3 | 0.0 | 0.0 | 16.7 | 0.0 | 0.0 |
| Lane LOS | F | | | C | | |
| Approach Delay (s) | 54.3 | 0.0 | | 0.1 | | |
| Approach LOS | F | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.5 | | |
| Intersection Capacity Utilization | 57.8% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 125 | 57 | 106 | 1627 | 1395 | 215 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 136 | 62 | 115 | 1768 | 1516 | 234 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2631 | 758 | 1516 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2631 | 758 | 1516 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 88 | 62 | | | |
| cM capacity (veh/h) | 46 | 526 | 304 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 198 | 115 | 884 | 884 | 758 | 758 | 234 |
| Volume Left | 136 | 115 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 62 | 0 | 0 | 0 | 0 | 0 | 234 |
| cSH | 64 | 304 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 3.07 | 0.38 | 0.52 | 0.52 | 0.45 | 0.45 | 0.14 |
| Queue Length 95th (ft) | Err | 43 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | Err | 23.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | C | | | | | |
| Approach Delay (s) | Err | 1.5 | | | 0.0 | | |
| Approach LOS | F | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 517.0 | | |
| Intersection Capacity Utilization | 61.4% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 34 | 7 | 13 | 110 | 17 | 59 | 18 | 817 | 71 | 44 | 864 | 31 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 0.99 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1748 | | | 1785 | 1583 | 1770 | 1840 | | 1770 | 1853 | |
| Flt Permitted | | 0.73 | | | 0.71 | 1.00 | 0.13 | 1.00 | | 0.12 | 1.00 | |
| Satd. Flow (perm) | | 1315 | | | 1327 | 1583 | 240 | 1840 | | 229 | 1853 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 37 | 8 | 14 | 120 | 18 | 64 | 20 | 888 | 77 | 48 | 939 | 34 |
| RTOR Reduction (vph) | 0 | 12 | 0 | 0 | 0 | 55 | 0 | 3 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 47 | 0 | 0 | 138 | 9 | 20 | 962 | 0 | 48 | 972 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 9.8 | | | 9.8 | 9.8 | 44.4 | 43.1 | | 45.6 | 43.7 | |
| Effective Green, g (s) | | 9.8 | | | 9.8 | 9.8 | 44.4 | 43.1 | | 45.6 | 43.7 | |
| Actuated g/C Ratio | | 0.14 | | | 0.14 | 0.14 | 0.64 | 0.62 | | 0.65 | 0.63 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 185 | | | 186 | 222 | 181 | 1136 | | 192 | 1160 | |
| v/s Ratio Prot | | | | | | | 0.00 | 0.52 | | c0.01 | c0.52 | |
| v/s Ratio Perm | | 0.04 | | | c0.10 | 0.01 | 0.07 | | | 0.16 | | |
| v/c Ratio | | 0.25 | | | 0.74 | 0.04 | 0.11 | 0.85 | | 0.25 | 0.84 | |
| Uniform Delay, d1 | | 26.7 | | | 28.8 | 25.9 | 9.4 | 10.7 | | 9.8 | 10.3 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.7 | | | 14.7 | 0.1 | 0.3 | 6.0 | | 0.7 | 5.4 | |
| Delay (s) | | 27.5 | | | 43.5 | 26.0 | 9.6 | 16.7 | | 10.5 | 15.7 | |
| Level of Service | | C | | | D | C | A | B | | B | B | |
| Approach Delay (s) | | 27.5 | | | 38.0 | | | 16.5 | | | 15.4 | |
| Approach LOS | | C | | | D | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 18.2 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.74 | | |
| Actuated Cycle Length (s) | 69.8 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 66.8% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 271 | 64 | 72 | 231 | 107 | 255 | 221 | 1538 | 27 | 315 | 1362 | 200 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 4.0 | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frpb, ped/bikes | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Flpb, ped/bikes | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1541 | 1770 | 1863 | 1583 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1541 | 1770 | 1863 | 1583 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 295 | 70 | 78 | 251 | 116 | 277 | 240 | 1672 | 29 | 342 | 1480 | 217 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 86 |
| Lane Group Flow (vph) | 295 | 70 | 78 | 251 | 116 | 277 | 240 | 1672 | 20 | 342 | 1480 | 131 |
| Confl. Peds. (#/hr) | | | 50 | 50 | | | | | | | | |
| Turn Type | Prot | | Free | Prot | | Free | Prot | | pm+ov | Prot | | pm+ov |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | 3 | 1 | 6 | 7 |
| Permitted Phases | | | Free | | | Free | | | 2 | | | 6 |
| Actuated Green, G (s) | 27.1 | 17.7 | 135.3 | 24.3 | 14.9 | 135.3 | 21.9 | 55.4 | 79.7 | 15.9 | 49.4 | 76.5 |
| Effective Green, g (s) | 27.1 | 17.7 | 135.3 | 24.3 | 14.9 | 135.3 | 21.9 | 55.4 | 79.7 | 15.9 | 49.4 | 76.5 |
| Actuated g/C Ratio | 0.20 | 0.13 | 1.00 | 0.18 | 0.11 | 1.00 | 0.16 | 0.41 | 0.59 | 0.12 | 0.37 | 0.57 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 355 | 244 | 1541 | 318 | 205 | 1583 | 286 | 1449 | 932 | 403 | 1292 | 895 |
| v/s Ratio Prot | c0.17 | 0.04 | | 0.14 | c0.06 | | c0.14 | c0.47 | 0.00 | 0.10 | 0.42 | 0.03 |
| v/s Ratio Perm | | | 0.05 | | | c0.17 | | | 0.01 | | | 0.05 |
| v/c Ratio | 0.83 | 0.29 | 0.05 | 0.79 | 0.57 | 0.17 | 0.84 | 1.15 | 0.02 | 0.85 | 1.15 | 0.15 |
| Uniform Delay, d1 | 51.9 | 53.1 | 0.0 | 53.1 | 57.1 | 0.0 | 55.0 | 40.0 | 11.6 | 58.5 | 43.0 | 13.9 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 15.1 | 0.7 | 0.1 | 12.2 | 3.6 | 0.2 | 18.9 | 77.6 | 0.0 | 15.2 | 75.0 | 0.1 |
| Delay (s) | 67.0 | 53.8 | 0.1 | 65.3 | 60.7 | 0.2 | 73.9 | 117.5 | 11.6 | 73.7 | 118.0 | 14.0 |
| Level of Service | E | D | A | E | E | A | E | F | B | E | F | B |
| Approach Delay (s) | | 53.1 | | | 36.5 | | | 110.5 | | | 99.5 | |
| Approach LOS | | D | | | D | | | F | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 91.7 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 0.98 | | |
| Actuated Cycle Length (s) | 135.3 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 87.3% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 39 | 37 | 58 | 148 | 35 | 138 | 71 | 671 | 140 | 78 | 816 | 28 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1816 | 1583 | | 1790 | 1583 | 1770 | 1863 | 1583 | 1770 | 1854 | |
| Flt Permitted | | 0.76 | 1.00 | | 0.71 | 1.00 | 0.10 | 1.00 | 1.00 | 0.24 | 1.00 | |
| Satd. Flow (perm) | | 1411 | 1583 | | 1325 | 1583 | 190 | 1863 | 1583 | 443 | 1854 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 42 | 40 | 63 | 161 | 38 | 150 | 77 | 729 | 152 | 85 | 887 | 30 |
| RTOR Reduction (vph) | 0 | 0 | 49 | 0 | 0 | 117 | 0 | 0 | 64 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 82 | 14 | 0 | 199 | 33 | 77 | 729 | 88 | 85 | 916 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 19.5 | 19.5 | | 19.5 | 19.5 | 55.3 | 51.6 | 51.6 | 53.7 | 50.8 | |
| Effective Green, g (s) | | 19.5 | 19.5 | | 19.5 | 19.5 | 55.3 | 51.6 | 51.6 | 53.7 | 50.8 | |
| Actuated g/C Ratio | | 0.22 | 0.22 | | 0.22 | 0.22 | 0.62 | 0.58 | 0.58 | 0.60 | 0.57 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 309 | 347 | | 290 | 347 | 184 | 1080 | 918 | 311 | 1058 | |
| v/s Ratio Prot | | | | | | | c0.02 | 0.39 | | 0.01 | c0.49 | |
| v/s Ratio Perm | | 0.06 | 0.01 | | c0.15 | 0.02 | 0.24 | | 0.06 | 0.16 | | |
| v/c Ratio | | 0.27 | 0.04 | | 0.69 | 0.09 | 0.42 | 0.68 | 0.10 | 0.27 | 0.87 | |
| Uniform Delay, d1 | | 28.8 | 27.4 | | 31.9 | 27.7 | 14.8 | 12.9 | 8.3 | 9.8 | 16.2 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.5 | 0.0 | | 6.6 | 0.1 | 1.5 | 1.7 | 0.0 | 0.5 | 7.6 | |
| Delay (s) | | 29.3 | 27.4 | | 38.5 | 27.8 | 16.3 | 14.6 | 8.4 | 10.3 | 23.8 | |
| Level of Service | | C | C | | D | C | B | B | A | B | C | |
| Approach Delay (s) | | 28.5 | | | 33.9 | | | 13.7 | | | 22.6 | |
| Approach LOS | | C | | | C | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 21.1 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.80 | | |
| Actuated Cycle Length (s) | 89.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 77.8% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 505 | 466 | 459 | 1963 | 1631 | 622 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 0.97 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 549 | 507 | 499 | 2134 | 1773 | 676 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 230 |
| Lane Group Flow (vph) | 549 | 507 | 499 | 2134 | 1773 | 446 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 32.4 | 191.4 | 55.0 | 148.0 | 87.0 | 87.0 |
| Effective Green, g (s) | 32.4 | 191.4 | 55.0 | 148.0 | 87.0 | 87.0 |
| Actuated g/C Ratio | 0.17 | 1.00 | 0.29 | 0.77 | 0.45 | 0.45 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 581 | 1583 | 509 | 2737 | 1609 | 720 |
| v/s Ratio Prot | c0.16 | | c0.28 | 0.60 | c0.50 | |
| v/s Ratio Perm | | 0.32 | | | | 0.28 |
| v/c Ratio | 0.94 | 0.32 | 0.98 | 0.78 | 1.10 | 0.62 |
| Uniform Delay, d1 | 78.6 | 0.0 | 67.7 | 12.4 | 52.2 | 39.6 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 24.3 | 0.5 | 34.7 | 1.5 | 55.8 | 1.6 |
| Delay (s) | 102.9 | 0.5 | 102.4 | 13.9 | 108.0 | 41.2 |
| Level of Service | F | A | F | B | F | D |
| Approach Delay (s) | 53.7 | | | 30.6 | 89.6 | |
| Approach LOS | D | | | C | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 58.1 | HCM Level of Service | E |
| HCM Volume to Capacity ratio | 1.03 | | |
| Actuated Cycle Length (s) | 191.4 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 99.1% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 223 | 63 | 128 | 19 | 692 | 197 | 91 | 578 | 25 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1793 | 1583 | 1770 | 1863 | 1583 | 1770 | 3517 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.40 | 1.00 | 1.00 | 0.15 | 1.00 | |
| Satd. Flow (perm) | | | | | 1793 | 1583 | 744 | 1863 | 1583 | 279 | 3517 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 242 | 68 | 139 | 21 | 752 | 214 | 99 | 628 | 27 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 104 | 0 | 0 | 106 | 0 | 3 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 310 | 35 | 21 | 752 | 108 | 99 | 652 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 19.8 | 19.8 | 41.5 | 40.3 | 40.3 | 47.9 | 43.5 | |
| Effective Green, g (s) | | | | | 19.8 | 19.8 | 41.5 | 40.3 | 40.3 | 47.9 | 43.5 | |
| Actuated g/C Ratio | | | | | 0.25 | 0.25 | 0.52 | 0.51 | 0.51 | 0.60 | 0.55 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 447 | 394 | 404 | 944 | 802 | 251 | 1924 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.40 | | c0.02 | 0.19 | |
| v/s Ratio Perm | | | | | 0.17 | 0.02 | 0.03 | | 0.07 | 0.22 | | |
| v/c Ratio | | | | | 0.69 | 0.09 | 0.05 | 0.80 | 0.14 | 0.39 | 0.34 | |
| Uniform Delay, d1 | | | | | 27.1 | 22.9 | 9.2 | 16.2 | 10.4 | 11.7 | 10.0 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 4.6 | 0.1 | 0.1 | 4.7 | 0.1 | 1.0 | 0.1 | |
| Delay (s) | | | | | 31.7 | 23.0 | 9.2 | 20.9 | 10.5 | 12.7 | 10.1 | |
| Level of Service | | | | | C | C | A | C | B | B | B | |
| Approach Delay (s) | | 0.0 | | | 29.0 | | | 18.4 | | | 10.5 | |
| Approach LOS | | A | | | C | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 17.9 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.80 | | |
| Actuated Cycle Length (s) | 79.5 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 69.6% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

## 19: East Waipuilani Road & Pi'ilani Highway Performance by movement

| Movement | EBR | WBR | NBT | NBR | SBT | SBR | All |
|---|---|---|---|---|---|---|---|
| Total Delay (hr) | 0.0 | 0.0 | 0.6 | 0.0 | 0.1 | 0.0 | 0.8 |
| Delay / Veh (s) | 1.2 | 2.1 | 3.9 | 6.8 | 0.9 | 1.7 | 2.5 |
| Total Stops | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Travel Dist (mi) | 0.4 | 6.5 | 116.1 | 3.0 | 55.2 | 3.1 | 184.3 |
| Travel Time (hr) | 0.0 | 0.3 | 3.3 | 0.1 | 1.4 | 0.1 | 5.2 |
| Avg Speed (mph) | 23 | 23 | 37 | 33 | 40 | 26 | 37 |
| Fuel Used (gal) | 0.0 | 0.2 | 3.8 | 0.1 | 1.6 | 0.0 | 5.7 |
| HC Emissions (g) | 0 | 1 | 52 | 1 | 17 | 0 | 71 |
| CO Emissions (g) | 1 | 44 | 2036 | 62 | 580 | 10 | 2733 |
| NOx Emissions (g) | 0 | 3 | 196 | 3 | 80 | 1 | 284 |
| Vehicles Entered | 2 | 60 | 539 | 14 | 522 | 31 | 1168 |
| Vehicles Exited | 2 | 60 | 547 | 14 | 526 | 31 | 1180 |
| Hourly Exit Rate | 8 | 240 | 2188 | 56 | 2104 | 124 | 4720 |
| Input Volume | 10 | 228 | 2188 | 54 | 2047 | 130 | 4657 |
| % of Volume | 80 | 105 | 100 | 104 | 103 | 95 | 101 |
| Denied Entry Before | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Denied Entry After | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## Total Network Performance

| | |
|---|---|
| Total Delay (hr) | 2.4 |
| Delay / Veh (s) | 7.3 |
| Total Stops | 64 |
| Travel Dist (mi) | 696.3 |
| Travel Time (hr) | 18.6 |
| Avg Speed (mph) | 38 |
| Fuel Used (gal) | 22.2 |
| HC Emissions (g) | 262 |
| CO Emissions (g) | 10060 |
| NOx Emissions (g) | 1119 |
| Vehicles Entered | 1163 |
| Vehicles Exited | 1189 |
| Hourly Exit Rate | 4756 |
| Input Volume | 13907 |
| % of Volume | 34 |
| Denied Entry Before | 0 |
| Denied Entry After | 2 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 85 | 257 | 18 | 72 | 263 | 87 | 16 | 60 | 88 | 44 | 67 | 112 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.99 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1844 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.58 | 1.00 | | 0.44 | 1.00 | 1.00 | 0.74 | 1.00 | 1.00 | 0.74 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1089 | 1844 | | 814 | 1863 | 1583 | 1380 | 1863 | 1583 | 1380 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 92 | 279 | 20 | 78 | 286 | 95 | 17 | 65 | 96 | 48 | 73 | 122 |
| RTOR Reduction (vph) | 0 | 4 | 0 | 0 | 0 | 63 | 0 | 0 | 80 | 0 | 0 | 101 |
| Lane Group Flow (vph) | 92 | 295 | 0 | 78 | 286 | 32 | 17 | 65 | 16 | 48 | 73 | 21 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 8.6 | 8.1 | | 13.8 | 10.7 | 10.7 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 |
| Effective Green, g (s) | 8.6 | 8.1 | | 13.8 | 10.7 | 10.7 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 |
| Actuated g/C Ratio | 0.27 | 0.26 | | 0.44 | 0.34 | 0.34 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 307 | 473 | | 449 | 631 | 536 | 236 | 318 | 271 | 236 | 318 | 271 |
| v/s Ratio Prot | 0.00 | c0.16 | | c0.02 | c0.15 | | | 0.03 | | | c0.04 | |
| v/s Ratio Perm | 0.08 | | | 0.06 | | 0.02 | 0.01 | | 0.01 | 0.03 | | 0.01 |
| v/c Ratio | 0.30 | 0.62 | | 0.17 | 0.45 | 0.06 | 0.07 | 0.20 | 0.06 | 0.20 | 0.23 | 0.08 |
| Uniform Delay, d1 | 8.9 | 10.4 | | 5.4 | 8.2 | 7.1 | 11.0 | 11.3 | 11.0 | 11.3 | 11.3 | 11.0 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.6 | 2.5 | | 0.2 | 0.5 | 0.0 | 0.1 | 0.3 | 0.1 | 0.4 | 0.4 | 0.1 |
| Delay (s) | 9.5 | 12.9 | | 5.5 | 8.7 | 7.1 | 11.1 | 11.6 | 11.1 | 11.7 | 11.7 | 11.1 |
| Level of Service | A | B | | A | A | A | B | B | B | B | B | B |
| Approach Delay (s) | | 12.1 | | | 7.8 | | | 11.3 | | | 11.4 | |
| Approach LOS | | B | | | A | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.59 | | |
| Actuated Cycle Length (s) | 31.6 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 40.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 7.7 |
| Intersection LOS | A |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 250 | 334 | 254 | 220 |
| Demand Flow Rate, veh/h | 255 | 340 | 259 | 225 |
| Vehicles Circulating, veh/h | 261 | 231 | 245 | 302 |
| Vehicles Exiting, veh/h | 266 | 273 | 271 | 269 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 7.4 | 8.5 | 7.3 | 7.4 |
| Approach LOS | A | A | A | A |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 255 | 340 | 259 | 225 |
| Cap Entry Lane, veh/h | 870 | 897 | 884 | 835 |
| Entry HV Adj Factor | 0.980 | 0.983 | 0.980 | 0.979 |
| Flow Entry, veh/h | 250 | 334 | 254 | 220 |
| Cap Entry, veh/h | 853 | 881 | 867 | 818 |
| V/C Ratio | 2.93 | 3.79 | 2.93 | 2.69 |
| Control Delay, s/veh | 7.4 | 8.5 | 7.3 | 7.4 |
| LOS | A | A | A | A |
| 95th %tile Queue, veh | 0.1 | 0.2 | 0.1 | 0.1 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 155 | 130 | 513 | 174 | 522 | 110 | 2037 | 477 | 483 | 1764 | 35 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.88 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 21 | 168 | 141 | 558 | 189 | 567 | 120 | 2214 | 518 | 525 | 1917 | 38 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 460 | 0 | 0 | 102 | 0 | 0 | 9 |
| Lane Group Flow (vph) | 21 | 168 | 141 | 558 | 189 | 107 | 120 | 2214 | 416 | 525 | 1917 | 29 |
| Turn Type | Split | | Free | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 15.2 | 15.2 | 139.2 | 20.0 | 20.0 | 20.0 | 9.0 | 63.0 | 63.0 | 19.0 | 73.0 | 73.0 |
| Effective Green, g (s) | 15.2 | 15.2 | 139.2 | 20.0 | 20.0 | 20.0 | 9.0 | 63.0 | 63.0 | 19.0 | 73.0 | 73.0 |
| Actuated g/C Ratio | 0.11 | 0.11 | 1.00 | 0.14 | 0.14 | 0.14 | 0.06 | 0.45 | 0.45 | 0.14 | 0.52 | 0.52 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 193 | 203 | 1583 | 493 | 268 | 400 | 114 | 1602 | 716 | 469 | 1856 | 830 |
| v/s Ratio Prot | 0.01 | c0.09 | | c0.16 | 0.10 | | 0.07 | c0.63 | | c0.15 | c0.54 | |
| v/s Ratio Perm | | | 0.09 | | | 0.04 | | | 0.26 | | | 0.02 |
| v/c Ratio | 0.11 | 0.83 | 0.09 | 1.13 | 0.71 | 0.27 | 1.05 | 1.38 | 0.58 | 1.12 | 1.03 | 0.04 |
| Uniform Delay, d1 | 55.9 | 60.7 | 0.0 | 59.6 | 56.8 | 53.1 | 65.1 | 38.1 | 28.3 | 60.1 | 33.1 | 16.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.3 | 23.3 | 0.1 | 82.0 | 8.2 | 0.4 | 99.1 | 175.9 | 1.2 | 78.4 | 29.9 | 0.0 |
| Delay (s) | 56.1 | 84.0 | 0.1 | 141.6 | 65.0 | 53.4 | 164.2 | 214.0 | 29.5 | 138.5 | 63.0 | 16.1 |
| Level of Service | E | F | A | F | E | D | F | F | C | F | E | B |
| Approach Delay (s) | | 46.4 | | | 92.5 | | | 178.4 | | | 78.2 | |
| Approach LOS | | D | | | F | | | F | | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 120.4 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.30 | | |
| Actuated Cycle Length (s) | 139.2 | Sum of lost time (s) | 28.0 |
| Intersection Capacity Utilization | 111.2% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 47 | 71 | 56 | 154 | 12 | 56 | 46 | 1552 | 283 | 117 | 2039 | 32 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 4.0 | 6.0 | 6.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1826 | 1583 | | 1780 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.67 | 1.00 | | 0.58 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1252 | 1583 | | 1073 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 51 | 77 | 61 | 167 | 13 | 61 | 50 | 1687 | 308 | 127 | 2216 | 35 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 128 | 61 | 0 | 180 | 61 | 50 | 1687 | 308 | 127 | 2216 | 35 |
| Turn Type | Perm | | Free | Perm | | Free | Prot | | Free | Prot | | Free |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | Free | 8 | | Free | | | Free | | | Free |
| Actuated Green, G (s) | | 25.1 | 128.6 | | 25.1 | 128.6 | 6.6 | 73.9 | 128.6 | 12.6 | 79.9 | 128.6 |
| Effective Green, g (s) | | 25.1 | 128.6 | | 25.1 | 128.6 | 6.6 | 73.9 | 128.6 | 12.6 | 79.9 | 128.6 |
| Actuated g/C Ratio | | 0.20 | 1.00 | | 0.20 | 1.00 | 0.05 | 0.57 | 1.00 | 0.10 | 0.62 | 1.00 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 244 | 1583 | | 209 | 1583 | 91 | 2034 | 1583 | 173 | 2199 | 1583 |
| v/s Ratio Prot | | | | | | | 0.03 | 0.48 | | c0.07 | c0.63 | |
| v/s Ratio Perm | | 0.10 | 0.04 | | c0.17 | 0.04 | | | 0.19 | | | 0.02 |
| v/c Ratio | | 0.52 | 0.04 | | 0.86 | 0.04 | 0.55 | 0.83 | 0.19 | 0.73 | 1.01 | 0.02 |
| Uniform Delay, d1 | | 46.4 | 0.0 | | 50.1 | 0.0 | 59.5 | 22.2 | 0.0 | 56.4 | 24.3 | 0.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 2.0 | 0.0 | | 28.5 | 0.0 | 6.6 | 2.9 | 0.3 | 14.9 | 21.1 | 0.0 |
| Delay (s) | | 48.4 | 0.0 | | 78.6 | 0.0 | 66.2 | 25.2 | 0.3 | 71.2 | 45.4 | 0.0 |
| Level of Service | | D | A | | E | A | E | C | A | E | D | A |
| Approach Delay (s) | | 32.8 | | | 58.7 | | | 22.4 | | | 46.1 | |
| Approach LOS | | C | | | E | | | C | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 36.3 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.98 | | |
| Actuated Cycle Length (s) | 128.6 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 89.7% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 6 | 24 | 1107 | 4 | 33 | 1370 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 7 | 26 | 1203 | 4 | 36 | 1489 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2022 | 604 | | | 1208 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2022 | 604 | | | 1208 | |
| tC, single (s) | 6.8 | 6.9 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 86 | 94 | | | 94 | |
| cM capacity (veh/h) | 47 | 442 | | | 574 | |

| Direction, Lane # | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 33 | 802 | 405 | 36 | 745 | 745 |
| Volume Left | 7 | 0 | 0 | 36 | 0 | 0 |
| Volume Right | 26 | 0 | 4 | 0 | 0 | 0 |
| cSH | 165 | 1700 | 1700 | 574 | 1700 | 1700 |
| Volume to Capacity | 0.20 | 0.47 | 0.24 | 0.06 | 0.44 | 0.44 |
| Queue Length 95th (ft) | 18 | 0 | 0 | 5 | 0 | 0 |
| Control Delay (s) | 32.0 | 0.0 | 0.0 | 11.7 | 0.0 | 0.0 |
| Lane LOS | D | | | B | | |
| Approach Delay (s) | 32.0 | 0.0 | | 0.3 | | |
| Approach LOS | D | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.5 | | |
| Intersection Capacity Utilization | 47.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 87 | 46 | 25 | 1104 | 1352 | 86 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 95 | 50 | 27 | 1200 | 1470 | 93 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2124 | 735 | 1470 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2124 | 735 | 1470 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 19 | 91 | 92 | | | |
| cM capacity (veh/h) | 116 | 538 | 320 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 145 | 27 | 600 | 600 | 735 | 735 | 93 |
| Volume Left | 95 | 27 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 50 | 0 | 0 | 0 | 0 | 0 | 93 |
| cSH | 178 | 320 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.81 | 0.08 | 0.35 | 0.35 | 0.43 | 0.43 | 0.05 |
| Queue Length 95th (ft) | 139 | 7 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 75.1 | 17.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | C | | | | | |
| Approach Delay (s) | 75.1 | 0.4 | | | 0.0 | | |
| Approach LOS | F | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.9 | | |
| Intersection Capacity Utilization | 48.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 29 | 11 | 11 | 56 | 11 | 69 | 3 | 512 | 47 | 38 | 453 | 9 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1759 | | | 1788 | 1583 | 1770 | 1839 | | 1770 | 1857 | |
| Flt Permitted | | 0.78 | | | 0.72 | 1.00 | 0.42 | 1.00 | | 0.30 | 1.00 | |
| Satd. Flow (perm) | | 1415 | | | 1345 | 1583 | 778 | 1839 | | 559 | 1857 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 32 | 12 | 12 | 61 | 12 | 75 | 3 | 557 | 51 | 41 | 492 | 10 |
| RTOR Reduction (vph) | 0 | 10 | 0 | 0 | 0 | 64 | 0 | 5 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 46 | 0 | 0 | 73 | 11 | 3 | 603 | 0 | 41 | 501 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 6.4 | | | 6.4 | 6.4 | 22.8 | 22.3 | | 24.0 | 22.9 | |
| Effective Green, g (s) | | 6.4 | | | 6.4 | 6.4 | 22.8 | 22.3 | | 24.0 | 22.9 | |
| Actuated g/C Ratio | | 0.14 | | | 0.14 | 0.14 | 0.51 | 0.50 | | 0.54 | 0.51 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 202 | | | 192 | 226 | 407 | 915 | | 329 | 949 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.33 | | c0.00 | 0.27 | |
| v/s Ratio Perm | | 0.03 | | | c0.05 | 0.01 | 0.00 | | | 0.06 | | |
| v/c Ratio | | 0.23 | | | 0.38 | 0.05 | 0.01 | 0.66 | | 0.12 | 0.53 | |
| Uniform Delay, d1 | | 17.0 | | | 17.4 | 16.6 | 5.5 | 8.4 | | 5.5 | 7.3 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.6 | | | 1.3 | 0.1 | 0.0 | 1.7 | | 0.2 | 0.5 | |
| Delay (s) | | 17.6 | | | 18.7 | 16.7 | 5.5 | 10.1 | | 5.7 | 7.9 | |
| Level of Service | | B | | | B | B | A | B | | A | A | |
| Approach Delay (s) | | 17.6 | | | 17.6 | | | 10.1 | | | 7.7 | |
| Approach LOS | | B | | | B | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.58 | | |
| Actuated Cycle Length (s) | 44.8 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 49.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 212 | 230 | 94 | 140 | 119 | 51 | 99 | 1006 | 104 | 556 | 1227 | 326 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 4.0 | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frpb, ped/bikes | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Flpb, ped/bikes | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1541 | 1770 | 1863 | 1583 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1541 | 1770 | 1863 | 1583 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 230 | 250 | 102 | 152 | 129 | 55 | 108 | 1093 | 113 | 604 | 1334 | 354 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 52 | 0 | 0 | 139 |
| Lane Group Flow (vph) | 230 | 250 | 102 | 152 | 129 | 55 | 108 | 1093 | 61 | 604 | 1334 | 215 |
| Confl. Peds. (#/hr) | | | 50 | 50 | | | | | | | | |
| Turn Type | Prot | | Free | Prot | | Free | Prot | | pm+ov | Prot | | pm+ov |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | 3 | 1 | 6 | 7 |
| Permitted Phases | | | Free | | | Free | | | 2 | | | 6 |
| Actuated Green, G (s) | 20.7 | 23.2 | 130.6 | 14.8 | 17.3 | 130.6 | 11.8 | 46.3 | 61.1 | 24.3 | 58.8 | 79.5 |
| Effective Green, g (s) | 20.7 | 23.2 | 130.6 | 14.8 | 17.3 | 130.6 | 11.8 | 46.3 | 61.1 | 24.3 | 58.8 | 79.5 |
| Actuated g/C Ratio | 0.16 | 0.18 | 1.00 | 0.11 | 0.13 | 1.00 | 0.09 | 0.35 | 0.47 | 0.19 | 0.45 | 0.61 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 281 | 331 | 1541 | 201 | 247 | 1583 | 160 | 1255 | 741 | 639 | 1593 | 964 |
| v/s Ratio Prot | c0.13 | c0.13 | | 0.09 | 0.07 | | 0.06 | 0.31 | 0.01 | c0.18 | c0.38 | 0.04 |
| v/s Ratio Perm | | | 0.07 | | | 0.03 | | | 0.03 | | | 0.10 |
| v/c Ratio | 0.82 | 0.76 | 0.07 | 0.76 | 0.52 | 0.03 | 0.68 | 0.87 | 0.08 | 0.95 | 0.84 | 0.22 |
| Uniform Delay, d1 | 53.1 | 51.0 | 0.0 | 56.2 | 52.8 | 0.0 | 57.5 | 39.4 | 19.2 | 52.5 | 31.7 | 11.6 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 16.7 | 9.4 | 0.1 | 14.9 | 2.0 | 0.0 | 10.7 | 6.9 | 0.0 | 22.8 | 4.0 | 0.1 |
| Delay (s) | 69.8 | 60.4 | 0.1 | 71.1 | 54.8 | 0.0 | 68.3 | 46.2 | 19.3 | 75.3 | 35.7 | 11.7 |
| Level of Service | E | E | A | E | D | A | E | D | B | E | D | B |
| Approach Delay (s) | | 53.6 | | | 53.2 | | | 45.7 | | | 42.4 | |
| Approach LOS | | D | | | D | | | D | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 45.6 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.80 | | |
| Actuated Cycle Length (s) | 130.6 | Sum of lost time (s) | 11.0 |
| Intersection Capacity Utilization | 82.9% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 20 | 24 | 58 | 75 | 18 | 159 | 24 | 417 | 117 | 137 | 353 | 6 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1821 | 1583 | | 1791 | 1583 | 1770 | 1863 | 1583 | 1770 | 1858 | |
| Flt Permitted | | 0.83 | 1.00 | | 0.74 | 1.00 | 0.53 | 1.00 | 1.00 | 0.30 | 1.00 | |
| Satd. Flow (perm) | | 1549 | 1583 | | 1370 | 1583 | 989 | 1863 | 1583 | 566 | 1858 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 26 | 63 | 82 | 20 | 173 | 26 | 453 | 127 | 149 | 384 | 7 |
| RTOR Reduction (vph) | 0 | 0 | 52 | 0 | 0 | 142 | 0 | 0 | 75 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 48 | 11 | 0 | 102 | 31 | 26 | 453 | 52 | 149 | 391 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 9.9 | 9.9 | | 9.9 | 9.9 | 24.9 | 22.9 | 22.9 | 35.7 | 28.7 | |
| Effective Green, g (s) | | 9.9 | 9.9 | | 9.9 | 9.9 | 24.9 | 22.9 | 22.9 | 35.7 | 28.7 | |
| Actuated g/C Ratio | | 0.18 | 0.18 | | 0.18 | 0.18 | 0.45 | 0.41 | 0.41 | 0.64 | 0.52 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 276 | 282 | | 244 | 282 | 471 | 767 | 652 | 532 | 959 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.24 | | c0.04 | c0.21 | |
| v/s Ratio Perm | | 0.03 | 0.01 | | c0.07 | 0.02 | 0.02 | | 0.03 | 0.14 | | |
| v/c Ratio | | 0.17 | 0.04 | | 0.42 | 0.11 | 0.06 | 0.59 | 0.08 | 0.28 | 0.41 | |
| Uniform Delay, d1 | | 19.4 | 18.9 | | 20.3 | 19.2 | 8.6 | 12.7 | 9.9 | 5.2 | 8.2 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.3 | 0.1 | | 1.2 | 0.2 | 0.0 | 1.2 | 0.1 | 0.3 | 0.3 | |
| Delay (s) | | 19.7 | 19.0 | | 21.5 | 19.3 | 8.7 | 13.9 | 10.0 | 5.5 | 8.5 | |
| Level of Service | | B | B | | C | B | A | B | A | A | A | |
| Approach Delay (s) | | 19.3 | | | 20.1 | | | 12.9 | | | 7.7 | |
| Approach LOS | | B | | | C | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 12.8 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.57 | | |
| Actuated Cycle Length (s) | 55.6 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 53.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 307 | 201 | 129 | 1158 | 1969 | 351 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 0.97 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 334 | 218 | 140 | 1259 | 2140 | 382 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 109 |
| Lane Group Flow (vph) | 334 | 218 | 140 | 1259 | 2140 | 273 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 19.0 | 141.1 | 15.8 | 111.1 | 89.3 | 89.3 |
| Effective Green, g (s) | 19.0 | 141.1 | 15.8 | 111.1 | 89.3 | 89.3 |
| Actuated g/C Ratio | 0.13 | 1.00 | 0.11 | 0.79 | 0.63 | 0.63 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 462 | 1583 | 198 | 2787 | 2240 | 1002 |
| v/s Ratio Prot | c0.10 | | c0.08 | 0.36 | c0.60 | |
| v/s Ratio Perm | | 0.14 | | | | 0.17 |
| v/c Ratio | 0.72 | 0.14 | 0.71 | 0.45 | 0.96 | 0.27 |
| Uniform Delay, d1 | 58.5 | 0.0 | 60.4 | 4.9 | 24.0 | 11.5 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 5.5 | 0.2 | 10.9 | 0.1 | 10.4 | 0.1 |
| Delay (s) | 64.1 | 0.2 | 71.4 | 5.1 | 34.5 | 11.6 |
| Level of Service | E | A | E | A | C | B |
| Approach Delay (s) | 38.8 | | | 11.7 | 31.0 | |
| Approach LOS | D | | | B | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 25.9 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.89 | | |
| Actuated Cycle Length (s) | 141.1 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 84.5% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 96 | 11 | 88 | 7 | 476 | 93 | 107 | 487 | 11 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1783 | 1583 | 1770 | 1863 | 1583 | 1770 | 3527 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.45 | 1.00 | 1.00 | 0.31 | 1.00 | |
| Satd. Flow (perm) | | | | | 1783 | 1583 | 839 | 1863 | 1583 | 582 | 3527 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 104 | 12 | 96 | 8 | 517 | 101 | 116 | 529 | 12 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 0 | 53 | 0 | 2 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 116 | 13 | 8 | 517 | 48 | 116 | 539 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 6.5 | 6.5 | 23.5 | 23.0 | 23.0 | 30.9 | 26.7 | |
| Effective Green, g (s) | | | | | 6.5 | 6.5 | 23.5 | 23.0 | 23.0 | 30.9 | 26.7 | |
| Actuated g/C Ratio | | | | | 0.13 | 0.13 | 0.48 | 0.47 | 0.47 | 0.63 | 0.55 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 238 | 211 | 414 | 880 | 748 | 472 | 1934 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.28 | | c0.02 | 0.15 | |
| v/s Ratio Perm | | | | | 0.07 | 0.01 | 0.01 | | 0.03 | 0.13 | | |
| v/c Ratio | | | | | 0.49 | 0.06 | 0.02 | 0.59 | 0.06 | 0.25 | 0.28 | |
| Uniform Delay, d1 | | | | | 19.6 | 18.4 | 6.5 | 9.4 | 7.0 | 4.5 | 5.9 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 1.6 | 0.1 | 0.0 | 1.0 | 0.0 | 0.3 | 0.1 | |
| Delay (s) | | | | | 21.1 | 18.6 | 6.6 | 10.4 | 7.0 | 4.7 | 5.9 | |
| Level of Service | | | | | C | B | A | B | A | A | A | |
| Approach Delay (s) | | 0.0 | | | 20.0 | | | 9.8 | | | 5.7 | |
| Approach LOS | | A | | | B | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.5 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.62 | | |
| Actuated Cycle Length (s) | 48.7 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 49.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

## 19: East Waipuilani Road & Pi'ilani Highway Performance by movement

| Movement | EBR | WBR | NBT | NBR | SBT | SBR | All |
|---|---|---|---|---|---|---|---|
| Total Delay (hr) | 0.0 | 0.0 | 0.2 | 0.0 | 0.2 | 0.0 | 0.4 |
| Delay / Veh (s) | 1.1 | 2.3 | 1.8 | 4.8 | 1.1 | 1.6 | 1.4 |
| Total Stops | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Travel Dist (mi) | 0.6 | 7.7 | 75.3 | 1.1 | 61.3 | 1.2 | 147.2 |
| Travel Time (hr) | 0.0 | 0.3 | 1.9 | 0.0 | 1.5 | 0.0 | 3.9 |
| Avg Speed (mph) | 23 | 23 | 40 | 35 | 40 | 26 | 38 |
| Fuel Used (gal) | 0.0 | 0.2 | 2.2 | 0.0 | 1.8 | 0.0 | 4.2 |
| HC Emissions (g) | 2 | 1 | 36 | 0 | 24 | 0 | 63 |
| CO Emissions (g) | 30 | 54 | 1225 | 13 | 713 | 6 | 2041 |
| NOx Emissions (g) | 5 | 4 | 138 | 1 | 97 | 0 | 244 |
| Vehicles Entered | 3 | 69 | 353 | 5 | 580 | 12 | 1022 |
| Vehicles Exited | 4 | 71 | 350 | 5 | 583 | 12 | 1025 |
| Hourly Exit Rate | 16 | 284 | 1400 | 20 | 2332 | 48 | 4100 |
| Input Volume | 30 | 248 | 1391 | 36 | 2303 | 76 | 4084 |
| % of Volume | 53 | 115 | 101 | 56 | 101 | 63 | 100 |
| Denied Entry Before | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Denied Entry After | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## Total Network Performance

| | |
|---|---|
| Total Delay (hr) | 1.8 |
| Delay / Veh (s) | 6.3 |
| Total Stops | 80 |
| Travel Dist (mi) | 606.1 |
| Travel Time (hr) | 15.9 |
| Avg Speed (mph) | 39 |
| Fuel Used (gal) | 19.2 |
| HC Emissions (g) | 274 |
| CO Emissions (g) | 9482 |
| NOx Emissions (g) | 1104 |
| Vehicles Entered | 1013 |
| Vehicles Exited | 1035 |
| Hourly Exit Rate | 4140 |
| Input Volume | 12186 |
| % of Volume | 34 |
| Denied Entry Before | 0 |
| Denied Entry After | 0 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 52 | 192 | 30 | 222 | 206 | 133 | 50 | 407 | 170 | 167 | 484 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.98 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1825 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.62 | 1.00 | | 0.38 | 1.00 | 1.00 | 0.24 | 1.00 | 1.00 | 0.33 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1152 | 1825 | | 709 | 1863 | 1583 | 447 | 1863 | 1583 | 617 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 57 | 209 | 33 | 241 | 224 | 145 | 54 | 442 | 185 | 182 | 526 | 85 |
| RTOR Reduction (vph) | 0 | 6 | 0 | 0 | 0 | 89 | 0 | 0 | 85 | 0 | 0 | 26 |
| Lane Group Flow (vph) | 57 | 236 | 0 | 241 | 224 | 56 | 54 | 442 | 100 | 182 | 526 | 59 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 19.6 | 17.6 | | 34.6 | 27.6 | 27.6 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 |
| Effective Green, g (s) | 19.6 | 17.6 | | 34.6 | 27.6 | 27.6 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 |
| Actuated g/C Ratio | 0.27 | 0.24 | | 0.48 | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 330 | 445 | | 517 | 713 | 606 | 170 | 711 | 604 | 235 | 711 | 604 |
| v/s Ratio Prot | 0.00 | 0.13 | | c0.08 | 0.12 | | | 0.24 | | | 0.28 | |
| v/s Ratio Perm | 0.04 | | | c0.15 | | 0.04 | 0.12 | | 0.06 | c0.29 | | 0.04 |
| v/c Ratio | 0.17 | 0.53 | | 0.47 | 0.31 | 0.09 | 0.32 | 0.62 | 0.17 | 0.77 | 0.74 | 0.10 |
| Uniform Delay, d1 | 19.8 | 23.7 | | 11.9 | 15.6 | 14.2 | 15.7 | 18.1 | 14.7 | 19.6 | 19.2 | 14.3 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.3 | 1.2 | | 0.7 | 0.3 | 0.1 | 1.1 | 1.7 | 0.1 | 14.7 | 4.0 | 0.1 |
| Delay (s) | 20.0 | 24.9 | | 12.6 | 15.9 | 14.3 | 16.8 | 19.8 | 14.9 | 34.2 | 23.3 | 14.4 |
| Level of Service | C | C | | B | B | B | B | B | B | C | C | B |
| Approach Delay (s) | | 23.9 | | | 14.2 | | | 18.2 | | | 24.8 | |
| Approach LOS | | C | | | B | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 20.1 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.59 | | |
| Actuated Cycle Length (s) | 72.1 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 71.6% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 14.3 |
| Intersection LOS | B |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 97 | 265 | 506 | 624 |
| Demand Flow Rate, veh/h | 99 | 270 | 516 | 637 |
| Vehicles Circulating, veh/h | 694 | 468 | 107 | 295 |
| Vehicles Exiting, veh/h | 238 | 155 | 685 | 443 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 8.8 | 10.3 | 9.8 | 20.4 |
| Approach LOS | A | B | A | C |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 99 | 270 | 516 | 637 |
| Cap Entry Lane, veh/h | 564 | 708 | 1015 | 841 |
| Entry HV Adj Factor | 0.977 | 0.980 | 0.980 | 0.979 |
| Flow Entry, veh/h | 97 | 265 | 506 | 624 |
| Cap Entry, veh/h | 552 | 694 | 995 | 824 |
| V/C Ratio | 1.75 | 3.82 | 5.08 | 7.57 |
| Control Delay, s/veh | 8.8 | 10.3 | 9.8 | 20.4 |
| LOS | A | B | A | C |
| 95th %tile Queue, veh | 0.1 | 0.2 | 0.3 | 0.7 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 24 | 69 | 198 | 81 | 43 | 83 | 61 | 1466 | 128 | 131 | 1909 | 24 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.88 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 26 | 75 | 215 | 88 | 47 | 90 | 66 | 1593 | 139 | 142 | 2075 | 26 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 0 | 30 | 0 | 0 | 4 |
| Lane Group Flow (vph) | 26 | 75 | 215 | 88 | 47 | 7 | 66 | 1593 | 109 | 142 | 2075 | 22 |
| Turn Type | Split | | Free | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 8.4 | 8.4 | 116.0 | 8.6 | 8.6 | 8.6 | 6.7 | 66.8 | 66.8 | 10.2 | 70.3 | 70.3 |
| Effective Green, g (s) | 8.4 | 8.4 | 116.0 | 8.6 | 8.6 | 8.6 | 6.7 | 66.8 | 66.8 | 10.2 | 70.3 | 70.3 |
| Actuated g/C Ratio | 0.07 | 0.07 | 1.00 | 0.07 | 0.07 | 0.07 | 0.06 | 0.58 | 0.58 | 0.09 | 0.61 | 0.61 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 128 | 135 | 1583 | 255 | 138 | 207 | 102 | 2038 | 912 | 302 | 2145 | 959 |
| v/s Ratio Prot | 0.01 | c0.04 | | c0.03 | 0.03 | | 0.04 | 0.45 | | c0.04 | c0.59 | |
| v/s Ratio Perm | | | 0.14 | | | 0.00 | | | 0.07 | | | 0.01 |
| v/c Ratio | 0.20 | 0.56 | 0.14 | 0.35 | 0.34 | 0.03 | 0.65 | 0.78 | 0.12 | 0.47 | 0.97 | 0.02 |
| Uniform Delay, d1 | 50.6 | 52.0 | 0.0 | 51.0 | 51.0 | 49.8 | 53.5 | 19.0 | 11.2 | 50.3 | 21.8 | 9.1 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.8 | 4.9 | 0.2 | 0.8 | 1.5 | 0.1 | 13.3 | 2.0 | 0.1 | 1.2 | 12.6 | 0.0 |
| Delay (s) | 51.4 | 56.9 | 0.2 | 51.8 | 52.5 | 49.9 | 66.8 | 21.0 | 11.3 | 51.5 | 34.3 | 9.1 |
| Level of Service | D | E | A | D | D | D | E | C | B | D | C | A |
| Approach Delay (s) | | 17.9 | | | 51.2 | | | 21.9 | | | 35.1 | |
| Approach LOS | | B | | | D | | | C | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 29.5 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.86 | | |
| Actuated Cycle Length (s) | 116.0 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 74.2% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 15 | 65 | 80 | 6 | 28 | 81 | 2266 | 61 | 25 | 2068 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 4.0 | 6.0 | 6.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.97 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1811 | 1583 | | 1780 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.80 | 1.00 | | 0.71 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1495 | 1583 | | 1332 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 21 | 16 | 71 | 87 | 7 | 30 | 88 | 2463 | 66 | 27 | 2248 | 85 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 37 | 71 | 0 | 94 | 30 | 88 | 2463 | 66 | 27 | 2248 | 85 |
| Turn Type | Perm | | Free | Perm | | Free | Prot | | Free | Prot | | Free |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | Free | 8 | | Free | | | Free | | | Free |
| Actuated Green, G (s) | | 13.7 | 122.5 | | 13.7 | 122.5 | 8.8 | 87.0 | 122.5 | 4.8 | 83.0 | 122.5 |
| Effective Green, g (s) | | 13.7 | 122.5 | | 13.7 | 122.5 | 8.8 | 87.0 | 122.5 | 4.8 | 83.0 | 122.5 |
| Actuated g/C Ratio | | 0.11 | 1.00 | | 0.11 | 1.00 | 0.07 | 0.71 | 1.00 | 0.04 | 0.68 | 1.00 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 167 | 1583 | | 149 | 1583 | 127 | 2513 | 1583 | 69 | 2398 | 1583 |
| v/s Ratio Prot | | | | | | | c0.05 | c0.70 | | 0.02 | 0.64 | |
| v/s Ratio Perm | | 0.02 | 0.04 | | c0.07 | 0.02 | | | 0.04 | | | 0.05 |
| v/c Ratio | | 0.22 | 0.04 | | 0.63 | 0.02 | 0.69 | 0.98 | 0.04 | 0.39 | 0.94 | 0.05 |
| Uniform Delay, d1 | | 49.5 | 0.0 | | 52.0 | 0.0 | 55.5 | 16.9 | 0.0 | 57.4 | 17.5 | 0.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 0.7 | 0.1 | | 8.4 | 0.0 | 15.1 | 13.6 | 0.0 | 3.6 | 7.8 | 0.1 |
| Delay (s) | | 50.2 | 0.1 | | 60.4 | 0.0 | 70.6 | 30.5 | 0.0 | 61.1 | 25.3 | 0.1 |
| Level of Service | | D | A | | E | A | E | C | A | E | C | A |
| Approach Delay (s) | | 17.2 | | | 45.8 | | | 31.1 | | | 24.8 | |
| Approach LOS | | B | | | D | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 28.3 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.94 | | |
| Actuated Cycle Length (s) | 122.5 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 87.9% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 6 | 24 | 1459 | 0 | 8 | 1313 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 7 | 26 | 1586 | 0 | 9 | 1427 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2317 | 793 | | | 1586 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2317 | 793 | | | 1586 | |
| tC, single (s) | 6.8 | 6.9 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 79 | 92 | | | 98 | |
| cM capacity (veh/h) | 31 | 331 | | | 410 | |

| Direction, Lane # | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 33 | 1057 | 529 | 9 | 714 | 714 |
| Volume Left | 7 | 0 | 0 | 9 | 0 | 0 |
| Volume Right | 26 | 0 | 0 | 0 | 0 | 0 |
| cSH | 113 | 1700 | 1700 | 410 | 1700 | 1700 |
| Volume to Capacity | 0.29 | 0.62 | 0.31 | 0.02 | 0.42 | 0.42 |
| Queue Length 95th (ft) | 27 | 0 | 0 | 2 | 0 | 0 |
| Control Delay (s) | 49.4 | 0.0 | 0.0 | 14.0 | 0.0 | 0.0 |
| Lane LOS | E | | | B | | |
| Approach Delay (s) | 49.4 | 0.0 | | 0.1 | | |
| Approach LOS | E | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.6 | | |
| Intersection Capacity Utilization | 50.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 99 | 46 | 85 | 1379 | 1264 | 172 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 108 | 50 | 92 | 1499 | 1374 | 187 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2308 | 687 | 1374 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2308 | 687 | 1374 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 91 | 74 | | | |
| cM capacity (veh/h) | 77 | 564 | 357 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 158 | 92 | 749 | 749 | 687 | 687 | 187 |
| Volume Left | 108 | 92 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 50 | 0 | 0 | 0 | 0 | 0 | 187 |
| cSH | 110 | 357 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 1.43 | 0.26 | 0.44 | 0.44 | 0.40 | 0.40 | 0.11 |
| Queue Length 95th (ft) | 280 | 25 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 308.2 | 18.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | C | | | | | |
| Approach Delay (s) | 308.2 | 1.1 | | | 0.0 | | |
| Approach LOS | F | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 15.2 | | |
| Intersection Capacity Utilization | 55.1% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 34 | 7 | 13 | 110 | 17 | 59 | 18 | 813 | 71 | 44 | 857 | 31 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 0.99 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1748 | | | 1785 | 1583 | 1770 | 1840 | | 1770 | 1853 | |
| Flt Permitted | | 0.73 | | | 0.71 | 1.00 | 0.13 | 1.00 | | 0.12 | 1.00 | |
| Satd. Flow (perm) | | 1315 | | | 1327 | 1583 | 247 | 1840 | | 232 | 1853 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 37 | 8 | 14 | 120 | 18 | 64 | 20 | 884 | 77 | 48 | 932 | 34 |
| RTOR Reduction (vph) | 0 | 12 | 0 | 0 | 0 | 55 | 0 | 3 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 47 | 0 | 0 | 138 | 9 | 20 | 958 | 0 | 48 | 965 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 9.7 | | | 9.7 | 9.7 | 44.1 | 42.8 | | 45.3 | 43.4 | |
| Effective Green, g (s) | | 9.7 | | | 9.7 | 9.7 | 44.1 | 42.8 | | 45.3 | 43.4 | |
| Actuated g/C Ratio | | 0.14 | | | 0.14 | 0.14 | 0.64 | 0.62 | | 0.65 | 0.63 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 184 | | | 185 | 221 | 185 | 1135 | | 194 | 1159 | |
| v/s Ratio Prot | | | | | | | 0.00 | 0.52 | | c0.01 | c0.52 | |
| v/s Ratio Perm | | 0.04 | | | c0.10 | 0.01 | 0.07 | | | 0.15 | | |
| v/c Ratio | | 0.26 | | | 0.75 | 0.04 | 0.11 | 0.84 | | 0.25 | 0.83 | |
| Uniform Delay, d1 | | 26.6 | | | 28.7 | 25.8 | 9.1 | 10.6 | | 9.6 | 10.2 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.7 | | | 15.0 | 0.1 | 0.3 | 5.9 | | 0.7 | 5.2 | |
| Delay (s) | | 27.4 | | | 43.7 | 25.9 | 9.4 | 16.5 | | 10.3 | 15.4 | |
| Level of Service | | C | | | D | C | A | B | | B | B | |
| Approach Delay (s) | | 27.4 | | | 38.1 | | | 16.4 | | | 15.2 | |
| Approach LOS | | C | | | D | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 18.1 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.74 | | |
| Actuated Cycle Length (s) | 69.4 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 66.6% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 214 | 114 | 58 | 203 | 184 | 232 | 177 | 1305 | 23 | 282 | 1230 | 160 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 4.0 | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frpb, ped/bikes | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Flpb, ped/bikes | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1541 | 1770 | 1863 | 1583 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1541 | 1770 | 1863 | 1583 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 233 | 124 | 63 | 221 | 200 | 252 | 192 | 1418 | 25 | 307 | 1337 | 174 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 69 |
| Lane Group Flow (vph) | 233 | 124 | 63 | 221 | 200 | 252 | 192 | 1418 | 15 | 307 | 1337 | 105 |
| Confl. Peds. (#/hr) | | | 50 | 50 | | | | | | | | |
| Turn Type | Prot | | Free | Prot | | Free | Prot | | pm+ov | Prot | | pm+ov |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | 3 | 1 | 6 | 7 |
| Permitted Phases | | | Free | | | Free | | | 2 | | | 6 |
| Actuated Green, G (s) | 20.9 | 20.2 | 133.7 | 20.3 | 19.6 | 133.7 | 17.5 | 57.2 | 77.5 | 14.0 | 53.7 | 74.6 |
| Effective Green, g (s) | 20.9 | 20.2 | 133.7 | 20.3 | 19.6 | 133.7 | 17.5 | 57.2 | 77.5 | 14.0 | 53.7 | 74.6 |
| Actuated g/C Ratio | 0.16 | 0.15 | 1.00 | 0.15 | 0.15 | 1.00 | 0.13 | 0.43 | 0.58 | 0.10 | 0.40 | 0.56 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 277 | 281 | 1541 | 269 | 273 | 1583 | 232 | 1514 | 918 | 359 | 1421 | 883 |
| v/s Ratio Prot | c0.13 | 0.07 | | 0.12 | c0.11 | | c0.11 | c0.40 | 0.00 | 0.09 | 0.38 | 0.02 |
| v/s Ratio Perm | | | 0.04 | | | c0.16 | | | 0.01 | | | 0.05 |
| v/c Ratio | 0.84 | 0.44 | 0.04 | 0.82 | 0.73 | 0.16 | 0.83 | 0.94 | 0.02 | 0.86 | 0.94 | 0.12 |
| Uniform Delay, d1 | 54.8 | 51.6 | 0.0 | 54.9 | 54.5 | 0.0 | 56.6 | 36.5 | 11.9 | 58.9 | 38.5 | 14.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 20.0 | 1.1 | 0.0 | 17.9 | 9.7 | 0.2 | 20.9 | 11.2 | 0.0 | 17.7 | 12.4 | 0.1 |
| Delay (s) | 74.8 | 52.7 | 0.0 | 72.9 | 64.3 | 0.2 | 77.5 | 47.7 | 11.9 | 76.5 | 50.9 | 14.1 |
| Level of Service | E | D | A | E | E | A | E | D | B | E | D | B |
| Approach Delay (s) | | 57.1 | | | 43.1 | | | 50.7 | | | 51.7 | |
| Approach LOS | | E | | | D | | | D | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 50.6 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.90 | | |
| Actuated Cycle Length (s) | 133.7 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 85.6% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 39 | 37 | 58 | 141 | 35 | 131 | 71 | 671 | 136 | 71 | 816 | 28 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1816 | 1583 | | 1791 | 1583 | 1770 | 1863 | 1583 | 1770 | 1854 | |
| Flt Permitted | | 0.77 | 1.00 | | 0.71 | 1.00 | 0.10 | 1.00 | 1.00 | 0.24 | 1.00 | |
| Satd. Flow (perm) | | 1437 | 1583 | | 1329 | 1583 | 191 | 1863 | 1583 | 445 | 1854 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 42 | 40 | 63 | 153 | 38 | 142 | 77 | 729 | 148 | 77 | 887 | 30 |
| RTOR Reduction (vph) | 0 | 0 | 49 | 0 | 0 | 111 | 0 | 0 | 62 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 82 | 14 | 0 | 191 | 31 | 77 | 729 | 86 | 77 | 916 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 19.0 | 19.0 | | 19.0 | 19.0 | 54.7 | 51.0 | 51.0 | 53.1 | 50.2 | |
| Effective Green, g (s) | | 19.0 | 19.0 | | 19.0 | 19.0 | 54.7 | 51.0 | 51.0 | 53.1 | 50.2 | |
| Actuated g/C Ratio | | 0.22 | 0.22 | | 0.22 | 0.22 | 0.62 | 0.58 | 0.58 | 0.60 | 0.57 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 311 | 342 | | 287 | 342 | 185 | 1081 | 918 | 313 | 1059 | |
| v/s Ratio Prot | | | | | | | c0.02 | 0.39 | | 0.01 | c0.49 | |
| v/s Ratio Perm | | 0.06 | 0.01 | | c0.14 | 0.02 | 0.24 | | 0.05 | 0.14 | | |
| v/c Ratio | | 0.26 | 0.04 | | 0.67 | 0.09 | 0.42 | 0.67 | 0.09 | 0.25 | 0.86 | |
| Uniform Delay, d1 | | 28.6 | 27.2 | | 31.5 | 27.5 | 14.5 | 12.7 | 8.2 | 9.6 | 16.0 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.5 | 0.0 | | 5.7 | 0.1 | 1.5 | 1.7 | 0.0 | 0.4 | 7.5 | |
| Delay (s) | | 29.1 | 27.3 | | 37.3 | 27.7 | 16.0 | 14.4 | 8.2 | 10.0 | 23.5 | |
| Level of Service | | C | C | | D | C | B | B | A | A | C | |
| Approach Delay (s) | | 28.3 | | | 33.2 | | | 13.6 | | | 22.4 | |
| Approach LOS | | C | | | C | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 20.8 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.79 | | |
| Actuated Cycle Length (s) | 87.9 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 77.4% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 421 | 373 | 367 | 1728 | 1519 | 498 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 0.97 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 458 | 405 | 399 | 1878 | 1651 | 541 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 183 |
| Lane Group Flow (vph) | 458 | 405 | 399 | 1878 | 1651 | 358 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 28.0 | 176.6 | 44.0 | 137.6 | 87.6 | 87.6 |
| Effective Green, g (s) | 28.0 | 176.6 | 44.0 | 137.6 | 87.6 | 87.6 |
| Actuated g/C Ratio | 0.16 | 1.00 | 0.25 | 0.78 | 0.50 | 0.50 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 544 | 1583 | 441 | 2757 | 1755 | 785 |
| v/s Ratio Prot | c0.13 | | c0.23 | 0.53 | c0.47 | |
| v/s Ratio Perm | | 0.26 | | | | 0.23 |
| v/c Ratio | 0.84 | 0.26 | 0.90 | 0.68 | 0.94 | 0.46 |
| Uniform Delay, d1 | 72.2 | 0.0 | 64.3 | 9.2 | 42.0 | 29.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 11.3 | 0.4 | 21.6 | 0.7 | 10.5 | 0.4 |
| Delay (s) | 83.5 | 0.4 | 85.9 | 9.9 | 52.6 | 29.4 |
| Level of Service | F | A | F | A | D | C |
| Approach Delay (s) | 44.5 | | | 23.2 | 46.9 | |
| Approach LOS | D | | | C | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 36.4 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.91 | | |
| Actuated Cycle Length (s) | 176.6 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 88.5% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 223 | 63 | 128 | 19 | 685 | 197 | 91 | 571 | 25 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1793 | 1583 | 1770 | 1863 | 1583 | 1770 | 3517 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.40 | 1.00 | 1.00 | 0.15 | 1.00 | |
| Satd. Flow (perm) | | | | | 1793 | 1583 | 752 | 1863 | 1583 | 287 | 3517 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 242 | 68 | 139 | 21 | 745 | 214 | 99 | 621 | 27 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 104 | 0 | 0 | 106 | 0 | 3 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 310 | 35 | 21 | 745 | 108 | 99 | 645 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 19.7 | 19.7 | 41.2 | 40.0 | 40.0 | 47.6 | 43.2 | |
| Effective Green, g (s) | | | | | 19.7 | 19.7 | 41.2 | 40.0 | 40.0 | 47.6 | 43.2 | |
| Actuated g/C Ratio | | | | | 0.25 | 0.25 | 0.52 | 0.51 | 0.51 | 0.60 | 0.55 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 447 | 394 | 407 | 942 | 801 | 255 | 1921 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.40 | | c0.02 | 0.18 | |
| v/s Ratio Perm | | | | | 0.17 | 0.02 | 0.03 | | 0.07 | 0.21 | | |
| v/c Ratio | | | | | 0.69 | 0.09 | 0.05 | 0.79 | 0.14 | 0.39 | 0.34 | |
| Uniform Delay, d1 | | | | | 27.0 | 22.8 | 9.2 | 16.1 | 10.4 | 11.5 | 10.0 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 4.6 | 0.1 | 0.1 | 4.6 | 0.1 | 1.0 | 0.1 | |
| Delay (s) | | | | | 31.6 | 22.9 | 9.2 | 20.7 | 10.4 | 12.5 | 10.1 | |
| Level of Service | | | | | C | C | A | C | B | B | B | |
| Approach Delay (s) | | 0.0 | | | 28.9 | | | 18.2 | | | 10.4 | |
| Approach LOS | | A | | | C | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 17.7 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.80 | | |
| Actuated Cycle Length (s) | 79.1 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 69.3% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

## 19: East Waipuilani Road & Pi'ilani Highway Performance by movement

| Movement | EBR | WBR | NBT | NBR | SBT | SBR | All |
|---|---|---|---|---|---|---|---|
| Total Delay (hr) | 0.0 | 0.0 | 0.3 | 0.0 | 0.1 | 0.0 | 0.4 |
| Delay / Veh (s) | 1.2 | 2.0 | 2.4 | 5.1 | 0.7 | 1.7 | 1.6 |
| Total Stops | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Travel Dist (mi) | 0.4 | 4.6 | 99.1 | 1.7 | 49.6 | 3.4 | 158.8 |
| Travel Time (hr) | 0.0 | 0.2 | 2.6 | 0.1 | 1.2 | 0.1 | 4.2 |
| Avg Speed (mph) | 23 | 24 | 40 | 36 | 41 | 26 | 39 |
| Fuel Used (gal) | 0.0 | 0.1 | 3.0 | 0.0 | 1.3 | 0.0 | 4.5 |
| HC Emissions (g) | 0 | 1 | 36 | 0 | 7 | 1 | 44 |
| CO Emissions (g) | 1 | 26 | 1389 | 12 | 309 | 8 | 1745 |
| NOx Emissions (g) | 0 | 2 | 153 | 1 | 47 | 1 | 204 |
| Vehicles Entered | 2 | 42 | 455 | 8 | 471 | 34 | 1012 |
| Vehicles Exited | 2 | 41 | 464 | 8 | 473 | 33 | 1021 |
| Hourly Exit Rate | 8 | 164 | 1856 | 32 | 1892 | 132 | 4084 |
| Input Volume | 10 | 201 | 1904 | 40 | 1811 | 130 | 4096 |
| % of Volume | 80 | 82 | 97 | 80 | 104 | 102 | 100 |
| Denied Entry Before | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Denied Entry After | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## Total Network Performance

| | |
|---|---|
| Total Delay (hr) | 1.5 |
| Delay / Veh (s) | 5.3 |
| Total Stops | 46 |
| Travel Dist (mi) | 608.4 |
| Travel Time (hr) | 15.6 |
| Avg Speed (mph) | 39 |
| Fuel Used (gal) | 18.1 |
| HC Emissions (g) | 163 |
| CO Emissions (g) | 6717 |
| NOx Emissions (g) | 813 |
| Vehicles Entered | 1014 |
| Vehicles Exited | 1029 |
| Hourly Exit Rate | 4116 |
| Input Volume | 12238 |
| % of Volume | 34 |
| Denied Entry Before | 1 |
| Denied Entry After | 0 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 85 | 246 | 18 | 121 | 249 | 129 | 16 | 473 | 120 | 73 | 433 | 112 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.99 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1843 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.59 | 1.00 | | 0.36 | 1.00 | 1.00 | 0.28 | 1.00 | 1.00 | 0.28 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1104 | 1843 | | 664 | 1863 | 1583 | 514 | 1863 | 1583 | 514 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 92 | 267 | 20 | 132 | 271 | 140 | 17 | 514 | 130 | 79 | 471 | 122 |
| RTOR Reduction (vph) | 0 | 4 | 0 | 0 | 0 | 66 | 0 | 0 | 77 | 0 | 0 | 63 |
| Lane Group Flow (vph) | 92 | 283 | 0 | 132 | 271 | 74 | 17 | 514 | 53 | 79 | 471 | 59 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 12.7 | 12.2 | | 23.0 | 17.5 | 17.5 | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 |
| Effective Green, g (s) | 12.7 | 12.2 | | 23.0 | 17.5 | 17.5 | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 |
| Actuated g/C Ratio | 0.27 | 0.26 | | 0.48 | 0.37 | 0.37 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 302 | 473 | | 457 | 686 | 583 | 157 | 569 | 483 | 157 | 569 | 483 |
| v/s Ratio Prot | 0.00 | c0.15 | | c0.04 | c0.15 | | | c0.28 | | | 0.25 | |
| v/s Ratio Perm | 0.08 | | | 0.10 | | 0.05 | 0.03 | | 0.03 | 0.15 | | 0.04 |
| v/c Ratio | 0.30 | 0.60 | | 0.29 | 0.40 | 0.13 | 0.11 | 0.90 | 0.11 | 0.50 | 0.83 | 0.12 |
| Uniform Delay, d1 | 13.7 | 15.5 | | 7.4 | 11.1 | 9.9 | 11.9 | 15.8 | 11.9 | 13.5 | 15.3 | 11.9 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.6 | 2.0 | | 0.4 | 0.4 | 0.1 | 0.3 | 17.7 | 0.1 | 2.5 | 9.6 | 0.1 |
| Delay (s) | 14.3 | 17.5 | | 7.7 | 11.5 | 10.0 | 12.2 | 33.5 | 12.0 | 16.1 | 25.0 | 12.0 |
| Level of Service | B | B | | A | B | B | B | C | B | B | C | B |
| Approach Delay (s) | | 16.7 | | | 10.2 | | | 28.7 | | | 21.6 | |
| Approach LOS | | B | | | B | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 20.1 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.81 | | |
| Actuated Cycle Length (s) | 47.5 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 66.3% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 23.4 |
| Intersection LOS | C |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 250 | 334 | 748 | 649 |
| Demand Flow Rate, veh/h | 255 | 340 | 763 | 662 |
| Vehicles Circulating, veh/h | 698 | 735 | 245 | 302 |
| Vehicles Exiting, veh/h | 266 | 273 | 708 | 773 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 14.1 | 20.6 | 28.2 | 22.9 |
| Approach LOS | B | C | D | C |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 255 | 340 | 763 | 662 |
| Cap Entry Lane, veh/h | 562 | 542 | 884 | 835 |
| Entry HV Adj Factor | 0.980 | 0.983 | 0.980 | 0.980 |
| Flow Entry, veh/h | 250 | 334 | 748 | 649 |
| Cap Entry, veh/h | 551 | 532 | 867 | 819 |
| V/C Ratio | 4.54 | 6.28 | 8.63 | 7.92 |
| Control Delay, s/veh | 14.1 | 20.6 | 28.2 | 22.9 |
| LOS | B | C | D | C |
| 95th %tile Queue, veh | 0.2 | 0.4 | 1.1 | 0.8 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 155 | 130 | 513 | 174 | 522 | 110 | 1726 | 477 | 483 | 1528 | 35 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.88 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 21 | 168 | 141 | 558 | 189 | 567 | 120 | 1876 | 518 | 525 | 1661 | 38 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 462 | 0 | 0 | 121 | 0 | 0 | 10 |
| Lane Group Flow (vph) | 21 | 168 | 141 | 558 | 189 | 105 | 120 | 1876 | 397 | 525 | 1661 | 28 |
| Turn Type | Split | | Free | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 15.2 | 15.2 | 139.2 | 20.0 | 20.0 | 20.0 | 9.0 | 63.0 | 63.0 | 19.0 | 73.0 | 73.0 |
| Effective Green, g (s) | 15.2 | 15.2 | 139.2 | 20.0 | 20.0 | 20.0 | 9.0 | 63.0 | 63.0 | 19.0 | 73.0 | 73.0 |
| Actuated g/C Ratio | 0.11 | 0.11 | 1.00 | 0.14 | 0.14 | 0.14 | 0.06 | 0.45 | 0.45 | 0.14 | 0.52 | 0.52 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 193 | 203 | 1583 | 493 | 268 | 400 | 114 | 1602 | 716 | 242 | 1856 | 830 |
| v/s Ratio Prot | 0.01 | c0.09 | | c0.16 | 0.10 | | 0.07 | c0.53 | | c0.30 | 0.47 | |
| v/s Ratio Perm | | | 0.09 | | | 0.04 | | | 0.25 | | | 0.02 |
| v/c Ratio | 0.11 | 0.83 | 0.09 | 1.13 | 0.71 | 0.26 | 1.05 | 1.17 | 0.55 | 2.17 | 0.89 | 0.03 |
| Uniform Delay, d1 | 55.9 | 60.7 | 0.0 | 59.6 | 56.8 | 53.0 | 65.1 | 38.1 | 27.8 | 60.1 | 29.7 | 16.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.3 | 23.3 | 0.1 | 82.0 | 8.2 | 0.4 | 99.1 | 84.0 | 0.9 | 539.7 | 6.0 | 0.0 |
| Delay (s) | 56.1 | 84.0 | 0.1 | 141.6 | 65.0 | 53.4 | 164.2 | 122.1 | 28.8 | 599.8 | 35.7 | 16.0 |
| Level of Service | E | F | A | F | E | D | F | F | C | F | D | B |
| Approach Delay (s) | | 46.4 | | | 92.5 | | | 104.9 | | | 168.5 | |
| Approach LOS | | D | | | F | | | F | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 121.5 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.28 | | |
| Actuated Cycle Length (s) | 139.2 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 115.6% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 47 | 71 | 56 | 154 | 12 | 56 | 46 | 1735 | 283 | 117 | 2420 | 32 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 4.0 | 6.0 | 6.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1826 | 1583 | | 1780 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.67 | 1.00 | | 0.57 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1242 | 1583 | | 1068 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 51 | 77 | 61 | 167 | 13 | 61 | 50 | 1886 | 308 | 127 | 2630 | 35 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 128 | 61 | 0 | 180 | 61 | 50 | 1886 | 308 | 127 | 2630 | 35 |
| Turn Type | Perm | | Free | Perm | | Free | Prot | | Free | Prot | | Free |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | Free | 8 | | Free | | | Free | | | Free |
| Actuated Green, G (s) | | 25.4 | 130.8 | | 25.4 | 130.8 | 6.7 | 75.7 | 130.8 | 12.7 | 81.7 | 130.8 |
| Effective Green, g (s) | | 25.4 | 130.8 | | 25.4 | 130.8 | 6.7 | 75.7 | 130.8 | 12.7 | 81.7 | 130.8 |
| Actuated g/C Ratio | | 0.19 | 1.00 | | 0.19 | 1.00 | 0.05 | 0.58 | 1.00 | 0.10 | 0.62 | 1.00 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 241 | 1583 | | 207 | 1583 | 91 | 2048 | 1583 | 172 | 2211 | 1583 |
| v/s Ratio Prot | | | | | | | 0.03 | 0.53 | | c0.07 | c0.74 | |
| v/s Ratio Perm | | 0.10 | 0.04 | | c0.17 | 0.04 | | | 0.19 | | | 0.02 |
| v/c Ratio | | 0.53 | 0.04 | | 0.87 | 0.04 | 0.55 | 0.92 | 0.19 | 0.74 | 1.19 | 0.02 |
| Uniform Delay, d1 | | 47.3 | 0.0 | | 51.1 | 0.0 | 60.6 | 24.8 | 0.0 | 57.4 | 24.6 | 0.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 2.2 | 0.0 | | 29.8 | 0.0 | 6.6 | 7.4 | 0.3 | 15.2 | 90.1 | 0.0 |
| Delay (s) | | 49.6 | 0.0 | | 80.9 | 0.0 | 67.2 | 32.2 | 0.3 | 72.7 | 114.7 | 0.0 |
| Level of Service | | D | A | | F | A | E | C | A | E | F | A |
| Approach Delay (s) | | 33.6 | | | 60.5 | | | 28.6 | | | 111.3 | |
| Approach LOS | | C | | | E | | | C | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 72.4 | HCM Level of Service | E |
| HCM Volume to Capacity ratio | 1.11 | | |
| Actuated Cycle Length (s) | 130.8 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 100.2% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 6 | 24 | 1364 | 4 | 33 | 1537 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 7 | 26 | 1483 | 4 | 36 | 1671 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2392 | 743 | | | 1487 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2392 | 743 | | | 1487 | |
| tC, single (s) | 6.8 | 6.9 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 75 | 93 | | | 92 | |
| cM capacity (veh/h) | 26 | 357 | | | 448 | |

| Direction, Lane # | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 33 | 988 | 499 | 36 | 835 | 835 |
| Volume Left | 7 | 0 | 0 | 36 | 0 | 0 |
| Volume Right | 26 | 0 | 4 | 0 | 0 | 0 |
| cSH | 100 | 1700 | 1700 | 448 | 1700 | 1700 |
| Volume to Capacity | 0.33 | 0.58 | 0.29 | 0.08 | 0.49 | 0.49 |
| Queue Length 95th (ft) | 31 | 0 | 0 | 6 | 0 | 0 |
| Control Delay (s) | 57.3 | 0.0 | 0.0 | 13.7 | 0.0 | 0.0 |
| Lane LOS | F | | | B | | |
| Approach Delay (s) | 57.3 | 0.0 | | 0.3 | | |
| Approach LOS | F | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.7 | | |
| Intersection Capacity Utilization | 52.5% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 116 | 58 | 31 | 1354 | 1502 | 108 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 126 | 63 | 34 | 1472 | 1633 | 117 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2436 | 816 | 1633 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2436 | 816 | 1633 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 87 | 87 | | | |
| cM capacity (veh/h) | 80 | 497 | 266 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 189 | 34 | 736 | 736 | 816 | 816 | 117 |
| Volume Left | 126 | 34 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 63 | 0 | 0 | 0 | 0 | 0 | 117 |
| cSH | 114 | 266 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 1.66 | 0.13 | 0.43 | 0.43 | 0.48 | 0.48 | 0.07 |
| Queue Length 95th (ft) | 358 | 11 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 398.0 | 20.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | C | | | | | |
| Approach Delay (s) | 398.0 | 0.5 | | | 0.0 | | |
| Approach LOS | F | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 22.1 | | |
| Intersection Capacity Utilization | 54.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 29 | 11 | 11 | 56 | 11 | 69 | 3 | 575 | 47 | 38 | 518 | 9 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1759 | | | 1788 | 1583 | 1770 | 1842 | | 1770 | 1858 | |
| Flt Permitted | | 0.78 | | | 0.72 | 1.00 | 0.36 | 1.00 | | 0.26 | 1.00 | |
| Satd. Flow (perm) | | 1415 | | | 1345 | 1583 | 678 | 1842 | | 485 | 1858 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 32 | 12 | 12 | 61 | 12 | 75 | 3 | 625 | 51 | 41 | 563 | 10 |
| RTOR Reduction (vph) | 0 | 10 | 0 | 0 | 0 | 65 | 0 | 4 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 46 | 0 | 0 | 73 | 10 | 3 | 672 | 0 | 41 | 572 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 6.6 | | | 6.6 | 6.6 | 25.5 | 25.0 | | 26.7 | 25.6 | |
| Effective Green, g (s) | | 6.6 | | | 6.6 | 6.6 | 25.5 | 25.0 | | 26.7 | 25.6 | |
| Actuated g/C Ratio | | 0.14 | | | 0.14 | 0.14 | 0.53 | 0.52 | | 0.56 | 0.54 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 196 | | | 186 | 219 | 374 | 965 | | 301 | 997 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.36 | | c0.00 | 0.31 | |
| v/s Ratio Perm | | 0.03 | | | c0.05 | 0.01 | 0.00 | | | 0.07 | | |
| v/c Ratio | | 0.23 | | | 0.39 | 0.05 | 0.01 | 0.70 | | 0.14 | 0.57 | |
| Uniform Delay, d1 | | 18.3 | | | 18.7 | 17.8 | 5.4 | 8.5 | | 5.7 | 7.4 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.6 | | | 1.4 | 0.1 | 0.0 | 2.2 | | 0.2 | 0.8 | |
| Delay (s) | | 18.9 | | | 20.1 | 17.9 | 5.4 | 10.7 | | 5.9 | 8.2 | |
| Level of Service | | B | | | C | B | A | B | | A | A | |
| Approach Delay (s) | | 18.9 | | | 19.0 | | | 10.7 | | | 8.0 | |
| Approach LOS | | B | | | B | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.7 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.62 | | |
| Actuated Cycle Length (s) | 47.7 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 53.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 328 | 13 | 136 | 6 | 1 | 14 | 143 | 1324 | 36 | 130 | 1510 | 474 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.95 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1777 | 1583 | | 1785 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.95 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1777 | 1583 | | 1785 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 357 | 14 | 148 | 7 | 1 | 15 | 155 | 1439 | 39 | 141 | 1641 | 515 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 153 |
| Lane Group Flow (vph) | 0 | 371 | 148 | 0 | 8 | 15 | 155 | 1439 | 25 | 141 | 1641 | 362 |
| Turn Type | Split | | Free | Split | | Free | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | Free | | | 2 | | | 6 |
| Actuated Green, G (s) | | 31.2 | 130.3 | | 1.3 | 130.3 | 14.5 | 61.9 | 61.9 | 13.9 | 61.3 | 61.3 |
| Effective Green, g (s) | | 31.2 | 130.3 | | 1.3 | 130.3 | 14.5 | 61.9 | 61.9 | 13.9 | 61.3 | 61.3 |
| Actuated g/C Ratio | | 0.24 | 1.00 | | 0.01 | 1.00 | 0.11 | 0.48 | 0.48 | 0.11 | 0.47 | 0.47 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 425 | 1583 | | 18 | 1583 | 197 | 1681 | 752 | 189 | 1665 | 745 |
| v/s Ratio Prot | | c0.21 | | | 0.00 | | c0.09 | 0.41 | | 0.08 | c0.46 | |
| v/s Ratio Perm | | | c0.09 | | | 0.01 | | | 0.02 | | | 0.23 |
| v/c Ratio | | 0.87 | 0.09 | | 0.44 | 0.01 | 0.79 | 0.86 | 0.03 | 0.75 | 0.99 | 0.49 |
| Uniform Delay, d1 | | 47.6 | 0.0 | | 64.1 | 0.0 | 56.4 | 30.3 | 18.2 | 56.5 | 34.1 | 23.7 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 17.6 | 0.1 | | 16.5 | 0.0 | 18.4 | 4.5 | 0.0 | 14.8 | 18.5 | 0.5 |
| Delay (s) | | 65.3 | 0.1 | | 80.7 | 0.0 | 74.8 | 34.8 | 18.3 | 71.3 | 52.6 | 24.2 |
| Level of Service | | E | A | | F | A | E | C | B | E | D | C |
| Approach Delay (s) | | 46.7 | | | 28.1 | | | 38.2 | | | 47.4 | |
| Approach LOS | | D | | | C | | | D | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 43.8 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.88 | | |
| Actuated Cycle Length (s) | 130.3 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 89.4% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 20 | 24 | 58 | 70 | 18 | 148 | 24 | 483 | 102 | 122 | 409 | 6 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1821 | 1583 | | 1792 | 1583 | 1770 | 1863 | 1583 | 1770 | 1858 | |
| Flt Permitted | | 0.84 | 1.00 | | 0.74 | 1.00 | 0.50 | 1.00 | 1.00 | 0.28 | 1.00 | |
| Satd. Flow (perm) | | 1558 | 1583 | | 1375 | 1583 | 924 | 1863 | 1583 | 523 | 1858 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 26 | 63 | 76 | 20 | 161 | 26 | 525 | 111 | 133 | 445 | 7 |
| RTOR Reduction (vph) | 0 | 0 | 51 | 0 | 0 | 132 | 0 | 0 | 61 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 48 | 12 | 0 | 96 | 29 | 26 | 525 | 50 | 133 | 452 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 10.2 | 10.2 | | 10.2 | 10.2 | 26.8 | 24.9 | 24.9 | 34.4 | 28.7 | |
| Effective Green, g (s) | | 10.2 | 10.2 | | 10.2 | 10.2 | 26.8 | 24.9 | 24.9 | 34.4 | 28.7 | |
| Actuated g/C Ratio | | 0.18 | 0.18 | | 0.18 | 0.18 | 0.48 | 0.45 | 0.45 | 0.62 | 0.51 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 285 | 289 | | 251 | 289 | 473 | 831 | 706 | 450 | 956 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.28 | | c0.03 | c0.24 | |
| v/s Ratio Perm | | 0.03 | 0.01 | | c0.07 | 0.02 | 0.02 | | 0.03 | 0.15 | | |
| v/c Ratio | | 0.17 | 0.04 | | 0.38 | 0.10 | 0.05 | 0.63 | 0.07 | 0.30 | 0.47 | |
| Uniform Delay, d1 | | 19.2 | 18.8 | | 20.0 | 19.0 | 7.6 | 11.9 | 8.8 | 5.8 | 8.7 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.3 | 0.1 | | 1.0 | 0.2 | 0.0 | 1.6 | 0.0 | 0.4 | 0.4 | |
| Delay (s) | | 19.5 | 18.8 | | 21.0 | 19.1 | 7.7 | 13.5 | 8.9 | 6.2 | 9.1 | |
| Level of Service | | B | B | | C | B | A | B | A | A | A | |
| Approach Delay (s) | | 19.1 | | | 19.8 | | | 12.5 | | | 8.4 | |
| Approach LOS | | B | | | B | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 12.6 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.60 | | |
| Actuated Cycle Length (s) | 55.8 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 56.2% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 396 | 291 | 161 | 1502 | 1912 | 508 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 430 | 316 | 175 | 1633 | 2078 | 552 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 194 |
| Lane Group Flow (vph) | 430 | 316 | 175 | 1633 | 2078 | 358 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 29.0 | 159.0 | 15.0 | 119.0 | 98.0 | 98.0 |
| Effective Green, g (s) | 29.0 | 159.0 | 15.0 | 119.0 | 98.0 | 98.0 |
| Actuated g/C Ratio | 0.18 | 1.00 | 0.09 | 0.75 | 0.62 | 0.62 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 323 | 1583 | 167 | 2649 | 2181 | 976 |
| v/s Ratio Prot | c0.24 | | c0.10 | 0.46 | c0.59 | |
| v/s Ratio Perm | | 0.20 | | | | 0.23 |
| v/c Ratio | 1.33 | 0.20 | 1.05 | 0.62 | 0.95 | 0.37 |
| Uniform Delay, d1 | 65.0 | 0.0 | 72.0 | 9.3 | 28.3 | 15.1 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 168.8 | 0.3 | 82.9 | 0.4 | 10.3 | 0.2 |
| Delay (s) | 233.8 | 0.3 | 154.9 | 9.8 | 38.7 | 15.4 |
| Level of Service | F | A | F | A | D | B |
| Approach Delay (s) | 134.9 | | | 23.8 | 33.8 | |
| Approach LOS | F | | | C | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 44.9 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 1.04 | | |
| Actuated Cycle Length (s) | 159.0 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 97.9% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 96 | 11 | 88 | 7 | 538 | 93 | 107 | 546 | 11 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1783 | 1583 | 1770 | 1863 | 1583 | 1770 | 3529 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.42 | 1.00 | 1.00 | 0.27 | 1.00 | |
| Satd. Flow (perm) | | | | | 1783 | 1583 | 788 | 1863 | 1583 | 511 | 3529 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 104 | 12 | 96 | 8 | 585 | 101 | 116 | 593 | 12 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 0 | 51 | 0 | 2 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 116 | 13 | 8 | 585 | 50 | 116 | 603 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 6.7 | 6.7 | 26.0 | 25.5 | 25.5 | 33.4 | 29.2 | |
| Effective Green, g (s) | | | | | 6.7 | 6.7 | 26.0 | 25.5 | 25.5 | 33.4 | 29.2 | |
| Actuated g/C Ratio | | | | | 0.13 | 0.13 | 0.51 | 0.50 | 0.50 | 0.65 | 0.57 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 232 | 206 | 408 | 924 | 785 | 435 | 2005 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.31 | | c0.02 | 0.17 | |
| v/s Ratio Perm | | | | | 0.07 | 0.01 | 0.01 | | 0.03 | 0.15 | | |
| v/c Ratio | | | | | 0.50 | 0.06 | 0.02 | 0.63 | 0.06 | 0.27 | 0.30 | |
| Uniform Delay, d1 | | | | | 20.8 | 19.6 | 6.3 | 9.5 | 6.7 | 4.8 | 5.8 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 1.7 | 0.1 | 0.0 | 1.4 | 0.0 | 0.3 | 0.1 | |
| Delay (s) | | | | | 22.5 | 19.7 | 6.3 | 10.9 | 6.8 | 5.1 | 5.9 | |
| Level of Service | | | | | C | B | A | B | A | A | A | |
| Approach Delay (s) | | 0.0 | | | 21.2 | | | 10.3 | | | 5.7 | |
| Approach LOS | | A | | | C | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.7 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.66 | | |
| Actuated Cycle Length (s) | 51.4 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 52.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 30 | 0 | 1781 | 2400 | 76 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 33 | 0 | 1936 | 2609 | 83 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 3577 | 1304 | 2609 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 3577 | 1304 | 2609 | | | |
| tC, single (s) | 6.8 | 6.9 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 100 | 78 | 100 | | | |
| cM capacity (veh/h) | 4 | 151 | 162 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 33 | 968 | 968 | 1304 | 1304 | 83 |
| Volume Left | 0 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 33 | 0 | 0 | 0 | 0 | 83 |
| cSH | 151 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.22 | 0.57 | 0.57 | 0.77 | 0.77 | 0.05 |
| Queue Length 95th (ft) | 20 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 35.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | E | | | | | |
| Approach Delay (s) | 35.3 | 0.0 | | 0.0 | | |
| Approach LOS | E | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.2 | | |
| Intersection Capacity Utilization | 76.3% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 52 | 162 | 30 | 168 | 190 | 85 | 50 | 153 | 73 | 77 | 172 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.98 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1819 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.63 | 1.00 | | 0.45 | 1.00 | 1.00 | 0.64 | 1.00 | 1.00 | 0.65 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1170 | 1819 | | 840 | 1863 | 1583 | 1192 | 1863 | 1583 | 1215 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 57 | 176 | 33 | 183 | 207 | 92 | 54 | 166 | 79 | 84 | 187 | 85 |
| RTOR Reduction (vph) | 0 | 7 | 0 | 0 | 0 | 55 | 0 | 0 | 61 | 0 | 0 | 65 |
| Lane Group Flow (vph) | 57 | 202 | 0 | 183 | 207 | 37 | 54 | 166 | 18 | 84 | 187 | 20 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 15.0 | 12.8 | | 25.9 | 18.7 | 18.7 | 10.7 | 10.7 | 10.7 | 10.7 | 10.7 | 10.7 |
| Effective Green, g (s) | 15.0 | 12.8 | | 25.9 | 18.7 | 18.7 | 10.7 | 10.7 | 10.7 | 10.7 | 10.7 | 10.7 |
| Actuated g/C Ratio | 0.32 | 0.27 | | 0.56 | 0.40 | 0.40 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 405 | 500 | | 629 | 748 | 635 | 274 | 428 | 363 | 279 | 428 | 363 |
| v/s Ratio Prot | 0.01 | c0.11 | | c0.05 | 0.11 | | | 0.09 | | | c0.10 | |
| v/s Ratio Perm | 0.04 | | | 0.11 | | 0.02 | 0.05 | | 0.01 | 0.07 | | 0.01 |
| v/c Ratio | 0.14 | 0.40 | | 0.29 | 0.28 | 0.06 | 0.20 | 0.39 | 0.05 | 0.30 | 0.44 | 0.05 |
| Uniform Delay, d1 | 11.1 | 13.8 | | 5.4 | 9.4 | 8.6 | 14.5 | 15.2 | 14.0 | 14.9 | 15.4 | 14.0 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.2 | 0.5 | | 0.3 | 0.2 | 0.0 | 0.4 | 0.6 | 0.1 | 0.6 | 0.7 | 0.1 |
| Delay (s) | 11.2 | 14.3 | | 5.7 | 9.6 | 8.6 | 14.8 | 15.8 | 14.0 | 15.5 | 16.1 | 14.1 |
| Level of Service | B | B | | A | A | A | B | B | B | B | B | B |
| Approach Delay (s) | | 13.7 | | | 7.9 | | | 15.1 | | | 15.5 | |
| Approach LOS | | B | | | A | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 12.5 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.40 | | |
| Actuated Cycle Length (s) | 46.6 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 48.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 6.0 |
| Intersection LOS | A |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 97 | 265 | 164 | 177 |
| Demand Flow Rate, veh/h | 99 | 270 | 167 | 181 |
| Vehicles Circulating, veh/h | 238 | 119 | 107 | 295 |
| Vehicles Exiting, veh/h | 238 | 155 | 229 | 94 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 5.2 | 6.3 | 5.2 | 6.7 |
| Approach LOS | A | A | A | A |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 99 | 270 | 167 | 181 |
| Cap Entry Lane, veh/h | 891 | 1003 | 1015 | 841 |
| Entry HV Adj Factor | 0.977 | 0.980 | 0.980 | 0.976 |
| Flow Entry, veh/h | 97 | 265 | 164 | 177 |
| Cap Entry, veh/h | 871 | 983 | 995 | 821 |
| V/C Ratio | 1.11 | 2.69 | 1.64 | 2.15 |
| Control Delay, s/veh | 5.2 | 6.3 | 5.2 | 6.7 |
| LOS | A | A | A | A |
| 95th %tile Queue, veh | 0.0 | 0.1 | 0.1 | 0.1 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 24 | 69 | 198 | 81 | 43 | 83 | 61 | 1649 | 128 | 131 | 2290 | 24 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.88 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 26 | 75 | 215 | 88 | 47 | 90 | 66 | 1792 | 139 | 142 | 2489 | 26 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 0 | 26 | 0 | 0 | 4 |
| Lane Group Flow (vph) | 26 | 75 | 215 | 88 | 47 | 7 | 66 | 1792 | 113 | 142 | 2489 | 22 |
| Turn Type | Split | | Free | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 8.5 | 8.5 | 117.6 | 8.6 | 8.6 | 8.6 | 6.8 | 68.3 | 68.3 | 10.2 | 71.7 | 71.7 |
| Effective Green, g (s) | 8.5 | 8.5 | 117.6 | 8.6 | 8.6 | 8.6 | 6.8 | 68.3 | 68.3 | 10.2 | 71.7 | 71.7 |
| Actuated g/C Ratio | 0.07 | 0.07 | 1.00 | 0.07 | 0.07 | 0.07 | 0.06 | 0.58 | 0.58 | 0.09 | 0.61 | 0.61 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 128 | 135 | 1583 | 251 | 136 | 204 | 102 | 2055 | 919 | 298 | 2158 | 965 |
| v/s Ratio Prot | 0.01 | c0.04 | | c0.03 | 0.03 | | 0.04 | 0.51 | | c0.04 | c0.70 | |
| v/s Ratio Perm | | | 0.14 | | | 0.00 | | | 0.07 | | | 0.01 |
| v/c Ratio | 0.20 | 0.56 | 0.14 | 0.35 | 0.35 | 0.03 | 0.65 | 0.87 | 0.12 | 0.48 | 1.15 | 0.02 |
| Uniform Delay, d1 | 51.4 | 52.7 | 0.0 | 51.8 | 51.8 | 50.6 | 54.2 | 20.9 | 11.1 | 51.2 | 22.9 | 9.1 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.8 | 4.9 | 0.2 | 0.8 | 1.5 | 0.1 | 13.3 | 4.4 | 0.1 | 1.2 | 74.8 | 0.0 |
| Delay (s) | 52.1 | 57.6 | 0.2 | 52.7 | 53.4 | 50.7 | 67.5 | 25.3 | 11.2 | 52.4 | 97.8 | 9.1 |
| Level of Service | D | E | A | D | D | D | E | C | B | D | F | A |
| Approach Delay (s) | | 18.1 | | | 52.0 | | | 25.7 | | | 94.5 | |
| Approach LOS | | B | | | D | | | C | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 61.6 | HCM Level of Service | E |
| HCM Volume to Capacity ratio | 1.00 | | |
| Actuated Cycle Length (s) | 117.6 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 81.4% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 15 | 65 | 80 | 6 | 28 | 81 | 2228 | 61 | 25 | 2160 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 4.0 | 6.0 | 6.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.97 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1811 | 1583 | | 1780 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.80 | 1.00 | | 0.71 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1495 | 1583 | | 1332 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 21 | 16 | 71 | 87 | 7 | 30 | 88 | 2422 | 66 | 27 | 2348 | 85 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 37 | 71 | 0 | 94 | 30 | 88 | 2422 | 66 | 27 | 2348 | 85 |
| Turn Type | Perm | | Free | Perm | | Free | Prot | | Free | Prot | | Free |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | Free | 8 | | Free | | | Free | | | Free |
| Actuated Green, G (s) | | 13.7 | 122.5 | | 13.7 | 122.5 | 8.8 | 87.0 | 122.5 | 4.8 | 83.0 | 122.5 |
| Effective Green, g (s) | | 13.7 | 122.5 | | 13.7 | 122.5 | 8.8 | 87.0 | 122.5 | 4.8 | 83.0 | 122.5 |
| Actuated g/C Ratio | | 0.11 | 1.00 | | 0.11 | 1.00 | 0.07 | 0.71 | 1.00 | 0.04 | 0.68 | 1.00 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 167 | 1583 | | 149 | 1583 | 127 | 2513 | 1583 | 69 | 2398 | 1583 |
| v/s Ratio Prot | | | | | | | c0.05 | c0.68 | | 0.02 | 0.66 | |
| v/s Ratio Perm | | 0.02 | 0.04 | | c0.07 | 0.02 | | | 0.04 | | | 0.05 |
| v/c Ratio | | 0.22 | 0.04 | | 0.63 | 0.02 | 0.69 | 0.96 | 0.04 | 0.39 | 0.98 | 0.05 |
| Uniform Delay, d1 | | 49.5 | 0.0 | | 52.0 | 0.0 | 55.5 | 16.3 | 0.0 | 57.4 | 18.9 | 0.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 0.7 | 0.1 | | 8.4 | 0.0 | 15.1 | 10.8 | 0.0 | 3.6 | 13.7 | 0.1 |
| Delay (s) | | 50.2 | 0.1 | | 60.4 | 0.0 | 70.6 | 27.1 | 0.0 | 61.1 | 32.6 | 0.1 |
| Level of Service | | D | A | | E | A | E | C | A | E | C | A |
| Approach Delay (s) | | 17.2 | | | 45.8 | | | 27.9 | | | 31.8 | |
| Approach LOS | | B | | | D | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 29.9 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.93 | | |
| Actuated Cycle Length (s) | 122.5 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 87.9% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 3 | 24 | 1920 | 0 | 8 | 1449 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 3 | 26 | 2087 | 0 | 9 | 1575 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2892 | 1043 | | | 2087 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2892 | 1043 | | | 2087 | |
| tC, single (s) | 6.8 | 6.9 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 73 | 88 | | | 97 | |
| cM capacity (veh/h) | 12 | 226 | | | 262 | |

| Direction, Lane # | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 29 | 1391 | 696 | 9 | 788 | 788 |
| Volume Left | 3 | 0 | 0 | 9 | 0 | 0 |
| Volume Right | 26 | 0 | 0 | 0 | 0 | 0 |
| cSH | 77 | 1700 | 1700 | 262 | 1700 | 1700 |
| Volume to Capacity | 0.38 | 0.82 | 0.41 | 0.03 | 0.46 | 0.46 |
| Queue Length 95th (ft) | 37 | 0 | 0 | 3 | 0 | 0 |
| Control Delay (s) | 78.5 | 0.0 | 0.0 | 19.2 | 0.0 | 0.0 |
| Lane LOS | F | | | C | | |
| Approach Delay (s) | 78.5 | 0.0 | | 0.1 | | |
| Approach LOS | F | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.7 | | |
| Intersection Capacity Utilization | 63.1% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 132 | 57 | 106 | 1804 | 1380 | 215 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 143 | 62 | 115 | 1961 | 1500 | 234 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2711 | 750 | 1500 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2711 | 750 | 1500 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 88 | 63 | | | |
| cM capacity (veh/h) | 42 | 530 | 309 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 205 | 115 | 980 | 980 | 750 | 750 | 234 |
| Volume Left | 143 | 115 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 62 | 0 | 0 | 0 | 0 | 0 | 234 |
| cSH | 59 | 309 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 3.49 | 0.37 | 0.58 | 0.58 | 0.44 | 0.44 | 0.14 |
| Queue Length 95th (ft) | Err | 42 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | Err | 23.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | C | | | | | |
| Approach Delay (s) | Err | 1.3 | | | 0.0 | | |
| Approach LOS | F | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 512.3 | | |
| Intersection Capacity Utilization | 63.8% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 34 | 7 | 13 | 110 | 17 | 59 | 18 | 933 | 71 | 44 | 984 | 31 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1748 | | | 1785 | 1583 | 1770 | 1843 | | 1770 | 1854 | |
| Flt Permitted | | 0.69 | | | 0.76 | 1.00 | 0.08 | 1.00 | | 0.08 | 1.00 | |
| Satd. Flow (perm) | | 1238 | | | 1413 | 1583 | 148 | 1843 | | 146 | 1854 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 37 | 8 | 14 | 120 | 18 | 64 | 20 | 1014 | 77 | 48 | 1070 | 34 |
| RTOR Reduction (vph) | 0 | 12 | 0 | 0 | 0 | 56 | 0 | 3 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 47 | 0 | 0 | 138 | 8 | 20 | 1088 | 0 | 48 | 1103 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 10.3 | | | 10.3 | 10.3 | 51.8 | 50.4 | | 53.2 | 51.1 | |
| Effective Green, g (s) | | 10.3 | | | 10.3 | 10.3 | 51.8 | 50.4 | | 53.2 | 51.1 | |
| Actuated g/C Ratio | | 0.13 | | | 0.13 | 0.13 | 0.67 | 0.65 | | 0.68 | 0.66 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 164 | | | 187 | 210 | 128 | 1194 | | 144 | 1218 | |
| v/s Ratio Prot | | | | | | | 0.00 | 0.59 | | c0.01 | c0.59 | |
| v/s Ratio Perm | | 0.04 | | | c0.10 | 0.01 | 0.10 | | | 0.22 | | |
| v/c Ratio | | 0.29 | | | 0.74 | 0.04 | 0.16 | 0.91 | | 0.33 | 0.91 | |
| Uniform Delay, d1 | | 30.4 | | | 32.5 | 29.4 | 13.4 | 11.8 | | 14.1 | 11.3 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 1.0 | | | 14.1 | 0.1 | 0.6 | 10.5 | | 1.4 | 9.7 | |
| Delay (s) | | 31.4 | | | 46.5 | 29.5 | 13.9 | 22.3 | | 15.4 | 21.0 | |
| Level of Service | | C | | | D | C | B | C | | B | C | |
| Approach Delay (s) | | 31.4 | | | 41.2 | | | 22.1 | | | 20.8 | |
| Approach LOS | | C | | | D | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 23.2 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.81 | | |
| Actuated Cycle Length (s) | 77.8 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 72.9% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 329 | 10 | 84 | 28 | 30 | 63 | 255 | 1717 | 13 | 79 | 1576 | 231 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.95 | 1.00 | | 0.98 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1777 | 1583 | | 1819 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.95 | 1.00 | | 0.98 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1777 | 1583 | | 1819 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 358 | 11 | 91 | 30 | 33 | 68 | 277 | 1866 | 14 | 86 | 1713 | 251 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 69 |
| Lane Group Flow (vph) | 0 | 369 | 91 | 0 | 63 | 68 | 277 | 1866 | 10 | 86 | 1713 | 182 |
| Turn Type | Split | | Free | Split | | Free | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | Free | | | 2 | | | 6 |
| Actuated Green, G (s) | | 35.1 | 159.7 | | 9.4 | 159.7 | 25.1 | 81.3 | 81.3 | 11.9 | 68.1 | 68.1 |
| Effective Green, g (s) | | 35.1 | 159.7 | | 9.4 | 159.7 | 25.1 | 81.3 | 81.3 | 11.9 | 68.1 | 68.1 |
| Actuated g/C Ratio | | 0.22 | 1.00 | | 0.06 | 1.00 | 0.16 | 0.51 | 0.51 | 0.07 | 0.43 | 0.43 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 391 | 1583 | | 107 | 1583 | 278 | 1802 | 806 | 132 | 1509 | 675 |
| v/s Ratio Prot | | c0.21 | | | c0.03 | | c0.16 | c0.53 | | 0.05 | c0.48 | |
| v/s Ratio Perm | | | 0.06 | | | 0.04 | | | 0.01 | | | 0.11 |
| v/c Ratio | | 0.94 | 0.06 | | 0.59 | 0.04 | 1.00 | 1.04 | 0.01 | 0.65 | 1.14 | 0.27 |
| Uniform Delay, d1 | | 61.3 | 0.0 | | 73.3 | 0.0 | 67.3 | 39.2 | 19.4 | 71.9 | 45.8 | 29.7 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 31.2 | 0.1 | | 8.0 | 0.1 | 52.6 | 31.0 | 0.0 | 11.0 | 69.6 | 0.2 |
| Delay (s) | | 92.6 | 0.1 | | 81.3 | 0.1 | 119.9 | 70.2 | 19.4 | 82.8 | 115.4 | 29.9 |
| Level of Service | | F | A | | F | A | F | E | B | F | F | C |
| Approach Delay (s) | | 74.3 | | | 39.1 | | | 76.3 | | | 103.6 | |
| Approach LOS | | E | | | D | | | E | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 86.7 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.08 | | |
| Actuated Cycle Length (s) | 159.7 | Sum of lost time (s) | 28.0 |
| Intersection Capacity Utilization | 97.3% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 39 | 37 | 58 | 134 | 35 | 117 | 71 | 776 | 129 | 64 | 944 | 28 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1816 | 1583 | | 1792 | 1583 | 1770 | 1863 | 1583 | 1770 | 1855 | |
| Flt Permitted | | 0.72 | 1.00 | | 0.72 | 1.00 | 0.06 | 1.00 | 1.00 | 0.20 | 1.00 | |
| Satd. Flow (perm) | | 1333 | 1583 | | 1333 | 1583 | 117 | 1863 | 1583 | 366 | 1855 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 42 | 40 | 63 | 146 | 38 | 127 | 77 | 843 | 140 | 70 | 1026 | 30 |
| RTOR Reduction (vph) | 0 | 0 | 51 | 0 | 0 | 102 | 0 | 0 | 52 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 82 | 12 | 0 | 184 | 25 | 77 | 843 | 88 | 70 | 1055 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 19.8 | 19.8 | | 19.8 | 19.8 | 67.2 | 63.6 | 63.6 | 65.8 | 62.9 | |
| Effective Green, g (s) | | 19.8 | 19.8 | | 19.8 | 19.8 | 67.2 | 63.6 | 63.6 | 65.8 | 62.9 | |
| Actuated g/C Ratio | | 0.20 | 0.20 | | 0.20 | 0.20 | 0.66 | 0.63 | 0.63 | 0.65 | 0.62 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 261 | 309 | | 261 | 309 | 136 | 1170 | 994 | 278 | 1152 | |
| v/s Ratio Prot | | | | | | | c0.02 | 0.45 | | 0.01 | c0.57 | |
| v/s Ratio Perm | | 0.06 | 0.01 | | c0.14 | 0.02 | 0.35 | | 0.06 | 0.16 | | |
| v/c Ratio | | 0.31 | 0.04 | | 0.70 | 0.08 | 0.57 | 0.72 | 0.09 | 0.25 | 0.92 | |
| Uniform Delay, d1 | | 34.9 | 33.0 | | 38.0 | 33.3 | 20.4 | 12.8 | 7.4 | 10.7 | 16.9 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.7 | 0.1 | | 8.4 | 0.1 | 5.3 | 2.2 | 0.0 | 0.5 | 11.2 | |
| Delay (s) | | 35.6 | 33.1 | | 46.4 | 33.4 | 25.8 | 15.0 | 7.5 | 11.1 | 28.1 | |
| Level of Service | | D | C | | D | C | C | B | A | B | C | |
| Approach Delay (s) | | 34.5 | | | 41.1 | | | 14.8 | | | 27.1 | |
| Approach LOS | | C | | | D | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 24.2 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.85 | | |
| Actuated Cycle Length (s) | 101.3 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 83.3% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 544 | 531 | 508 | 1987 | 1614 | 696 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 591 | 577 | 552 | 2160 | 1754 | 757 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 226 |
| Lane Group Flow (vph) | 591 | 577 | 552 | 2160 | 1754 | 531 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 29.2 | 182.6 | 30.2 | 142.4 | 106.2 | 106.2 |
| Effective Green, g (s) | 29.2 | 182.6 | 30.2 | 142.4 | 106.2 | 106.2 |
| Actuated g/C Ratio | 0.16 | 1.00 | 0.17 | 0.78 | 0.58 | 0.58 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 283 | 1583 | 293 | 2760 | 2058 | 921 |
| v/s Ratio Prot | c0.33 | | c0.31 | 0.61 | c0.50 | |
| v/s Ratio Perm | | 0.36 | | | | 0.34 |
| v/c Ratio | 2.09 | 0.36 | 1.88 | 0.78 | 0.85 | 0.58 |
| Uniform Delay, d1 | 76.7 | 0.0 | 76.2 | 11.4 | 31.7 | 24.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 501.7 | 0.7 | 410.5 | 1.5 | 3.6 | 0.9 |
| Delay (s) | 578.4 | 0.7 | 486.7 | 12.9 | 35.3 | 24.9 |
| Level of Service | F | A | F | B | D | C |
| Approach Delay (s) | 293.0 | | | 109.3 | 32.2 | |
| Approach LOS | F | | | F | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 112.6 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.26 | | |
| Actuated Cycle Length (s) | 182.6 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 117.1% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 223 | 63 | 128 | 19 | 776 | 197 | 91 | 653 | 25 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1793 | 1583 | 1770 | 1863 | 1583 | 1770 | 3520 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.35 | 1.00 | 1.00 | 0.11 | 1.00 | |
| Satd. Flow (perm) | | | | | 1793 | 1583 | 659 | 1863 | 1583 | 209 | 3520 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 242 | 68 | 139 | 21 | 843 | 214 | 99 | 710 | 27 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 105 | 0 | 0 | 95 | 0 | 3 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 310 | 34 | 21 | 843 | 119 | 99 | 734 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 20.8 | 20.8 | 47.4 | 46.1 | 46.1 | 53.4 | 49.1 | |
| Effective Green, g (s) | | | | | 20.8 | 20.8 | 47.4 | 46.1 | 46.1 | 53.4 | 49.1 | |
| Actuated g/C Ratio | | | | | 0.24 | 0.24 | 0.55 | 0.53 | 0.53 | 0.62 | 0.57 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 433 | 382 | 379 | 996 | 847 | 207 | 2005 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.45 | | c0.02 | 0.21 | |
| v/s Ratio Perm | | | | | 0.17 | 0.02 | 0.03 | | 0.07 | 0.27 | | |
| v/c Ratio | | | | | 0.72 | 0.09 | 0.06 | 0.85 | 0.14 | 0.48 | 0.37 | |
| Uniform Delay, d1 | | | | | 30.0 | 25.3 | 8.9 | 17.0 | 10.1 | 14.2 | 10.1 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 5.6 | 0.1 | 0.1 | 6.7 | 0.1 | 1.7 | 0.1 | |
| Delay (s) | | | | | 35.6 | 25.4 | 8.9 | 23.8 | 10.2 | 15.9 | 10.2 | |
| Level of Service | | | | | D | C | A | C | B | B | B | |
| Approach Delay (s) | | 0.0 | | | 32.4 | | | 20.8 | | | 10.9 | |
| Approach LOS | | A | | | C | | | C | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 19.5 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.85 | | |
| Actuated Cycle Length (s) | 86.2 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 74.0% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 10 | 0 | 2309 | 2095 | 130 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 11 | 0 | 2510 | 2277 | 141 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 3532 | 1139 | 2277 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 3532 | 1139 | 2277 | | | |
| tC, single (s) | 6.8 | 6.9 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 100 | 94 | 100 | | | |
| cM capacity (veh/h) | 4 | 195 | 220 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 11 | 1255 | 1255 | 1139 | 1139 | 141 |
| Volume Left | 0 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 11 | 0 | 0 | 0 | 0 | 141 |
| cSH | 195 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.06 | 0.74 | 0.74 | 0.67 | 0.67 | 0.08 |
| Queue Length 95th (ft) | 4 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 24.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | C | | | | | |
| Approach Delay (s) | 24.5 | 0.0 | | 0.0 | | |
| Approach LOS | C | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.1 | | |
| Intersection Capacity Utilization | 67.9% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 85 | 232 | 18 | 51 | 228 | 66 | 16 | 70 | 74 | 30 | 78 | 112 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.99 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1842 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.61 | 1.00 | | 0.51 | 1.00 | 1.00 | 0.71 | 1.00 | 1.00 | 0.71 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1127 | 1842 | | 951 | 1863 | 1583 | 1331 | 1863 | 1583 | 1331 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 92 | 252 | 20 | 55 | 248 | 72 | 17 | 76 | 80 | 33 | 85 | 122 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 0 | 49 | 0 | 0 | 66 | 0 | 0 | 100 |
| Lane Group Flow (vph) | 92 | 267 | 0 | 55 | 248 | 23 | 17 | 76 | 14 | 33 | 85 | 22 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 9.3 | 8.8 | | 12.1 | 10.2 | 10.2 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 |
| Effective Green, g (s) | 9.3 | 8.8 | | 12.1 | 10.2 | 10.2 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 |
| Actuated g/C Ratio | 0.30 | 0.28 | | 0.39 | 0.33 | 0.33 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 345 | 518 | | 417 | 607 | 516 | 238 | 333 | 283 | 238 | 333 | 283 |
| v/s Ratio Prot | 0.00 | c0.14 | | c0.01 | 0.13 | | | 0.04 | | | c0.05 | |
| v/s Ratio Perm | 0.07 | | | 0.04 | | 0.01 | 0.01 | | 0.01 | 0.02 | | 0.01 |
| v/c Ratio | 0.27 | 0.52 | | 0.13 | 0.41 | 0.05 | 0.07 | 0.23 | 0.05 | 0.14 | 0.26 | 0.08 |
| Uniform Delay, d1 | 8.2 | 9.5 | | 6.1 | 8.2 | 7.2 | 10.7 | 11.0 | 10.6 | 10.8 | 11.1 | 10.7 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.4 | 0.9 | | 0.1 | 0.4 | 0.0 | 0.1 | 0.4 | 0.1 | 0.3 | 0.4 | 0.1 |
| Delay (s) | 8.7 | 10.3 | | 6.3 | 8.7 | 7.3 | 10.8 | 11.4 | 10.7 | 11.1 | 11.5 | 10.8 |
| Level of Service | A | B | | A | A | A | B | B | B | B | B | B |
| Approach Delay (s) | | 9.9 | | | 8.0 | | | 11.0 | | | 11.1 | |
| Approach LOS | | A | | | A | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.7 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.38 | | |
| Actuated Cycle Length (s) | 31.3 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 37.5% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 7.7 |
| Intersection LOS | A |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 250 | 334 | 253 | 224 |
| Demand Flow Rate, veh/h | 255 | 340 | 258 | 229 |
| Vehicles Circulating, veh/h | 265 | 230 | 245 | 302 |
| Vehicles Exiting, veh/h | 266 | 273 | 275 | 268 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 7.5 | 8.4 | 7.3 | 7.4 |
| Approach LOS | A | A | A | A |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 255 | 340 | 258 | 229 |
| Cap Entry Lane, veh/h | 867 | 898 | 884 | 835 |
| Entry HV Adj Factor | 0.980 | 0.983 | 0.980 | 0.979 |
| Flow Entry, veh/h | 250 | 334 | 253 | 224 |
| Cap Entry, veh/h | 850 | 882 | 867 | 818 |
| V/C Ratio | 2.94 | 3.79 | 2.92 | 2.74 |
| Control Delay, s/veh | 7.5 | 8.4 | 7.3 | 7.4 |
| LOS | A | A | A | A |
| 95th %tile Queue, veh | 0.1 | 0.2 | 0.1 | 0.1 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 155 | 130 | 513 | 174 | 522 | 110 | 1688 | 477 | 483 | 1620 | 35 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.88 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 21 | 168 | 141 | 558 | 189 | 567 | 120 | 1835 | 518 | 525 | 1761 | 38 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 462 | 0 | 0 | 124 | 0 | 0 | 10 |
| Lane Group Flow (vph) | 21 | 168 | 141 | 558 | 189 | 105 | 120 | 1835 | 394 | 525 | 1761 | 28 |
| Turn Type | Split | | Free | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 15.2 | 15.2 | 139.2 | 20.0 | 20.0 | 20.0 | 9.0 | 63.0 | 63.0 | 19.0 | 73.0 | 73.0 |
| Effective Green, g (s) | 15.2 | 15.2 | 139.2 | 20.0 | 20.0 | 20.0 | 9.0 | 63.0 | 63.0 | 19.0 | 73.0 | 73.0 |
| Actuated g/C Ratio | 0.11 | 0.11 | 1.00 | 0.14 | 0.14 | 0.14 | 0.06 | 0.45 | 0.45 | 0.14 | 0.52 | 0.52 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 193 | 203 | 1583 | 493 | 268 | 400 | 114 | 1602 | 716 | 469 | 1856 | 830 |
| v/s Ratio Prot | 0.01 | c0.09 | | c0.16 | 0.10 | | 0.07 | c0.52 | | c0.15 | 0.50 | |
| v/s Ratio Perm | | | 0.09 | | | 0.04 | | | 0.25 | | | 0.02 |
| v/c Ratio | 0.11 | 0.83 | 0.09 | 1.13 | 0.71 | 0.26 | 1.05 | 1.15 | 0.55 | 1.12 | 0.95 | 0.03 |
| Uniform Delay, d1 | 55.9 | 60.7 | 0.0 | 59.6 | 56.8 | 53.0 | 65.1 | 38.1 | 27.8 | 60.1 | 31.3 | 16.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.3 | 23.3 | 0.1 | 82.0 | 8.2 | 0.4 | 99.1 | 73.3 | 0.9 | 78.4 | 11.0 | 0.0 |
| Delay (s) | 56.1 | 84.0 | 0.1 | 141.6 | 65.0 | 53.4 | 164.2 | 111.4 | 28.7 | 138.5 | 42.3 | 16.0 |
| Level of Service | E | F | A | F | E | D | F | F | C | F | D | B |
| Approach Delay (s) | | 46.4 | | | 92.5 | | | 96.7 | | | 63.6 | |
| Approach LOS | | D | | | F | | | F | | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 81.3 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.10 | | |
| Actuated Cycle Length (s) | 139.2 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 101.6% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 47 | 71 | 56 | 154 | 12 | 56 | 46 | 2145 | 283 | 117 | 3324 | 32 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 4.0 | 6.0 | 6.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1826 | 1583 | | 1780 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.67 | 1.00 | | 0.57 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1242 | 1583 | | 1068 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 51 | 77 | 61 | 167 | 13 | 61 | 50 | 2332 | 308 | 127 | 3613 | 35 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 128 | 61 | 0 | 180 | 61 | 50 | 2332 | 308 | 127 | 3613 | 35 |
| Turn Type | Perm | | Free | Perm | | Free | Prot | | Free | Prot | | Free |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | Free | 8 | | Free | | | Free | | | Free |
| Actuated Green, G (s) | | 25.4 | 130.8 | | 25.4 | 130.8 | 6.7 | 75.7 | 130.8 | 12.7 | 81.7 | 130.8 |
| Effective Green, g (s) | | 25.4 | 130.8 | | 25.4 | 130.8 | 6.7 | 75.7 | 130.8 | 12.7 | 81.7 | 130.8 |
| Actuated g/C Ratio | | 0.19 | 1.00 | | 0.19 | 1.00 | 0.05 | 0.58 | 1.00 | 0.10 | 0.62 | 1.00 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 241 | 1583 | | 207 | 1583 | 91 | 2048 | 1583 | 172 | 2211 | 1583 |
| v/s Ratio Prot | | | | | | | 0.03 | 0.66 | | c0.07 | c1.02 | |
| v/s Ratio Perm | | 0.10 | 0.04 | | c0.17 | 0.04 | | | 0.19 | | | 0.02 |
| v/c Ratio | | 0.53 | 0.04 | | 0.87 | 0.04 | 0.55 | 1.14 | 0.19 | 0.74 | 1.63 | 0.02 |
| Uniform Delay, d1 | | 47.3 | 0.0 | | 51.1 | 0.0 | 60.6 | 27.6 | 0.0 | 57.4 | 24.6 | 0.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 2.2 | 0.0 | | 29.8 | 0.0 | 6.6 | 68.9 | 0.3 | 15.2 | 287.4 | 0.0 |
| Delay (s) | | 49.6 | 0.0 | | 80.9 | 0.0 | 67.2 | 96.5 | 0.3 | 72.7 | 312.0 | 0.0 |
| Level of Service | | D | A | | F | A | E | F | A | E | F | A |
| Approach Delay (s) | | 33.6 | | | 60.5 | | | 84.9 | | | 301.0 | |
| Approach LOS | | C | | | E | | | F | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 201.0 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.43 | | |
| Actuated Cycle Length (s) | 130.8 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 122.2% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 6 | 24 | 1590 | 94 | 33 | 1728 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 7 | 26 | 1728 | 102 | 36 | 1878 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2790 | 915 | | | 1830 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2790 | 915 | | | 1830 | |
| tC, single (s) | 6.8 | 6.9 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 51 | 91 | | | 89 | |
| cM capacity (veh/h) | 13 | 275 | | | 330 | |

| Direction, Lane # | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 33 | 1152 | 678 | 36 | 939 | 939 |
| Volume Left | 7 | 0 | 0 | 36 | 0 | 0 |
| Volume Right | 26 | 0 | 102 | 0 | 0 | 0 |
| cSH | 56 | 1700 | 1700 | 330 | 1700 | 1700 |
| Volume to Capacity | 0.59 | 0.68 | 0.40 | 0.11 | 0.55 | 0.55 |
| Queue Length 95th (ft) | 59 | 0 | 0 | 9 | 0 | 0 |
| Control Delay (s) | 137.2 | 0.0 | 0.0 | 17.2 | 0.0 | 0.0 |
| Lane LOS | F | | | C | | |
| Approach Delay (s) | 137.2 | 0.0 | | 0.3 | | |
| Approach LOS | F | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.3 | | |
| Intersection Capacity Utilization | 57.8% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 116 | 58 | 31 | 1580 | 1693 | 108 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 126 | 63 | 34 | 1717 | 1840 | 117 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 2766 | 920 | 1840 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 2766 | 920 | 1840 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 86 | 84 | | | |
| cM capacity (veh/h) | 53 | 448 | 211 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 189 | 34 | 859 | 859 | 920 | 920 | 117 |
| Volume Left | 126 | 34 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 63 | 0 | 0 | 0 | 0 | 0 | 117 |
| cSH | 77 | 211 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 2.47 | 0.16 | 0.51 | 0.51 | 0.54 | 0.54 | 0.07 |
| Queue Length 95th (ft) | 450 | 14 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 785.3 | 25.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | D | | | | | |
| Approach Delay (s) | 785.3 | 0.5 | | | 0.0 | | |
| Approach LOS | F | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 38.3 | | |
| Intersection Capacity Utilization | 59.9% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 29 | 11 | 11 | 56 | 11 | 69 | 3 | 589 | 47 | 38 | 525 | 9 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1759 | | | 1788 | 1583 | 1770 | 1842 | | 1770 | 1858 | |
| Flt Permitted | | 0.78 | | | 0.72 | 1.00 | 0.36 | 1.00 | | 0.25 | 1.00 | |
| Satd. Flow (perm) | | 1415 | | | 1345 | 1583 | 670 | 1842 | | 471 | 1858 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 32 | 12 | 12 | 61 | 12 | 75 | 3 | 640 | 51 | 41 | 571 | 10 |
| RTOR Reduction (vph) | 0 | 10 | 0 | 0 | 0 | 65 | 0 | 4 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 46 | 0 | 0 | 73 | 10 | 3 | 687 | 0 | 41 | 580 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 6.7 | | | 6.7 | 6.7 | 26.3 | 25.8 | | 27.5 | 26.4 | |
| Effective Green, g (s) | | 6.7 | | | 6.7 | 6.7 | 26.3 | 25.8 | | 27.5 | 26.4 | |
| Actuated g/C Ratio | | 0.14 | | | 0.14 | 0.14 | 0.54 | 0.53 | | 0.57 | 0.54 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 195 | | | 185 | 218 | 374 | 978 | | 296 | 1009 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.37 | | c0.00 | 0.31 | |
| v/s Ratio Perm | | 0.03 | | | c0.05 | 0.01 | 0.00 | | | 0.08 | | |
| v/c Ratio | | 0.23 | | | 0.39 | 0.05 | 0.01 | 0.70 | | 0.14 | 0.57 | |
| Uniform Delay, d1 | | 18.7 | | | 19.1 | 18.2 | 5.4 | 8.5 | | 5.7 | 7.4 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.6 | | | 1.4 | 0.1 | 0.0 | 2.3 | | 0.2 | 0.8 | |
| Delay (s) | | 19.3 | | | 20.5 | 18.3 | 5.4 | 10.8 | | 6.0 | 8.2 | |
| Level of Service | | B | | | C | B | A | B | | A | A | |
| Approach Delay (s) | | 19.3 | | | 19.4 | | | 10.8 | | | 8.0 | |
| Approach LOS | | B | | | B | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.8 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.62 | | |
| Actuated Cycle Length (s) | 48.6 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 54.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 328 | 296 | 136 | 197 | 107 | 424 | 143 | 1324 | 262 | 1034 | 1510 | 471 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.97 | 1.00 | | 0.97 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1815 | 1583 | | 1804 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.97 | 1.00 | | 0.97 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1815 | 1583 | | 1804 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 357 | 322 | 148 | 214 | 116 | 461 | 155 | 1439 | 285 | 1124 | 1641 | 512 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 117 | 0 | 0 | 170 |
| Lane Group Flow (vph) | 0 | 679 | 148 | 0 | 330 | 461 | 155 | 1439 | 168 | 1124 | 1641 | 342 |
| Turn Type | Split | | Free | Split | | Free | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | Free | | | 2 | | | 6 |
| Actuated Green, G (s) | | 35.0 | 150.0 | | 17.0 | 150.0 | 14.7 | 61.0 | 61.0 | 15.0 | 61.3 | 61.3 |
| Effective Green, g (s) | | 35.0 | 150.0 | | 17.0 | 150.0 | 14.7 | 61.0 | 61.0 | 15.0 | 61.3 | 61.3 |
| Actuated g/C Ratio | | 0.23 | 1.00 | | 0.11 | 1.00 | 0.10 | 0.41 | 0.41 | 0.10 | 0.41 | 0.41 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 424 | 1583 | | 204 | 1583 | 173 | 1439 | 644 | 177 | 1446 | 647 |
| v/s Ratio Prot | | c0.37 | | | c0.18 | | 0.09 | 0.41 | | c0.64 | c0.46 | |
| v/s Ratio Perm | | | 0.09 | | | c0.29 | | | 0.11 | | | 0.22 |
| v/c Ratio | | 1.60 | 0.09 | | 1.62 | 0.29 | 0.90 | 1.00 | 0.26 | 6.35 | 1.13 | 0.53 |
| Uniform Delay, d1 | | 57.5 | 0.0 | | 66.5 | 0.0 | 66.9 | 44.5 | 29.5 | 67.5 | 44.4 | 33.4 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 281.5 | 0.1 | | 299.4 | 0.5 | 39.9 | 23.7 | 0.2 | 2419.6 | 69.8 | 0.8 |
| Delay (s) | | 339.0 | 0.1 | | 365.9 | 0.5 | 106.8 | 68.2 | 29.7 | 2487.1 | 114.1 | 34.2 |
| Level of Service | | F | A | | F | A | F | E | C | F | F | C |
| Approach Delay (s) | | 278.4 | | | 152.9 | | | 65.6 | | | 915.6 | |
| Approach LOS | | F | | | F | | | E | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 513.0 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.85 | | |
| Actuated Cycle Length (s) | 150.0 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 162.5% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 20 | 24 | 58 | 77 | 18 | 155 | 24 | 483 | 116 | 150 | 409 | 6 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1821 | 1583 | | 1790 | 1583 | 1770 | 1863 | 1583 | 1770 | 1858 | |
| Flt Permitted | | 0.83 | 1.00 | | 0.73 | 1.00 | 0.50 | 1.00 | 1.00 | 0.27 | 1.00 | |
| Satd. Flow (perm) | | 1551 | 1583 | | 1368 | 1583 | 935 | 1863 | 1583 | 494 | 1858 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 26 | 63 | 84 | 20 | 168 | 26 | 525 | 126 | 163 | 445 | 7 |
| RTOR Reduction (vph) | 0 | 0 | 52 | 0 | 0 | 139 | 0 | 0 | 70 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 48 | 11 | 0 | 104 | 29 | 26 | 525 | 56 | 163 | 452 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 10.4 | 10.4 | | 10.4 | 10.4 | 28.7 | 26.7 | 26.7 | 39.8 | 32.8 | |
| Effective Green, g (s) | | 10.4 | 10.4 | | 10.4 | 10.4 | 28.7 | 26.7 | 26.7 | 39.8 | 32.8 | |
| Actuated g/C Ratio | | 0.17 | 0.17 | | 0.17 | 0.17 | 0.48 | 0.44 | 0.44 | 0.66 | 0.54 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 268 | 273 | | 236 | 273 | 473 | 826 | 702 | 498 | 1012 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.28 | | c0.04 | c0.24 | |
| v/s Ratio Perm | | 0.03 | 0.01 | | c0.08 | 0.02 | 0.02 | | 0.04 | 0.17 | | |
| v/c Ratio | | 0.18 | 0.04 | | 0.44 | 0.11 | 0.05 | 0.64 | 0.08 | 0.33 | 0.45 | |
| Uniform Delay, d1 | | 21.3 | 20.7 | | 22.3 | 21.0 | 8.4 | 13.0 | 9.7 | 5.7 | 8.2 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.3 | 0.1 | | 1.3 | 0.2 | 0.0 | 1.6 | 0.0 | 0.4 | 0.3 | |
| Delay (s) | | 21.6 | 20.8 | | 23.6 | 21.2 | 8.4 | 14.6 | 9.7 | 6.1 | 8.6 | |
| Level of Service | | C | C | | C | C | A | B | A | A | A | |
| Approach Delay (s) | | 21.1 | | | 22.1 | | | 13.4 | | | 7.9 | |
| Approach LOS | | C | | | C | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 13.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.61 | | |
| Actuated Cycle Length (s) | 60.2 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 58.1% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 396 | 291 | 186 | 1912 | 2816 | 508 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 430 | 316 | 202 | 2078 | 3061 | 552 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 132 |
| Lane Group Flow (vph) | 430 | 316 | 202 | 2078 | 3061 | 420 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 29.0 | 159.0 | 15.0 | 119.0 | 98.0 | 98.0 |
| Effective Green, g (s) | 29.0 | 159.0 | 15.0 | 119.0 | 98.0 | 98.0 |
| Actuated g/C Ratio | 0.18 | 1.00 | 0.09 | 0.75 | 0.62 | 0.62 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 323 | 1583 | 167 | 2649 | 2181 | 976 |
| v/s Ratio Prot | c0.24 | | c0.11 | 0.59 | c0.86 | |
| v/s Ratio Perm | | 0.20 | | | | 0.27 |
| v/c Ratio | 1.33 | 0.20 | 1.21 | 0.78 | 1.40 | 0.43 |
| Uniform Delay, d1 | 65.0 | 0.0 | 72.0 | 12.2 | 30.5 | 15.9 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 168.8 | 0.3 | 137.1 | 1.6 | 184.4 | 0.3 |
| Delay (s) | 233.8 | 0.3 | 209.1 | 13.8 | 214.9 | 16.2 |
| Level of Service | F | A | F | B | F | B |
| Approach Delay (s) | 134.9 | | | 31.1 | 184.5 | |
| Approach LOS | F | | | C | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 126.3 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.37 | | |
| Actuated Cycle Length (s) | 159.0 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 124.3% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 96 | 11 | 88 | 7 | 545 | 93 | 107 | 574 | 11 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1783 | 1583 | 1770 | 1863 | 1583 | 1770 | 3529 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.41 | 1.00 | 1.00 | 0.27 | 1.00 | |
| Satd. Flow (perm) | | | | | 1783 | 1583 | 764 | 1863 | 1583 | 509 | 3529 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 104 | 12 | 96 | 8 | 592 | 101 | 116 | 624 | 12 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 84 | 0 | 0 | 50 | 0 | 2 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 116 | 12 | 8 | 592 | 51 | 116 | 634 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 6.7 | 6.7 | 26.5 | 26.0 | 26.0 | 33.7 | 29.6 | |
| Effective Green, g (s) | | | | | 6.7 | 6.7 | 26.5 | 26.0 | 26.0 | 33.7 | 29.6 | |
| Actuated g/C Ratio | | | | | 0.13 | 0.13 | 0.51 | 0.50 | 0.50 | 0.65 | 0.57 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 231 | 205 | 401 | 935 | 795 | 431 | 2017 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.32 | | c0.02 | 0.18 | |
| v/s Ratio Perm | | | | | 0.07 | 0.01 | 0.01 | | 0.03 | 0.15 | | |
| v/c Ratio | | | | | 0.50 | 0.06 | 0.02 | 0.63 | 0.06 | 0.27 | 0.31 | |
| Uniform Delay, d1 | | | | | 21.0 | 19.8 | 6.2 | 9.4 | 6.6 | 4.8 | 5.8 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 1.7 | 0.1 | 0.0 | 1.4 | 0.0 | 0.3 | 0.1 | |
| Delay (s) | | | | | 22.7 | 19.9 | 6.2 | 10.8 | 6.7 | 5.1 | 5.9 | |
| Level of Service | | | | | C | B | A | B | A | A | A | |
| Approach Delay (s) | | 0.0 | | | 21.4 | | | 10.2 | | | 5.8 | |
| Approach LOS | | A | | | C | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.6 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.66 | | |
| Actuated Cycle Length (s) | 51.8 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 53.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 30 | 0 | 2191 | 3304 | 76 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 33 | 0 | 2382 | 3591 | 83 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 4782 | 1796 | 3591 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 4782 | 1796 | 3591 | | | |
| tC, single (s) | 6.8 | 6.9 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 100 | 53 | 100 | | | |
| cM capacity (veh/h) | 1 | 70 | 65 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 33 | 1191 | 1191 | 1796 | 1796 | 83 |
| Volume Left | 0 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 33 | 0 | 0 | 0 | 0 | 83 |
| cSH | 70 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.47 | 0.70 | 0.70 | 1.06 | 1.06 | 0.05 |
| Queue Length 95th (ft) | 47 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 95.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | | | | | |
| Approach Delay (s) | 95.8 | 0.0 | | 0.0 | | |
| Approach LOS | F | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.5 | | |
| Intersection Capacity Utilization | 101.3% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 52 | 204 | 30 | 217 | 204 | 127 | 50 | 153 | 200 | 190 | 172 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.98 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1827 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.62 | 1.00 | | 0.41 | 1.00 | 1.00 | 0.64 | 1.00 | 1.00 | 0.65 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1154 | 1827 | | 755 | 1863 | 1583 | 1192 | 1863 | 1583 | 1215 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 57 | 222 | 33 | 236 | 222 | 138 | 54 | 166 | 217 | 207 | 187 | 85 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 0 | 80 | 0 | 0 | 155 | 0 | 0 | 61 |
| Lane Group Flow (vph) | 57 | 250 | 0 | 236 | 222 | 58 | 54 | 166 | 62 | 207 | 187 | 24 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 18.1 | 16.0 | | 31.1 | 24.0 | 24.0 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 |
| Effective Green, g (s) | 18.1 | 16.0 | | 31.1 | 24.0 | 24.0 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 |
| Actuated g/C Ratio | 0.31 | 0.28 | | 0.54 | 0.42 | 0.42 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 386 | 508 | | 587 | 778 | 661 | 340 | 531 | 451 | 347 | 531 | 451 |
| v/s Ratio Prot | 0.01 | c0.14 | | c0.07 | 0.12 | | | 0.09 | | | 0.10 | |
| v/s Ratio Perm | 0.04 | | | 0.15 | | 0.04 | 0.05 | | 0.04 | c0.17 | | 0.02 |
| v/c Ratio | 0.15 | 0.49 | | 0.40 | 0.29 | 0.09 | 0.16 | 0.31 | 0.14 | 0.60 | 0.35 | 0.05 |
| Uniform Delay, d1 | 13.9 | 17.4 | | 7.5 | 11.1 | 10.1 | 15.4 | 16.1 | 15.3 | 17.7 | 16.3 | 14.9 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.2 | 0.8 | | 0.5 | 0.2 | 0.1 | 0.2 | 0.3 | 0.1 | 2.8 | 0.4 | 0.0 |
| Delay (s) | 14.1 | 18.1 | | 8.0 | 11.3 | 10.2 | 15.6 | 16.5 | 15.4 | 20.5 | 16.7 | 15.0 |
| Level of Service | B | B | | A | B | B | B | B | B | C | B | B |
| Approach Delay (s) | | 17.4 | | | 9.7 | | | 15.8 | | | 18.0 | |
| Approach LOS | | B | | | A | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 14.7 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.52 | | |
| Actuated Cycle Length (s) | 57.5 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 59.8% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 7.1 |
| Intersection LOS | A |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 97 | 265 | 210 | 300 |
| Demand Flow Rate, veh/h | 99 | 270 | 214 | 307 |
| Vehicles Circulating, veh/h | 364 | 166 | 107 | 295 |
| Vehicles Exiting, veh/h | 238 | 155 | 355 | 141 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 6.0 | 6.7 | 5.6 | 8.7 |
| Approach LOS | A | A | A | A |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 99 | 270 | 214 | 307 |
| Cap Entry Lane, veh/h | 785 | 957 | 1015 | 841 |
| Entry HV Adj Factor | 0.977 | 0.980 | 0.980 | 0.978 |
| Flow Entry, veh/h | 97 | 265 | 210 | 300 |
| Cap Entry, veh/h | 767 | 938 | 995 | 823 |
| V/C Ratio | 1.26 | 2.82 | 2.11 | 3.65 |
| Control Delay, s/veh | 6.0 | 6.7 | 5.6 | 8.7 |
| LOS | A | A | A | A |
| 95th %tile Queue, veh | 0.0 | 0.1 | 0.1 | 0.2 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 24 | 69 | 198 | 81 | 43 | 83 | 61 | 2059 | 128 | 131 | 3194 | 24 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.88 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 26 | 75 | 215 | 88 | 47 | 90 | 66 | 2238 | 139 | 142 | 3472 | 26 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 0 | 21 | 0 | 0 | 2 |
| Lane Group Flow (vph) | 26 | 75 | 215 | 88 | 47 | 7 | 66 | 2238 | 118 | 142 | 3472 | 24 |
| Turn Type | Split | | Free | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 8.5 | 8.5 | 117.6 | 8.6 | 8.6 | 8.6 | 6.8 | 68.3 | 68.3 | 10.2 | 71.7 | 71.7 |
| Effective Green, g (s) | 8.5 | 8.5 | 117.6 | 8.6 | 8.6 | 8.6 | 6.8 | 68.3 | 68.3 | 10.2 | 71.7 | 71.7 |
| Actuated g/C Ratio | 0.07 | 0.07 | 1.00 | 0.07 | 0.07 | 0.07 | 0.06 | 0.58 | 0.58 | 0.09 | 0.61 | 0.61 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 128 | 135 | 1583 | 251 | 136 | 204 | 102 | 2055 | 919 | 298 | 2158 | 965 |
| v/s Ratio Prot | 0.01 | c0.04 | | c0.03 | 0.03 | | 0.04 | 0.63 | | c0.04 | c0.98 | |
| v/s Ratio Perm | | | 0.14 | | | 0.00 | | | 0.07 | | | 0.01 |
| v/c Ratio | 0.20 | 0.56 | 0.14 | 0.35 | 0.35 | 0.03 | 0.65 | 1.09 | 0.13 | 0.48 | 1.61 | 0.02 |
| Uniform Delay, d1 | 51.4 | 52.7 | 0.0 | 51.8 | 51.8 | 50.6 | 54.2 | 24.6 | 11.2 | 51.2 | 22.9 | 9.1 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.8 | 4.9 | 0.2 | 0.8 | 1.5 | 0.1 | 13.3 | 48.9 | 0.1 | 1.2 | 276.2 | 0.0 |
| Delay (s) | 52.1 | 57.6 | 0.2 | 52.7 | 53.4 | 50.7 | 67.5 | 73.5 | 11.2 | 52.4 | 299.1 | 9.1 |
| Level of Service | D | E | A | D | D | D | E | E | B | D | F | A |
| Approach Delay (s) | | 18.1 | | | 52.0 | | | 69.8 | | | 287.4 | |
| Approach LOS | | B | | | D | | | E | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 186.3 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.34 | | |
| Actuated Cycle Length (s) | 117.6 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 106.4% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 15 | 65 | 80 | 6 | 28 | 81 | 2997 | 61 | 25 | 2549 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 4.0 | 6.0 | 6.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.97 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1811 | 1583 | | 1780 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.80 | 1.00 | | 0.71 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1495 | 1583 | | 1332 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 21 | 16 | 71 | 87 | 7 | 30 | 88 | 3258 | 66 | 27 | 2771 | 85 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 37 | 71 | 0 | 94 | 30 | 88 | 3258 | 66 | 27 | 2771 | 85 |
| Turn Type | Perm | | Free | Perm | | Free | Prot | | Free | Prot | | Free |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | Free | 8 | | Free | | | Free | | | Free |
| Actuated Green, G (s) | | 13.7 | 122.5 | | 13.7 | 122.5 | 8.8 | 87.0 | 122.5 | 4.8 | 83.0 | 122.5 |
| Effective Green, g (s) | | 13.7 | 122.5 | | 13.7 | 122.5 | 8.8 | 87.0 | 122.5 | 4.8 | 83.0 | 122.5 |
| Actuated g/C Ratio | | 0.11 | 1.00 | | 0.11 | 1.00 | 0.07 | 0.71 | 1.00 | 0.04 | 0.68 | 1.00 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 167 | 1583 | | 149 | 1583 | 127 | 2513 | 1583 | 69 | 2398 | 1583 |
| v/s Ratio Prot | | | | | | | c0.05 | c0.92 | | 0.02 | 0.78 | |
| v/s Ratio Perm | | 0.02 | 0.04 | | c0.07 | 0.02 | | | 0.04 | | | 0.05 |
| v/c Ratio | | 0.22 | 0.04 | | 0.63 | 0.02 | 0.69 | 1.30 | 0.04 | 0.39 | 1.16 | 0.05 |
| Uniform Delay, d1 | | 49.5 | 0.0 | | 52.0 | 0.0 | 55.5 | 17.8 | 0.0 | 57.4 | 19.8 | 0.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 0.7 | 0.1 | | 8.4 | 0.0 | 15.1 | 136.5 | 0.0 | 3.6 | 75.2 | 0.1 |
| Delay (s) | | 50.2 | 0.1 | | 60.4 | 0.0 | 70.6 | 154.2 | 0.0 | 61.1 | 94.9 | 0.1 |
| Level of Service | | D | A | | E | A | E | F | A | E | F | A |
| Approach Delay (s) | | 17.2 | | | 45.8 | | | 149.1 | | | 91.8 | |
| Approach LOS | | B | | | D | | | F | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 119.6 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.21 | | |
| Actuated Cycle Length (s) | 122.5 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 103.4% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 3 | 24 | 2017 | 12 | 8 | 1807 |
| Sign Control | Stop | | Free | | | Free |
| Grade | 0% | | 0% | | | 0% |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 3 | 26 | 2192 | 13 | 9 | 1964 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | None | | | None |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 3198 | 1103 | | | 2205 | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 3198 | 1103 | | | 2205 | |
| tC, single (s) | 6.8 | 6.9 | | | 4.1 | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | | | 2.2 | |
| p0 queue free % | 56 | 87 | | | 96 | |
| cM capacity (veh/h) | 7 | 206 | | | 235 | |

| Direction, Lane # | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 29 | 1462 | 744 | 9 | 982 | 982 |
| Volume Left | 3 | 0 | 0 | 9 | 0 | 0 |
| Volume Right | 26 | 0 | 13 | 0 | 0 | 0 |
| cSH | 52 | 1700 | 1700 | 235 | 1700 | 1700 |
| Volume to Capacity | 0.57 | 0.86 | 0.44 | 0.04 | 0.58 | 0.58 |
| Queue Length 95th (ft) | 55 | 0 | 0 | 3 | 0 | 0 |
| Control Delay (s) | 142.4 | 0.0 | 0.0 | 20.9 | 0.0 | 0.0 |
| Lane LOS | F | | | C | | |
| Approach Delay (s) | 142.4 | 0.0 | | 0.1 | | |
| Approach LOS | F | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.0 | | |
| Intersection Capacity Utilization | 66.1% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 132 | 57 | 106 | 1901 | 1738 | 215 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 143 | 62 | 115 | 2066 | 1889 | 234 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 3153 | 945 | 1889 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 3153 | 945 | 1889 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 86 | 42 | | | |
| cM capacity (veh/h) | 17 | 437 | 199 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 205 | 115 | 1033 | 1033 | 945 | 945 | 234 |
| Volume Left | 143 | 115 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 62 | 0 | 0 | 0 | 0 | 0 | 234 |
| cSH | 25 | 199 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 8.35 | 0.58 | 0.61 | 0.61 | 0.56 | 0.56 | 0.14 |
| Queue Length 95th (ft) | Err | 79 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | Err | 45.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | E | | | | | |
| Approach Delay (s) | Err | 2.4 | | | 0.0 | | |
| Approach LOS | F | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 456.6 | | |
| Intersection Capacity Utilization | 71.2% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 34 | 7 | 13 | 110 | 17 | 59 | 18 | 939 | 71 | 44 | 997 | 31 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1748 | | | 1785 | 1583 | 1770 | 1843 | | 1770 | 1854 | |
| Flt Permitted | | 0.69 | | | 0.76 | 1.00 | 0.08 | 1.00 | | 0.08 | 1.00 | |
| Satd. Flow (perm) | | 1238 | | | 1413 | 1583 | 148 | 1843 | | 146 | 1854 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 37 | 8 | 14 | 120 | 18 | 64 | 20 | 1021 | 77 | 48 | 1084 | 34 |
| RTOR Reduction (vph) | 0 | 12 | 0 | 0 | 0 | 56 | 0 | 3 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 47 | 0 | 0 | 138 | 8 | 20 | 1095 | 0 | 48 | 1117 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 10.3 | | | 10.3 | 10.3 | 51.8 | 50.4 | | 53.2 | 51.1 | |
| Effective Green, g (s) | | 10.3 | | | 10.3 | 10.3 | 51.8 | 50.4 | | 53.2 | 51.1 | |
| Actuated g/C Ratio | | 0.13 | | | 0.13 | 0.13 | 0.67 | 0.65 | | 0.68 | 0.66 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 164 | | | 187 | 210 | 128 | 1194 | | 144 | 1218 | |
| v/s Ratio Prot | | | | | | | 0.00 | 0.59 | | c0.01 | c0.60 | |
| v/s Ratio Perm | | 0.04 | | | c0.10 | 0.01 | 0.10 | | | 0.22 | | |
| v/c Ratio | | 0.29 | | | 0.74 | 0.04 | 0.16 | 0.92 | | 0.33 | 0.92 | |
| Uniform Delay, d1 | | 30.4 | | | 32.5 | 29.4 | 14.0 | 11.9 | | 14.4 | 11.5 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 1.0 | | | 14.1 | 0.1 | 0.6 | 11.0 | | 1.4 | 10.8 | |
| Delay (s) | | 31.4 | | | 46.5 | 29.5 | 14.6 | 22.9 | | 15.8 | 22.4 | |
| Level of Service | | C | | | D | C | B | C | | B | C | |
| Approach Delay (s) | | 31.4 | | | 41.2 | | | 22.8 | | | 22.1 | |
| Approach LOS | | C | | | D | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 24.1 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.81 | | |
| Actuated Cycle Length (s) | 77.8 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 73.2% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 329 | 132 | 84 | 386 | 229 | 832 | 255 | 1717 | 110 | 468 | 1576 | 231 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.97 | 1.00 | | 0.97 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1798 | 1583 | | 1806 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.97 | 1.00 | | 0.97 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1798 | 1583 | | 1806 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 358 | 143 | 91 | 420 | 249 | 904 | 277 | 1866 | 120 | 509 | 1713 | 251 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 | 0 | 0 | 72 |
| Lane Group Flow (vph) | 0 | 501 | 91 | 0 | 669 | 904 | 277 | 1866 | 86 | 509 | 1713 | 179 |
| Turn Type | Split | | Free | Split | | Free | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | Free | | | 2 | | | 6 |
| Actuated Green, G (s) | | 35.0 | 167.0 | | 17.0 | 167.0 | 25.0 | 79.0 | 79.0 | 14.0 | 68.0 | 68.0 |
| Effective Green, g (s) | | 35.0 | 167.0 | | 17.0 | 167.0 | 25.0 | 79.0 | 79.0 | 14.0 | 68.0 | 68.0 |
| Actuated g/C Ratio | | 0.21 | 1.00 | | 0.10 | 1.00 | 0.15 | 0.47 | 0.47 | 0.08 | 0.41 | 0.41 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | | 377 | 1583 | | 184 | 1583 | 265 | 1674 | 749 | 148 | 1441 | 645 |
| v/s Ratio Prot | | c0.28 | | | c0.37 | | 0.16 | c0.53 | | c0.29 | c0.48 | |
| v/s Ratio Perm | | | 0.06 | | | 0.57 | | | 0.05 | | | 0.11 |
| v/c Ratio | | 1.33 | 0.06 | | 3.64 | 0.57 | 1.05 | 1.11 | 0.11 | 3.44 | 1.19 | 0.28 |
| Uniform Delay, d1 | | 66.0 | 0.0 | | 75.0 | 0.0 | 71.0 | 44.0 | 24.5 | 76.5 | 49.5 | 33.1 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 165.3 | 0.1 | | 1199.5 | 1.5 | 67.6 | 60.5 | 0.1 | 1114.5 | 92.2 | 0.2 |
| Delay (s) | | 231.3 | 0.1 | | 1274.5 | 1.5 | 138.6 | 104.5 | 24.6 | 1191.0 | 141.7 | 33.3 |
| Level of Service | | F | A | | F | A | F | F | C | F | F | C |
| Approach Delay (s) | | 195.7 | | | 542.9 | | | 104.5 | | | 346.7 | |
| Approach LOS | | F | | | F | | | F | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 299.0 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.78 | | |
| Actuated Cycle Length (s) | 167.0 | Sum of lost time (s) | 28.0 |
| Intersection Capacity Utilization | 150.3% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 39 | 37 | 58 | 147 | 35 | 130 | 71 | 776 | 135 | 76 | 944 | 28 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1816 | 1583 | | 1790 | 1583 | 1770 | 1863 | 1583 | 1770 | 1855 | |
| Flt Permitted | | 0.70 | 1.00 | | 0.71 | 1.00 | 0.06 | 1.00 | 1.00 | 0.19 | 1.00 | |
| Satd. Flow (perm) | | 1302 | 1583 | | 1326 | 1583 | 116 | 1863 | 1583 | 358 | 1855 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 42 | 40 | 63 | 160 | 38 | 141 | 77 | 843 | 147 | 83 | 1026 | 30 |
| RTOR Reduction (vph) | 0 | 0 | 50 | 0 | 0 | 112 | 0 | 0 | 55 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 82 | 13 | 0 | 198 | 29 | 77 | 843 | 92 | 83 | 1055 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 20.9 | 20.9 | | 20.9 | 20.9 | 67.6 | 64.0 | 64.0 | 66.2 | 63.3 | |
| Effective Green, g (s) | | 20.9 | 20.9 | | 20.9 | 20.9 | 67.6 | 64.0 | 64.0 | 66.2 | 63.3 | |
| Actuated g/C Ratio | | 0.20 | 0.20 | | 0.20 | 0.20 | 0.66 | 0.62 | 0.62 | 0.64 | 0.62 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 265 | 322 | | 270 | 322 | 134 | 1160 | 986 | 270 | 1142 | |
| v/s Ratio Prot | | | | | | | c0.02 | 0.45 | | 0.01 | c0.57 | |
| v/s Ratio Perm | | 0.06 | 0.01 | | c0.15 | 0.02 | 0.36 | | 0.06 | 0.19 | | |
| v/c Ratio | | 0.31 | 0.04 | | 0.73 | 0.09 | 0.57 | 0.73 | 0.09 | 0.31 | 0.92 | |
| Uniform Delay, d1 | | 34.8 | 32.9 | | 38.3 | 33.2 | 21.2 | 13.4 | 7.8 | 11.4 | 17.6 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.7 | 0.1 | | 9.9 | 0.1 | 5.8 | 2.3 | 0.0 | 0.6 | 12.3 | |
| Delay (s) | | 35.5 | 32.9 | | 48.2 | 33.3 | 27.1 | 15.7 | 7.8 | 12.0 | 29.9 | |
| Level of Service | | D | C | | D | C | C | B | A | B | C | |
| Approach Delay (s) | | 34.4 | | | 42.0 | | | 15.4 | | | 28.6 | |
| Approach LOS | | C | | | D | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 25.4 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.86 | | |
| Actuated Cycle Length (s) | 102.8 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 84.5% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 544 | 531 | 508 | 2756 | 2003 | 696 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 591 | 577 | 552 | 2996 | 2177 | 757 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 211 |
| Lane Group Flow (vph) | 591 | 577 | 552 | 2996 | 2177 | 546 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 29.0 | 192.0 | 30.0 | 152.0 | 116.0 | 116.0 |
| Effective Green, g (s) | 29.0 | 192.0 | 30.0 | 152.0 | 116.0 | 116.0 |
| Actuated g/C Ratio | 0.15 | 1.00 | 0.16 | 0.79 | 0.60 | 0.60 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 267 | 1583 | 277 | 2802 | 2138 | 956 |
| v/s Ratio Prot | c0.33 | | c0.31 | c0.85 | 0.62 | |
| v/s Ratio Perm | | 0.36 | | | | 0.35 |
| v/c Ratio | 2.21 | 0.36 | 1.99 | 1.07 | 1.02 | 0.57 |
| Uniform Delay, d1 | 81.5 | 0.0 | 81.0 | 20.0 | 38.0 | 23.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 558.1 | 0.7 | 459.4 | 39.1 | 24.2 | 0.8 |
| Delay (s) | 639.6 | 0.7 | 540.4 | 59.1 | 62.2 | 23.8 |
| Level of Service | F | A | F | E | E | C |
| Approach Delay (s) | 324.0 | | | 134.0 | 52.3 | |
| Approach LOS | F | | | F | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 131.6 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.39 | | |
| Actuated Cycle Length (s) | 192.0 | Sum of lost time (s) | 11.0 |
| Intersection Capacity Utilization | 127.8% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 223 | 63 | 128 | 19 | 789 | 197 | 91 | 665 | 25 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1793 | 1583 | 1770 | 1863 | 1583 | 1770 | 3520 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.35 | 1.00 | 1.00 | 0.11 | 1.00 | |
| Satd. Flow (perm) | | | | | 1793 | 1583 | 648 | 1863 | 1583 | 196 | 3520 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 242 | 68 | 139 | 21 | 858 | 214 | 99 | 723 | 27 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 106 | 0 | 0 | 93 | 0 | 3 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 310 | 33 | 21 | 858 | 121 | 99 | 747 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 20.9 | 20.9 | 48.2 | 46.9 | 46.9 | 54.2 | 49.9 | |
| Effective Green, g (s) | | | | | 20.9 | 20.9 | 48.2 | 46.9 | 46.9 | 54.2 | 49.9 | |
| Actuated g/C Ratio | | | | | 0.24 | 0.24 | 0.55 | 0.54 | 0.54 | 0.62 | 0.57 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 430 | 380 | 375 | 1003 | 852 | 200 | 2017 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.46 | | c0.02 | 0.21 | |
| v/s Ratio Perm | | | | | 0.17 | 0.02 | 0.03 | | 0.08 | 0.28 | | |
| v/c Ratio | | | | | 0.72 | 0.09 | 0.06 | 0.86 | 0.14 | 0.49 | 0.37 | |
| Uniform Delay, d1 | | | | | 30.4 | 25.7 | 8.8 | 17.2 | 10.0 | 14.7 | 10.1 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 5.9 | 0.1 | 0.1 | 7.3 | 0.1 | 1.9 | 0.1 | |
| Delay (s) | | | | | 36.3 | 25.8 | 8.9 | 24.5 | 10.1 | 16.6 | 10.2 | |
| Level of Service | | | | | D | C | A | C | B | B | B | |
| Approach Delay (s) | | 0.0 | | | 33.0 | | | 21.4 | | | 11.0 | |
| Approach LOS | | A | | | C | | | C | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 19.9 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.85 | | |
| Actuated Cycle Length (s) | 87.1 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 74.7% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 10 | 0 | 3078 | 2484 | 130 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 0 | 11 | 0 | 3346 | 2700 | 141 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 4373 | 1350 | 2700 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 4373 | 1350 | 2700 | | | |
| tC, single (s) | 6.8 | 6.9 | 4.1 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 100 | 92 | 100 | | | |
| cM capacity (veh/h) | 1 | 140 | 149 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|
| Volume Total | 11 | 1673 | 1673 | 1350 | 1350 | 141 |
| Volume Left | 0 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 11 | 0 | 0 | 0 | 0 | 141 |
| cSH | 140 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.08 | 0.98 | 0.98 | 0.79 | 0.79 | 0.08 |
| Queue Length 95th (ft) | 6 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 32.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | D | | | | | |
| Approach Delay (s) | 32.8 | 0.0 | | 0.0 | | |
| Approach LOS | D | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.1 | | |
| Intersection Capacity Utilization | 88.4% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 85 | 250 | 18 | 144 | 255 | 146 | 16 | 70 | 129 | 79 | 78 | 112 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.99 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1844 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.59 | 1.00 | | 0.37 | 1.00 | 1.00 | 0.70 | 1.00 | 1.00 | 0.71 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1098 | 1844 | | 686 | 1863 | 1583 | 1307 | 1863 | 1583 | 1318 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 92 | 272 | 20 | 157 | 277 | 159 | 17 | 76 | 140 | 86 | 85 | 122 |
| RTOR Reduction (vph) | 0 | 4 | 0 | 0 | 0 | 97 | 0 | 0 | 115 | 0 | 0 | 100 |
| Lane Group Flow (vph) | 92 | 288 | 0 | 157 | 277 | 62 | 17 | 76 | 25 | 86 | 85 | 22 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 9.5 | 9.0 | | 19.3 | 13.9 | 13.9 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 |
| Effective Green, g (s) | 9.5 | 9.0 | | 19.3 | 13.9 | 13.9 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 |
| Actuated g/C Ratio | 0.27 | 0.25 | | 0.54 | 0.39 | 0.39 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 301 | 464 | | 533 | 723 | 615 | 234 | 333 | 283 | 236 | 333 | 283 |
| v/s Ratio Prot | 0.00 | c0.16 | | c0.04 | 0.15 | | | 0.04 | | | 0.05 | |
| v/s Ratio Perm | 0.08 | | | 0.11 | | 0.04 | 0.01 | | 0.02 | c0.07 | | 0.01 |
| v/c Ratio | 0.31 | 0.62 | | 0.29 | 0.38 | 0.10 | 0.07 | 0.23 | 0.09 | 0.36 | 0.26 | 0.08 |
| Uniform Delay, d1 | 10.3 | 11.9 | | 4.6 | 7.9 | 7.0 | 12.2 | 12.6 | 12.3 | 12.9 | 12.6 | 12.2 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.6 | 2.5 | | 0.3 | 0.3 | 0.1 | 0.1 | 0.4 | 0.1 | 1.0 | 0.4 | 0.1 |
| Delay (s) | 10.9 | 14.3 | | 4.9 | 8.2 | 7.0 | 12.4 | 12.9 | 12.4 | 13.9 | 13.1 | 12.4 |
| Level of Service | B | B | | A | A | A | B | B | B | B | B | B |
| Approach Delay (s) | | 13.5 | | | 7.0 | | | 12.6 | | | 13.0 | |
| Approach LOS | | B | | | A | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.7 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.62 | | |
| Actuated Cycle Length (s) | 35.8 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 45.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 8.7 |
| Intersection LOS | A |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 250 | 334 | 339 | 277 |
| Demand Flow Rate, veh/h | 255 | 340 | 346 | 283 |
| Vehicles Circulating, veh/h | 319 | 318 | 245 | 302 |
| Vehicles Exiting, veh/h | 266 | 273 | 329 | 356 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 8.0 | 9.6 | 8.8 | 8.3 |
| Approach LOS | A | A | A | A |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 255 | 340 | 346 | 283 |
| Cap Entry Lane, veh/h | 821 | 822 | 884 | 835 |
| Entry HV Adj Factor | 0.980 | 0.983 | 0.980 | 0.979 |
| Flow Entry, veh/h | 250 | 334 | 339 | 277 |
| Cap Entry, veh/h | 805 | 808 | 867 | 818 |
| V/C Ratio | 3.10 | 4.14 | 3.91 | 3.39 |
| Control Delay, s/veh | 8.0 | 9.6 | 8.8 | 8.3 |
| LOS | A | A | A | A |
| 95th %tile Queue, veh | 0.1 | 0.2 | 0.2 | 0.2 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 155 | 130 | 513 | 174 | 522 | 110 | 2457 | 477 | 483 | 2009 | 35 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.88 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 21 | 168 | 141 | 558 | 189 | 567 | 120 | 2671 | 518 | 525 | 2184 | 38 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 472 | 0 | 0 | 85 | 0 | 0 | 8 |
| Lane Group Flow (vph) | 21 | 168 | 141 | 558 | 189 | 95 | 120 | 2671 | 433 | 525 | 2184 | 30 |
| Turn Type | Split | | Free | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 15.2 | 15.2 | 139.2 | 20.0 | 20.0 | 20.0 | 10.0 | 64.0 | 64.0 | 19.0 | 73.0 | 73.0 |
| Effective Green, g (s) | 15.2 | 15.2 | 139.2 | 20.0 | 20.0 | 20.0 | 10.0 | 64.0 | 64.0 | 19.0 | 73.0 | 73.0 |
| Actuated g/C Ratio | 0.11 | 0.11 | 1.00 | 0.14 | 0.14 | 0.14 | 0.07 | 0.46 | 0.46 | 0.14 | 0.52 | 0.52 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 193 | 203 | 1583 | 493 | 268 | 400 | 127 | 1627 | 728 | 469 | 1856 | 830 |
| v/s Ratio Prot | 0.01 | c0.09 | | c0.16 | 0.10 | | 0.07 | c0.75 | | c0.15 | c0.62 | |
| v/s Ratio Perm | | | 0.09 | | | 0.03 | | | 0.27 | | | 0.02 |
| v/c Ratio | 0.11 | 0.83 | 0.09 | 1.13 | 0.71 | 0.24 | 0.94 | 1.64 | 0.60 | 1.12 | 1.18 | 0.04 |
| Uniform Delay, d1 | 55.9 | 60.7 | 0.0 | 59.6 | 56.8 | 52.8 | 64.3 | 37.6 | 28.0 | 60.1 | 33.1 | 16.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.3 | 23.3 | 0.1 | 82.0 | 8.2 | 0.3 | 62.4 | 291.6 | 1.3 | 78.4 | 85.5 | 0.0 |
| Delay (s) | 56.1 | 84.0 | 0.1 | 141.6 | 65.0 | 53.2 | 126.8 | 329.2 | 29.3 | 138.5 | 118.6 | 16.1 |
| Level of Service | E | F | A | F | E | D | F | F | C | F | F | B |
| Approach Delay (s) | | 46.4 | | | 92.4 | | | 274.9 | | | 121.0 | |
| Approach LOS | | D | | | F | | | F | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 179.1 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.45 | | |
| Actuated Cycle Length (s) | 139.2 | Sum of lost time (s) | 27.0 |
| Intersection Capacity Utilization | 122.0% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 47 | 71 | 56 | 154 | 12 | 56 | 46 | 2145 | 283 | 117 | 3324 | 32 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 4.0 | 6.0 | 6.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1826 | 1583 | | 1780 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.67 | 1.00 | | 0.57 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1242 | 1583 | | 1068 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 51 | 77 | 61 | 167 | 13 | 61 | 50 | 2332 | 308 | 127 | 3613 | 35 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 128 | 61 | 0 | 180 | 61 | 50 | 2332 | 308 | 127 | 3613 | 35 |
| Turn Type | Perm | | Free | Perm | | Free | Prot | | Free | Prot | | Free |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | Free | 8 | | Free | | | Free | | | Free |
| Actuated Green, G (s) | | 25.4 | 130.8 | | 25.4 | 130.8 | 6.7 | 75.7 | 130.8 | 12.7 | 81.7 | 130.8 |
| Effective Green, g (s) | | 25.4 | 130.8 | | 25.4 | 130.8 | 6.7 | 75.7 | 130.8 | 12.7 | 81.7 | 130.8 |
| Actuated g/C Ratio | | 0.19 | 1.00 | | 0.19 | 1.00 | 0.05 | 0.58 | 1.00 | 0.10 | 0.62 | 1.00 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 241 | 1583 | | 207 | 1583 | 91 | 2048 | 1583 | 172 | 2211 | 1583 |
| v/s Ratio Prot | | | | | | | 0.03 | 0.66 | | c0.07 | c1.02 | |
| v/s Ratio Perm | | 0.10 | 0.04 | | c0.17 | 0.04 | | | 0.19 | | | 0.02 |
| v/c Ratio | | 0.53 | 0.04 | | 0.87 | 0.04 | 0.55 | 1.14 | 0.19 | 0.74 | 1.63 | 0.02 |
| Uniform Delay, d1 | | 47.3 | 0.0 | | 51.1 | 0.0 | 60.6 | 27.6 | 0.0 | 57.4 | 24.6 | 0.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 2.2 | 0.0 | | 29.8 | 0.0 | 6.6 | 68.9 | 0.3 | 15.2 | 287.4 | 0.0 |
| Delay (s) | | 49.6 | 0.0 | | 80.9 | 0.0 | 67.2 | 96.5 | 0.3 | 72.7 | 312.0 | 0.0 |
| Level of Service | | D | A | | F | A | E | F | A | E | F | A |
| Approach Delay (s) | | 33.6 | | | 60.5 | | | 84.9 | | | 301.0 | |
| Approach LOS | | C | | | E | | | F | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 201.0 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.43 | | |
| Actuated Cycle Length (s) | 130.8 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 122.2% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 101 | 54 | 1500 | 94 | 504 | 1632 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 |
| Frt | 1.00 | 0.85 | 1.00 | 0.85 | 1.00 | 1.00 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 3539 | 1583 | 1770 | 3539 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 3539 | 1583 | 1770 | 3539 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 110 | 59 | 1630 | 102 | 548 | 1774 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 26 | 0 | 0 |
| Lane Group Flow (vph) | 110 | 59 | 1630 | 76 | 548 | 1774 |
| Turn Type | | Free | | Perm | Prot | |
| Protected Phases | 8 | | 2 | | 1 | 6 |
| Permitted Phases | | Free | | 2 | | |
| Actuated Green, G (s) | 13.6 | 137.6 | 70.6 | 70.6 | 36.4 | 113.0 |
| Effective Green, g (s) | 13.6 | 137.6 | 70.6 | 70.6 | 36.4 | 113.0 |
| Actuated g/C Ratio | 0.10 | 1.00 | 0.51 | 0.51 | 0.26 | 0.82 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 175 | 1583 | 1816 | 812 | 468 | 2906 |
| v/s Ratio Prot | c0.06 | | c0.46 | | c0.31 | 0.50 |
| v/s Ratio Perm | | 0.04 | | 0.05 | | |
| v/c Ratio | 0.63 | 0.04 | 0.90 | 0.09 | 1.17 | 0.61 |
| Uniform Delay, d1 | 59.6 | 0.0 | 30.2 | 17.1 | 50.6 | 4.4 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 6.9 | 0.0 | 6.3 | 0.1 | 97.7 | 0.4 |
| Delay (s) | 66.5 | 0.0 | 36.5 | 17.2 | 148.3 | 4.8 |
| Level of Service | E | A | D | B | F | A |
| Approach Delay (s) | 43.3 | | 35.4 | | | 38.7 |
| Approach LOS | D | | D | | | D |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 37.5 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.95 | | |
| Actuated Cycle Length (s) | 137.6 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 89.1% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 116 | 58 | 31 | 1520 | 2068 | 108 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 126 | 63 | 34 | 1652 | 2248 | 117 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | 1137 | | |
| pX, platoon unblocked | 0.55 | | | | | |
| vC, conflicting volume | 3141 | 1124 | 2248 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 3255 | 1124 | 2248 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 83 | 74 | | | |
| cM capacity (veh/h) | 15 | 366 | 132 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 189 | 34 | 826 | 826 | 1124 | 1124 | 117 |
| Volume Left | 126 | 34 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 63 | 0 | 0 | 0 | 0 | 0 | 117 |
| cSH | 22 | 132 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 8.43 | 0.26 | 0.49 | 0.49 | 0.66 | 0.66 | 0.07 |
| Queue Length 95th (ft) | Err | 24 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | Err | 41.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | E | | | | | |
| Approach Delay (s) | Err | 0.8 | | | 0.0 | | |
| Approach LOS | F | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 446.3 | | |
| Intersection Capacity Utilization | 70.3% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 29 | 11 | 11 | 56 | 11 | 69 | 3 | 589 | 47 | 38 | 525 | 9 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1759 | | | 1788 | 1583 | 1770 | 1842 | | 1770 | 1858 | |
| Flt Permitted | | 0.78 | | | 0.72 | 1.00 | 0.36 | 1.00 | | 0.25 | 1.00 | |
| Satd. Flow (perm) | | 1415 | | | 1345 | 1583 | 670 | 1842 | | 471 | 1858 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 32 | 12 | 12 | 61 | 12 | 75 | 3 | 640 | 51 | 41 | 571 | 10 |
| RTOR Reduction (vph) | 0 | 10 | 0 | 0 | 0 | 65 | 0 | 4 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 46 | 0 | 0 | 73 | 10 | 3 | 687 | 0 | 41 | 580 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 6.7 | | | 6.7 | 6.7 | 26.3 | 25.8 | | 27.5 | 26.4 | |
| Effective Green, g (s) | | 6.7 | | | 6.7 | 6.7 | 26.3 | 25.8 | | 27.5 | 26.4 | |
| Actuated g/C Ratio | | 0.14 | | | 0.14 | 0.14 | 0.54 | 0.53 | | 0.57 | 0.54 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 195 | | | 185 | 218 | 374 | 978 | | 296 | 1009 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.37 | | c0.00 | 0.31 | |
| v/s Ratio Perm | | 0.03 | | | c0.05 | 0.01 | 0.00 | | | 0.08 | | |
| v/c Ratio | | 0.23 | | | 0.39 | 0.05 | 0.01 | 0.70 | | 0.14 | 0.57 | |
| Uniform Delay, d1 | | 18.7 | | | 19.1 | 18.2 | 5.4 | 8.5 | | 5.7 | 7.4 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.6 | | | 1.4 | 0.1 | 0.0 | 2.3 | | 0.2 | 0.8 | |
| Delay (s) | | 19.3 | | | 20.5 | 18.3 | 5.4 | 10.8 | | 6.0 | 8.2 | |
| Level of Service | | B | | | C | B | A | B | | A | A | |
| Approach Delay (s) | | 19.3 | | | 19.4 | | | 10.8 | | | 8.0 | |
| Approach LOS | | B | | | B | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.8 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.62 | | |
| Actuated Cycle Length (s) | 48.6 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 54.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 328 | 183 | 248 | 101 | 107 | 75 | 143 | 1400 | 126 | 675 | 1869 | 471 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 4.0 | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frpb, ped/bikes | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Flpb, ped/bikes | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1541 | 1770 | 1863 | 1583 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1541 | 1770 | 1863 | 1583 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 357 | 199 | 270 | 110 | 116 | 82 | 155 | 1522 | 137 | 734 | 2032 | 512 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 57 | 0 | 0 | 90 |
| Lane Group Flow (vph) | 357 | 199 | 270 | 110 | 116 | 82 | 155 | 1522 | 80 | 734 | 2032 | 422 |
| Confl. Peds. (#/hr) | | | 50 | 50 | | | | | | | | |
| Turn Type | Prot | | Free | Prot | | Free | Prot | | pm+ov | Prot | | pm+ov |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | 3 | 1 | 6 | 7 |
| Permitted Phases | | | Free | | | Free | | | 2 | | | 6 |
| Actuated Green, G (s) | 29.0 | 31.0 | 145.1 | 12.1 | 14.1 | 145.1 | 15.3 | 53.0 | 65.1 | 27.0 | 64.7 | 93.7 |
| Effective Green, g (s) | 29.0 | 31.0 | 145.1 | 12.1 | 14.1 | 145.1 | 15.3 | 53.0 | 65.1 | 27.0 | 64.7 | 93.7 |
| Actuated g/C Ratio | 0.20 | 0.21 | 1.00 | 0.08 | 0.10 | 1.00 | 0.11 | 0.37 | 0.45 | 0.19 | 0.45 | 0.65 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 354 | 398 | 1541 | 148 | 181 | 1583 | 187 | 1293 | 710 | 639 | 1578 | 1022 |
| v/s Ratio Prot | c0.20 | 0.11 | | 0.06 | c0.06 | | 0.09 | 0.43 | 0.01 | c0.21 | c0.57 | 0.08 |
| v/s Ratio Perm | | | 0.18 | | | 0.05 | | | 0.04 | | | 0.18 |
| v/c Ratio | 1.01 | 0.50 | 0.18 | 0.74 | 0.64 | 0.05 | 0.83 | 1.18 | 0.11 | 1.15 | 1.29 | 0.41 |
| Uniform Delay, d1 | 58.0 | 50.2 | 0.0 | 65.0 | 63.1 | 0.0 | 63.6 | 46.0 | 23.2 | 59.0 | 40.2 | 12.4 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 50.0 | 1.0 | 0.2 | 18.1 | 7.5 | 0.1 | 25.0 | 88.1 | 0.1 | 84.2 | 134.4 | 0.3 |
| Delay (s) | 108.0 | 51.2 | 0.2 | 83.1 | 70.6 | 0.1 | 88.7 | 134.1 | 23.3 | 143.2 | 174.6 | 12.7 |
| Level of Service | F | D | A | F | E | A | F | F | C | F | F | B |
| Approach Delay (s) | | 59.1 | | | 56.3 | | | 121.9 | | | 142.3 | |
| Approach LOS | | E | | | E | | | F | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 121.0 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.16 | | |
| Actuated Cycle Length (s) | 145.1 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 101.7% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 20 | 24 | 58 | 77 | 18 | 155 | 24 | 483 | 116 | 150 | 409 | 6 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1821 | 1583 | | 1790 | 1583 | 1770 | 1863 | 1583 | 1770 | 1858 | |
| Flt Permitted | | 0.83 | 1.00 | | 0.73 | 1.00 | 0.50 | 1.00 | 1.00 | 0.27 | 1.00 | |
| Satd. Flow (perm) | | 1551 | 1583 | | 1368 | 1583 | 935 | 1863 | 1583 | 494 | 1858 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 26 | 63 | 84 | 20 | 168 | 26 | 525 | 126 | 163 | 445 | 7 |
| RTOR Reduction (vph) | 0 | 0 | 52 | 0 | 0 | 139 | 0 | 0 | 70 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 48 | 11 | 0 | 104 | 29 | 26 | 525 | 56 | 163 | 452 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 10.4 | 10.4 | | 10.4 | 10.4 | 28.7 | 26.7 | 26.7 | 39.8 | 32.8 | |
| Effective Green, g (s) | | 10.4 | 10.4 | | 10.4 | 10.4 | 28.7 | 26.7 | 26.7 | 39.8 | 32.8 | |
| Actuated g/C Ratio | | 0.17 | 0.17 | | 0.17 | 0.17 | 0.48 | 0.44 | 0.44 | 0.66 | 0.54 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 268 | 273 | | 236 | 273 | 473 | 826 | 702 | 498 | 1012 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.28 | | c0.04 | c0.24 | |
| v/s Ratio Perm | | 0.03 | 0.01 | | c0.08 | 0.02 | 0.02 | | 0.04 | 0.17 | | |
| v/c Ratio | | 0.18 | 0.04 | | 0.44 | 0.11 | 0.05 | 0.64 | 0.08 | 0.33 | 0.45 | |
| Uniform Delay, d1 | | 21.3 | 20.7 | | 22.3 | 21.0 | 8.4 | 13.0 | 9.7 | 5.7 | 8.2 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.3 | 0.1 | | 1.3 | 0.2 | 0.0 | 1.6 | 0.0 | 0.4 | 0.3 | |
| Delay (s) | | 21.6 | 20.8 | | 23.6 | 21.2 | 8.4 | 14.6 | 9.7 | 6.1 | 8.6 | |
| Level of Service | | C | C | | C | C | A | B | A | A | A | |
| Approach Delay (s) | | 21.1 | | | 22.1 | | | 13.4 | | | 7.9 | |
| Approach LOS | | C | | | C | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 13.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.61 | | |
| Actuated Cycle Length (s) | 60.2 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 58.1% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 396 | 291 | 186 | 1639 | 2816 | 508 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 0.97 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 430 | 316 | 202 | 1782 | 3061 | 552 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 121 |
| Lane Group Flow (vph) | 430 | 316 | 202 | 1782 | 3061 | 431 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 23.8 | 149.3 | 19.4 | 114.5 | 89.1 | 89.1 |
| Effective Green, g (s) | 23.8 | 149.3 | 19.4 | 114.5 | 89.1 | 89.1 |
| Actuated g/C Ratio | 0.16 | 1.00 | 0.13 | 0.77 | 0.60 | 0.60 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 547 | 1583 | 230 | 2714 | 2112 | 945 |
| v/s Ratio Prot | c0.13 | | c0.11 | 0.50 | c0.86 | |
| v/s Ratio Perm | | 0.20 | | | | 0.27 |
| v/c Ratio | 0.79 | 0.20 | 0.88 | 0.66 | 1.45 | 0.46 |
| Uniform Delay, d1 | 60.3 | 0.0 | 63.8 | 8.2 | 30.1 | 16.7 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 7.3 | 0.3 | 29.2 | 0.6 | 204.9 | 0.4 |
| Delay (s) | 67.6 | 0.3 | 93.0 | 8.8 | 235.0 | 17.0 |
| Level of Service | E | A | F | A | F | B |
| Approach Delay (s) | 39.1 | | | 17.3 | 201.7 | |
| Approach LOS | D | | | B | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 124.9 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.25 | | |
| Actuated Cycle Length (s) | 149.3 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 113.6% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 96 | 11 | 88 | 7 | 545 | 93 | 107 | 574 | 11 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1783 | 1583 | 1770 | 1863 | 1583 | 1770 | 3529 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.41 | 1.00 | 1.00 | 0.27 | 1.00 | |
| Satd. Flow (perm) | | | | | 1783 | 1583 | 764 | 1863 | 1583 | 509 | 3529 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 104 | 12 | 96 | 8 | 592 | 101 | 116 | 624 | 12 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 84 | 0 | 0 | 50 | 0 | 2 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 116 | 12 | 8 | 592 | 51 | 116 | 634 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 6.7 | 6.7 | 26.5 | 26.0 | 26.0 | 33.7 | 29.6 | |
| Effective Green, g (s) | | | | | 6.7 | 6.7 | 26.5 | 26.0 | 26.0 | 33.7 | 29.6 | |
| Actuated g/C Ratio | | | | | 0.13 | 0.13 | 0.51 | 0.50 | 0.50 | 0.65 | 0.57 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 231 | 205 | 401 | 935 | 795 | 431 | 2017 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.32 | | c0.02 | 0.18 | |
| v/s Ratio Perm | | | | | 0.07 | 0.01 | 0.01 | | 0.03 | 0.15 | | |
| v/c Ratio | | | | | 0.50 | 0.06 | 0.02 | 0.63 | 0.06 | 0.27 | 0.31 | |
| Uniform Delay, d1 | | | | | 21.0 | 19.8 | 6.2 | 9.4 | 6.6 | 4.8 | 5.8 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 1.7 | 0.1 | 0.0 | 1.4 | 0.0 | 0.3 | 0.1 | |
| Delay (s) | | | | | 22.7 | 19.9 | 6.2 | 10.8 | 6.7 | 5.1 | 5.9 | |
| Level of Service | | | | | C | B | A | B | A | A | A | |
| Approach Delay (s) | | 0.0 | | | 21.4 | | | 10.2 | | | 5.8 | |
| Approach LOS | | A | | | C | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.6 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.66 | | |
| Actuated Cycle Length (s) | 51.8 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 53.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

## 19: East Waipuilani Road & Pi'ilani Highway Performance by movement

| Movement | EBR | WBR | NBT | NBR | SBT | SBR | All |
|---|---|---|---|---|---|---|---|
| Total Delay (hr) | 0.0 | 0.1 | 0.2 | 0.0 | 0.8 | 0.0 | 1.0 |
| Delay / Veh (s) | 1.6 | 2.3 | 1.2 | 0.1 | 3.4 | 2.4 | 2.6 |
| Total Stops | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Travel Dist (mi) | 2.2 | 10.0 | 24.0 | 0.3 | 83.8 | 1.3 | 121.6 |
| Travel Time (hr) | 0.1 | 0.4 | 0.7 | 0.0 | 2.6 | 0.1 | 3.9 |
| Avg Speed (mph) | 23 | 23 | 35 | 22 | 32 | 25 | 31 |
| Fuel Used (gal) | 0.1 | 0.3 | 0.7 | 0.0 | 2.6 | 0.0 | 3.7 |
| HC Emissions (g) | 0 | 3 | 9 | 0 | 30 | 0 | 43 |
| CO Emissions (g) | 4 | 106 | 327 | 1 | 839 | 26 | 1304 |
| NOx Emissions (g) | 1 | 9 | 36 | 0 | 117 | 1 | 163 |
| Vehicles Entered | 11 | 91 | 446 | 6 | 796 | 13 | 1363 |
| Vehicles Exited | 12 | 93 | 444 | 7 | 795 | 13 | 1364 |
| Hourly Exit Rate | 48 | 372 | 1776 | 28 | 3180 | 52 | 5456 |
| Input Volume | 30 | 319 | 1872 | 46 | 3304 | 76 | 5647 |
| % of Volume | 160 | 117 | 95 | 61 | 96 | 68 | 97 |
| Denied Entry Before | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Denied Entry After | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## Total Network Performance

| | |
|---|---|
| Total Delay (hr) | 18.8 |
| Delay / Veh (s) | 49.7 |
| Total Stops | 138 |
| Travel Dist (mi) | 805.0 |
| Travel Time (hr) | 37.5 |
| Avg Speed (mph) | 32 |
| Fuel Used (gal) | 31.6 |
| HC Emissions (g) | 353 |
| CO Emissions (g) | 12483 |
| NOx Emissions (g) | 1399 |
| Vehicles Entered | 1371 |
| Vehicles Exited | 1352 |
| Hourly Exit Rate | 5408 |
| Input Volume | 22117 |
| % of Volume | 24 |
| Denied Entry Before | 1 |
| Denied Entry After | 68 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 52 | 204 | 30 | 217 | 204 | 127 | 50 | 153 | 200 | 190 | 172 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.98 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1827 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.62 | 1.00 | | 0.41 | 1.00 | 1.00 | 0.64 | 1.00 | 1.00 | 0.65 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1154 | 1827 | | 755 | 1863 | 1583 | 1192 | 1863 | 1583 | 1215 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 57 | 222 | 33 | 236 | 222 | 138 | 54 | 166 | 217 | 207 | 187 | 85 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 0 | 80 | 0 | 0 | 155 | 0 | 0 | 61 |
| Lane Group Flow (vph) | 57 | 250 | 0 | 236 | 222 | 58 | 54 | 166 | 62 | 207 | 187 | 24 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 18.1 | 16.0 | | 31.1 | 24.0 | 24.0 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 |
| Effective Green, g (s) | 18.1 | 16.0 | | 31.1 | 24.0 | 24.0 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 |
| Actuated g/C Ratio | 0.31 | 0.28 | | 0.54 | 0.42 | 0.42 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 386 | 508 | | 587 | 778 | 661 | 340 | 531 | 451 | 347 | 531 | 451 |
| v/s Ratio Prot | 0.01 | c0.14 | | c0.07 | 0.12 | | | 0.09 | | | 0.10 | |
| v/s Ratio Perm | 0.04 | | | 0.15 | | 0.04 | 0.05 | | 0.04 | c0.17 | | 0.02 |
| v/c Ratio | 0.15 | 0.49 | | 0.40 | 0.29 | 0.09 | 0.16 | 0.31 | 0.14 | 0.60 | 0.35 | 0.05 |
| Uniform Delay, d1 | 13.9 | 17.4 | | 7.5 | 11.1 | 10.1 | 15.4 | 16.1 | 15.3 | 17.7 | 16.3 | 14.9 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.2 | 0.8 | | 0.5 | 0.2 | 0.1 | 0.2 | 0.3 | 0.1 | 2.8 | 0.4 | 0.0 |
| Delay (s) | 14.1 | 18.1 | | 8.0 | 11.3 | 10.2 | 15.6 | 16.5 | 15.4 | 20.5 | 16.7 | 15.0 |
| Level of Service | B | B | | A | B | B | B | B | B | C | B | B |
| Approach Delay (s) | | 17.4 | | | 9.7 | | | 15.8 | | | 18.0 | |
| Approach LOS | | B | | | A | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 14.7 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.52 | | |
| Actuated Cycle Length (s) | 57.5 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 59.8% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 7.1 |
| Intersection LOS | A |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 97 | 265 | 210 | 300 |
| Demand Flow Rate, veh/h | 99 | 270 | 214 | 307 |
| Vehicles Circulating, veh/h | 364 | 166 | 107 | 295 |
| Vehicles Exiting, veh/h | 238 | 155 | 355 | 141 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 6.0 | 6.7 | 5.6 | 8.7 |
| Approach LOS | A | A | A | A |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 99 | 270 | 214 | 307 |
| Cap Entry Lane, veh/h | 785 | 957 | 1015 | 841 |
| Entry HV Adj Factor | 0.977 | 0.980 | 0.980 | 0.978 |
| Flow Entry, veh/h | 97 | 265 | 210 | 300 |
| Cap Entry, veh/h | 767 | 938 | 995 | 823 |
| V/C Ratio | 1.26 | 2.82 | 2.11 | 3.65 |
| Control Delay, s/veh | 6.0 | 6.7 | 5.6 | 8.7 |
| LOS | A | A | A | A |
| 95th %tile Queue, veh | 0.0 | 0.1 | 0.1 | 0.2 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 24 | 69 | 198 | 81 | 43 | 83 | 61 | 2059 | 128 | 131 | 3194 | 24 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.88 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 26 | 75 | 215 | 88 | 47 | 90 | 66 | 2238 | 139 | 142 | 3472 | 26 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 0 | 21 | 0 | 0 | 2 |
| Lane Group Flow (vph) | 26 | 75 | 215 | 88 | 47 | 7 | 66 | 2238 | 118 | 142 | 3472 | 24 |
| Turn Type | Split | | Free | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 8.5 | 8.5 | 117.6 | 8.6 | 8.6 | 8.6 | 6.8 | 68.3 | 68.3 | 10.2 | 71.7 | 71.7 |
| Effective Green, g (s) | 8.5 | 8.5 | 117.6 | 8.6 | 8.6 | 8.6 | 6.8 | 68.3 | 68.3 | 10.2 | 71.7 | 71.7 |
| Actuated g/C Ratio | 0.07 | 0.07 | 1.00 | 0.07 | 0.07 | 0.07 | 0.06 | 0.58 | 0.58 | 0.09 | 0.61 | 0.61 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 128 | 135 | 1583 | 251 | 136 | 204 | 102 | 2055 | 919 | 298 | 2158 | 965 |
| v/s Ratio Prot | 0.01 | c0.04 | | c0.03 | 0.03 | | 0.04 | 0.63 | | c0.04 | c0.98 | |
| v/s Ratio Perm | | | 0.14 | | | 0.00 | | | 0.07 | | | 0.01 |
| v/c Ratio | 0.20 | 0.56 | 0.14 | 0.35 | 0.35 | 0.03 | 0.65 | 1.09 | 0.13 | 0.48 | 1.61 | 0.02 |
| Uniform Delay, d1 | 51.4 | 52.7 | 0.0 | 51.8 | 51.8 | 50.6 | 54.2 | 24.6 | 11.2 | 51.2 | 22.9 | 9.1 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.8 | 4.9 | 0.2 | 0.8 | 1.5 | 0.1 | 13.3 | 48.9 | 0.1 | 1.2 | 276.2 | 0.0 |
| Delay (s) | 52.1 | 57.6 | 0.2 | 52.7 | 53.4 | 50.7 | 67.5 | 73.5 | 11.2 | 52.4 | 299.1 | 9.1 |
| Level of Service | D | E | A | D | D | D | E | E | B | D | F | A |
| Approach Delay (s) | | 18.1 | | | 52.0 | | | 69.8 | | | 287.4 | |
| Approach LOS | | B | | | D | | | E | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 186.3 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.34 | | |
| Actuated Cycle Length (s) | 117.6 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 106.4% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 15 | 65 | 80 | 6 | 28 | 81 | 2997 | 61 | 25 | 2549 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 4.0 | 6.0 | 6.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.97 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1811 | 1583 | | 1780 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.80 | 1.00 | | 0.71 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1495 | 1583 | | 1332 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 21 | 16 | 71 | 87 | 7 | 30 | 88 | 3258 | 66 | 27 | 2771 | 85 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 37 | 71 | 0 | 94 | 30 | 88 | 3258 | 66 | 27 | 2771 | 85 |
| Turn Type | Perm | | Free | Perm | | Free | Prot | | Free | Prot | | Free |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | Free | 8 | | Free | | | Free | | | Free |
| Actuated Green, G (s) | | 13.7 | 122.5 | | 13.7 | 122.5 | 8.8 | 87.0 | 122.5 | 4.8 | 83.0 | 122.5 |
| Effective Green, g (s) | | 13.7 | 122.5 | | 13.7 | 122.5 | 8.8 | 87.0 | 122.5 | 4.8 | 83.0 | 122.5 |
| Actuated g/C Ratio | | 0.11 | 1.00 | | 0.11 | 1.00 | 0.07 | 0.71 | 1.00 | 0.04 | 0.68 | 1.00 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 167 | 1583 | | 149 | 1583 | 127 | 2513 | 1583 | 69 | 2398 | 1583 |
| v/s Ratio Prot | | | | | | | c0.05 | c0.92 | | 0.02 | 0.78 | |
| v/s Ratio Perm | | 0.02 | 0.04 | | c0.07 | 0.02 | | | 0.04 | | | 0.05 |
| v/c Ratio | | 0.22 | 0.04 | | 0.63 | 0.02 | 0.69 | 1.30 | 0.04 | 0.39 | 1.16 | 0.05 |
| Uniform Delay, d1 | | 49.5 | 0.0 | | 52.0 | 0.0 | 55.5 | 17.8 | 0.0 | 57.4 | 19.8 | 0.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 0.7 | 0.1 | | 8.4 | 0.0 | 15.1 | 136.5 | 0.0 | 3.6 | 75.2 | 0.1 |
| Delay (s) | | 50.2 | 0.1 | | 60.4 | 0.0 | 70.6 | 154.2 | 0.0 | 61.1 | 94.9 | 0.1 |
| Level of Service | | D | A | | E | A | E | F | A | E | F | A |
| Approach Delay (s) | | 17.2 | | | 45.8 | | | 149.1 | | | 91.8 | |
| Approach LOS | | B | | | D | | | F | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 119.6 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.21 | | |
| Actuated Cycle Length (s) | 122.5 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 103.4% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 182 | 162 | 2005 | 12 | 71 | 1628 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 |
| Frt | 1.00 | 0.85 | 1.00 | 0.85 | 1.00 | 1.00 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 3539 | 1583 | 1770 | 3539 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 3539 | 1583 | 1770 | 3539 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 198 | 176 | 2179 | 13 | 77 | 1770 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 2 | 0 | 0 |
| Lane Group Flow (vph) | 198 | 176 | 2179 | 11 | 77 | 1770 |
| Turn Type | | Free | | Perm | Prot | |
| Protected Phases | 8 | | 2 | | 1 | 6 |
| Permitted Phases | | Free | | 2 | | |
| Actuated Green, G (s) | 20.3 | 149.8 | 103.4 | 103.4 | 9.1 | 118.5 |
| Effective Green, g (s) | 20.3 | 149.8 | 103.4 | 103.4 | 9.1 | 118.5 |
| Actuated g/C Ratio | 0.14 | 1.00 | 0.69 | 0.69 | 0.06 | 0.79 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 240 | 1583 | 2443 | 1093 | 108 | 2800 |
| v/s Ratio Prot | c0.11 | | c0.62 | | 0.04 | c0.50 |
| v/s Ratio Perm | | 0.11 | | 0.01 | | |
| v/c Ratio | 0.82 | 0.11 | 0.89 | 0.01 | 0.71 | 0.63 |
| Uniform Delay, d1 | 63.0 | 0.0 | 18.7 | 7.2 | 69.1 | 6.5 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 20.1 | 0.1 | 4.6 | 0.0 | 19.9 | 0.5 |
| Delay (s) | 83.1 | 0.1 | 23.3 | 7.2 | 88.9 | 7.0 |
| Level of Service | F | A | C | A | F | A |
| Approach Delay (s) | 44.1 | | 23.2 | | | 10.4 |
| Approach LOS | D | | C | | | B |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 19.6 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.88 | | |
| Actuated Cycle Length (s) | 149.8 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 78.3% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 132 | 57 | 106 | 2027 | 1622 | 215 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 143 | 62 | 115 | 2203 | 1763 | 234 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | 1137 | | |
| pX, platoon unblocked | 0.35 | | | | | |
| vC, conflicting volume | 3095 | 882 | 1763 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 3274 | 882 | 1763 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 0 | 87 | 50 | | | |
| cM capacity (veh/h) | 6 | 466 | 230 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 205 | 115 | 1102 | 1102 | 882 | 882 | 234 |
| Volume Left | 143 | 115 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 62 | 0 | 0 | 0 | 0 | 0 | 234 |
| cSH | 9 | 230 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 23.03 | 0.50 | 0.65 | 0.65 | 0.52 | 0.52 | 0.14 |
| Queue Length 95th (ft) | Err | 64 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | Err | 35.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | F | E | | | | | |
| Approach Delay (s) | Err | 1.8 | | | 0.0 | | |
| Approach LOS | F | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 455.3 | | |
| Intersection Capacity Utilization | 70.0% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 34 | 7 | 13 | 110 | 17 | 59 | 18 | 939 | 71 | 44 | 997 | 31 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1748 | | | 1785 | 1583 | 1770 | 1843 | | 1770 | 1854 | |
| Flt Permitted | | 0.69 | | | 0.76 | 1.00 | 0.08 | 1.00 | | 0.08 | 1.00 | |
| Satd. Flow (perm) | | 1238 | | | 1413 | 1583 | 148 | 1843 | | 146 | 1854 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 37 | 8 | 14 | 120 | 18 | 64 | 20 | 1021 | 77 | 48 | 1084 | 34 |
| RTOR Reduction (vph) | 0 | 12 | 0 | 0 | 0 | 56 | 0 | 3 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 47 | 0 | 0 | 138 | 8 | 20 | 1095 | 0 | 48 | 1117 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 10.3 | | | 10.3 | 10.3 | 51.8 | 50.4 | | 53.2 | 51.1 | |
| Effective Green, g (s) | | 10.3 | | | 10.3 | 10.3 | 51.8 | 50.4 | | 53.2 | 51.1 | |
| Actuated g/C Ratio | | 0.13 | | | 0.13 | 0.13 | 0.67 | 0.65 | | 0.68 | 0.66 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 164 | | | 187 | 210 | 128 | 1194 | | 144 | 1218 | |
| v/s Ratio Prot | | | | | | | 0.00 | 0.59 | | c0.01 | c0.60 | |
| v/s Ratio Perm | | 0.04 | | | c0.10 | 0.01 | 0.10 | | | 0.22 | | |
| v/c Ratio | | 0.29 | | | 0.74 | 0.04 | 0.16 | 0.92 | | 0.33 | 0.92 | |
| Uniform Delay, d1 | | 30.4 | | | 32.5 | 29.4 | 14.0 | 11.9 | | 14.4 | 11.5 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 1.0 | | | 14.1 | 0.1 | 0.6 | 11.0 | | 1.4 | 10.8 | |
| Delay (s) | | 31.4 | | | 46.5 | 29.5 | 14.6 | 22.9 | | 15.8 | 22.4 | |
| Level of Service | | C | | | D | C | B | C | | B | C | |
| Approach Delay (s) | | 31.4 | | | 41.2 | | | 22.8 | | | 22.1 | |
| Approach LOS | | C | | | D | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 24.1 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.81 | | |
| Actuated Cycle Length (s) | 77.8 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 73.2% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 329 | 119 | 99 | 207 | 229 | 340 | 255 | 1928 | 25 | 420 | 1624 | 231 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 4.0 | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frpb, ped/bikes | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Flpb, ped/bikes | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1541 | 1770 | 1863 | 1583 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1541 | 1770 | 1863 | 1583 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 358 | 129 | 108 | 225 | 249 | 370 | 277 | 2096 | 27 | 457 | 1765 | 251 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 48 |
| Lane Group Flow (vph) | 358 | 129 | 108 | 225 | 249 | 370 | 277 | 2096 | 19 | 457 | 1765 | 203 |
| Confl. Peds. (#/hr) | | | 50 | 50 | | | | | | | | |
| Turn Type | Prot | | Free | Prot | | Free | Prot | | pm+ov | Prot | | pm+ov |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | 3 | 1 | 6 | 7 |
| Permitted Phases | | | Free | | | Free | | | 2 | | | 6 |
| Actuated Green, G (s) | 32.9 | 32.0 | 146.1 | 21.0 | 20.1 | 146.1 | 24.5 | 55.1 | 76.1 | 16.0 | 46.6 | 79.5 |
| Effective Green, g (s) | 32.9 | 32.0 | 146.1 | 21.0 | 20.1 | 146.1 | 24.5 | 55.1 | 76.1 | 16.0 | 46.6 | 79.5 |
| Actuated g/C Ratio | 0.23 | 0.22 | 1.00 | 0.14 | 0.14 | 1.00 | 0.17 | 0.38 | 0.52 | 0.11 | 0.32 | 0.54 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 399 | 408 | 1541 | 254 | 256 | 1583 | 297 | 1335 | 825 | 376 | 1129 | 861 |
| v/s Ratio Prot | c0.20 | 0.07 | | 0.13 | c0.13 | | 0.16 | c0.59 | 0.00 | c0.13 | 0.50 | 0.05 |
| v/s Ratio Perm | | | 0.07 | | | 0.23 | | | 0.01 | | | 0.08 |
| v/c Ratio | 0.90 | 0.32 | 0.07 | 0.89 | 0.97 | 0.23 | 0.93 | 1.57 | 0.02 | 1.22 | 1.56 | 0.24 |
| Uniform Delay, d1 | 55.0 | 47.9 | 0.0 | 61.4 | 62.7 | 0.0 | 60.0 | 45.5 | 17.0 | 65.0 | 49.8 | 17.4 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 22.0 | 0.4 | 0.1 | 28.6 | 48.3 | 0.3 | 34.7 | 260.2 | 0.0 | 119.0 | 257.8 | 0.1 |
| Delay (s) | 77.0 | 48.3 | 0.1 | 89.9 | 111.1 | 0.3 | 94.7 | 305.7 | 17.0 | 184.0 | 307.6 | 17.6 |
| Level of Service | E | D | A | F | F | A | F | F | B | F | F | B |
| Approach Delay (s) | | 56.8 | | | 56.9 | | | 278.1 | | | 255.3 | |
| Approach LOS | | E | | | E | | | F | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 218.7 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.25 | | |
| Actuated Cycle Length (s) | 146.1 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 113.9% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 39 | 37 | 58 | 147 | 35 | 130 | 71 | 776 | 135 | 76 | 944 | 28 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1816 | 1583 | | 1790 | 1583 | 1770 | 1863 | 1583 | 1770 | 1855 | |
| Flt Permitted | | 0.70 | 1.00 | | 0.71 | 1.00 | 0.06 | 1.00 | 1.00 | 0.19 | 1.00 | |
| Satd. Flow (perm) | | 1302 | 1583 | | 1326 | 1583 | 116 | 1863 | 1583 | 358 | 1855 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 42 | 40 | 63 | 160 | 38 | 141 | 77 | 843 | 147 | 83 | 1026 | 30 |
| RTOR Reduction (vph) | 0 | 0 | 50 | 0 | 0 | 112 | 0 | 0 | 55 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 82 | 13 | 0 | 198 | 29 | 77 | 843 | 92 | 83 | 1055 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 20.9 | 20.9 | | 20.9 | 20.9 | 67.6 | 64.0 | 64.0 | 66.2 | 63.3 | |
| Effective Green, g (s) | | 20.9 | 20.9 | | 20.9 | 20.9 | 67.6 | 64.0 | 64.0 | 66.2 | 63.3 | |
| Actuated g/C Ratio | | 0.20 | 0.20 | | 0.20 | 0.20 | 0.66 | 0.62 | 0.62 | 0.64 | 0.62 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 265 | 322 | | 270 | 322 | 134 | 1160 | 986 | 270 | 1142 | |
| v/s Ratio Prot | | | | | | | c0.02 | 0.45 | | 0.01 | c0.57 | |
| v/s Ratio Perm | | 0.06 | 0.01 | | c0.15 | 0.02 | 0.36 | | 0.06 | 0.19 | | |
| v/c Ratio | | 0.31 | 0.04 | | 0.73 | 0.09 | 0.57 | 0.73 | 0.09 | 0.31 | 0.92 | |
| Uniform Delay, d1 | | 34.8 | 32.9 | | 38.3 | 33.2 | 21.2 | 13.4 | 7.8 | 11.4 | 17.6 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.7 | 0.1 | | 9.9 | 0.1 | 5.8 | 2.3 | 0.0 | 0.6 | 12.3 | |
| Delay (s) | | 35.5 | 32.9 | | 48.2 | 33.3 | 27.1 | 15.7 | 7.8 | 12.0 | 29.9 | |
| Level of Service | | D | C | | D | C | C | B | A | B | C | |
| Approach Delay (s) | | 34.4 | | | 42.0 | | | 15.4 | | | 28.6 | |
| Approach LOS | | C | | | D | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 25.4 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.86 | | |
| Actuated Cycle Length (s) | 102.8 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 84.5% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 544 | 531 | 508 | 2475 | 2003 | 696 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 0.97 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 591 | 577 | 552 | 2690 | 2177 | 757 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 211 |
| Lane Group Flow (vph) | 591 | 577 | 552 | 2690 | 2177 | 546 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 33.0 | 192.0 | 55.0 | 148.0 | 87.0 | 87.0 |
| Effective Green, g (s) | 33.0 | 192.0 | 55.0 | 148.0 | 87.0 | 87.0 |
| Actuated g/C Ratio | 0.17 | 1.00 | 0.29 | 0.77 | 0.45 | 0.45 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 590 | 1583 | 507 | 2728 | 1604 | 717 |
| v/s Ratio Prot | c0.17 | | c0.31 | 0.76 | c0.62 | |
| v/s Ratio Perm | | 0.36 | | | | 0.35 |
| v/c Ratio | 1.00 | 0.36 | 1.09 | 0.99 | 1.36 | 0.76 |
| Uniform Delay, d1 | 79.5 | 0.0 | 68.5 | 21.0 | 52.5 | 43.9 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 37.5 | 0.7 | 66.2 | 14.0 | 164.9 | 4.8 |
| Delay (s) | 117.0 | 0.7 | 134.7 | 35.0 | 217.4 | 48.7 |
| Level of Service | F | A | F | D | F | D |
| Approach Delay (s) | 59.5 | | | 52.0 | 173.9 | |
| Approach LOS | E | | | D | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 101.9 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.21 | | |
| Actuated Cycle Length (s) | 192.0 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 113.2% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 223 | 63 | 128 | 19 | 789 | 197 | 91 | 665 | 25 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1793 | 1583 | 1770 | 1863 | 1583 | 1770 | 3520 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.35 | 1.00 | 1.00 | 0.11 | 1.00 | |
| Satd. Flow (perm) | | | | | 1793 | 1583 | 648 | 1863 | 1583 | 196 | 3520 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 242 | 68 | 139 | 21 | 858 | 214 | 99 | 723 | 27 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 106 | 0 | 0 | 93 | 0 | 3 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 310 | 33 | 21 | 858 | 121 | 99 | 747 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 20.9 | 20.9 | 48.2 | 46.9 | 46.9 | 54.2 | 49.9 | |
| Effective Green, g (s) | | | | | 20.9 | 20.9 | 48.2 | 46.9 | 46.9 | 54.2 | 49.9 | |
| Actuated g/C Ratio | | | | | 0.24 | 0.24 | 0.55 | 0.54 | 0.54 | 0.62 | 0.57 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 430 | 380 | 375 | 1003 | 852 | 200 | 2017 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.46 | | c0.02 | 0.21 | |
| v/s Ratio Perm | | | | | 0.17 | 0.02 | 0.03 | | 0.08 | 0.28 | | |
| v/c Ratio | | | | | 0.72 | 0.09 | 0.06 | 0.86 | 0.14 | 0.49 | 0.37 | |
| Uniform Delay, d1 | | | | | 30.4 | 25.7 | 8.8 | 17.2 | 10.0 | 14.7 | 10.1 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 5.9 | 0.1 | 0.1 | 7.3 | 0.1 | 1.9 | 0.1 | |
| Delay (s) | | | | | 36.3 | 25.8 | 8.9 | 24.5 | 10.1 | 16.6 | 10.2 | |
| Level of Service | | | | | D | C | A | C | B | B | B | |
| Approach Delay (s) | | 0.0 | | | 33.0 | | | 21.4 | | | 11.0 | |
| Approach LOS | | A | | | C | | | C | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 19.9 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.85 | | |
| Actuated Cycle Length (s) | 87.1 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 74.7% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

## 19: East Waipuilani Road & Pi'ilani Highway Performance by movement

| Movement | EBR | WBR | NBT | NBR | SBT | SBR | All |
|---|---|---|---|---|---|---|---|
| Total Delay (hr) | 0.0 | 0.1 | 4.2 | 0.1 | 0.2 | 0.0 | 4.7 |
| Delay / Veh (s) | 1.2 | 3.3 | 22.2 | 21.2 | 1.3 | 1.8 | 11.6 |
| Total Stops | 0 | 15 | 112 | 1 | 0 | 0 | 128 |
| Travel Dist (mi) | 0.2 | 10.9 | 147.2 | 3.7 | 64.4 | 3.0 | 229.5 |
| Travel Time (hr) | 0.0 | 0.5 | 7.8 | 0.2 | 1.7 | 0.1 | 10.3 |
| Avg Speed (mph) | 22 | 22 | 21 | 21 | 39 | 26 | 24 |
| Fuel Used (gal) | 0.0 | 0.3 | 4.5 | 0.1 | 1.9 | 0.0 | 6.9 |
| HC Emissions (g) | 0 | 3 | 41 | 1 | 29 | 0 | 75 |
| CO Emissions (g) | 0 | 112 | 1239 | 37 | 882 | 15 | 2286 |
| NOx Emissions (g) | 0 | 8 | 143 | 3 | 112 | 1 | 267 |
| Vehicles Entered | 1 | 99 | 681 | 17 | 611 | 31 | 1440 |
| Vehicles Exited | 1 | 99 | 691 | 18 | 610 | 29 | 1448 |
| Hourly Exit Rate | 4 | 396 | 2764 | 72 | 2440 | 116 | 5792 |
| Input Volume | 10 | 354 | 2724 | 73 | 2484 | 130 | 5775 |
| % of Volume | 40 | 112 | 101 | 99 | 98 | 89 | 100 |
| Denied Entry Before | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Denied Entry After | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## Total Network Performance

| | |
|---|---|
| Total Delay (hr) | 9.4 |
| Delay / Veh (s) | 23.3 |
| Total Stops | 302 |
| Travel Dist (mi) | 856.7 |
| Travel Time (hr) | 29.5 |
| Avg Speed (mph) | 30 |
| Fuel Used (gal) | 30.7 |
| HC Emissions (g) | 378 |
| CO Emissions (g) | 13308 |
| NOx Emissions (g) | 1491 |
| Vehicles Entered | 1441 |
| Vehicles Exited | 1462 |
| Hourly Exit Rate | 5848 |
| Input Volume | 17242 |
| % of Volume | 34 |
| Denied Entry Before | 1 |
| Denied Entry After | 1 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 85 | 250 | 18 | 144 | 255 | 146 | 16 | 70 | 129 | 79 | 78 | 112 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.99 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1844 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.59 | 1.00 | | 0.37 | 1.00 | 1.00 | 0.70 | 1.00 | 1.00 | 0.71 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1098 | 1844 | | 686 | 1863 | 1583 | 1307 | 1863 | 1583 | 1318 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 92 | 272 | 20 | 157 | 277 | 159 | 17 | 76 | 140 | 86 | 85 | 122 |
| RTOR Reduction (vph) | 0 | 4 | 0 | 0 | 0 | 97 | 0 | 0 | 115 | 0 | 0 | 100 |
| Lane Group Flow (vph) | 92 | 288 | 0 | 157 | 277 | 62 | 17 | 76 | 25 | 86 | 85 | 22 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 9.5 | 9.0 | | 19.3 | 13.9 | 13.9 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 |
| Effective Green, g (s) | 9.5 | 9.0 | | 19.3 | 13.9 | 13.9 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 |
| Actuated g/C Ratio | 0.27 | 0.25 | | 0.54 | 0.39 | 0.39 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 301 | 464 | | 533 | 723 | 615 | 234 | 333 | 283 | 236 | 333 | 283 |
| v/s Ratio Prot | 0.00 | c0.16 | | c0.04 | 0.15 | | | 0.04 | | | 0.05 | |
| v/s Ratio Perm | 0.08 | | | 0.11 | | 0.04 | 0.01 | | 0.02 | c0.07 | | 0.01 |
| v/c Ratio | 0.31 | 0.62 | | 0.29 | 0.38 | 0.10 | 0.07 | 0.23 | 0.09 | 0.36 | 0.26 | 0.08 |
| Uniform Delay, d1 | 10.3 | 11.9 | | 4.6 | 7.9 | 7.0 | 12.2 | 12.6 | 12.3 | 12.9 | 12.6 | 12.2 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.6 | 2.5 | | 0.3 | 0.3 | 0.1 | 0.1 | 0.4 | 0.1 | 1.0 | 0.4 | 0.1 |
| Delay (s) | 10.9 | 14.3 | | 4.9 | 8.2 | 7.0 | 12.4 | 12.9 | 12.4 | 13.9 | 13.1 | 12.4 |
| Level of Service | B | B | | A | A | A | B | B | B | B | B | B |
| Approach Delay (s) | | 13.5 | | | 7.0 | | | 12.6 | | | 13.0 | |
| Approach LOS | | B | | | A | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.7 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.62 | | |
| Actuated Cycle Length (s) | 35.8 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 45.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 8.7 |
| Intersection LOS | A |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 250 | 334 | 339 | 277 |
| Demand Flow Rate, veh/h | 255 | 340 | 346 | 283 |
| Vehicles Circulating, veh/h | 319 | 318 | 245 | 302 |
| Vehicles Exiting, veh/h | 266 | 273 | 329 | 356 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 8.0 | 9.6 | 8.8 | 8.3 |
| Approach LOS | A | A | A | A |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 255 | 340 | 346 | 283 |
| Cap Entry Lane, veh/h | 821 | 822 | 884 | 835 |
| Entry HV Adj Factor | 0.980 | 0.983 | 0.980 | 0.979 |
| Flow Entry, veh/h | 250 | 334 | 339 | 277 |
| Cap Entry, veh/h | 805 | 808 | 867 | 818 |
| V/C Ratio | 3.10 | 4.14 | 3.91 | 3.39 |
| Control Delay, s/veh | 8.0 | 9.6 | 8.8 | 8.3 |
| LOS | A | A | A | A |
| 95th %tile Queue, veh | 0.1 | 0.2 | 0.2 | 0.2 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 155 | 130 | 513 | 174 | 522 | 110 | 2457 | 477 | 483 | 2009 | 35 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.88 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 21 | 168 | 141 | 558 | 189 | 567 | 120 | 2671 | 518 | 525 | 2184 | 38 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 459 | 0 | 0 | 85 | 0 | 0 | 8 |
| Lane Group Flow (vph) | 21 | 168 | 141 | 558 | 189 | 108 | 120 | 2671 | 433 | 525 | 2184 | 30 |
| Turn Type | Split | | Free | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 15.2 | 15.2 | 139.2 | 20.0 | 20.0 | 20.0 | 9.0 | 63.0 | 63.0 | 19.0 | 73.0 | 73.0 |
| Effective Green, g (s) | 15.2 | 15.2 | 139.2 | 20.0 | 20.0 | 20.0 | 9.0 | 63.0 | 63.0 | 19.0 | 73.0 | 73.0 |
| Actuated g/C Ratio | 0.11 | 0.11 | 1.00 | 0.14 | 0.14 | 0.14 | 0.06 | 0.45 | 0.45 | 0.14 | 0.52 | 0.52 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 193 | 203 | 1583 | 493 | 268 | 400 | 114 | 1602 | 716 | 469 | 1856 | 830 |
| v/s Ratio Prot | 0.01 | c0.09 | | c0.16 | 0.10 | | 0.07 | c0.75 | | c0.15 | c0.62 | |
| v/s Ratio Perm | | | 0.09 | | | 0.04 | | | 0.27 | | | 0.02 |
| v/c Ratio | 0.11 | 0.83 | 0.09 | 1.13 | 0.71 | 0.27 | 1.05 | 1.67 | 0.60 | 1.12 | 1.18 | 0.04 |
| Uniform Delay, d1 | 55.9 | 60.7 | 0.0 | 59.6 | 56.8 | 53.1 | 65.1 | 38.1 | 28.7 | 60.1 | 33.1 | 16.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.3 | 23.3 | 0.1 | 82.0 | 8.2 | 0.4 | 99.1 | 303.1 | 1.5 | 78.4 | 85.5 | 0.0 |
| Delay (s) | 56.1 | 84.0 | 0.1 | 141.6 | 65.0 | 53.5 | 164.2 | 341.2 | 30.2 | 138.5 | 118.6 | 16.1 |
| Level of Service | E | F | A | F | E | D | F | F | C | F | F | B |
| Approach Delay (s) | | 46.4 | | | 92.5 | | | 286.1 | | | 121.0 | |
| Approach LOS | | D | | | F | | | F | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 183.9 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.47 | | |
| Actuated Cycle Length (s) | 139.2 | Sum of lost time (s) | 28.0 |
| Intersection Capacity Utilization | 122.8% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 47 | 71 | 56 | 154 | 12 | 56 | 46 | 1184 | 283 | 117 | 2005 | 32 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 4.0 | 6.0 | 6.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1826 | 1583 | | 1780 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.67 | 1.00 | | 0.58 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1252 | 1583 | | 1073 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 51 | 77 | 61 | 167 | 13 | 61 | 50 | 1287 | 308 | 127 | 2179 | 35 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 128 | 61 | 0 | 180 | 61 | 50 | 1287 | 308 | 127 | 2179 | 35 |
| Turn Type | Perm | | Free | Perm | | Free | Prot | | Free | Prot | | Free |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | Free | 8 | | Free | | | Free | | | Free |
| Actuated Green, G (s) | | 25.1 | 128.6 | | 25.1 | 128.6 | 6.6 | 73.9 | 128.6 | 12.6 | 79.9 | 128.6 |
| Effective Green, g (s) | | 25.1 | 128.6 | | 25.1 | 128.6 | 6.6 | 73.9 | 128.6 | 12.6 | 79.9 | 128.6 |
| Actuated g/C Ratio | | 0.20 | 1.00 | | 0.20 | 1.00 | 0.05 | 0.57 | 1.00 | 0.10 | 0.62 | 1.00 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 244 | 1583 | | 209 | 1583 | 91 | 2034 | 1583 | 173 | 2199 | 1583 |
| v/s Ratio Prot | | | | | | | 0.03 | 0.36 | | c0.07 | c0.62 | |
| v/s Ratio Perm | | 0.10 | 0.04 | | c0.17 | 0.04 | | | 0.19 | | | 0.02 |
| v/c Ratio | | 0.52 | 0.04 | | 0.86 | 0.04 | 0.55 | 0.63 | 0.19 | 0.73 | 0.99 | 0.02 |
| Uniform Delay, d1 | | 46.4 | 0.0 | | 50.1 | 0.0 | 59.5 | 18.3 | 0.0 | 56.4 | 24.0 | 0.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 2.0 | 0.0 | | 28.5 | 0.0 | 6.6 | 0.7 | 0.3 | 14.9 | 17.0 | 0.0 |
| Delay (s) | | 48.4 | 0.0 | | 78.6 | 0.0 | 66.2 | 18.9 | 0.3 | 71.2 | 41.0 | 0.0 |
| Level of Service | | D | A | | E | A | E | B | A | E | D | A |
| Approach Delay (s) | | 32.8 | | | 58.7 | | | 16.9 | | | 42.0 | |
| Approach LOS | | C | | | E | | | B | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 33.2 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.97 | | |
| Actuated Cycle Length (s) | 128.6 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 88.8% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 30 | 31 | 855 | 26 | 235 | 1041 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 |
| Frt | 1.00 | 0.85 | 1.00 | 0.85 | 1.00 | 1.00 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 3539 | 1583 | 1770 | 3539 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 3539 | 1583 | 1770 | 3539 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 33 | 34 | 929 | 28 | 255 | 1132 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 15 | 0 | 0 |
| Lane Group Flow (vph) | 33 | 34 | 929 | 13 | 255 | 1132 |
| Turn Type | | Free | | Perm | Prot | |
| Protected Phases | 8 | | 2 | | 1 | 6 |
| Permitted Phases | | Free | | 2 | | |
| Actuated Green, G (s) | 4.0 | 65.3 | 28.3 | 28.3 | 16.0 | 50.3 |
| Effective Green, g (s) | 4.0 | 65.3 | 28.3 | 28.3 | 16.0 | 50.3 |
| Actuated g/C Ratio | 0.06 | 1.00 | 0.43 | 0.43 | 0.25 | 0.77 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 108 | 1583 | 1534 | 686 | 434 | 2726 |
| v/s Ratio Prot | c0.02 | | c0.26 | | c0.14 | 0.32 |
| v/s Ratio Perm | | 0.02 | | 0.01 | | |
| v/c Ratio | 0.31 | 0.02 | 0.61 | 0.02 | 0.59 | 0.42 |
| Uniform Delay, d1 | 29.3 | 0.0 | 14.2 | 10.6 | 21.7 | 2.5 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 1.6 | 0.0 | 0.7 | 0.0 | 2.0 | 0.1 |
| Delay (s) | 30.9 | 0.0 | 14.9 | 10.6 | 23.8 | 2.6 |
| Level of Service | C | A | B | B | C | A |
| Approach Delay (s) | 15.2 | | 14.8 | | | 6.5 |
| Approach LOS | B | | B | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.0 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.57 | | |
| Actuated Cycle Length (s) | 65.3 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 54.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 87 | 46 | 25 | 828 | 1220 | 86 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 95 | 50 | 27 | 900 | 1326 | 93 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | 1137 | | |
| pX, platoon unblocked | 0.83 | | | | | |
| vC, conflicting volume | 1830 | 663 | 1326 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1592 | 663 | 1326 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 44 | 91 | 93 | | | |
| cM capacity (veh/h) | 170 | 577 | 376 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 145 | 27 | 450 | 450 | 663 | 663 | 93 |
| Volume Left | 95 | 27 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 50 | 0 | 0 | 0 | 0 | 0 | 93 |
| cSH | 260 | 376 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.56 | 0.07 | 0.26 | 0.26 | 0.39 | 0.39 | 0.05 |
| Queue Length 95th (ft) | 77 | 6 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 36.6 | 15.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | E | C | | | | | |
| Approach Delay (s) | 36.6 | 0.4 | | | 0.0 | | |
| Approach LOS | E | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.3 | | |
| Intersection Capacity Utilization | 45.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 29 | 11 | 11 | 56 | 11 | 69 | 3 | 603 | 47 | 38 | 525 | 9 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1759 | | | 1788 | 1583 | 1770 | 1843 | | 1770 | 1858 | |
| Flt Permitted | | 0.78 | | | 0.72 | 1.00 | 0.36 | 1.00 | | 0.25 | 1.00 | |
| Satd. Flow (perm) | | 1415 | | | 1345 | 1583 | 674 | 1843 | | 458 | 1858 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 32 | 12 | 12 | 61 | 12 | 75 | 3 | 655 | 51 | 41 | 571 | 10 |
| RTOR Reduction (vph) | 0 | 10 | 0 | 0 | 0 | 65 | 0 | 4 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 46 | 0 | 0 | 73 | 10 | 3 | 702 | 0 | 41 | 580 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 6.7 | | | 6.7 | 6.7 | 27.0 | 26.5 | | 28.2 | 27.1 | |
| Effective Green, g (s) | | 6.7 | | | 6.7 | 6.7 | 27.0 | 26.5 | | 28.2 | 27.1 | |
| Actuated g/C Ratio | | 0.14 | | | 0.14 | 0.14 | 0.55 | 0.54 | | 0.57 | 0.55 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 192 | | | 183 | 215 | 380 | 991 | | 291 | 1021 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.38 | | c0.00 | 0.31 | |
| v/s Ratio Perm | | 0.03 | | | c0.05 | 0.01 | 0.00 | | | 0.08 | | |
| v/c Ratio | | 0.24 | | | 0.40 | 0.05 | 0.01 | 0.71 | | 0.14 | 0.57 | |
| Uniform Delay, d1 | | 19.0 | | | 19.5 | 18.5 | 5.3 | 8.5 | | 5.8 | 7.3 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.6 | | | 1.4 | 0.1 | 0.0 | 2.3 | | 0.2 | 0.7 | |
| Delay (s) | | 19.7 | | | 20.9 | 18.6 | 5.3 | 10.9 | | 6.0 | 8.0 | |
| Level of Service | | B | | | C | B | A | B | | A | A | |
| Approach Delay (s) | | 19.7 | | | 19.7 | | | 10.8 | | | 7.9 | |
| Approach LOS | | B | | | B | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.8 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.63 | | |
| Actuated Cycle Length (s) | 49.3 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 54.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 246 | 184 | 221 | 30 | 107 | 29 | 114 | 776 | 58 | 266 | 1087 | 377 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 4.0 | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frpb, ped/bikes | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Flpb, ped/bikes | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1541 | 1770 | 1863 | 1583 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1541 | 1770 | 1863 | 1583 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 267 | 200 | 240 | 33 | 116 | 32 | 124 | 843 | 63 | 289 | 1182 | 410 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 | 0 | 0 | 118 |
| Lane Group Flow (vph) | 267 | 200 | 240 | 33 | 116 | 32 | 124 | 843 | 27 | 289 | 1182 | 292 |
| Confl. Peds. (#/hr) | | | 50 | 50 | | | | | | | | |
| Turn Type | Prot | | Free | Prot | | Free | Prot | | pm+ov | Prot | | pm+ov |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | 3 | 1 | 6 | 7 |
| Permitted Phases | | | Free | | | Free | | | 2 | | | 6 |
| Actuated Green, G (s) | 23.5 | 31.8 | 122.8 | 6.5 | 14.8 | 122.8 | 13.3 | 46.2 | 52.7 | 16.3 | 49.2 | 72.7 |
| Effective Green, g (s) | 23.5 | 31.8 | 122.8 | 6.5 | 14.8 | 122.8 | 13.3 | 46.2 | 52.7 | 16.3 | 49.2 | 72.7 |
| Actuated g/C Ratio | 0.19 | 0.26 | 1.00 | 0.05 | 0.12 | 1.00 | 0.11 | 0.38 | 0.43 | 0.13 | 0.40 | 0.59 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 339 | 482 | 1541 | 94 | 225 | 1583 | 192 | 1331 | 679 | 456 | 1418 | 937 |
| v/s Ratio Prot | c0.15 | 0.11 | | 0.02 | c0.06 | | 0.07 | 0.24 | 0.00 | c0.08 | c0.33 | 0.06 |
| v/s Ratio Perm | | | c0.16 | | | 0.02 | | | 0.01 | | | 0.12 |
| v/c Ratio | 0.79 | 0.41 | 0.16 | 0.35 | 0.52 | 0.02 | 0.65 | 0.63 | 0.04 | 0.63 | 0.83 | 0.31 |
| Uniform Delay, d1 | 47.3 | 37.8 | 0.0 | 56.1 | 50.6 | 0.0 | 52.5 | 31.4 | 20.4 | 50.4 | 33.1 | 12.5 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 11.5 | 0.6 | 0.2 | 2.3 | 2.0 | 0.0 | 7.3 | 1.0 | 0.0 | 2.9 | 4.4 | 0.2 |
| Delay (s) | 58.7 | 38.4 | 0.2 | 58.4 | 52.6 | 0.0 | 59.8 | 32.4 | 20.4 | 53.3 | 37.5 | 12.7 |
| Level of Service | E | D | A | E | D | A | E | C | C | D | D | B |
| Approach Delay (s) | | 33.1 | | | 44.4 | | | 34.9 | | | 34.5 | |
| Approach LOS | | C | | | D | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 34.8 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.73 | | |
| Actuated Cycle Length (s) | 122.8 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 74.0% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 20 | 24 | 58 | 77 | 18 | 155 | 24 | 483 | 130 | 150 | 409 | 6 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1821 | 1583 | | 1790 | 1583 | 1770 | 1863 | 1583 | 1770 | 1858 | |
| Flt Permitted | | 0.83 | 1.00 | | 0.73 | 1.00 | 0.50 | 1.00 | 1.00 | 0.27 | 1.00 | |
| Satd. Flow (perm) | | 1551 | 1583 | | 1368 | 1583 | 935 | 1863 | 1583 | 494 | 1858 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 22 | 26 | 63 | 84 | 20 | 168 | 26 | 525 | 141 | 163 | 445 | 7 |
| RTOR Reduction (vph) | 0 | 0 | 52 | 0 | 0 | 139 | 0 | 0 | 78 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 48 | 11 | 0 | 104 | 29 | 26 | 525 | 63 | 163 | 452 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 10.4 | 10.4 | | 10.4 | 10.4 | 28.7 | 26.7 | 26.7 | 39.8 | 32.8 | |
| Effective Green, g (s) | | 10.4 | 10.4 | | 10.4 | 10.4 | 28.7 | 26.7 | 26.7 | 39.8 | 32.8 | |
| Actuated g/C Ratio | | 0.17 | 0.17 | | 0.17 | 0.17 | 0.48 | 0.44 | 0.44 | 0.66 | 0.54 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 268 | 273 | | 236 | 273 | 473 | 826 | 702 | 498 | 1012 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.28 | | c0.04 | c0.24 | |
| v/s Ratio Perm | | 0.03 | 0.01 | | c0.08 | 0.02 | 0.02 | | 0.04 | 0.17 | | |
| v/c Ratio | | 0.18 | 0.04 | | 0.44 | 0.11 | 0.05 | 0.64 | 0.09 | 0.33 | 0.45 | |
| Uniform Delay, d1 | | 21.3 | 20.7 | | 22.3 | 21.0 | 8.4 | 13.0 | 9.7 | 5.7 | 8.2 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.3 | 0.1 | | 1.3 | 0.2 | 0.0 | 1.6 | 0.1 | 0.4 | 0.3 | |
| Delay (s) | | 21.6 | 20.8 | | 23.6 | 21.2 | 8.4 | 14.6 | 9.8 | 6.1 | 8.6 | |
| Level of Service | | C | C | | C | C | A | B | A | A | A | |
| Approach Delay (s) | | 21.1 | | | 22.1 | | | 13.4 | | | 7.9 | |
| Approach LOS | | C | | | C | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 13.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.61 | | |
| Actuated Cycle Length (s) | 60.2 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 58.1% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 354 | 233 | 149 | 924 | 1599 | 406 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 0.97 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 385 | 253 | 162 | 1004 | 1738 | 441 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 175 |
| Lane Group Flow (vph) | 385 | 253 | 162 | 1004 | 1738 | 266 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 21.0 | 132.4 | 17.0 | 100.4 | 77.4 | 77.4 |
| Effective Green, g (s) | 21.0 | 132.4 | 17.0 | 100.4 | 77.4 | 77.4 |
| Actuated g/C Ratio | 0.16 | 1.00 | 0.13 | 0.76 | 0.58 | 0.58 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 545 | 1583 | 227 | 2684 | 2069 | 925 |
| v/s Ratio Prot | c0.11 | | c0.09 | 0.28 | c0.49 | |
| v/s Ratio Perm | | 0.16 | | | | 0.17 |
| v/c Ratio | 0.71 | 0.16 | 0.71 | 0.37 | 0.84 | 0.29 |
| Uniform Delay, d1 | 52.8 | 0.0 | 55.4 | 5.4 | 22.4 | 13.7 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 4.2 | 0.2 | 10.1 | 0.1 | 3.3 | 0.2 |
| Delay (s) | 56.9 | 0.2 | 65.5 | 5.5 | 25.7 | 13.9 |
| Level of Service | E | A | E | A | C | B |
| Approach Delay (s) | 34.4 | | | 13.8 | 23.3 | |
| Approach LOS | C | | | B | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 22.3 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.80 | | |
| Actuated Cycle Length (s) | 132.4 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 76.7% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 96 | 11 | 88 | 7 | 491 | 93 | 107 | 519 | 11 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1783 | 1583 | 1770 | 1863 | 1583 | 1770 | 3528 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.44 | 1.00 | 1.00 | 0.30 | 1.00 | |
| Satd. Flow (perm) | | | | | 1783 | 1583 | 811 | 1863 | 1583 | 565 | 3528 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 104 | 12 | 96 | 8 | 534 | 101 | 116 | 564 | 12 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 0 | 53 | 0 | 2 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 116 | 13 | 8 | 534 | 48 | 116 | 574 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 6.6 | 6.6 | 24.3 | 23.8 | 23.8 | 31.7 | 27.5 | |
| Effective Green, g (s) | | | | | 6.6 | 6.6 | 24.3 | 23.8 | 23.8 | 31.7 | 27.5 | |
| Actuated g/C Ratio | | | | | 0.13 | 0.13 | 0.49 | 0.48 | 0.48 | 0.64 | 0.55 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 237 | 211 | 407 | 894 | 760 | 463 | 1956 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.29 | | c0.02 | 0.16 | |
| v/s Ratio Perm | | | | | 0.07 | 0.01 | 0.01 | | 0.03 | 0.14 | | |
| v/c Ratio | | | | | 0.49 | 0.06 | 0.02 | 0.60 | 0.06 | 0.25 | 0.29 | |
| Uniform Delay, d1 | | | | | 19.9 | 18.8 | 6.5 | 9.4 | 6.9 | 4.5 | 5.9 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 1.6 | 0.1 | 0.0 | 1.1 | 0.0 | 0.3 | 0.1 | |
| Delay (s) | | | | | 21.5 | 18.9 | 6.5 | 10.5 | 7.0 | 4.8 | 6.0 | |
| Level of Service | | | | | C | B | A | B | A | A | A | |
| Approach Delay (s) | | 0.0 | | | 20.3 | | | 9.9 | | | 5.8 | |
| Approach LOS | | A | | | C | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.5 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.63 | | |
| Actuated Cycle Length (s) | 49.6 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 50.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

## 19: East Waipuilani Road & Pi'ilani Highway Performance by movement

| Movement | EBR | WBR | NBT | NBR | SBT | SBR | All |
|---|---|---|---|---|---|---|---|
| Total Delay (hr) | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.2 |
| Delay / Veh (s) | 1.7 | 1.1 | 0.9 | 4.6 | 0.9 | 1.3 | 0.9 |
| Total Stops | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Travel Dist (mi) | 1.9 | 1.9 | 57.6 | 0.2 | 55.0 | 1.0 | 117.8 |
| Travel Time (hr) | 0.1 | 0.1 | 1.4 | 0.0 | 1.4 | 0.0 | 3.0 |
| Avg Speed (mph) | 22 | 25 | 42 | 33 | 40 | 26 | 40 |
| Fuel Used (gal) | 0.1 | 0.0 | 1.6 | 0.0 | 1.6 | 0.0 | 3.3 |
| HC Emissions (g) | 2 | 1 | 30 | 0 | 17 | 0 | 50 |
| CO Emissions (g) | 34 | 16 | 849 | 1 | 579 | 3 | 1481 |
| NOx Emissions (g) | 5 | 2 | 117 | 0 | 76 | 0 | 202 |
| Vehicles Entered | 11 | 18 | 271 | 1 | 524 | 10 | 835 |
| Vehicles Exited | 10 | 17 | 268 | 1 | 523 | 12 | 831 |
| Hourly Exit Rate | 40 | 68 | 1072 | 4 | 2092 | 48 | 3324 |
| Input Volume | 30 | 80 | 1150 | 11 | 1985 | 76 | 3332 |
| % of Volume | 133 | 85 | 93 | 36 | 105 | 63 | 100 |
| Denied Entry Before | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Denied Entry After | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## Total Network Performance

| | |
|---|---|
| Total Delay (hr) | 1.1 |
| Delay / Veh (s) | 4.5 |
| Total Stops | 29 |
| Travel Dist (mi) | 497.7 |
| Travel Time (hr) | 12.6 |
| Avg Speed (mph) | 40 |
| Fuel Used (gal) | 14.7 |
| HC Emissions (g) | 210 |
| CO Emissions (g) | 6745 |
| NOx Emissions (g) | 868 |
| Vehicles Entered | 833 |
| Vehicles Exited | 851 |
| Hourly Exit Rate | 3404 |
| Input Volume | 9955 |
| % of Volume | 34 |
| Denied Entry Before | 0 |
| Denied Entry After | 0 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 52 | 204 | 30 | 217 | 204 | 127 | 50 | 428 | 200 | 190 | 508 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.98 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1827 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.62 | 1.00 | | 0.35 | 1.00 | 1.00 | 0.24 | 1.00 | 1.00 | 0.33 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1154 | 1827 | | 646 | 1863 | 1583 | 454 | 1863 | 1583 | 613 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 57 | 222 | 33 | 236 | 222 | 138 | 54 | 465 | 217 | 207 | 552 | 85 |
| RTOR Reduction (vph) | 0 | 5 | 0 | 0 | 0 | 87 | 0 | 0 | 89 | 0 | 0 | 23 |
| Lane Group Flow (vph) | 57 | 250 | 0 | 236 | 222 | 51 | 54 | 465 | 128 | 207 | 552 | 62 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 20.6 | 18.5 | | 36.0 | 28.9 | 28.9 | 32.8 | 32.8 | 32.8 | 32.8 | 32.8 | 32.8 |
| Effective Green, g (s) | 20.6 | 18.5 | | 36.0 | 28.9 | 28.9 | 32.8 | 32.8 | 32.8 | 32.8 | 32.8 | 32.8 |
| Actuated g/C Ratio | 0.26 | 0.23 | | 0.46 | 0.37 | 0.37 | 0.42 | 0.42 | 0.42 | 0.42 | 0.42 | 0.42 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 318 | 429 | | 473 | 683 | 581 | 189 | 775 | 659 | 255 | 775 | 659 |
| v/s Ratio Prot | 0.00 | c0.14 | | c0.08 | 0.12 | | | 0.25 | | | 0.30 | |
| v/s Ratio Perm | 0.04 | | | 0.15 | | 0.03 | 0.12 | | 0.08 | c0.34 | | 0.04 |
| v/c Ratio | 0.18 | 0.58 | | 0.50 | 0.33 | 0.09 | 0.29 | 0.60 | 0.19 | 0.81 | 0.71 | 0.09 |
| Uniform Delay, d1 | 22.2 | 26.7 | | 14.2 | 17.9 | 16.3 | 15.2 | 17.9 | 14.6 | 20.3 | 19.1 | 14.0 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.3 | 2.0 | | 0.8 | 0.3 | 0.1 | 0.8 | 1.3 | 0.1 | 17.6 | 3.1 | 0.1 |
| Delay (s) | 22.5 | 28.7 | | 15.0 | 18.2 | 16.4 | 16.1 | 19.2 | 14.7 | 37.8 | 22.2 | 14.0 |
| Level of Service | C | C | | B | B | B | B | B | B | D | C | B |
| Approach Delay (s) | | 27.6 | | | 16.5 | | | 17.6 | | | 25.2 | |
| Approach LOS | | C | | | B | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 21.2 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.69 | | |
| Actuated Cycle Length (s) | 78.8 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 74.3% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 19.9 |
| Intersection LOS | C |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 97 | 265 | 509 | 727 |
| Demand Flow Rate, veh/h | 99 | 270 | 519 | 742 |
| Vehicles Circulating, veh/h | 799 | 471 | 107 | 295 |
| Vehicles Exiting, veh/h | 238 | 155 | 790 | 446 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 10.0 | 10.3 | 9.9 | 31.6 |
| Approach LOS | A | B | A | D |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 99 | 270 | 519 | 742 |
| Cap Entry Lane, veh/h | 508 | 706 | 1015 | 841 |
| Entry HV Adj Factor | 0.977 | 0.980 | 0.980 | 0.979 |
| Flow Entry, veh/h | 97 | 265 | 509 | 727 |
| Cap Entry, veh/h | 497 | 692 | 995 | 824 |
| V/C Ratio | 1.95 | 3.83 | 5.11 | 8.82 |
| Control Delay, s/veh | 10.0 | 10.3 | 9.9 | 31.6 |
| LOS | A | B | A | D |
| 95th %tile Queue, veh | 0.1 | 0.2 | 0.3 | 1.2 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 24 | 89 | 198 | 310 | 63 | 103 | 61 | 933 | 293 | 151 | 1646 | 24 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.88 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 26 | 97 | 215 | 337 | 68 | 112 | 66 | 1014 | 318 | 164 | 1789 | 26 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 97 | 0 | 0 | 124 | 0 | 0 | 6 |
| Lane Group Flow (vph) | 26 | 97 | 215 | 337 | 68 | 15 | 66 | 1014 | 194 | 164 | 1789 | 20 |
| Turn Type | Split | | Free | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 12.0 | 12.0 | 127.7 | 17.2 | 17.2 | 17.2 | 6.8 | 65.3 | 65.3 | 11.2 | 69.7 | 69.7 |
| Effective Green, g (s) | 12.0 | 12.0 | 127.7 | 17.2 | 17.2 | 17.2 | 6.8 | 65.3 | 65.3 | 11.2 | 69.7 | 69.7 |
| Actuated g/C Ratio | 0.09 | 0.09 | 1.00 | 0.13 | 0.13 | 0.13 | 0.05 | 0.51 | 0.51 | 0.09 | 0.55 | 0.55 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 166 | 175 | 1583 | 462 | 251 | 375 | 94 | 1810 | 809 | 301 | 1932 | 864 |
| v/s Ratio Prot | 0.01 | c0.05 | | c0.10 | 0.04 | | 0.04 | 0.29 | | c0.05 | c0.51 | |
| v/s Ratio Perm | | | 0.14 | | | 0.01 | | | 0.12 | | | 0.01 |
| v/c Ratio | 0.16 | 0.55 | 0.14 | 0.73 | 0.27 | 0.04 | 0.70 | 0.56 | 0.24 | 0.54 | 0.93 | 0.02 |
| Uniform Delay, d1 | 53.2 | 55.3 | 0.0 | 53.0 | 49.6 | 48.1 | 59.5 | 21.4 | 17.4 | 55.8 | 26.6 | 13.3 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.4 | 3.8 | 0.2 | 5.7 | 0.6 | 0.0 | 21.1 | 0.4 | 0.2 | 2.0 | 8.2 | 0.0 |
| Delay (s) | 53.6 | 59.1 | 0.2 | 58.7 | 50.2 | 48.1 | 80.5 | 21.8 | 17.5 | 57.8 | 34.8 | 13.4 |
| Level of Service | D | E | A | E | D | D | F | C | B | E | C | B |
| Approach Delay (s) | | 21.2 | | | 55.3 | | | 23.6 | | | 36.4 | |
| Approach LOS | | C | | | E | | | C | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 33.3 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.85 | | |
| Actuated Cycle Length (s) | 127.7 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 78.6% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 15 | 65 | 80 | 6 | 28 | 81 | 1598 | 61 | 25 | 1636 | 78 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 4.0 | | 5.0 | 4.0 | 6.0 | 6.0 | 4.0 | 6.0 | 6.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.97 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1811 | 1583 | | 1780 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | | 0.81 | 1.00 | | 0.71 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1501 | 1583 | | 1332 | 1583 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 21 | 16 | 71 | 87 | 7 | 30 | 88 | 1737 | 66 | 27 | 1778 | 85 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 37 | 71 | 0 | 94 | 30 | 88 | 1737 | 66 | 27 | 1778 | 85 |
| Turn Type | Perm | | Free | Perm | | Free | Prot | | Free | Prot | | Free |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | Free | 8 | | Free | | | Free | | | Free |
| Actuated Green, G (s) | | 13.4 | 110.7 | | 13.4 | 110.7 | 8.9 | 75.8 | 110.7 | 4.5 | 71.4 | 110.7 |
| Effective Green, g (s) | | 13.4 | 110.7 | | 13.4 | 110.7 | 8.9 | 75.8 | 110.7 | 4.5 | 71.4 | 110.7 |
| Actuated g/C Ratio | | 0.12 | 1.00 | | 0.12 | 1.00 | 0.08 | 0.68 | 1.00 | 0.04 | 0.64 | 1.00 |
| Clearance Time (s) | | 5.0 | | | 5.0 | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 182 | 1583 | | 161 | 1583 | 142 | 2423 | 1583 | 72 | 2283 | 1583 |
| v/s Ratio Prot | | | | | | | c0.05 | c0.49 | | 0.02 | c0.50 | |
| v/s Ratio Perm | | 0.02 | 0.04 | | c0.07 | 0.02 | | | 0.04 | | | 0.05 |
| v/c Ratio | | 0.20 | 0.04 | | 0.58 | 0.02 | 0.62 | 0.72 | 0.04 | 0.38 | 0.78 | 0.05 |
| Uniform Delay, d1 | | 43.8 | 0.0 | | 46.0 | 0.0 | 49.3 | 10.8 | 0.0 | 51.7 | 14.0 | 0.0 |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 0.6 | 0.1 | | 5.3 | 0.0 | 7.8 | 1.0 | 0.0 | 3.3 | 1.7 | 0.1 |
| Delay (s) | | 44.4 | 0.1 | | 51.3 | 0.0 | 57.1 | 11.8 | 0.0 | 55.0 | 15.8 | 0.1 |
| Level of Service | | D | A | | D | A | E | B | A | D | B | A |
| Approach Delay (s) | | 15.2 | | | 38.9 | | | 13.5 | | | 15.6 | |
| Approach LOS | | B | | | D | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 15.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.80 | | |
| Actuated Cycle Length (s) | 110.7 | Sum of lost time (s) | 23.0 |
| Intersection Capacity Utilization | 75.3% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | WBL | WBR | NBT | NBR | SBL | SBT |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 48 | 58 | 1270 | 3 | 35 | 967 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 |
| Frt | 1.00 | 0.85 | 1.00 | 0.85 | 1.00 | 1.00 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 1770 | 1583 | 3539 | 1583 | 1770 | 3539 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 1770 | 1583 | 3539 | 1583 | 1770 | 3539 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 52 | 63 | 1380 | 3 | 38 | 1051 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 1 | 0 | 0 |
| Lane Group Flow (vph) | 52 | 63 | 1380 | 2 | 38 | 1051 |
| Turn Type | | Free | | Perm | Prot | |
| Protected Phases | 8 | | 2 | | 1 | 6 |
| Permitted Phases | | Free | | 2 | | |
| Actuated Green, G (s) | 6.1 | 71.7 | 44.5 | 44.5 | 4.1 | 54.6 |
| Effective Green, g (s) | 6.1 | 71.7 | 44.5 | 44.5 | 4.1 | 54.6 |
| Actuated g/C Ratio | 0.09 | 1.00 | 0.62 | 0.62 | 0.06 | 0.76 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 151 | 1583 | 2196 | 982 | 101 | 2695 |
| v/s Ratio Prot | c0.03 | | c0.39 | | 0.02 | c0.30 |
| v/s Ratio Perm | | 0.04 | | 0.00 | | |
| v/c Ratio | 0.34 | 0.04 | 0.63 | 0.00 | 0.38 | 0.39 |
| Uniform Delay, d1 | 30.9 | 0.0 | 8.5 | 5.2 | 32.6 | 2.9 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 1.4 | 0.0 | 0.6 | 0.0 | 2.3 | 0.1 |
| Delay (s) | 32.3 | 0.0 | 9.0 | 5.2 | 34.9 | 3.0 |
| Level of Service | C | A | A | A | C | A |
| Approach Delay (s) | 14.6 | | 9.0 | | | 4.1 |
| Approach LOS | B | | A | | | A |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 7.2 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.60 | | |
| Actuated Cycle Length (s) | 71.7 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 47.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 99 | 46 | 85 | 1067 | 936 | 172 |
| Sign Control | Stop | | | Free | Free | |
| Grade | 0% | | | 0% | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 108 | 50 | 92 | 1160 | 1017 | 187 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | 6 | | | | |
| Median type | | | | None | None | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | 1137 | | |
| pX, platoon unblocked | 0.81 | | | | | |
| vC, conflicting volume | 1782 | 509 | 1017 | | | |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 1505 | 509 | 1017 | | | |
| tC, single (s) | *5.0 | *5.0 | *5.0 | | | |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 3.5 | 3.3 | 2.2 | | | |
| p0 queue free % | 34 | 93 | 83 | | | |
| cM capacity (veh/h) | 163 | 670 | 531 | | | |

| Direction, Lane # | EB 1 | NB 1 | NB 2 | NB 3 | SB 1 | SB 2 | SB 3 |
|---|---|---|---|---|---|---|---|
| Volume Total | 158 | 92 | 580 | 580 | 509 | 509 | 187 |
| Volume Left | 108 | 92 | 0 | 0 | 0 | 0 | 0 |
| Volume Right | 50 | 0 | 0 | 0 | 0 | 0 | 187 |
| cSH | 238 | 531 | 1700 | 1700 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.66 | 0.17 | 0.34 | 0.34 | 0.30 | 0.30 | 0.11 |
| Queue Length 95th (ft) | 104 | 16 | 0 | 0 | 0 | 0 | 0 |
| Control Delay (s) | 46.0 | 13.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | E | B | | | | | |
| Approach Delay (s) | 46.0 | 1.0 | | | 0.0 | | |
| Approach LOS | E | | | | | | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 3.2 | | |
| Intersection Capacity Utilization | 46.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

* User Entered Value

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 34 | 7 | 13 | 110 | 17 | 59 | 18 | 945 | 71 | 44 | 997 | 31 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 1.00 | |
| Flt Protected | | 0.97 | | | 0.96 | 1.00 | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1748 | | | 1785 | 1583 | 1770 | 1843 | | 1770 | 1854 | |
| Flt Permitted | | 0.69 | | | 0.76 | 1.00 | 0.08 | 1.00 | | 0.08 | 1.00 | |
| Satd. Flow (perm) | | 1238 | | | 1413 | 1583 | 148 | 1843 | | 146 | 1854 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 37 | 8 | 14 | 120 | 18 | 64 | 20 | 1027 | 77 | 48 | 1084 | 34 |
| RTOR Reduction (vph) | 0 | 12 | 0 | 0 | 0 | 56 | 0 | 3 | 0 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 47 | 0 | 0 | 138 | 8 | 20 | 1101 | 0 | 48 | 1117 | 0 |
| Turn Type | Perm | | | Perm | | Perm | pm+pt | | | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | | 6 | | |
| Actuated Green, G (s) | | 10.3 | | | 10.3 | 10.3 | 51.8 | 50.4 | | 53.2 | 51.1 | |
| Effective Green, g (s) | | 10.3 | | | 10.3 | 10.3 | 51.8 | 50.4 | | 53.2 | 51.1 | |
| Actuated g/C Ratio | | 0.13 | | | 0.13 | 0.13 | 0.67 | 0.65 | | 0.68 | 0.66 | |
| Clearance Time (s) | | 5.0 | | | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 164 | | | 187 | 210 | 128 | 1194 | | 144 | 1218 | |
| v/s Ratio Prot | | | | | | | 0.00 | 0.60 | | c0.01 | c0.60 | |
| v/s Ratio Perm | | 0.04 | | | c0.10 | 0.01 | 0.10 | | | 0.22 | | |
| v/c Ratio | | 0.29 | | | 0.74 | 0.04 | 0.16 | 0.92 | | 0.33 | 0.92 | |
| Uniform Delay, d1 | | 30.4 | | | 32.5 | 29.4 | 14.0 | 12.0 | | 14.7 | 11.5 | |
| Progression Factor | | 1.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 1.0 | | | 14.1 | 0.1 | 0.6 | 11.7 | | 1.4 | 10.8 | |
| Delay (s) | | 31.4 | | | 46.5 | 29.5 | 14.6 | 23.7 | | 16.0 | 22.4 | |
| Level of Service | | C | | | D | C | B | C | | B | C | |
| Approach Delay (s) | | 31.4 | | | 41.2 | | | 23.5 | | | 22.1 | |
| Approach LOS | | C | | | D | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 24.4 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.81 | | |
| Actuated Cycle Length (s) | 77.8 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 73.5% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 247 | 117 | 82 | 73 | 229 | 132 | 204 | 999 | 16 | 164 | 1046 | 185 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 4.0 | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 |
| Frpb, ped/bikes | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Flpb, ped/bikes | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1541 | 1770 | 1863 | 1583 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1541 | 1770 | 1863 | 1583 | 1770 | 3539 | 1583 | 3433 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 268 | 127 | 89 | 79 | 249 | 143 | 222 | 1086 | 17 | 178 | 1137 | 201 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 96 |
| Lane Group Flow (vph) | 268 | 127 | 89 | 79 | 249 | 143 | 222 | 1086 | 8 | 178 | 1137 | 105 |
| Confl. Peds. (#/hr) | | | 50 | 50 | | | | | | | | |
| Turn Type | Prot | | Free | Prot | | Free | Prot | | pm+ov | Prot | | pm+ov |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | 3 | 1 | 6 | 7 |
| Permitted Phases | | | Free | | | Free | | | 2 | | | 6 |
| Actuated Green, G (s) | 23.8 | 36.0 | 138.3 | 11.5 | 23.7 | 138.3 | 20.5 | 56.8 | 68.3 | 12.0 | 48.3 | 72.1 |
| Effective Green, g (s) | 23.8 | 36.0 | 138.3 | 11.5 | 23.7 | 138.3 | 20.5 | 56.8 | 68.3 | 12.0 | 48.3 | 72.1 |
| Actuated g/C Ratio | 0.17 | 0.26 | 1.00 | 0.08 | 0.17 | 1.00 | 0.15 | 0.41 | 0.49 | 0.09 | 0.35 | 0.52 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 305 | 485 | 1541 | 147 | 319 | 1583 | 262 | 1453 | 782 | 298 | 1236 | 825 |
| v/s Ratio Prot | c0.15 | 0.07 | | 0.04 | c0.13 | | c0.13 | c0.31 | 0.00 | 0.05 | c0.32 | 0.02 |
| v/s Ratio Perm | | | 0.06 | | | 0.09 | | | 0.00 | | | 0.04 |
| v/c Ratio | 0.88 | 0.26 | 0.06 | 0.54 | 0.78 | 0.09 | 0.85 | 0.75 | 0.01 | 0.60 | 0.92 | 0.13 |
| Uniform Delay, d1 | 55.8 | 40.6 | 0.0 | 60.8 | 54.8 | 0.0 | 57.4 | 34.7 | 17.8 | 60.8 | 43.1 | 17.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 23.6 | 0.3 | 0.1 | 3.7 | 11.7 | 0.1 | 21.6 | 2.1 | 0.0 | 3.2 | 11.0 | 0.1 |
| Delay (s) | 79.5 | 40.9 | 0.1 | 64.6 | 66.5 | 0.1 | 79.0 | 36.8 | 17.8 | 64.0 | 54.1 | 17.0 |
| Level of Service | E | D | A | E | E | A | E | D | B | E | D | B |
| Approach Delay (s) | | 54.7 | | | 46.0 | | | 43.6 | | | 50.4 | |
| Approach LOS | | D | | | D | | | D | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 48.0 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.92 | | |
| Actuated Cycle Length (s) | 138.3 | Sum of lost time (s) | 28.0 |
| Intersection Capacity Utilization | 84.3% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 39 | 37 | 58 | 147 | 35 | 130 | 71 | 776 | 141 | 76 | 944 | 28 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | |
| Flt Protected | | 0.98 | 1.00 | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1816 | 1583 | | 1790 | 1583 | 1770 | 1863 | 1583 | 1770 | 1855 | |
| Flt Permitted | | 0.70 | 1.00 | | 0.71 | 1.00 | 0.06 | 1.00 | 1.00 | 0.19 | 1.00 | |
| Satd. Flow (perm) | | 1302 | 1583 | | 1326 | 1583 | 116 | 1863 | 1583 | 358 | 1855 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 42 | 40 | 63 | 160 | 38 | 141 | 77 | 843 | 153 | 83 | 1026 | 30 |
| RTOR Reduction (vph) | 0 | 0 | 50 | 0 | 0 | 112 | 0 | 0 | 58 | 0 | 1 | 0 |
| Lane Group Flow (vph) | 0 | 82 | 13 | 0 | 198 | 29 | 77 | 843 | 95 | 83 | 1055 | 0 |
| Turn Type | Perm | | Perm | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | 20.9 | 20.9 | | 20.9 | 20.9 | 67.6 | 64.0 | 64.0 | 66.2 | 63.3 | |
| Effective Green, g (s) | | 20.9 | 20.9 | | 20.9 | 20.9 | 67.6 | 64.0 | 64.0 | 66.2 | 63.3 | |
| Actuated g/C Ratio | | 0.20 | 0.20 | | 0.20 | 0.20 | 0.66 | 0.62 | 0.62 | 0.64 | 0.62 | |
| Clearance Time (s) | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | 265 | 322 | | 270 | 322 | 134 | 1160 | 986 | 270 | 1142 | |
| v/s Ratio Prot | | | | | | | c0.02 | 0.45 | | 0.01 | c0.57 | |
| v/s Ratio Perm | | 0.06 | 0.01 | | c0.15 | 0.02 | 0.36 | | 0.06 | 0.19 | | |
| v/c Ratio | | 0.31 | 0.04 | | 0.73 | 0.09 | 0.57 | 0.73 | 0.10 | 0.31 | 0.92 | |
| Uniform Delay, d1 | | 34.8 | 32.9 | | 38.3 | 33.2 | 21.2 | 13.4 | 7.8 | 11.4 | 17.6 | |
| Progression Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 0.7 | 0.1 | | 9.9 | 0.1 | 5.8 | 2.3 | 0.0 | 0.6 | 12.3 | |
| Delay (s) | | 35.5 | 32.9 | | 48.2 | 33.3 | 27.1 | 15.7 | 7.8 | 12.0 | 29.9 | |
| Level of Service | | D | C | | D | C | C | B | A | B | C | |
| Approach Delay (s) | | 34.4 | | | 42.0 | | | 15.4 | | | 28.6 | |
| Approach LOS | | C | | | D | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 25.3 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.86 | | |
| Actuated Cycle Length (s) | 102.8 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 84.5% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 473 | 425 | 406 | 1358 | 1229 | 557 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 4.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 0.97 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Frt | 1.00 | 0.85 | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 0.95 | 1.00 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 1583 | 1770 | 3539 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 514 | 462 | 441 | 1476 | 1336 | 605 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 275 |
| Lane Group Flow (vph) | 514 | 462 | 441 | 1476 | 1336 | 330 |
| Turn Type | | Free | Prot | | | Perm |
| Protected Phases | 4 | | 5 | 2 | 6 | |
| Permitted Phases | | Free | | | | 6 |
| Actuated Green, G (s) | 29.9 | 171.2 | 47.5 | 130.3 | 76.8 | 76.8 |
| Effective Green, g (s) | 29.9 | 171.2 | 47.5 | 130.3 | 76.8 | 76.8 |
| Actuated g/C Ratio | 0.17 | 1.00 | 0.28 | 0.76 | 0.45 | 0.45 |
| Clearance Time (s) | 5.0 | | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 600 | 1583 | 491 | 2694 | 1588 | 710 |
| v/s Ratio Prot | c0.15 | | c0.25 | 0.42 | c0.38 | |
| v/s Ratio Perm | | 0.29 | | | | 0.21 |
| v/c Ratio | 0.86 | 0.29 | 0.90 | 0.55 | 0.84 | 0.46 |
| Uniform Delay, d1 | 68.6 | 0.0 | 59.5 | 8.4 | 41.8 | 32.9 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 11.6 | 0.5 | 18.9 | 0.2 | 4.2 | 0.5 |
| Delay (s) | 80.1 | 0.5 | 78.4 | 8.6 | 46.0 | 33.4 |
| Level of Service | F | A | E | A | D | C |
| Approach Delay (s) | 42.4 | | | 24.7 | 42.1 | |
| Approach LOS | D | | | C | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 35.2 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.86 | | |
| Actuated Cycle Length (s) | 171.2 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 84.1% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 223 | 63 | 128 | 19 | 711 | 197 | 91 | 600 | 25 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lane Util. Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.95 | |
| Frt | | | | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | |
| Flt Protected | | | | | 0.96 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | |
| Satd. Flow (prot) | | | | | 1793 | 1583 | 1770 | 1863 | 1583 | 1770 | 3518 | |
| Flt Permitted | | | | | 0.96 | 1.00 | 0.39 | 1.00 | 1.00 | 0.14 | 1.00 | |
| Satd. Flow (perm) | | | | | 1793 | 1583 | 719 | 1863 | 1583 | 263 | 3518 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 242 | 68 | 139 | 21 | 773 | 214 | 99 | 652 | 27 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 105 | 0 | 0 | 104 | 0 | 3 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 310 | 34 | 21 | 773 | 110 | 99 | 676 | 0 |
| Turn Type | | | | Perm | | Perm | pm+pt | | Perm | pm+pt | | |
| Protected Phases | | | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | | 8 | | 8 | 2 | | 2 | 6 | | |
| Actuated Green, G (s) | | | | | 20.1 | 20.1 | 43.0 | 41.8 | 41.8 | 49.4 | 45.0 | |
| Effective Green, g (s) | | | | | 20.1 | 20.1 | 43.0 | 41.8 | 41.8 | 49.4 | 45.0 | |
| Actuated g/C Ratio | | | | | 0.25 | 0.25 | 0.53 | 0.51 | 0.51 | 0.61 | 0.55 | |
| Clearance Time (s) | | | | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Vehicle Extension (s) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | | 443 | 391 | 396 | 958 | 814 | 241 | 1947 | |
| v/s Ratio Prot | | | | | | | 0.00 | c0.41 | | c0.02 | 0.19 | |
| v/s Ratio Perm | | | | | 0.17 | 0.02 | 0.03 | | 0.07 | 0.23 | | |
| v/c Ratio | | | | | 0.70 | 0.09 | 0.05 | 0.81 | 0.14 | 0.41 | 0.35 | |
| Uniform Delay, d1 | | | | | 27.9 | 23.5 | 9.1 | 16.4 | 10.3 | 12.2 | 10.0 | |
| Progression Factor | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | | 4.8 | 0.1 | 0.1 | 5.0 | 0.1 | 1.1 | 0.1 | |
| Delay (s) | | | | | 32.6 | 23.6 | 9.2 | 21.4 | 10.4 | 13.4 | 10.1 | |
| Level of Service | | | | | C | C | A | C | B | B | B | |
| Approach Delay (s) | | 0.0 | | | 29.9 | | | 18.8 | | | 10.6 | |
| Approach LOS | | A | | | C | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 18.2 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.81 | | |
| Actuated Cycle Length (s) | 81.3 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 70.6% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

## 19: East Waipuilani Road & Pi'ilani Highway Performance by movement

| Movement | EBR | WBR | NBT | NBR | SBT | SBR | All |
|---|---|---|---|---|---|---|---|
| Total Delay (hr) | 0.0 | 0.0 | 0.2 | 0.0 | 0.1 | 0.0 | 0.3 |
| Delay / Veh (s) | 1.2 | 1.3 | 1.7 | 6.7 | 0.6 | 1.6 | 1.2 |
| Total Stops | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Travel Dist (mi) | 0.8 | 2.3 | 87.6 | 1.1 | 43.2 | 3.1 | 138.0 |
| Travel Time (hr) | 0.0 | 0.1 | 2.2 | 0.0 | 1.0 | 0.1 | 3.5 |
| Avg Speed (mph) | 23 | 24 | 40 | 33 | 41 | 26 | 40 |
| Fuel Used (gal) | 0.0 | 0.1 | 2.7 | 0.0 | 1.2 | 0.0 | 4.1 |
| HC Emissions (g) | 0 | 1 | 33 | 0 | 16 | 0 | 50 |
| CO Emissions (g) | 1 | 24 | 1332 | 21 | 469 | 9 | 1856 |
| NOx Emissions (g) | 0 | 3 | 143 | 1 | 70 | 1 | 217 |
| Vehicles Entered | 4 | 21 | 408 | 5 | 410 | 31 | 879 |
| Vehicles Exited | 4 | 22 | 407 | 5 | 411 | 31 | 880 |
| Hourly Exit Rate | 16 | 88 | 1628 | 20 | 1644 | 124 | 3520 |
| Input Volume | 10 | 88 | 1591 | 18 | 1571 | 130 | 3408 |
| % of Volume | 160 | 100 | 102 | 111 | 105 | 95 | 103 |
| Denied Entry Before | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Denied Entry After | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## Total Network Performance

| | |
|---|---|
| Total Delay (hr) | 1.0 |
| Delay / Veh (s) | 4.3 |
| Total Stops | 26 |
| Travel Dist (mi) | 523.6 |
| Travel Time (hr) | 13.2 |
| Avg Speed (mph) | 40 |
| Fuel Used (gal) | 15.5 |
| HC Emissions (g) | 194 |
| CO Emissions (g) | 6550 |
| NOx Emissions (g) | 846 |
| Vehicles Entered | 874 |
| Vehicles Exited | 882 |
| Hourly Exit Rate | 3528 |
| Input Volume | 10196 |
| % of Volume | 35 |
| Denied Entry Before | 1 |
| Denied Entry After | 0 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 85 | 250 | 18 | 144 | 255 | 146 | 16 | 483 | 129 | 79 | 444 | 112 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 0.99 | | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1844 | | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.59 | 1.00 | | 0.35 | 1.00 | 1.00 | 0.28 | 1.00 | 1.00 | 0.28 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1098 | 1844 | | 650 | 1863 | 1583 | 514 | 1863 | 1583 | 514 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 92 | 272 | 20 | 157 | 277 | 159 | 17 | 525 | 140 | 86 | 483 | 122 |
| RTOR Reduction (vph) | 0 | 4 | 0 | 0 | 0 | 63 | 0 | 0 | 82 | 0 | 0 | 62 |
| Lane Group Flow (vph) | 92 | 288 | 0 | 157 | 277 | 97 | 17 | 525 | 58 | 86 | 483 | 60 |
| Turn Type | pm+pt | | | pm+pt | | Perm | Perm | | Perm | Perm | | Perm |
| Protected Phases | 7 | 4 | | 3 | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | 8 | 2 | | 2 | 6 | | 6 |
| Actuated Green, G (s) | 12.8 | 12.3 | | 23.5 | 18.0 | 18.0 | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 |
| Effective Green, g (s) | 12.8 | 12.3 | | 23.5 | 18.0 | 18.0 | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 |
| Actuated g/C Ratio | 0.27 | 0.26 | | 0.49 | 0.38 | 0.38 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 300 | 473 | | 463 | 699 | 594 | 155 | 563 | 478 | 155 | 563 | 478 |
| v/s Ratio Prot | 0.00 | c0.16 | | c0.04 | 0.15 | | | c0.28 | | | 0.26 | |
| v/s Ratio Perm | 0.08 | | | 0.12 | | 0.06 | 0.03 | | 0.04 | 0.17 | | 0.04 |
| v/c Ratio | 0.31 | 0.61 | | 0.34 | 0.40 | 0.16 | 0.11 | 0.93 | 0.12 | 0.55 | 0.86 | 0.13 |
| Uniform Delay, d1 | 13.9 | 15.7 | | 7.4 | 11.0 | 10.0 | 12.1 | 16.3 | 12.1 | 14.0 | 15.8 | 12.1 |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.6 | 2.2 | | 0.4 | 0.4 | 0.1 | 0.3 | 22.5 | 0.1 | 4.3 | 12.3 | 0.1 |
| Delay (s) | 14.5 | 17.9 | | 7.9 | 11.4 | 10.1 | 12.4 | 38.8 | 12.3 | 18.3 | 28.1 | 12.3 |
| Level of Service | B | B | | A | B | B | B | D | B | B | C | B |
| Approach Delay (s) | | 17.1 | | | 10.1 | | | 32.7 | | | 24.1 | |
| Approach LOS | | B | | | B | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 21.9 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.71 | | |
| Actuated Cycle Length (s) | 48.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 68.7% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 28.2 |
| Intersection LOS | D |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Entry Lanes | 1 | 1 | 1 | 1 |
| Conflicting Circle Lanes | 1 | 1 | 1 | 1 |
| Adj Approach Flow, veh/h | 250 | 334 | 788 | 701 |
| Demand Flow Rate, veh/h | 255 | 340 | 804 | 715 |
| Vehicles Circulating, veh/h | 751 | 776 | 245 | 302 |
| Vehicles Exiting, veh/h | 266 | 273 | 761 | 814 |
| Follow-Up Headway, s | 3.186 | 3.186 | 3.186 | 3.186 |
| Ped Vol Crossing Leg, #/h | 0 | 0 | 0 | 0 |
| Ped Cap Adj | 1.000 | 1.000 | 1.000 | 1.000 |
| Approach Delay, s/veh | 15.4 | 22.6 | 34.3 | 28.6 |
| Approach LOS | C | C | D | D |

| Lane | Left | Left | Left | Left |
|---|---|---|---|---|
| Designated Moves | LTR | LTR | LTR | LTR |
| Assumed Moves | LTR | LTR | LTR | LTR |
| RT Channelized | | | | |
| Lane Util | 1.000 | 1.000 | 1.000 | 1.000 |
| Critical Headway, s | 5.193 | 5.193 | 5.193 | 5.193 |
| Entry Flow, veh/h | 255 | 340 | 804 | 715 |
| Cap Entry Lane, veh/h | 533 | 520 | 884 | 835 |
| Entry HV Adj Factor | 0.980 | 0.983 | 0.980 | 0.980 |
| Flow Entry, veh/h | 250 | 334 | 788 | 701 |
| Cap Entry, veh/h | 523 | 511 | 867 | 819 |
| V/C Ratio | 4.78 | 6.54 | 9.09 | 8.56 |
| Control Delay, s/veh | 15.4 | 22.6 | 34.3 | 28.6 |
| LOS | C | C | D | D |
| 95th %tile Queue, veh | 0.3 | 0.5 | 1.3 | 1.0 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 175 | 130 | 675 | 194 | 542 | 110 | 889 | 646 | 503 | 934 | 35 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 0.97 | 1.00 | 0.88 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 1770 | 1863 | 1583 | 3433 | 1863 | 2787 | 1770 | 3539 | 1583 | 1770 | 3539 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 21 | 190 | 141 | 734 | 211 | 589 | 120 | 966 | 702 | 547 | 1015 | 38 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 495 | 0 | 0 | 294 | 0 | 0 | 18 |
| Lane Group Flow (vph) | 21 | 190 | 141 | 734 | 211 | 94 | 120 | 966 | 408 | 547 | 1015 | 20 |
| Turn Type | Split | | Free | Split | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | 4 | 4 | | 8 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | 15.5 | 15.5 | 127.0 | 20.2 | 20.2 | 20.2 | 9.1 | 50.1 | 50.1 | 19.2 | 60.2 | 60.2 |
| Effective Green, g (s) | 15.5 | 15.5 | 127.0 | 20.2 | 20.2 | 20.2 | 9.1 | 50.1 | 50.1 | 19.2 | 60.2 | 60.2 |
| Actuated g/C Ratio | 0.12 | 0.12 | 1.00 | 0.16 | 0.16 | 0.16 | 0.07 | 0.39 | 0.39 | 0.15 | 0.47 | 0.47 |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| Vehicle Extension (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Lane Grp Cap (vph) | 216 | 227 | 1583 | 546 | 296 | 443 | 127 | 1396 | 624 | 268 | 1678 | 750 |
| v/s Ratio Prot | 0.01 | c0.10 | | c0.21 | 0.11 | | 0.07 | c0.27 | | c0.31 | 0.29 | |
| v/s Ratio Perm | | | 0.09 | | | 0.03 | | | 0.26 | | | 0.01 |
| v/c Ratio | 0.10 | 0.84 | 0.09 | 1.34 | 0.71 | 0.21 | 0.94 | 0.69 | 0.65 | 2.04 | 0.60 | 0.03 |
| Uniform Delay, d1 | 49.5 | 54.5 | 0.0 | 53.4 | 50.6 | 46.5 | 58.7 | 32.0 | 31.4 | 53.9 | 24.6 | 17.8 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.2 | 22.6 | 0.1 | 166.9 | 7.9 | 0.2 | 62.4 | 1.5 | 2.5 | 481.3 | 0.6 | 0.0 |
| Delay (s) | 49.7 | 77.2 | 0.1 | 220.3 | 58.5 | 46.7 | 121.1 | 33.5 | 33.8 | 535.2 | 25.3 | 17.8 |
| Level of Service | D | E | A | F | E | D | F | C | C | F | C | B |
| Approach Delay (s) | | 44.7 | | | 131.4 | | | 39.5 | | | 199.4 | |
| Approach LOS | | D | | | F | | | D | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 115.1 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.09 | | |
| Actuated Cycle Length (s) | 127.0 | Sum of lost time (s) | 22.0 |
| Intersection Capacity Utilization | 99.2% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

# Appendix D Internal Capture

The proposed MRTP Master Plan Update utilizes the principles of New Urbanism and Smart Growth to transform the current, single-use large lot research and technology campus into an integrated and vibrant mixed-use community focused around a regional knowledge-based industry employment base. The planned housing will target industries characterized by highly-skilled workers in science and research, information technology, education, healthcare and medicine, manufacturing and professional services, and similarly related knowledge-based organizations. There is a great potential for interaction between land uses within a mixed-use site like MRTP. These interactions still count as trips generated by each land use, but because they remain on-site, they do not show up on the external roadway network. These internal trips are trips generated by MRTP which remain internal to the development.

Residential

Residential development, especially development with a wide variety of unit types targeted toward workers in the park, would be an amenity, helping businesses in the park attract and retain qualified workers and reducing the barrier of the high cost of housing on the island as well as the cost of commuting.

- By providing apartments, townhouses, and single-family residences, the diversity of Housing within MRTP can accommodate the different needs of individuals and families. As one's life situation changes, additional options would be available within the MRTP community;
- The employment is the most difficult element to obtain for creation of walkable mixed use. An existing and established employment base is easier to surround with supporting amenities such as residential, commercial, and civic land uses;
- The knowledge industry within MRTP will be compatible with other land uses including residential. High skill, high paying jobs match up with potential home owners.

Because the residential component of the development will target the employees of MRTP, the need for employees to drive to and from work will be lessened. 15% of internal capture was applied to residential and office land uses conservatively.

Schools

A 102k SF elementary school is planned to be included in Phase 1. The school would be located between Ninau Street and Hookena Street within the northern half of Phase 1 of MRTP. This elementary school is primarily expected to serve MRTP for several reasons:

- The MRTP elementary school is located in the heart of MRTP and is surrounded by residential parcels. It would be easily accessible on foot and by bicycle;
- There is an established existing alternative in the vicinity of MRTP. Kihei Elementary School is located on Lipoa Street across Piilani Highway. The school was established in 1977 and has an enrollment of 818 students. Because the school is established, the new MRTP school is not expected to be attractive to students outside MRTP.
- The MRTP development will be attractive to families either with children or with future plans to have children.
- In addition, MRTP is committed to build an internal access to the planned Kihei High School. This will further decrease the shares of the homes to school vehicular trips appearing on Piilani Highway.

The planned elementary school will be built largely for MRTP. It is not anticipated that the school will generate a significant amount of external trips.

Retail commercial

100k SF worth of retail commercial is planned. It is assumed that this will include a mix of local retail and restaurants which will be primarily used by MRTP residents and employees. The retail will be located along Hookena Street and Ninau Street within the mixed use core of Phase 1. It will be accessible on foot or by bike. The retail commercial is also primarily expected to serve MRTP internally. Therefore, it is assumed that no significant amount of regional trips will be attracted for the following reasons:

- The retail commercial is located in the heart of MRTP and is surrounded by residential parcels. It would be easily accessible on foot and by bicycle. Retail will be pedestrian friendly through the use of design concepts such as setbacks, frontage, building orientation, and open space;
- The type of retail commercial provided would be planned specifically to divert trips from Piilani Highway by providing practical goods and services such as coffee

shops, restaurants, and dry cleaners. Business services will be amenities for employees of the park. The overall amount of area devoted to retail commercial is relatively small and no big boxes or anchor stores are planned.

- The retail commercial will be located well off of Piilani Highway. In fact, it will hardly be visible from Piilani Highway. It is unlikely that the retail will draw much, if any, regional traffic. More convenient retail options are located along Piikea Avenue and Liloa Drive, including Azeka Shopping Center, Piilani Village Shopping Center, and future commercial developments such as Downtown Kihei and Piilani Promenade.

Hotel

A 150-room business hotel is planned to serve visitors to the MRTP community as part of Phase 1. The hotel would be located on the fringe of the mixed-use core. The planned hotel targets only those patrons who will have businesses such as meetings, seminars, and conferences in MRTP.

- The hotel's location would be within walking distance of stores and restaurants;
- The hotel would cater to travelers on trips specifically to conduct business within MRTP.
    - As such, it is likely that there would be a strong interaction between the hotel and the employment core;
    - In addition, these likely work-related trips would be made during the AM and PM commuter peaks and therefore produce more internal trips during these peak periods rather than would typically be expected from a resort hotel;
    - Because business would likely be the expected reason for staying at the hotel, fewer external trips would need to be made for tourist reasons;
- The hotel is not expected to attract tourists with no business within MRTP. A significant number of viable alternatives are located within Kihei along South Kihei Road and also to the south in the Wailea-Makena area.

Three-tiered approach

In addition, MRTP has consulted with HDOT on estimating the internal capture understanding that internal capture rates between different types of development are not thoroughly defined in ITE Trip Generation Manual and Hawaii's local conditions may not be consistent with the trends documented in the national researches. It was determined after a

series of consultation and discussion with HDOT that a three-tiered approach may yield the best estimates based on the assumed low, medium, and high internal capture rates for the planned school, retail, and hotel.

Low, medium, and high internal capture rates were developed to represent the internal interactions between the different land uses for Phase 1. Table D1 shows the tiers of internal capture rates for Phase 1. The Commercial and School land uses are expected to interact strongly with the Residential land use. In addition, the Business Hotel is expected to have a strong interaction with the Employment.

Table D1 Phase 1 Internal Capture Tiers

| | | Low | Medium | High |
|---|---|---|---|---|
| | Residential | 41% | 45% | 49% |
| | Office | 18% | 19% | 19% |
| | Commercial | 42% | 50% | 58% |
| | School | 37% | 43% | 47% |
| | Hotel | 44% | 55% | 67% |
| | Total | 32% | 35% | 39% |

The tiers of internal capture rates for Phase 2 are shown in Table D2.

Table D2 Phase 2 Internal Capture Tiers

| | | Low | Medium | High |
|---|---|---|---|---|
| | Residential | 34% | 39% | 42% |
| | Office | 12% | 12% | 12% |
| | Commercial | 42% | 51% | 58% |
| | School | 41% | 51% | 56% |
| | Hotel | 50% | 63% | 73% |
| | Total | 24% | 28% | 30% |

For the purpose of this analysis, the low internal capture that would result in highest external trips was used. Specifically,

- 220/1055 or 21% of residential trips interacted directly with the school and the Kihei High School to which MRTP will have an internal access;
- 68/1055 or 6% of residential trips interacted directly with the commercial;
- 143/1318 or 11% of employment trips interacted directly with the residential;
- 47/1318 or 4% of employment trips interacted directly with the business hotel;

Tables D3-D8 show the assumed internal trips for each pair of land uses.

Table D3 Phase 1 Internal Capture – AM Low

| | | To | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Resident -ial | Office | Commer -cial | School | Hotel | External | Total |
| From | Residential | X | 65 | 1 | 130 | 0 | 238 | 434 |
| | Office | 15 | X | 4 | 0 | 6 | 93 | 118 |
| | Commercial | 2 | 8 | X | 0 | 0 | 17 | 27 |
| | School | 31 | 0 | 0 | X | 0 | 177 | 208 |
| | Hotel | 0 | 13 | 1 | 0 | X | 12 | 26 |
| | External | 54 | 489 | 37 | 135 | 33 | X | 748 |
| | Total | 102 | 575 | 43 | 265 | 39 | 537 | |

Table D4 Phase 1 Internal Capture – PM Low

| | | To | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Resident -ial | Office | Commer -cial | School | Hotel | External | Total |
| From | Residential | X | 14 | 34 | 26 | 0 | 119 | 193 |
| | Office | 49 | X | 33 | 0 | 23 | 426 | 531 |
| | Commercial | 31 | 3 | X | 0 | 1 | 104 | 139 |
| | School | 33 | 0 | 0 | X | 0 | 32 | 65 |
| | Hotel | 0 | 5 | 17 | 0 | X | 18 | 40 |
| | External | 213 | 72 | 25 | 26 | 21 | X | 357 |
| | Total | 326 | 94 | 109 | 52 | 45 | 699 | |

## Table D5 Phase 1 Internal Capture – AM Medium

| | | To | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Resident -ial | Office | Commer -cial | School | Hotel | External | Total |
| From | Residential | X | 65 | 3 | 143 | 0 | 223 | 434 |
| | Office | 15 | X | 4 | 0 | 6 | 93 | 118 |
| | Commercial | 4 | 8 | X | 0 | 2 | 13 | 27 |
| | School | 34 | 0 | 0 | X | 0 | 174 | 208 |
| | Hotel | 0 | 16 | 3 | 0 | X | 7 | 26 |
| | External | 49 | 486 | 33 | 122 | 31 | X | 721 |
| | Total | 102 | 575 | 43 | 265 | 39 | 510 | |

## Table D6 Phase 1 Internal Capture – PM Medium

| | | To | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Resident -ial | Office | Commer -cial | School | Hotel | External | Total |
| From | Residential | X | 14 | 39 | 33 | 0 | 107 | 193 |
| | Office | 49 | X | 33 | 0 | 28 | 421 | 531 |
| | Commercial | 38 | 3 | X | 0 | 4 | 94 | 139 |
| | School | 41 | 0 | 0 | X | 0 | 24 | 65 |
| | Hotel | 0 | 5 | 19 | 0 | X | 16 | 40 |
| | External | 198 | 72 | 18 | 19 | 13 | X | 320 |
| | Total | 326 | 94 | 109 | 52 | 45 | 662 | |

## Table D7 Phase 1 Internal Capture – AM High

| | | To | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Resident -ial | Office | Commer -cial | School | Hotel | External | Total |
| From | Residential | X | 65 | 6 | 152 | 0 | 211 | 434 |
| | Office | 15 | X | 4 | 0 | 6 | 93 | 118 |
| | Commercial | 5 | 8 | X | 0 | 3 | 11 | 27 |
| | School | 36 | 0 | 0 | X | 0 | 172 | 208 |
| | Hotel | 0 | 20 | 5 | 0 | X | 1 | 26 |
| | External | 46 | 482 | 28 | 113 | 30 | X | 699 |
| | Total | 102 | 575 | 43 | 265 | 39 | 488 | |

Table D8 Phase 1 Internal Capture – PM High

| | | To | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Resident -ial | Office | Commer -cial | School | Hotel | External | Total |
| From | Residential | X | 14 | 45 | 39 | 0 | 95 | 193 |
| | Office | 49 | X | 33 | 0 | 34 | 415 | 531 |
| | Commercial | 44 | 3 | X | 0 | 6 | 86 | 139 |
| | School | 49 | 0 | 0 | X | 0 | 16 | 65 |
| | Hotel | 0 | 5 | 21 | 0 | X | 14 | 40 |
| | External | 184 | 72 | 10 | 13 | 5 | X | 284 |
| | Total | 326 | 94 | 109 | 52 | 45 | 626 | |

Similar to Phase 1, low, medium, and high internal capture rates were developed to represent the internal interactions between the different land uses when Phase 2 is added to Phase 1. For the purpose of this analysis, the low internal capture that would result in highest external trips was used. Specifically,

- 220/1536 or 14% of residential trips interacted directly with the school;
- 68/1536 or 4% of residential trips interacted directly with the commercial
- 244/2756 or 8% of employment trips interacted directly with the residential;
- 56/1318 or 2% of employment trips interacted directly with the business hotel;

Tables D9-D14 show the assumed internal trips for each pair of land uses for Phase 2.

Table D9 Phase 2 Internal Capture – AM Low

| | | To | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Resident -ial | Office | Commer -cial | School | Hotel | External | Total |
| From | Residential | X | 79 | 1 | 133 | 0 | 312 | 525 |
| | Office | 26 | X | 4 | 0 | 10 | 210 | 250 |
| | Commercial | 2 | 8 | X | 0 | 0 | 17 | 27 |
| | School | 52 | 0 | 0 | X | 0 | 156 | 208 |
| | Hotel | 0 | 13 | 1 | 0 | X | 12 | 26 |
| | External | 92 | 1123 | 37 | 132 | 29 | X | 1413 |
| | Total | 172 | 1223 | 43 | 265 | 39 | 707 | |

## Table D10 Phase 2 Internal Capture – PM Low

| | | To | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Resident -ial | Office | Commer -cial | School | Hotel | External | Total |
| From | Residential | X | 29 | 34 | 26 | 0 | 222 | 311 |
| | Office | 79 | X | 33 | 0 | 23 | 955 | 1090 |
| | Commercial | 31 | 3 | X | 0 | 1 | 104 | 139 |
| | School | 33 | 0 | 0 | X | 0 | 32 | 65 |
| | Hotel | 0 | 10 | 17 | 0 | X | 13 | 40 |
| | External | 385 | 151 | 25 | 26 | 21 | X | 608 |
| | Total | 528 | 193 | 109 | 52 | 45 | 1326 | |

## Table D11 Phase 2 Internal Capture – AM Medium

| | | To | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Resident -ial | Office | Commer -cial | School | Hotel | External | Total |
| From | Residential | X | 79 | 3 | 167 | 0 | 276 | 525 |
| | Office | 26 | X | 4 | 0 | 10 | 210 | 250 |
| | Commercial | 4 | 8 | X | 0 | 4 | 11 | 27 |
| | School | 57 | 0 | 0 | X | 0 | 151 | 208 |
| | Hotel | 0 | 16 | 3 | 0 | X | 7 | 26 |
| | External | 85 | 1120 | 33 | 98 | 25 | X | 1361 |
| | Total | 172 | 1223 | 43 | 265 | 39 | 655 | |

## Table D12 Phase 2 Internal Capture – PM Medium

| | | To | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Resident -ial | Office | Commer -cial | School | Hotel | External | Total |
| From | Residential | X | 29 | 39 | 33 | 0 | 210 | 311 |
| | Office | 79 | X | 33 | 0 | 28 | 950 | 1090 |
| | Commercial | 38 | 3 | X | 0 | 4 | 94 | 139 |
| | School | 41 | 0 | 0 | X | 0 | 24 | 65 |
| | Hotel | 0 | 10 | 19 | 0 | X | 11 | 40 |
| | External | 370 | 151 | 18 | 19 | 13 | X | 571 |
| | Total | 528 | 193 | 109 | 52 | 45 | 1289 | |

Table D13 Phase 2 Internal Capture – AM High

| | | To | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Resident -ial | Office | Commer -cial | School | Hotel | External | Total |
| From | Residential | X | 79 | 6 | 184 | 0 | 256 | 525 |
| | Office | 26 | X | 4 | 0 | 10 | 210 | 250 |
| | Commercial | 5 | 8 | X | 0 | 3 | 11 | 27 |
| | School | 60 | 0 | 0 | X | 0 | 148 | 208 |
| | Hotel | 0 | 20 | 5 | 0 | X | 1 | 26 |
| | External | 81 | 1116 | 28 | 81 | 26 | X | 1332 |
| | Total | 172 | 1223 | 43 | 265 | 39 | 626 | |

Table D14 Phase 2 Internal Capture – PM High

| | | To | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Resident -ial | Office | Commer -cial | School | Hotel | External | Total |
| From | Residential | X | 29 | 45 | 39 | 0 | 198 | 311 |
| | Office | 79 | X | 33 | 0 | 34 | 944 | 1090 |
| | Commercial | 44 | 3 | X | 0 | 6 | 86 | 139 |
| | School | 49 | 0 | 0 | X | 0 | 16 | 65 |
| | Hotel | 0 | 10 | 21 | 0 | X | 9 | 40 |
| | External | 356 | 151 | 10 | 13 | 5 | X | 535 |
| | Total | 528 | 193 | 109 | 52 | 45 | 1253 | |

Internal capture for local school, community shopping center, and business hotel are not clearly defined by the ITE Trip Generation Manual. The community shopping center as currently planned is not visible from Piilani Highway and will mostly serve the MRTP itself. With Kihei Elementary School nearby, other more convenient shopping centers, and plenty of hotels located makai of Piilani Highway, an internal capture rate higher than 15% rate was assumed for the planned school, community shopping center, and hotel.

# Appendix E Makai Collector Supporting Documents

# COUNTY OF MAUI
# FISCAL YEAR 2013

# VOLUME II:
## MAYOR'S CAPITAL BUDGET PROPOSAL

Project Name: North-South Collector Road CBS No: CBS-1064

Department: Department of Public Works District: Kihei-Makena Project Type: Road Improvements

Anticipated Life: 30 years

| Prior Years | Current Appr | Ensuing | Subsequent Years | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| Expend/Encb | FY 2012 | FY 2013 | FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 | 6-Year |
| 0 | 0 | 0 | 0 | 800,000 | 800,000 | 8,300,000 | 8,300,000 | 18,200,000 |

## PROJECT DESCRIPTION

To construct two roadway segments of the North/South Collector road. Phase I will be the segment from Kaonoulu Street to Waipuilani Road and Phase II, Lokelani School to Kanani Road. Funding request sequence as follows: Phase I: FY 2015 - Design and Environmental Assessment, FY 2017 - Construction phase. Phase II: FY 2016 - Design and Environmental Assessment, FY 2018 - Construction phase.

## PROJECT JUSTIFICATION

Project necessary to alleviate traffic congestion for vehicular travel in the North-South direction in South Maui. Traffic on South Kihei road is already gridlocked in morning and afternoon peak hours. Future development in the Kihei-Makena areas will add to the congestion South Maui residents are already experiencing.

## STRATEGIC PLAN ALIGNMENT

| Department's Strategic Plan | Countywide Priority Results |
|---|---|
| Goal #3: Identify and resolve traffic congestion, circulation and safety issues.<br>Objective 3.1: Address capacity and circulation issues by installing additional lanes, acceleration/deceleration lanes, install traffic control devices at major intersections and creation of new roadway systems. | A Suitable Public Infrastructure<br>A Strong, Diversified Economy<br>A Prepared, Safe, and Liveable County<br>A Healthy and Sustainable Community |

## Operating Impact Narrative

No significant impact on staffing or operations anticipated.

## FUNDING DETAILS

| Phase Description | Fund Code | Current Appr | FY 2013 | FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 |
|---|---|---|---|---|---|---|---|---|
| Design | GB | 0 | 0 | 0 | 800,000 | 800,000 | 0 | 0 |
| New Construction | FD | 0 | 0 | 0 | 0 | 0 | 6,000,000 | 6,000,000 |
| New Construction | GB | 0 | 0 | 0 | 0 | 0 | 1,500,000 | 1,500,000 |
| Other | GB | 0 | 0 | 0 | 0 | 0 | 800,000 | 800,000 |

### Schedule of Activities

| Activity | Start | End | Amount |
|---|---|---|---|
| Design | 07/01/2014 | 07/31/2016 | 1,600,000 |
| New Construction | 10/01/2016 | 02/28/2017 | 15,000,000 |
| Other | 10/01/2016 | 02/28/2017 | 1,600,000 |
| Total Capital Project Costs | | | 18,200,000 |
| Total O&M Costs | | | 0 |
| Total Capital & Operating Costs | | | 18,200,000 |

| Methods of Financing (Ensuing + 5 Years) | |
|---|---|
| **Funding Source** | **Amount** |
| Federal Fund | 12,000,000 |
| General Obligation Fund | 6,200,000 |
| Total Funding Requirements | 18,200,000 |

# Maui Research and Technology Park Meeting Minutes

Date 10-16-2012
Time: 130-245PM HST
Topic: DOT Comment Letter on the Draft EIS/ TIAR

Attendance:

| | |
|---|---|
| DPW: | David Goode/ Rowena Dagdag-Andaya/ Nolly Yagin |
| DOT Maui HW: | Fred Cajigal/ Charlene Shibuya |
| MRTP: | Steve Perkins |
| CH&P: | Chris Hart/Jennifer Maydan/ Brett Davis |

- Maui Public Works and State DOT Maui Highways both agree that it is not a matter of "if" the N-S Collector road will be developed, it is a matter of "when". There are many details involved, but eventually the road will be built. Best guess on timeline is 5-7 years. During that time Public Works will have to go through the environmental assessment and Special Management Area permitting process, which will include public comments. We agreed to engage in the process and advocate for the roadway at public hearings, with community groups, etc to help expedite the development of the remaining segments of the N/S collector road. David Goode noted that the Mayor is in support of the N/S collector road.

- Public works and Maui officials from Hawaii DOT supported our idea of an in-tract north south transportation network mauka of Piilani Highway. We introduced them to the concept that MRTP was building nearly a mile and a half of a N/S roadway that could be used as a mauka collector road to provide relief from Piilani Highway.

- The process of adding the roadways to the state's planning documents begins with the long-term transportation plan. We will make sure the necessary roadways are in that document, and later make sure they are advocated for inclusion in the STIP. The plan will come out in early 2013. After this plan is released, the Dept. of Public Works should start working on the south Maui regional traffic study. We pointed out to them that they had more money allocated to the study than they thought, so we'll follow up on this to make sure it stays top of mind.

- We have all the info needed from public works in preparation for our 10/29 meeting with Hawaii DOT in Honolulu.

# Appendix F Mauka Collector Supporting Documents

ALAN M. ARAKAWA
Mayor

WILLIAM R. SPENCE
Director

MICHELE CHOUTEAU McLEAN
Deputy Director

RECEIVED
AUG 14 2012
CHRIS HART & PARTNERS, INC.
Landscape Architecture and Planning

cc: Brent
08/13/2

COUNTY OF MAUI

# DEPARTMENT OF PLANNING

August 13, 2012

Mr. Daniel E. Orodenker, Executive Director
State of Hawaii Land Use Commission
P.O. Box 2359
Honolulu, Hawaii 96804-2359

Dear Mr. Orodenker:

**SUBJECT: DRAFT ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR THE PROPOSED LAND USE DISTRICT BOUNDARY AMENDMENT (DBA) FOR THE MAUI RESEARCH & TECHNOLOGY PARK MASTER PLAN, AT KIHEI, MAUI, HAWAII; TMK(S): (2) 2-2-024:001-009; 014-018; 031; 032; 034; 036-046; AND (2) 2-2-002:054 (POR.) (EAC 2012/0013)**

The Department of Planning (Department) is in receipt of the above-referenced document for the proposed petition to amend the land use boundary to effect a district reclassification of approximately 256.243 acres of land situated at Kihei, Maui, Hawaii, from the Agricultural District to the Urban District for the Maui Research & Technology Park. The Department understands the proposed action includes the following:

- The Applicant is Maui R&T Partners, LLC;
- The Applicant is requesting a Land Use DBA for a reclassification of approximately 256.243 acres of land from the Agricultural District to the Urban District and the land is identified by Tax Map Key (TMK) Parcel Nos. (2) 2-2-024:016 and 017 and a portion of (2) 2-2-002:054. Additionally, the project will require amendments to the conditions placed upon currently urbanized lands, comprising approximately 157.76 acres;
- The Approving Agency is the Land Use Commission of the State of Hawaii;
- The proposed project will require an amendment to the Kihei-Makena Community Plan (CPA) from Project District 6, Public/Quasi Public, and Agricultural to a District that better aligns with the Maui Research & Technology Park Master Plan strategic vision and changes of Maui County Code (MCC), Title 19.33 "Kihei Research & Technology Park District." The CPA will require approval by the Maui County Council;
- The proposed project will require a Maui County Change in Zoning (CIZ) in order to bring the entire Park site into the Research and Technology Park District, whereas portions of the Park are currently zoned Agricultural. The CIZ will require approval by the Maui County Council; and

- The CPA and anticipated "off-site" infrastructure work affecting State and County "rights-of-way" are "triggers" for the preparation of an EIS.

Based on the foregoing, the Department provides the following comments of the Draft EIS:

1. The Department concurs that the Petition to amend the land use district boundary of certain lands consisting of 256.243 acres from the Agricultural District to the Urban District is related to TMK Nos. (2) 2-2-024:016, and 017, and (2) 2-2-002:054 (POR.);

2. The Department concurs that the proposed CPA and anticipated use of State and County lands are "triggers" that require compliance with Chapter 343, Hawaii Revised Statutes (HRS);

3. The Department concurs that the State Land Use Commission shall be the Approving Agency for the EIS pursuant to Chapter 343, HRS;

4. On June 23, 2010, the Applicant filed a petition with the State Land Use Commission for a DBA from Agriculture to Urban for certain lands as identified;

5. The Applicant has filed a Consolidated Application for a CPA and CIZ for the Project which shall be reviewed by the Maui Planning Commission and Maui County Council;

6. The Draft EIS that looks at the Maui Research & Technology Park Master Plan Update as a whole shall include Transportation Demand Management Measures along with a Traffic Impact and Analysis Report (TIAR) for the project which shall seek to reduce or mitigate traffic impacts. Applicable and relevant updates to these reports should be provided on a timely basis at project milestones as changes in the timing and project scope may occur over the duration of the project;

7. The Draft EIS that looks at the Maui Research & Technology Park Master Plan Update as a whole shall state how the project will provide affordable housing in accordance with the County's Workforce Housing Policy as applicable and require that the Applicant coordinate with the Department of Housing and Human Concerns an appropriate affordable housing program per Maui County requirements;

8. The Department strongly recommends that this project as a whole be reviewed by the Maui County Urban Design Review Board (UDRB) to allow for a discussion of project design as it will include residential, civic, and commercial mixed-use components, along with areas of open space and parks. Review by

the UDRB may involve multiple meetings due to the scope and complexity of this project;

9. The County of Maui is currently reviewing the Draft Maui Island Plan that proposes a Directed Growth Strategy to establish urban growth boundaries and the land area under review for this Petition for a DBA from the Agricultural District to the Urban District is within the proposed urban growth boundaries of the Draft Maui Island Plan. Please include a map of the Draft Maui Island Plan Kihei-Makena growth area boundary and include the location of the Maui Research & Technology Park site; and

10. The Department concurs that the location and timing of a Kihei-Mauka North-South Collector Road is an unresolved issue as the schedule for the development of this roadway is uncertain at this time. In order to create an interconnected Kihei-Mauka transportation network in advance of the potential development of a Kihei-Mauka Collector Road, the Department strongly recommends that the Applicant consider designating and designing Ninau Street as a "complete street" with on street dedicated bicycle lanes, pedestrian facilities, median and through travel lanes, that would connect with North-South roadways of adjacent future development mauka of Pi`ilani Highway.

Thank you for the opportunity to comment. Should you require further clarification, please contact Staff Planner Kurt Wollenhaupt at kurt.wollenhaupt@mauicounty.gov or at (808) 270-1789; Staff Planner Kathleen Kern of the Long Range Division at kathleen.kern@mauicounty.gov or at (808) 270-7841; or Staff Planner Paul Critchlow of the Zoning Administration and Enforcement Division at paul.critchlow@mauicounty.gov or at (808) 270-5795.

Sincerely,

WILLIAM SPENCE
Planning Director

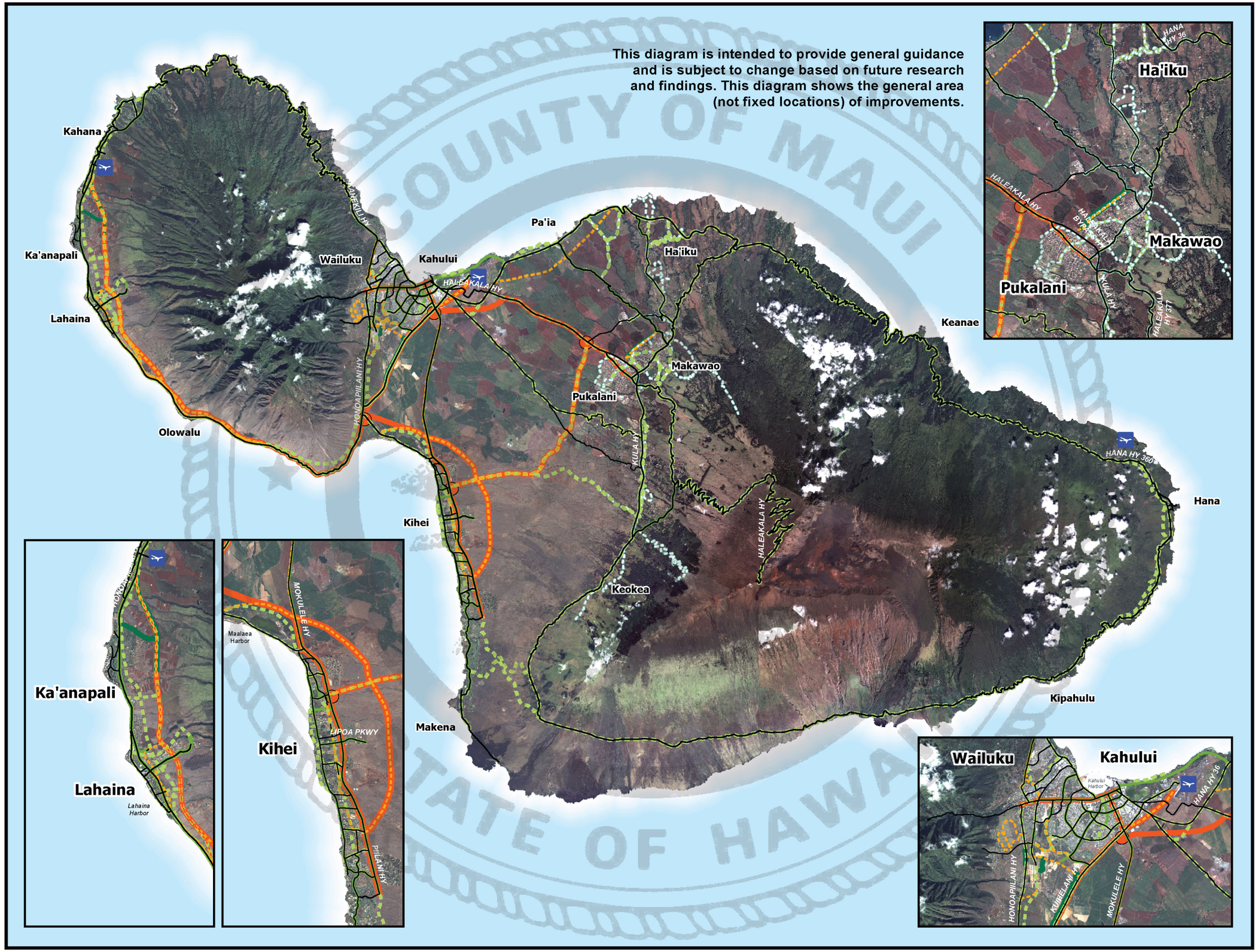
xc: Clayton I. Yoshida, AICP, Planning Program Administrator (PDF)
Aaron H. Shinmoto, PE, Planning Program Administrator (PDF)
John F. Summers, Planning Program Administrator (PDF)
Kathleen Kern, Staff Planner (PDF)
Paul B. Critchlow, Staff Planner (PDF)
Kurt F. Wollenhaupt, Staff Planner (PDF)
Brett Davis, Chris Hart & Partners, Inc.
Project File
General File

WRS:KFW:cr
K:\WP_DOCS\PLANNING\EAC\2012\0013_MauiResearchPark\FinalComment.DOC

# Regional Transportation Network

Island of Maui

This diagram is intended to provide general guidance and is subject to change based on future research and findings. This diagram shows the general area (not fixed locations) of improvements.

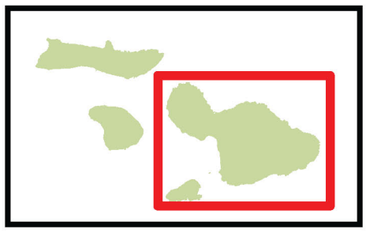



## Legend

- Primary Road
- Secondary Road
- Bike Path
- Airport

**Proposed**

- Conceptual Transit Station
- Conceptual Transit Corridor
- Lahaina Bypass
- Road or Highway
- Bike Path
- Upcountry Greenways Plan
- Maui Island Plan Greenways



Miles

0 1 2 3 4 5 6

Product Code: M-CET_20120920-m1

Copyright © September 20, 2012

This is not a zoning map. Please contact the Planning Department for Zoning confirmation.

Prepared By:
Long Range Planning Division
Department of Planning
County of Maui
250 South High Street
Wailuku, Hawaii 96793

**Diagram 6-1**

Appendix H
Economic and Fiscal Impact Assessment

# Market Study, Economic Impact Analysis, and Public Fiscal Assessment of the Proposed

# MAUI RESEARCH & TECHNOLOGY PARK MASTER PLAN UPDATE

## Kihei, Maui, Hawaii

THE HALLSTROM GROUP INC.

REAL ESTATE
CONSULTANTS
& APPRAISERS

June 5, 2012

Mr. Steve Perkins
Project Coordinator
Maui R&T Partners LLC
1300 North Holopono Street, Suite 201
Kihei, Hawaii 96753

**Market Study, Economic Impact Analysis and Public Fiscal Assessment of the Proposed Maui Research & Technology Park Updated Master Plan e Kihei, Maui, Hawaii**

Dear Mr. Perkins:

At your request, we have completed a series of market and econometric analyses associated with the proposed Maui Research & Technology Park (MRTP) Master Plan Update, an evolution in the design of the 20-year old project in response to market trends and land use needs which will enable the development to better meet the real estate requirements of Maui and the Kihei-Makena region over the long-term.

The original vision of MRTP as a use-restricted, large lot, 432-acre business campus did not provide sufficient diversity to achieve its technology-driven potentials within the Maui economy. The updated plan will provide for a wider spectrum of industrial, business park, commercial, mixed-use and residential use types creating cumulative attraction and synergy, currently lacking in the project, while offering product that is more responsive to community demands.

As presently proposed, the Master Plan Update will establish a mixed-use community, comprised of:

ARBITRATION
VALUATION AND
MARKET STUDIES

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HAWAII 96813-6442

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email@hallstromgroup.com
www.hallstromgroup.com

- Up to 1,250 resident housing units preliminarily divided between 750 single family homes and 500 multifamily/townhouse units. Featuring a diverse inventory, the anticipated price range will be oriented towards meeting the housing needs of MRTP workers and their families, and the resident households of South Maui.

- Up to 1.6 million gross square feet of light industrial, business park, and commercial floor area. The large majority of space will be of the first two use-types, continuing the Park focus on technology but also expanding the opportunities for other job-creating activities and a wider spectrum of tenants. Commercial is anticipated to be limited to neighborhood-oriented retail, restaurant and service/support offerings meeting the daily needs of project residents, workers and customers, in addition to mixed-use areas promoting "live/work" and other creative and marketing spaces.

- An "Economic Opportunity Campus Area" of some 30 to 40 acres capable of supporting upwards of 400,000 gross square feet of floor space, which will be available for a major institutional, educational, corporate or research user seeking a large, integrated campus environment on Maui. The availability of a large, ready-to-build site in a modern, competitive setting will be essential in attracting and servicing many major new uses that may come to Maui as it continues its economic evolution.

- 52 acres of parks, trails, greenbelts and open space which extend throughout the project, along with sites for civic and other community supporting uses.

The updated master plan includes a Village Center, Employment Core, Knowledge Industry Expansion/Campus and residential neighborhoods, to be accessed via interior streets extending from Lipoa Parkway. The plan is consistent with the steadily increasing amount of existing and proposed development in the corridor mauka of Piilani Highway.

The 400-plus acre remaining undeveloped site is divided between a 150 acre portion with in-place land use approvals supporting the master plan (the "Entitled Area"), encompassing where Park development has occurred to date, and a 256 acre section for which approvals are being sought (the "Petition Area"). The project will be built in two phases.

Our assignment was to: determine the level of demand for the MRTP Master Plan Update inventory relative to available supply; assess the appropriateness of the site and master plan from a market perspective; and quantify the economic impacts of the project within the public and private spheres presently and in the future. Our study was primarily comprised of three elements:

1. **Market Study**. To ascertain whether there currently exists, or will exist, sufficient demand in the Maui and Kihei-Makena residential, industrial/business park, and commercial real estate sectors to successfully absorb the finished subject inventory in a timely manner given its characteristics and those of competing in-place and proposed regional developments.

2. **Economic Impact Analysis**. To estimate the general and specific effects on the local economy which will result from MRTP build-out, including construction and business employment, wages and income, contractor/supplier profits, end-user expenditures, and other regional monetary and employment effects. This study also forecasts the de facto population of the subject community including residents, guests and workers, household income and discretionary spending levels.

3. **Public Fiscal Assessment**. To quantify the tax receipts, public costs, and net benefits which will be received by the State of Hawaii and the County of Maui resulting from the actualization and operation of the MRTP Master Plan Update.

The subject property, identified on State of Hawaii Tax maps as Second Division Tax Map Key 2-2-24, Parcels 1-9, 14-17, 31 & 34; and, 2-2-2 Parcel 54 (por.) 13: varies from near level to moderately sloping; has favorable access, but limited frontage/exposure characteristics; offers some superior view panoramas; and is within an urbanizing corridor.

The pertinent results from our studies are presented in the following report, which opens with an Executive Summary focusing on brief narrative describing our conclusions. The remainder of the report is comprised of a series of six addenda exhibits containing the tabular presentation of our data, analysis and modeling for each aspect of the assignment.

As part of our investigation program, we have: visited the subject property and its environs; researched the Maui and Kihei-Makena submarkets including residential, industrial/business park and commercial real property sectors; interviewed knowledgeable parties active in the regional economy; reviewed government statistics, policies and publications; accessed on-line databases; and compiled materials from published and private sources.

All conclusions presented herein are subject to the limiting conditions, assumptions and certifications of The Hallstrom Group, Inc., in addition to any others specifically set forth in the text. All work has been completed in conformance with the Code of Professional Ethics and Standards of Professional Appraisal Practice of the Appraisal Institute, and the Uniform Standards of Professional Appraisal Practice (USPAP).

We appreciate the opportunity to be of service to the Maui R&T Partners LLC in regards to this prominent mixed-use community.

Respectfully submitted,

THE HALLSTROM GROUP, INC.

Tom W. Holliday

Tom W. Holliday

/as

THE HALLSTROM GROUP INC.
REAL ESTATE
CONSULTANTS
& APPRAISERS

# Market Study, Economic Impact Analysis, and Public Fiscal Assessment of the

# PROPOSED MAUI RESEARCH & TECHNOLOGY PARK MASTER PLAN UPDATE

**Located at**

**Kihei, Maui, Hawaii**

**Prepared for**

**Mr. Steve Perkins**
**Maui R&T Partners, LLC**

ARBITRATION
VALUATION AND
MARKET STUDIES

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**As of**

**May 2012**

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ADDENDA

**Exhibit I** - Residential Market Study Tables
**Exhibit II** - Commercial Market Study Tables
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**Exhibit IV** - Economic Impact Summary Model Tables
**Exhibit V** - Public Fiscal Assessment Summary Table
**Qualifications of The Hallstrom Group, Inc.**
**Qualifications of the Analysts**

# INTRODUCTION

The Maui Research & Technology Park (MRTP) Master Plan Update comprises approximately 360 acres of undeveloped urban-classified lands located mauka of Piilani Highway in the central inland area of Kihei Town. It is situated on the lower northwesterly flanks of Haleakala, one mile from the shoreline and twelve miles from the Kahului Airport (OGG).

The irregularly-shaped site, lying adjacent to the Eleair Maui Golf Club, is surrounded by a mix of undeveloped, developed and proposed-for-development lands within the interior of the Kihei-Makena Corridor, a natural growth area for the expanding resident and resort community. The gently to moderately-sloping site has favorable mauka and makai view planes, an excellent climate, and ease of access to the region's main thoroughfare and the island's roadway system.

When originally envisioned and entitled a quarter century ago, the subject property was intended to be a restricted-use (research & technology concerns only) business park/campus setting offering a quality location for high-tech and other new knowledge-oriented companies, access to the Maui High Performance Computing Center, and a quality, competitive environment for leading-edge ideas to be developed.

However, as described in the Draft Environmental Impact Statement, the breadth an depth of employment opportunities is significantly less than what more modern and progressively planned park's are capable of delivering, necessitating an updating of the master plan to maximize market and synergy opportunities:

> "Development activity at the MRTP during the past two decades has occurred at a significantly slower rate than initially expected. Since its inception in the late 1980's, the approximate 432 acre MRTP is only at approximately 10 percent build-out, with 11 lots sold and approximately 180,000 square feet of structures in five (5) buildings with a total of 400 employees. Today,

> everyone working in the Park commutes since the development has no housing, and few support services or amenities. Over twenty years have passed since the original controlling documents for the development have been updated. Best practices in planning, land development, and strategies for economic development through diversification have changed dramatically since the initial development of the Park. The development plan for MRTP needs to conform to current state of the art practices in modern, successful employment centers in order to deliver the economic development benefits desired by the community.
>
> This Master Plan Update proposes to utilize the principles of New Urbanism and Smart Growth to transform the current, single-use large lot research and technology campus into an integrated and vibrant mixed-use community focused around a regional knowledge-based industry employment base. The Master Plan Update includes fundamental design elements that will have positive effects on the environment, on individual health and well being, and on the long-term economic viability and adaptability of the Park. The Master Plan Update encompasses approximately 432 acres and includes the following components: employment core; knowledge industry expansion; mixed-use village center; residential areas; and an open space network and parks…
>
> The Master Plan Update will be implemented over a period of years. It is anticipated that all of the necessary entitlements to fully implement the Plan will be obtained by early 2014. The Master Plan Update will be implemented in phases, with key infrastructure improvements tied to the phase of development and as the improvements are warranted."

The MRTP Master Plan Update, designed by Calthorpe Associates, calls for a mixed-use community offering a comprehensive lifestyle, transportation connectivity and environmental sustainability, with the primary marketable components including:

- Up to 1,250 resident housing units preliminarily divided between 750 single family homes and 500 multifamily/townhouse units. The diverse inventory and anticipated price range will be oriented towards

meeting the housing needs of MRTP workers and their families, and the resident households of South Maui.

- Up to 1.6 million gross square feet of light industrial, business park, and commercial floor area. The large majority of space will be of the first two use-types, continuing the Park focus on technology but also expanding the opportunities for other job-creating activities and a wider spectrum of tenants. Commercial is anticipated to be limited to neighborhood-oriented retail, restaurant and service/support offerings meeting the daily needs of project residents, workers and customers, in addition to mixed-use areas promoting "live/work" and other creative and marketing spaces.

- An "Economic Opportunity Campus Area", of some 30 to 40 acres capable of supporting upwards of 400,000 gross square feet of floor space, which will be available for a major institutional, educational, corporate or research user seeking a large, integrated campus environment on Maui. The availability of a large, ready-to-build site in a modern, competitive setting will be essential in attracting and servicing many major new uses that may come to Maui as it continues its economic evolution.

- 52 acres of parks, trails, greenbelts and open space which extend throughout the project, along with sites for civic and other community supporting uses.

The site and master plan is divided between existing "entitled area" lands (about 150 acres) and the "petition area" (256 acres). The petition area, will contain 850 of the residential units, 615,000 square feet of industrial/commercial floor space and the Economic Opportunity Campus. The project will be developed in two phases over an estimated two decade build-out.

The updated subject community will contain an increased spectrum of use-types creating a critical mass currently lacking in the project. According to the developer, "the focus and intent of those uses will be economic diversification and expansion of the existing knowledge industry in the park, and supporting the

workers in those industries with services and amenities that will make the development attractive to knowledge industry employers."

The evolved plan will also loosen the "onerous restrictions" which have hampered business development and the formation of cumulative attraction at MRTP, such as lot size, use restrictions, and setback/landscaping requirements, while promoting an integrated "live, work, play" village concept with the flexibility to embrace new ideas and emerging land use trends. It is anticipated some of the employees of the commercial and industrial businesses will be Park residents, lessening the impact of the development on regional roads and highways.

The updated vision will transform a well-located, urban-classified, underutilized property that has thus far not lived up to its economic potential for+ Maui, into a regional asset providing needed reasonably-priced housing, supporting business growth producing thousands of "worker years" of employment and wages, attracting significant new capital investment, and stimulating spending. This activity will in turn generate enhanced employment and business opportunities for island residents and companies while further expanding the tax base for the state and county.

The Hallstrom Appraisal Group, Inc.'s assignment was to analyze the proposed MRTP Master Plan Update from a real estate market perspective and to identify and quantify probable market and economic impacts associated with its development in light of competitive, regional, prevailing and forecast trends to answer four basic study questions:

1. Is there sufficient demand to absorb the various "marketable" components of the subject community (especially within the petition area) during a reasonable exposure period given competing developments and projected statewide/regional market trends?

2. Will the community be an appropriate use of the underlying site relative to market needs?

3. What will be the general/specific and direct/indirect economic impacts on Maui resulting from the undertaking of the subject community via employment, wages, business operations, population, and other economic activity related to the real property asset?

4. What will be the effect on the state and county "public purse" from the project in regards to costs of services required to service the MRTP population and increased tax/fee receipts flowing from its development?

These issues were addressed through a comprehensive research and inquiry process utilizing data from market investigation, governmental agencies, various Hawaii-based media, industry spokespersons/sources, on-line databases, and published public and private documents.

The pertinent results of our study are highlighted in the following Executive Summary, comprising the body of our report, which contains a concise narrative and tabular synopsis of our conclusions. Additional materials, contained in data tables and models depicting the subject community's lifespan from commencement to completion, are presented in the Addenda.

Our narrative presentation is divided into five sections:

1. **Primary Study Conclusions**

2. **Real Estate Outlook**

3. **Market Study of the MRTP Master Plan Update Components**

4. **Economic Impacts of the Proposed Community**

5. **Public Fiscal Costs and Benefits Associated With MRTP**

The primary source information regarding the subject community used in our study were: maps, master plans, unit

counts, density analysis, cost estimates and background materials provided by Maui R&T Partners LLC, Calthorpe Associates, Chris Hart & Partners, and other members of the development/consultant team; resident population and housing projections, community plan materials and other data from the Maui County Planning Department; the United States 2010 Census; sales and listing data from the Maui Board of Realtors and Hawaii Information Service; and, data from our files.

The MRTP site and environs have been viewed by our firm on many occasions and specifically for this assignment. The effective date of study was April 1, 2012.

## PRIMARY STUDY CONCLUSIONS

Based on our analysis of the subject property, its environs, and envisioned development we have reached the following conclusions as of April 1, 2012 regarding the probable market standing and economic impacts of the proposed Maui Research & Technology Park Master Plan Update:

**Market Study**

- Hawaii is slowly but steadily recovering from the recent recession and associated down-cycle in the real estate market. Current expectations are activity will generally recover towards long-term average levels over the next several years, and that another up-cycle will subsequently ensue, consistent with long-term economic trends in the islands.

- Maui, along with Oahu, has shown the greatest movement towards recovery among the islands. The unemployment rate has dropped to 7.2 percent from a high of 9.1 percent during the depths of the recession, total visitor days and spending are up more than 20 and 35 percent respectively since 2009, and median household income is up 2.2 percent from last year. Business creation and floor space absorption remain mixed, but are expected to show growth in 2012-13.

- Regardless of the point in the economic cycle, there remains a chronic unmet demand for additional affordably-priced housing on Maui. While numerous directed projects have been proposed, along with other mixed-use developments with a workforce housing component, they have been slow to reach fruition.

- The "Kihei-Makena Study Area" is a suburban coastal community, with residential-oriented uses in the inland areas (housing units, neighborhood commercial and limited industrial), and resort/vacation-oriented uses dominating the shoreline (condos, hotels, timeshare and destination resorts). It has expanded dramatically in the past three decades, growing four-fold in resident population, adding nearly one million square feet of commercial and industrial floor area and more than 2,500 visitor units, and evolving into a major hub of Maui investment and business activity. Forecasts are the study area population will increase from the current figure of 27,500 to between 42,000 to 46,000 by 2035 (a gain of 53 to 67 percent), and increase its importance in the island's economy; particularly as Makena Resort experiences further development and the Maui Research & Technology Park (MRTP), Honuaula and other master-planned projects are manifest.

- The demand for new residential units in the Kihei-Makena Corridor will be from 7,760 to 12,009 units over the next 24 years (through 2035). The number of existing unsold and planned resident housing units within the regional "Directed Growth Boundary", excluding the MRTP, totals some 6,634 units. This indicates there will be a shortfall in the sector of from 1,126 to 5,375 new residential units; with a mid-point under-supply of 3,251 units. Our analysis indicates there will be sufficient unmet demand to absorb the 1,250 units of subject inventory.

- Regardless of the point in the economic cycle there remains a chronic unmet demand for additional affordably-priced housing on Maui. While numerous

directed projects have been proposed, along with other mixed-use developments with a workforce housing component, they have been slow to reach fruition. Approximately 43 percent of the demand for resident housing in the Kihei-Makena Study Area will be for units with a current price of $640,000 or less; the upper-price threshold for meeting County affordability standards (140 percent of median household income). Approximately 56 percent of the proposed product should be single family (homes or lots) and 44 percent multifamily units.

- We estimate the 750 single family homes/lots of the subject development will require approximately 14 years to be absorbed following commencement of pre-sales in 2017 (or 53.5 sales per year), and the 500 multifamily units will sell-out in 13 years (38 annually). It is likely most of the multifamily units will have market-based prices at, or below, affordability thresholds.

- At present, the study area is a secondary commercial center of Maui, meaningfully behind Kahului-Wailuku, with an estimated 700,000 square feet of commercial floor space, or 16 percent of the island total. As Kihei-Makena contains 24 percent of the de facto population of Maui, it can be asserted it is "under-serviced". The vacancy rate on the island for retail, restaurant and service/support commercial floor space is currently at just over nine percent; the highest level in many years. Rents have stabilized since mid-decade, and net absorption for the year was a negative 11,297 square feet, the smallest loss since 2008, and an indication the sector has stabilized and is likely to return to a positive absorption stance in 2012-13. Tenant stability is relatively high in Kihei-Makena (particularly compared to West Maui), with increasing interest being expressed in vacant bays as the market continues through its recovery phase.

- We estimate there will be demand for an additional 907,000 to 1,506,000 million square feet of gross leasable floor space in Kihei-Makena (the "Study Area") by 2035,

more than doubling the existing inventory, as Kahului lands are built-out, the Kihei population continues to increase, and the importance of the study area in the island's economy expands. This equates to an additional 83 to 141 acres of vacant gross land area to support expected market needs.

- While there are substantial available (and under-built) commercial lands in Kihei-Makena, and there will be sites in many of the major proposed master-planned developments, we consider it unlikely there will be sufficient competitive acreage to meet the forecast mid-point to maximum demand levels. However, it is not the intent of the MRTP Master Plan Update to directly compete within the general regional commercial market on an overall basis.

- The purpose of the subject commercial component is to meet the demand for "neighborhood" retail, restaurant, and service commercial uses among the some 2,765 de facto residents of the community, in support of the 5,878 employees of the Park tenants and their daily patrons, and to provide opportunities for small and specialized businesses within a mixed-use environment. We estimate the MRTP could readily support up to 521,000 square feet of gross commercial floor area by build-out.

- The study area industrial space sector has approximately 850,000 square feet of inventory, or less than eight percent of the total amount built on Maui; again, indicating the region is under-serviced. The majority of space is in storage/warehousing, staging, small businesses and quasi-commercial uses. Island-wide the vacancy rate for industrial floor area is about 2.0 percent (well below the State average of 4.8 percent), and though the sector showed a negative absorption of 74,764 square feet in 2011, the fourth quarter achieved a meaningfully positive absorption of 48,444 square feet; a sign of initial recovery. Brokers report a renewed interest in Greater Kihei industrial spaces, with several owner/user and

multi-tenant buildings under construction or in the final approval stages.

- Assuming historic economic trends continue, we estimate the demand for additional industrial floor space on Maui over the next 24 years (through 2035) will total from 5.3 million to 6.7 million square feet, an increase of from 49 to 63 percent above current levels. This equates to a demand for between 466 to 599 gross acres of underlying sites at prevailing "business park" densities; significantly more acreage (two to three times greater) if base yards, quarries, and open storage uses are included.

- On a gross basis, there is sufficient existing and proposed vacant industrial land on the island to meet demand, with some 2,000 potential acres apart from the already-zoned subject holdings. However, this acreage includes heavy industrial, restricted use (airport and harbor), agricultural-oriented (Puunene sugar mill), dump and waste transfer sites, outlying locations, and other non-competitive properties which severely decrease the amount of land available to meet demand.

- Based on its locational attributes, timing of development, availability of competitive sites in Kihei-Makena, revisions to the restrictions in MRTP, and other factors, we estimate the subject project could capture from 1.1 million to 1.5 million square feet of the projected demand on Maui (with a mid-point of 1.3 million square feet); or about 21 percent of the island-wide demand during the projection period to 2035.

- There is a significant probability that as Maui continues its evolution from an agrarian to service-based economy, and its de facto population expands, it will move beyond its current "secondary suburban" status into a "primary urban" center. Instead of largely looking to Oahu/Honolulu for corporate, financial, professional, and specialized services, these businesses (and their employees) would locate on Maui. In addition to increasing demand for industrial/business park/office

space in Central and South Maui, it would help stem the on-going "brain drain" on the island as the better educated young adults out-migrate in search of higher profile, higher paying employment opportunities in Honolulu and on the mainland.

- As the Maui economy continues to grow and diversify over the next generation, there could be numerous educational, institutional and business/R&D uses possibly seeking out a Maui location. Such uses require from 30 to 200 acre sites for facilities/campuses of between 300,000 and 1.1 million square feet of floor space. In keeping with County planning and economic goals to provide for and support such development, the updated MRTP master plan contains a circa 40 acre Economic Opportunity Campus Area.

- The subject property is a superior location for the proposed development in regards to access, views, slope, shape, complimentary existing adjacent uses, climate and ability to provide a quality lifestyle and business opportunities for a wide-range of owners and end-users. It will have the attributes necessary to be highly competitive in all its product sectors, and will capture a reasonable market share during its offering period.

Our annualized mid-point absorption estimates are summarized on Table A. We did not make a specific projection as to the likely timing of demand for the Economic Opportunity Campus Area.

We note, Phase I of the Petition Area, containing 350 single family homes, is projected to be absorbed during an nine-year construction and sales period (2016 through 2024). Phase II of the Petition Area, containing 300 homes, 200 multifamily units, some 585,200 square feet of light industrial/business park and commercial floor space, along with the economic opportunity campus acreage, is forecast to be fully absorbed over a ten-year period, 2025 to 2034.

TABLE A

**SUMMARY OF PROJECT ABSORPTION BY DEVELOPMENT TYPE AND AREA**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**
**Assuming Mid-Point Demand Estimates**

| Year | | Petition Area SF (Homes) | Petition Area MF (Units) | Petition Area Comm/Other (Sq. Ft.) | Petition Area Ind/Bus (Sq. Ft.) | Existing Entitled Area SF (Homes) | Existing Entitled Area MF (Units) | Existing Entitled Area Comm/Other (Sq. Ft.) | Existing Entitled Area Ind/Bus (Sq. Ft.) | Total Project Area SF (Homes) | Total Project Area MF (Units) | Total Project Area Comm/Other (Sq. Ft.) | Total Project Area Ind/Bus (Sq. Ft.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2013 | | | | | | | | | 50,000 | | | | 50,000 |
| 2014 | | | | | | | | | 10,000 | | | | 10,000 |
| 2015 | Phase I Commences | | Entitlements Completed | | | | | | 15,000 | | | | 15,000 |
| 2016 | | | Infrastructure Emplaced | | | | | | 20,000 | | | | 20,000 |
| 2017 | Sales Begin | 60 | | | | 15 | 50 | 15,542 | 30,770 | 75 | 50 | 15,542 | 30,770 |
| 2018 | | 42 | | | | 15 | 40 | 15,542 | 30,770 | 57 | 40 | 15,542 | 30,770 |
| 2019 | | 42 | | | | 15 | 40 | 15,542 | 30,770 | 57 | 40 | 15,542 | 30,770 |
| 2020 | | 42 | | | | 15 | 40 | 105,542 (1) | 30,770 | 57 | 40 | 105,542 | 30,770 |
| 2021 | | 42 | | | | 15 | 40 | 18,423 | 50,596 | 57 | 40 | 18,423 | 50,596 |
| 2022 | | 42 | | | | 15 | 40 | 52,423 (2) | 50,596 | 57 | 40 | 52,423 | 50,596 |
| 2023 | | 42 | | | | 10 | 40 | 18,423 | 50,596 | 52 | 40 | 18,423 | 50,596 |
| 2024 | Phase I Petition Area Sold-Out | 38 | | | | | 10 | 18,423 | 50,596 | 38 | 10 | 18,423 | 50,596 |
| **Phase I Totals** | | **350** | **0** | **0** | **0** | **100** | **300** | **259,860** | **420,461** | **450** | **300** | **259,860** | **420,461** |
| Total Residential Units | | | | **350** | | | | **400** | | | | **750** | |
| Total Ind/Comm Gross Leasable Area | | | | **0** | | | | **680,321** | | | | **680,321** | |
| 2025 | Phase II Commences | 57 | 40 | 62,305 (3) | 25,298 | | | 6,135 | 25,298 | 57 | 40 | 68,440 | 50,596 |
| 2026 | | 57 | 40 | 14,086 | 37,863 | | | 7,032 | 37,863 | 57 | 40 | 21,118 | 75,725 |
| 2027 | | 57 | 40 | 14,086 | 37,863 | | | 7,032 | 37,863 | 57 | 40 | 21,118 | 75,725 |
| 2028 | | 57 | 40 | 14,086 | 37,863 | | | 7,032 | 37,863 | 57 | 40 | 21,118 | 75,725 |
| 2029 | | 57 | 40 | 14,086 | 37,863 | | | 7,032 | 37,863 | 57 | 40 | 21,118 | 75,725 |
| 2030 | | 15 | | 14,086 | 37,863 | | | 7,032 | 37,863 | 15 | 0 | 21,118 | 75,725 |
| 2031 | | | | 16,249 | 44,868 | | | 8,113 | 44,868 | 0 | 0 | 24,362 | 89,736 |
| 2032 | | | | 20,708 | 44,868 | | | 3,654 | 44,868 | 0 | 0 | 24,362 | 89,736 |
| 2033 | | | | 24,362 | 44,868 | | | | 44,868 | 0 | 0 | 24,362 | 89,736 |
| 2034 | Phase II Petition Area Sold-Out | | | 14,362 | 27,568 | | | | | 0 | 0 | 14,362 | 27,568 |
| **Phase II Totals** | | **300** | **200** | **208,414** | **376,783** | **0** | **0** | **53,063** | **349,215** | **300** | **200** | **261,478** | **725,999** |
| Total Residential Units | | | | **500** | | | | **0** | | | | **500** | |
| Total Ind/Comm Gross Leasable Area | | | | **585,198** | | | | **402,278** | | | | **987,476** | |
| Economic Opportunity "Campus" Reserve | | | | **400,000** | | | | **0** | | | | **400,000** | |
| Total Industrial/Business/Commercial GLA | | | | **985,198** | | | | **402,278** | | | | **1,387,476** | |
| **PROJECT TOTALS** | | **650** | **200** | **208,414** | **376,783** | **100** | **300** | **312,923** | **769,676** | **750** | **500** | **521,338** | **1,146,459** |
| Total Residential Units | | | | **850** | | | | **400** | | | | **1,250** | |
| Total Ind/Comm Gross Leasable Area | | | | **585,198** | | | | **1,082,599** | | | | **1,667,797** | |
| Economic Opportunity "Campus" Reserve | | | | **400,000** | | | | **0** | | | | **400,000** | |
| Total Industrial/Business/Commercial GLA | | | | **985,198** | | | | **1,082,599** | | | | **2,067,797** | |

(1) Business hotel opens (90,000 square feet).
(2) Post Office Sorting Center opens (34,000 square feet).
(3) Civic facility opens (50,000 square feet).

Source: The Hallstrom Group, Inc.

Our forecasts show the residential, industrial/business park, and commercial inventory in the Existing Entitled Area being absorbed at an equitable pace with the Petition Area product, although the larger Entitled industrial/business park component will require an additional year to achieve full-absorption. As the timing of the absorption and construction of the Economic Opportunity Campus Area is an unknown, we have placed it in the last development year of our models (2034). Should it be opened sooner, the economic impacts of the MRTP would be more significant during the build-out period.

**Economic Impact Analysis**

We have constructed a model depicting the economic impact of the MRTP Master Plan Update on the Maui and Statewide community during the course of its "lifespan" from ground-breaking in 2016 through the build-out of Phase II of the Petition Area in 2034. The model builds on the absorption estimates and data contained in our market study.

All estimated amounts are in constant 2012 dollars.

- Under the updated master plan, the subject development (including the Economic Opportunity Campus Area) will generate circa $1.39 billion in capital investment into the island's economy. The construction of the Park and on-going operations/maintenance of the residences, on-site commercial and industrial/businesses, and community facilities, will provide an estimated 63,507 "worker-years" of employment and $2.7 billion in total wages over a 19-year period. After "stabilization" the urban village community will support some 5,878 permanent jobs on-site with an annual payroll of about $217 million, and an additional 1,469 workers with $68.6 million in yearly wages off-site.

- The on-going business activity within the commercial and industrial/business park components will be substantial, both directly on-site and in stimulation of existing off-site companies. During the construction and absorption period, a total of $6.2 billion in taxable sales/revenues are projected, averaging $324.7 million per year. Following stabilization, $557 million annually

in business activity will be occurring in the community. The Economic Opportunity Campus Area will contribute upwards of an estimated $160 million per year in operating revenues to the MRTP, depending upon the ultimate use of the property.

- The majority of the gross operating revenues within the project, 92 percent, will be a result of outside patrons coming to the in-project companies. The base economic impact on Maui will total at least $7.8 billion during build-out and $903.9 million annually upon stabilization.

- At build-out the de facto population of the community will be some 2,765 persons of which 2,367 will be full-time residents (with an estimated 369 school-age children), 218 will be comprised of non-resident owners and their guests periodically using their house or condominium unit, and 180 (on average) will be guests in the business hotel proposed for the MRTP.

- The cumulative resident household income during the 20-year modeling period from final entitlements in 2015, through completion of Phase II of the Petition Area in 2034, will total $708.5 million, and will stabilize at $74.2 million annually (in constant 2012 dollars) thereafter. Discretionary expenditures into Maui businesses by the MRTP de facto population will be some $802.4 million during build-out and average $74.2 million per year on a stabilized basis.

**Public Fiscal Assessment**

- The project will have nominal impacts on the socio-economic aspects of the surrounding community that relate to real estate issues. Property values in the Kihei Makena Study Region are largely driven by external, cyclical economic factors and its existing cumulative mass, not any single new project. Further, the estimated selling prices of the envisioned MRTP residences are comparable to (or less than) the prevailing prices for the new and existing regional inventory. Based on current construction costs and other factors, it is anticipated a substantial number of the subject units will be sold at

prices within current "affordability" guidelines. It is not expected there will be meaningful in-migration to Maui as a direct result of the operating components of the community.

- The County of Maui will realize Real Property and Transient Accommodations taxes, other secondary receipts and impact fees of $141.3 million during the 19-year construction and absorption period, and $28.5 million annually on a stabilized basis thereafter). The net benefit to the County purse will be of $25.3 million during development, and $21.5 million annually on a stabilized basis.

- The State of Hawaii will receive Gross Excise, Income, and Transient Accommodation taxes, secondary revenues, and impact fees of $752.5 million during the build and sales projection time frame, and $80.4 million per year thereafter. The net benefit to the State purse will be in excess of $466.3 million during development, and a stabilized 'profit' of $57.3 million per year.

The major economic impacts and public fiscal conclusions are shown on Table B. The column on the left summarizes the cumulative impacts during the initial 20-year construction and sales period, and the right hand column the annual impacts after stabilization. All figures include the Economic Opportunity Campus Area where appropriate.

## REAL ESTATE OUTLOOK

The Hawaii economy began recovery from the depths of a significant recession at the end of 2009. During the following year growth returned to the vital visitor industries of Oahu and Maui (less so for Kauai and the Big Island), and other economic sectors showed signs of stabilization. Business activity, employment, real estate and tax receipts, among other indicators, appeared to have passed through the nadir of the down-cycle and into a nascent recovery mode.

TABLE B

**SUMMARY COMPARISON OF MAJOR ECONOMIC IMPACTS AND PUBLIC FISCAL COSTS/BENEFITS**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**
**All Amounts Expressed in Constant, Uninflated 2012 Dollars**

| Analysis Item | Cumulative During Build-Out Period | Stabilized Annually Thereafter |
|---|---|---|
| Direct Capital Investment | $1,390,578,257 | |
| Local Contractor's Profits | $139,057,826 | |
| Local Supplier's Profits | $55,623,130 | |
| Worker Years of Jobs | 63,507 | 7,347 |
| Employee Wages | $2,668,233,305 | $285,538,154 |
| De Facto Resident/Owner/Guest Population | | 2,765 |
| Full-Time Resident Household Income | $708,494,466 | $74,175,841 |
| De Facto Population Expenditures (On & Off Site) | $802,415,886 | $74,152,630 |
| Total Operating Gross Receipts | $6,169,542,446 | $572,080,983 |
| Outside Patronage Expenditures | $5,714,641,830 | $526,424,926 |
| Total Maui "Base" Economic Impact | $7,766,656,365 | $903,921,722 |
| | | |
| County of Maui Gross Tax Receipts | $141,300,531 | $28,502,055 |
| State of Hawaii Gross Tax Receipts | $752,462,434 | $80,440,455 |
| County of Maui Costs of Services (per capita basis) | $86,960,702 | $7,034,482 |
| State Costs of Services (per capita basis) | $286,144,364 | $23,146,977 |
| County of Maui Net Benefits or (Loss) | $25,256,329 | $21,467,573 |
| State Net Benefits or (Loss) | $466,318,070 | $57,293,478 |

Source: The Hallstrom Group, Inc.

The positive signs continued into early 2011, but were de-stabilized in the spring by events external to the islands, including the Japan earthquake and tsunami, political instability in the Middle East, rising oil prices, European credit issues, and a sluggish mainland US recovery. Tourism, hotel and retail indicators, the underpinning of the islands' private sector economy, showed resilience and generally shrugged off the concerns, continuing to experience growth through the rest of the year and the first quarter of 2012.

Many industries in the Hawaii economy have moved into/through the post-recession stabilization phase and are achieving recovery and offering signs of emerging growth trends. Others, such as construction, remain mired within an extended slow-down without major near-term recovery prospects. Outside of the visitor industry, widespread economic expansion is still not occurring, particularly on the neighbor islands.

While activity and interest levels have shown significant increases, prices in most sectors of the Hawaii real estate market have not demonstrated substantial revival during the initial economic recovery over the past two years.

However, on Maui, demand for moderate to lower priced residential units continues to be very high (and evidencing some appreciation), investor interest in hotels and other commercial properties has meaningfully increased, and there are escalating numbers of Asian buyers (notably Japanese, Chinese and Korean) attracted by the post-recessionary prices and a favorable exchange rate.

Notwithstanding the impacts on the Maui residential sector from continuing external factors, the market has foundational conditions which should enable a move towards an upcycle if the national economy stays out of recessionary mode. Mortgages are again readily available at generationally-low interest rates (although the approval process is more extensive), there is no major "overhang" of existing inventory which must be absorbed as in many American cities, and there has been continuing natural household growth over the past four years

which creates pent up demand that will again express itself via real estate as the island economy regains its vigor.

According to the University of Hawaii Economic research Organization (UHERO) May 2012 forecasts, 2012 will see further tourism strength, the beginnings of recovery in construction, healthier government finances, and increases in employment and wages; with favorable trends extending into 2013 and beyond. Maui will continue to lead the neighbor islands in recovery and in returning to an up-cycle economy, although Kauai and the Big Island are expected to post widespread gains this year after thusfar being left behind in the recovery process.

The State of Hawaii Department of Business, Economic Development and Tourism (DBEDT) is also bullish in its 2nd quarter 2012 forecasts, stating:

> "Based on the most recent development in the national and global economy, the performance of Hawaii's tourism industry, the labor market conditions in the state, and growth of personal income and tax revenues, Hawaii's economy is expected to continue positive growth for the rest of 2012 and into 2013. Overall, the current DBEDT forecast is more optimistic for most of the economic indicators, especially visitor related indicators, compared with the previous forecast."

This economic cycle of "boom, bust, stabilization, then recovery to another boom period" has been numerously repeated since Statehood in seven to 10-plus year time-frames.

Expectations are statewide real estate activity will show modest gains for the remainder of 2012 and into 2013 (albeit at lower prices and absorption levels than mid-decade highs), followed by movement into the next growth cycle by 2014-15. Based on historic trending, by the mid to latter part of this decade, hyper-appreciation and shortages of supply may well again be community concerns.

In 2011, both the statewide industrial and retail leasing markets experienced a negative net absorption, with each "losing" more than 100,000 square feet of tenants; the third straight year of

increasing vacancy. However, in the fourth quarter, retail space leasing showed positive absorption in every sector but Maui, and gains in most industrial areas throughout the islands. Expectations are that gains will continue to strengthen through the remainder of 2012 and show major lease-up of space in 2013-14.

The non-resort real estate market in the Kihei-Makena study area reflected overall market trends and fared similar to other neighbor island locales during the recent recession.

The average prices for single family homes plummeted by circa 40 percent from the 2006-08 peaks, with condominium prices off by "only" 25-plus percent. Activity in both sectors fell by upwards of two-thirds. By the end of 2012, the level of buyer interest was recovering and the number of sales up significantly from the lows in 2008-09.

The current environment of exceptionally low interest rates, pent-up demand (unexpressed during the recession), recovering economy and employment, and few overhanging units, is expected to stimulate demand and prices for residential properties and industrial and commercial space over the coming 18 months.

Regardless of the near-term issues, a solid foundation supports a continuing demand for a variety of urban uses in the primary study area over near to long-term.

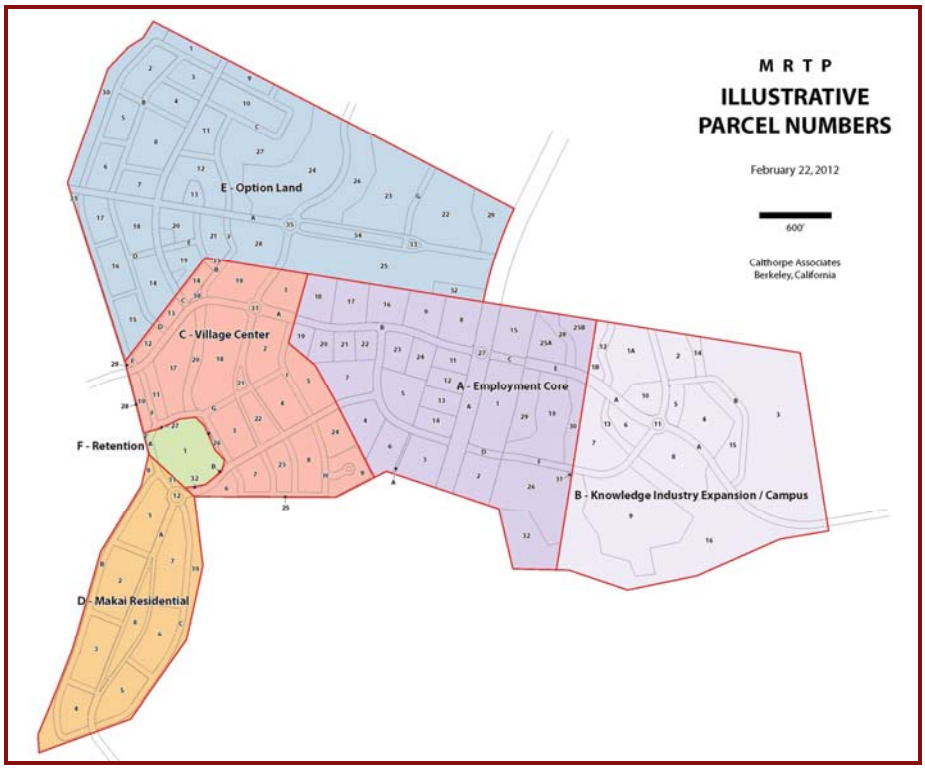
By the time the Park begins to offer parcels and residences for sale in the Petition Area, anticipated in late 2014 or 2015, the State/Maui economy and real estate market are expected to have fully recovered and be into a cyclical growth period marked by strong activity and increased absorption relative to current levels.

During the build-out period of MRTP there will be one or more economic/market cycles with periods of rapid absorption and others slow. And the recent recession and resulting impacts will be several years in the past by the time the project comes onto the market.

# OVERVIEW OF THE MASTER PLAN MARKET CONCEPT

The Maui Research & Technology Park (MRTP) Master Plan Update envisions an urban village embodying leading-edge planning, design, and development techniques providing a comprehensive lifestyle opportunity for a diverse population of residents, workers and customers within a sustainable, environmentally-aware project.

The Park will serve as a primary economic engine and high-value employment center for Maui over the next generation, providing an opportunity for expanding and new businesses to find space in a modern, amenitied, mixed-use community outside of the island's traditional industrial parks and commercial centers. The development is complementary to the other uses and exiting and proposed projects within the urbanizing Piilani Highway corridor.



We note, the "commercial/other" category includes a projected business hotel (90,000 square feet), a post office sorting center (34,000 square feet), and two civic facilities (each 50,000 square feet), in addition to a neighborhood shopping center (150,000 square feet), a mixed-use component, and a variety of other retail, restaurant and service spaces serving the MRTP community.

From a market perspective, the master plan builds upon several favorable factors, primary of which are:

- *It is within an expanding, high-demand area.* Kihei has grown many-fold in the past forty years while evolving from a sleepy visitor-oriented beach town into Maui's "second city".

  The demand for residential units in the area is strong, it experiences among the highest industrial and non-resort commercial occupancy levels on Maui, with available space typically quickly filled. Many of the stores, restaurants and service providers have been at their location for decades. It is becoming a more desirable business and shopping destination over time, with solid highway access characteristics and a well-populated neighborhood trade area. Kihei is an increasingly competitive location for new and expanding businesses.

  MRTP will enhance the standing of South Maui as a destination for business via new inventory specifically designed to comprehensively meet the demands of residents, workers and business within an integrated environment.

- *In concert with market trends.* While mixed-use, master-planned developments have been part of the market in Hawaii for several decades, they have traditionally been oriented heavily towards residential and supporting neighborhood commercial uses; lacking a true diversity of industrial/business park and other uses which create major employment centers. As such, much of the

transportation benefits, synergy, and lifestyle objectives sought by planners have not been achieved.

The MRTP Master Plan Update embraces a design which will create Maui's first comprehensive community, where thousands of residents will potentially have the opportunity to live, work, shop and play within a single development (of walkable scale) without having to add traffic to the regional road system.

- *Adaptability to an evolving market environment*. A competitive, large-scale, mixed-use project taking years to build-out, requires the ability to adapt to a changing market environment.

  In addition to enlarging the focus of MRTP beyond just the technology sphere and embracing a more diverse range of standard and emerging uses, the developer perceives a potential for other uses that could be successfully incorporated over time. These include a business hotel, civic facilities, and mixed-use and live/work spaces. The Economic Opportunity Campus Area is another atypical aspect of the master plan which will provide ready-developable acreage for a major land user interested in locating on Maui.

Based on our analysis of the subject property and project from a market perspective, we conclude the proposed MRTP Master Plan Update will:

- Embrace leading edge mixed use "urban village" design concepts.

- Maximize the reasonable development potentials of a well-located parcel.

- Complement the existing urban development in its Piilani Highway corridor, while establishing an integrated, lifestyle design precedent for future developments to follow.

- Address existing and forecast needs for additional residential, industrial/business park and commercial inventory in the study area.
- Integrate well with established and evolving planning and transportation goals.
- Provide a desirable/competitive and comprehensive "live, work" experience.
- Is representative of the highest and best use of the property.

## MARKET STUDY OF THE MASTER PLAN COMPONENTS AND ABSORPTION ESTIMATES

**The Study Area Residential Market**

The tables containing the model components summarized in this section are presented in Addenda Exhibit I.

Prior to the 1970s, Kihei was a small coastal village with fewer than 3,000 residents, with very limited resort-oriented and commercial uses. The development of Wailea Resort coupled with numerous condominium projects along South Kihei Road served to create a desirable visitor destination. At the same time, Kihei was identified as the most appropriate location for resident housing for the employees of the South and West Maui resort areas and to support the natural and in-migrating population growth of the island.

By 1980, the population had more than doubled to about 7,000 persons, substantial commercial space was being developed, and the region was well-established as a desirable vacation locale offering a wide variety of resort units.

While the near-makai areas continued to be dominated by resort/transient-oriented and non-resident use and ownership, the inland areas of Kihei began being developed at a rapid pace for local resident households. Over the next two decades, the resident population more than tripled.

Initially during this surge, most resident-oriented product was developed as vacant home sites which were then (for the most part) built-out individually as "custom" homes. However, over-time the trend was towards larger builders constructing spec tract homes. Today, 60 percent of the residential inventory in the study area is of a single family type.

Some full-time residents did locate into makai multifamily units, and there was a surge of resident-oriented interior condominium/apartment development, so that presently about 40 percent of regional households are in multifamily projects.

There were 17,981 non-resort "residential" units in the Kihei-Makena region as of the 2010 census. Of these, 4,433 units were transient vacation rentals (DBEDT Visitor Inventory Survey) and 13,548 were used for housing; 10,731 units (79.21%) by full-time resident households and 2,817 (20.79%) were second homes/part-time residences.

Long-range planning indicates there will be a need for an increase of 50 to 80 percent in order to service the anticipated demand created by community growth. It is expected that the division in product type will continue to favor single family homes/lots, but that condominium development will slightly increase as a percentage of the total market as available entitled, serviced land becomes further scarce and unit prices increase over time.

Until the last decade, most of the interior subdivision and multi-family inventory was purchased by resident households; the intended users from a planning perspective. But, given the desirability of the region among vacation home purchasers and the exceptionally high prices of in-resort units, well-capitalized non-resident buyers began to grab up homes and units in mauka non-resort developments; often out-competing the local segment for scarce inventory.

Studies done for the County and which we have completed, indicate that circa 20 to 30-plus percent of demand for new residential units in Kihei-Makena is created by non-resident

purchasers. This trend is anticipated to continue unabated apart from cyclical influences.

While purchaser restrictions can be/are applied to some categories of housing (specifically lower income and workforce housing types), there will always be competing non-resident purchaser pressure on the market-priced inventory. Thus, in order to achieve market stability and sufficient supply for resident families, it is necessary to provide suitable types and amounts of product to satiate this demand apart from resident neighborhoods.

Notwithstanding brief periodic downturns, as is presently being experienced, residential construction in Greater Kihei has progressed at a generally consistent and fairly rapid pace over the past three decades; a trend we anticipate will continue as long as suitable lands are made available for development. Among the primary reasons for this conclusion are:

- The region provides for a quality, comprehensive, modern, suburban lifestyle;
- There is a scarcity of alternative, entitled acceptable development areas throughout the island;
- In addition to the in-community availability of a broad range of commercial, industrial and service businesses, Kihei is proximate to goods, services, and support uses in Central Maui;
- Relative ease of access to major South Maui and Central Maui employment centers and other areas of the island;
- A warm, generally dry climate considered highly desirable by many residents and most non-residents; and
- Superior view panoramas from many interior locations.

Relative to most neighbor island areas, the balance between demand and supply in Kihei-Makena has been more stable than in most regions; although like elsewhere the market remains

generally under-supplied (just not acutely) from a long-term perspective. Yet, there remains significant unmet need for additional affordable housing opportunities.

The population of the Kihei-Makena study area was quantified at 26,810 as of 2010 US Census, and was estimated to be 27,436 as of year-end 2011.

Projections published by the County of Maui Planning Department in their *Socio-Economic Forecast: The economic projections for the Maui County General Plan 2030* (June 2006) estimate the resident population of Kihei-Makena will reach between 38,757 and 42,000 persons by 2030.

To provide at least a two decade study perspective, and as subject absorption will stretch past 2030, we have lengthened the time-frame to 2035 by escalating the Planning Department forecasts by an additional five years at the 2025-2030 growth rate in the model. We project that by 2035 the resident population in the study area will be between 41,750 and 46,200 persons.

Using the current average household size of 2.5 persons in Kihei-Makena (and acknowledging the long-term trend towards smaller households), along with an allowance of non-resident purchasers in the region of 20 to 25 percent, and a vacancy allowance of three to five percent to achieve a stable market, we have quantified the total demand for new housing inventory at between 7,760 and 12,009 units between 2012 and 2035, with a mid-point of 9,885 units.

These figures are consistent with Planning Department projections through 2030.

In order to best fit the forecast demand for units in the region over the next 24 years they will need to be priced (in 2012 dollars) at:

- 20 percent under $320,000, which meet affordability guidelines for a household of four earning 80 percent of the County median household income ("Low Income");

- 23 percent from $320,000 to $640,000, considered affordable to households earning from 81 percent to 140 percent of median County income ("Below Moderate" to "Gap Income" categories);

- 25 percent from $640,000 to $1,000,000; and

- 32 percent at over $1,000,000.

The year-end 2011 average price on Maui for a single family home was $787,552 and at $485,874 for a multi-family unit.

Through the end of last year, the Kihei-Makena market remained significantly down from its 2005-07 peaks; however, the number of single family house and multi-family unit sales has increased in each of the last two full years since bottoming-out in 2009, though still well below activity at mid-decade.

Prices continue to be soft in the study area, but are demonstrating stabilization, with early 2012 data pointing to strengthening prices in the near term. The average price for a single family home in the Kihei-Makena region in 2011 was $1,173,343, up nominally from 2010. The average price of a multi-family unit during last year was $550,318, down five percent from 2010.

The projected demand in the study area will be met through increasing percentages of multi-family units in the regional inventory, moving from recent development trends of circa 40 percent of the total new product to 47 percent new units by 2035, and comprising 44 percent of new unit additions. Single family product will drop from 60 percent to 53 percent during the 24 year projection period, and vacant house lots will continue to decline in market share.

Relative to past down economic cycles, there was not a significant amount of unsold new product "overhanging" in the study area waiting to be absorbed as the market recovered. As a result, virtually all projected demand must be met via new development.

There are numerous residential projects entitled, proposed, or announced in the study area. As part of the on-going Community Plan updating process the Planning Department has created a series of maps showing the scope and extent of the existing and proposed urban uses in the region. The Department has also worked with Citizen Advisory Committees to produce recommendations regarding future development.

The *South Maui Development Projects Directed Growth Boundaries Map* prepared by the Long Range Planning Division of the County Planning Department, which is intended to identify the extent of the proposed Directed Growth Boundaries in the Kihei-Makena region and the proposed development therein, contains approved/proposed projects totaling approximately 7,752 units (excluding time share/hotel and MRTP units, and an assumption that 60 percent of the proposed Kaononulu Village is within the boundary).

Of this total, some 1,716 are within the Wailea and Makena destination communities or along the shoreline between them; of which we estimate only about 40 percent of those within Makena will be competitive in the resident-oriented housing sector, the remainder being upscale resort-residential product.

The net resident-oriented housing unit supply would be about 6,539 total new units in the approved/proposed projects, of which 3,364 (51.5 percent) are to be single family homes/lots and 3,175 (48.5 percent) will be multi-family.

This total will be insufficient to meet even the minimum demand for housing in Kihei-Makena over the next 24 years, estimated at 7,760 units, and fall well short of the maximum of 12,009 units.

The Maui County General Plan Advisory Committee also prepared maps to support the on-going update of the Kihei-Makena Community Plan. While similar to the Planning Department, there are only portions of Kaonoulu Village and Ohukai Village and some projects with lowered densities included in the recommendations.

Their proposals equate to a total of 5,784 new housing units in the study area; or nearly 2,000 units less than minimum market demand requirements to 2035.

We have estimated the probable market acceptance levels and resulting absorption of the saleable master plan components of the Maui Research & Technology Park updated master plan using three methodologies.

- Gross Demand/Supply Comparison -- This technique assumes that if there is insufficient existing and planned supply to meet projected market gross demand levels during the projection period there is rational support for the subject units.

- The Residual Method -- In this technique, the competitive inventory planned for the Study Area over the projection period is placed on a time-line depicting their combined anticipated rates of absorption or assuming a reasonable market share. To the extent this periodic supply of units fall short of the forecast periodic demand for product in the Study Area, an undersupply situation is present and there is "residual" demand remaining for the MRTP inventory. This method is considered the most conservative as it allows all of the competitive product to achieve their absorption potential before the residual is available to absorb the subject.

- The Market Shares Method -- This approach accounts for the probable competitiveness of the subject inventory regardless of the total level of product being otherwise offered on the market. In essence, it is an estimate of how much of the total forecast demand in the Kihei-Makena region (or alternatively islandwide) the subject could expect to capture on an annual basis in light of its location, estimated pricing, competitiveness, and amenity characteristics.

Gross Demand for additional housing units in the study area will exceed anticipated supply by between 1,200 (minimum) to

6,225 units (maximum), with a mid-point shortfall of some 3,300 to 4,100 units.

Even if all of the under-construction and other potential units identified in the region achieve the absorption velocities anticipated, or enter the market as quickly as possible, there will still remain substantial unmet Residual Demand for both single family homes/lots and multi-family units in every five-year projection period from 2012 through 2035.

Using mid-point demand estimates and the higher Long Range Planning Division supply figures, the unmet periodic demand ranges from 372 units (from 2016 to 2020) to 1,030 units (2031-35). This residual demand is sufficient to absorb the subject units in a timely manner within a 12 to 15-year exposure period (pre-sale to sell-out) commencing in 2016.

Given the master-planned amenities, anticipated mid to lower-end pricing, and comprehensive lifestyle envisioned for MRTP, it will achieve a solid standing and prove strongly competitive in the regional housing market; able to garner a significant share of demand even though there are large numbers of competing units proposed.

We estimate the subject could achieve an average Market Shares (or "Capture") Rate of circa 20.7 percent of the total Kihei-Makena demand for new resident-oriented single family homes/lots during its offering period, and 21.8 percent of multi-family unit demand. A total absorption period for the subject residential product of about 16 years is indicated by this analysis, within a range of 11 to 17 years for the multi-family units and 13 to 21 years for the single family homes.

We conclude the 1,250 proposed units of the MRTP master plan will achieve full absorption within approximately fourteen-years of initial pre-sale offerings; which are anticipated to commence in 2017.

**The Study Area Commercial Market**

The tables containing the model components summarized in this section are presented in Addenda Exhibit II.

The primary focus for commercial uses at MRTP will be to meet the retail, restaurant, service, medical and support commercial demands created by residents and workers in the community along with their guests and customers. Live/work and mixed-use opportunities, along with some specialty retailers and the cumulative attraction (synergy) of an emerging economic center on the island will also add to the floor space demand in the project. But it is not an objective of the updated master plan for MRTP to become a major regional/island shopping destination or support big box development.

Historically, Kihei-Makena has been a secondary commercial sector on Maui. While floor space has been steadily added since the mid-1980s, including major new projects during the past decade, it has continued to be focused towards resident-serving "neighborhood" and visitor-oriented businesses. Most "big box", major mall, destination and specialty retailers serving a super-regional/islandwide market are still located in Wailuku-Kahului. For the most part, this trend is expected to continue, particularly in regards to big box development; however, an increase in specialty retailers is probable for the study area in coming decades along with some destination types and perhaps a major mall.

At present, there is some 4.5 million square feet of commercial floor space on Maui, or the equivalent of 23 square feet of gross leasable area per capita of the de facto population (residents and visitors).

In Kihei-Makena, there is an estimated 697,208 square feet of competitive commercial floor space, or about 15.5 percent of the gross floor area on the island. This equates to a per capita spatial allowance of 15 square feet per member of the de facto study area population, or only 65 percent of the islandwide per capita average.

Given the shortfall between the study area per capita floor space (15 square feet) and the islandwide average (23 square feet), it can be asserted that the Kihei-Makena region is generally underserviced in regards to commercial floor space on a gross demand/supply basis.

The commercial development and per capita demand capture rate in Kihei is reflective of the suburban "bedroom" community it has become.

Neighborhood retail uses typically constitute about 45 to 55 percent of per capita demand, with Service Commercial, Medical and Support commercial spaces combining for another 25 to 35 percent of the total. The majority of these uses are already available in the study area to serve local needs, and capture most of the demand created by the study area population for such businesses.

The remaining 10 to 30 percent of per capita demand is oriented towards big boxes, major centers, destination and specialty retailers and in-hotel space. Apart from the hotel spaces in Wailea and Makena, most of this demand is focused towards other areas of the island.

As Greater Kihei continues to grow and evolve as a community, the commercial uses in the region will intensify and diversify as a broader range of businesses seek to locate in an expanding market area. The regional capture rate of the study area per capita demand will increase over time from its current level of 65 percent to between 80 and 90 percent by 2035.

Total regional capture (100 percent) of all per capita demand is not likely, as many businesses serving an islandwide market, specialty retailers and big boxes will remain focused in Wailuku/Kahului.

The combination of a growing de facto population, increasing per capita demand (forecast to reach 30.5 to 33.0 square feet per person on Maui by 2035), and an escalating regional capture rate, will create demand for between 907,000 and 1,506,000 square feet of new gross commercial floor area in Kihei-Makena over the next 24 years, with a mid-point of 1,206,812 square feet; more than double the existing inventory.

An estimated 83 to 141 gross acres of land (112 acres mid-point) will be needed to support this forthcoming demand.

We estimate there are less than 60 acres of vacant, general plan-designated commercial sites in Kihei-Makena at present. Additional supply will be provided within several master planned communities in the corridor.

On a gross demand/supply comparison basis, there will be shortfall of commercial land in the study area over the next 24 years.

Application of the residual method is problematic due to the size and locational characteristics of the available sites and diversity of ownerships; however, it is apparent there will be a shortage of supply by next decade, and there will be substantial unmet residual demand available for MRTP.

With such a large "captive" resident and worker population (estimated at up to 8,643 persons), the number of persons who will be visiting the park to do business with the companies there, and the synergistic benefits of locating in an economic center, we conclude MRTP will prove competitive in the regional commercial market and capable of achieving a significant share of regional demand even though it is not a primary focus of the project.

We estimate the subject could achieve an average Market Shares (or "Capture") Rate of circa 37.6 percent of the total Kihei-Makena demand for new commercial floor space during its offering period from 2015 through 2034. This would equate to between 274,000 and 539,500 square feet of gross leasable floor area, with a mid-point of 406,750 square feet.

An estimated 179,090 square feet of this demand would be for neighborhood and related businesses serving the daily needs of the community, as shown on the following table.

**SUMMARY OF NEIGHBORHOOD COMMERCIAL SPACE DEMAND**
**CREATED BY SUBJECT RESIDENTS AT BUILD-OUT**
**Market Study of the Proposed Maui Tech Park Revised Master Plan**
**Aiea, Oahu, Hawaii**

| | | |
|---|---|---|
| ***1. Stabilized Subject Population*** | | |
| Full-Time Residents (2.5 persons per household) | | 2,765 |
| Full Time Eqivalent On-Site Workers | | 5,878 |
| ***2. Project Resident Per Capita Demand for Commercial Space (in Gross Square Feet per Person)*** | | |
| Total for All Commercial Needs (1) | | 33.0 |
| "Neighborhood Retail" Space Demand as Percent of Total | | 55% |
| Total Per Capita "Neighborhood Retail" Commercial Space Demand in Square Feet | | 18.2 |
| Allowance for "Service Commercial/Medical" Space (40% of Neighborhood demand) | | 7.3 |
| Allowance for "Support/Other/Destination Commercial" Space (20% of Neighborhood demand) | | 3.6 |
| Total Per Capita Floor Space Demand for Resident-Oriented/Neighborhood Commercial Space | | 29.0 |
| Capture Rate of In-Project Resident Neighborhood Demand | | 90.0% |
| Total Floor Space Demand for Resident-Oriented/Neighborhood Commercial Space | | 72,266 |
| ***3. Project Worker Resident Per Capita Demand for Commercial Space (in Gross Square Feet per Person)*** | | |
| Estimated Percent of Workers not Residing in Project | | 85.0% |
| Non-Resident Workers Patronizing Subject Commercial Businesses | | 4,996 |
| Total Per Capita Floor Space Demand by Workers for Neighborhood Commercial Space (2) | | 7.3 |
| Total Floor Space Demand by Workers for Neighborhood Commercial Space | | 36,273 |
| ***3. Indicated Subject Commercial Floor Space Demand*** | | |
| From Subject Project Population | | 108,539 |
| Patronage From Other Sources | **% of Community Demand** | |
| Day Workers and Patrons of Other Businesses in Community | 30% | 32,562 |
| Nearby Population in Non-Subject Projects | 15% | 16,281 |
| Passer-Bys/Intercept and Others | 20% | 21,708 |
| **Total Estimated Gross Floor Space Demand at Stabilization** | | **179,090** |

(1) Based on mid-point per person spatial demand in 2030.
(2) Based on capture rate of 25 percent of per capita resident demand in square feet.

Source: The Hallstrom Group, Inc.

In addition to the neighborhood-based and general demand contributing to the absorption of the subject commercial component, there is also envisioned a 150-room, limited service, business hotel (90,000 square feet), a 34,000 square foot US Post Office mail sorting center, and 50,000 square feet of civic facilities.

Overall, we estimate MRTP will absorb some 521,000 square feet of commercial and related uses during its 2017 through 2034 offering period.

**The Maui Industrial Market**

The tables containing the model components summarized in this section are presented in Addenda Exhibit III.

We have quantified the demand for the subject's industrial component using an islandwide (as opposed to Kihei-Makena regional) analysis. Light industrial uses are not as locationally-dependant as many commercial uses and they often have a distinct and wide-spread customer base. As such, a business may consider a variety of competitive, alternative locations.

Historically, the focus of industrial development on Maui has been in Wailuku/Kahului, owing to its proximity to the island's working port, airport, large population, seat of government, central location and access to major highways.

At present, there are some 10.72 million square feet of light industrial space on Maui, or about 55.7 square feet per person of the de facto population. More than two-thirds of the island's industrial space is in Wailuku/Kahului.

Some of this space is used for office development, and there are numerous base yards which utilize industrial lands.

There can also be large amounts of commercial/retail space in "industrial" projects, particularly in newer ones. This has been a trend in the neighbor islands for the past two decades, with some developments having upwards of 45 percent commercial or quasi-commercial users due to the leniency of zoning regulations.

Whether these uses are located in industrial or commercial complexes is irrelevant to total per capita floor space demand square foot multipliers and our conclusions. Regardless of how it is classified the total floor space required by the market would not be meaningfully different, just moved from one designated market sector to another.

Until the mid-1990s, Kihei-Makena did not have meaningful amounts of industrial development; few sites were available, established businesses preferred a Wailuku/Kahului location,

and prior to the opening of Piilani Highway, access was inferior and traffic congestion common.

Over the past two decades there has been increasing industrial development in the study area, fueled by an expanding regional population, increasing economic importance, rising land costs in Kahului, land use entitlement efforts, and enhanced transportation in and out of Kihei. Today, approaching 25 percent of new industrial/business/office development on Maui is oriented towards Kihei-Makena; a figure forecast to increase in coming decades.

Using the Department of Planning population projections for the islands as a base, we quantified the demand for additional industrial floor space on the island through 2035. We assume the per capita demand will continue to rise slowly from the current level to between 66.75 and 70.75 square feet by the end of the projection period.

We estimate the demand for additional "light industrial" floor space (of all types) on Maui from 2012 through 2035 will be from 5.26 million to 6.74 million square feet, with a mid-point of 6.00 million. This would represent a 56 percent increase over the current in-place total.

An estimated 466 to 599 gross acres of land (532 acres mid-point) will be needed to support forecast demand.

Of this demand, we anticipate that (assuming sufficient competitive space is made available) 50 percent will be directed towards Central Maui, 35 percent will flow into the South Maui study area, and 15 percent will take place elsewhere else on the island.

In light of its favorable characteristics, including a central/northerly Kihei location, proximity and ease of access to Piilani Highway, benefits of a master planned community, and limited availability of alternative sites, we forecast MRTP will capture a market share of about 62 percent of total South Maui industrial demand during the projection period (2012 to 2035) Absorption would start at 30 percent of the regional market in

the initial years of the project as it became established and other available sites were developed, escalating to a high of 75 percent of the sector by 2031-35 as the Park achieved full market standing, the other components were completed, and alternative lands became scarce.

A CB Richard Ellis survey estimated there are currently 884 parcels comprising some 2,620 acres of vacant industrial lands on Maui. This figure includes specialized sites near the harbor and airport, base yards, surrounding the Puunene mill, quarries, dump, and many parcels that are lacking infrastructure or otherwise not competitive in the general market. Most are located in Central Maui. While there is not a general shortage islandwide, the availability of quality sites is not as over-supplied as first appears.

The only significant "reservoir" of vacant industrial land in Kihei is on the mauka side of Piilani Highway, extending from the southerly frontage Ohukai Road, approximately one mile north of the subject. The general planned-designated area contains about 70 vacant acres. We anticipate these lands will be reasonably-competitive with the MRTP product, effectively splitting demand, until it is fully absorbed in 10 to 15 years and the subject moves into a somewhat dominant position in the market.

Overall, we estimate MRTP will absorb some 1.14 million to 1.48 million square feet of industrial/business park and related uses during its 2017 through 2034 offering period, with a mid-point of 1.31 million.

**The Economic Opportunity "Campus" Area Component**

In addition to the industrial, residential and commercial components previously analyzed, MRTP will contain a circa 40 acre "Economic Opportunity Campus Area" capable of supporting a major, atypical user(s) seeking a large, quality, well-serviced, integrated holding for a facility or institution of 300,000 to 500,000 square feet of floor space to conduct business.

Apart from selected public institutions, a few major hotels and commercial centers, such scale of uses are currently uncommon on Maui; particularly in private enterprise.

However, as Maui continues its evolution from a traditional rural, agrarian-based economy into a modern, urbanized service-based model, new and increasingly major users will be seeking appropriate locations on the island. Particularly as the population grows, the economy expands and Maui continues on the path away from Honolulu's dominance of the primary business and professional fields.

Evidence of this on-going trend can be found in the emergence of big box stores on the island over the past 15 years, ever increasing numbers of direct mainland flights, the movement towards tract-style home development, and even the construction of a non-resort airport/business hotel.

While identifying specific potential users, and to some degree even use-types, is problematic, as by definition they are outside the current market framework, Table C summarizes the scale of floor space requirements for some of the probable uses which may be looking for a Maui location over the next quarter century.

The MRTP developer reports that it has had discussions with public and private concerns interested in a large campus site within the park, including for a general hospital, skilled nursing/senior housing facility, executive health center/medical-tourism campus, an Air Force laboratory, and private educational institutions.

Efficient, sustainable land planning within an expanding economy calls for the provision of these sites, especially in a rapidly changing economic environment as Maui has been for the last four decades, for many reasons, among them:

1. Major users are looking for entitled, infrastructure-serviced development sites. Rarely do they seek to acquire a bulk parcel, undertake a prolonged entitlement process, and make a large capital investment in site infrastructure prior to building. It is very difficult to begin engaging potential users in detailed discussions regarding facility needs without a "shovel-ready" site.

TABLE C

**SUMMARY OF SPATIAL DEMANDS FOR SELECTED ATYPICAL MAJOR BUSINESS PARK/CAMPUS USES**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**

| | Educational | | Institutional | | Business/R&D | |
|---|---|---|---|---|---|---|
| **Use** | **Private/Secondary Campus** | **University Campus** | **Regional Medical Center** | **Community Arts & Civic Campus** | **Centralized Service Center** | **Major R&D Campus** |
| Primary Gross Site Area in Acres | 40 | 75 to 200 | 50 | 45 | 30 | 40 |
| Primary Gross Finished Floor Area | 275,000 | 500,000 to 1,100,000 | 450,000 | 350,000 | 325,000 | 400,000 |
| Effective FAR | 0.1578 | 0.1263 to 0.1530 | 0.2066 | 0.1786 | 0.2487 | 0.2296 |
| Ancillary Use Potentials | None | Dorms, R&D Park | Support Medical Space | F&B, Office | None | Office |
| Ancillary Gross Site Area in Acres | | 25 to 200 | 15 to 50 | 10 to 30 | | 5 to 25 |
| Ancillary Gross Finished Floor Area | | 200,000 to 1,500,000 | 150,000 to 550,000 | 125,000 to 325,000 | | 50,000 to 300,000 |
| Effective FAR | | 0.1837 to 0.1722 | 0.2296 to 0.2525 | 0.2870 to 0.2487 | | 0.2296 to 0.2755 |

Source: The Hallstrom Group, Inc.

2. These users often are choosing between locations in several communities. Not having a readily buildable site would place Maui in a meaningfully less competitive position to attract a user having other options.

3. The MRTP Updated Master Plan is designed to be a comprehensive, holistic, inter-working system. If implemented all at once, as proposed, it will be able to accommodate virtually any scale of business opportunity, from very small multi-tenant spaces to a major corporate campus. If not, the flexibility to accommodate the overall range of users will be reduced; an obstacle that impacted the Park during its first generation of development.

Although the timing for absorption of the Economic Opportunity Campus Area is unpredictable, we consider it likely to occur during the Park build-out period (by 2034). Further, we conclude it is an important asset of the MRTP which could strongly stimulate the velocity of the other subject industrial, residential and commercial inventory should it occur early in the project, and have potentially major positive impacts on the Park and regional economy well-beyond the eventual user.

Within our Economic Impact and Public Fiscal analyses, we have assumed this area of the master plan is developed with 400,000 square feet of floor space and opens in 2034; the end of the modeling period, as the timing of absorption and development of the "campus" is problematic to precisely forecast.

## ECONOMIC IMPACTS FROM DEVELOPMENT

Selected summary tables from the modeling process are contained in Addenda Exhibit IV. The primary sources and variables contributing to the model are footnoted on each table. All monetary figures are expressed in constant 2012 dollars.

MRTP has the potential to become a major "engine" in the Maui economy over the coming generation with investment, employment and business activity on a par with the primary resort and industrial/business projects on the island.

In order to forecast the primary economic impacts resulting from the development of the Updated Master Plan, we have constructed a model depicting the "lifespan" of the project from groundbreaking on Phase I (assumed in 2016), through the completion of the Phase II infrastructure emplacement in 2025, post-construction absorption to 2034, and stabilized "operation" thereafter.

The models also show the period from 2013 to 2015 during which there will be some development in the Park on the existing entitled and serviced lands (outside the petition area), and the master plan will be moving through the entitlement process.

The total "Build-Out" time-frame in the model stretches across 19-years, commencing in 2016, with sales/leasing and initial operations starting in the second year (2017).

Sources for the primary model factors include:

- Construction timing/phasing and costs were estimated by the development team.
- Job counts were taken from similar projects and operations, and/or based on industry standards.
- Wages are based on data from the State Department of Labor & Industrial Relations.
- Household size, income and spending, and de facto population estimates were based on government materials including US Department of Housing and Urban Development and 2010 census data.
- Business activity variables are based on our analysis of similar use-types on Maui and Statewide.

Since the timing of absorption and development of the Economic Opportunity Campus Area is an unknown, we have adopted a conservative perspective and assumed it is constructed in the final development period (2031 to 2034) for modeling purposes. This may result in an understatement of total economic impacts should it be built and put into operation at an earlier date.

The development and build-out of MRTP over the coming two decades will infuse some $1.39 billion in capital investment into the Maui economy. Local contractor and supplier profits are estimated to total more than $195.6 million.

The construction of the approximately two million square feet of industrial/commercial floor area and 1,250 housing units in the Park will require an estimated 6,461 "worker years" in a variety of trades, suppliers and services; an average of 340 Full Time Equivalent (FTE) positions per year for the 19 years of building. This is in addition to those jobs created by development on existing Park lots during the next several years pending implementation of the Updated Master Plan.

Most of these positions will not be new jobs for new businesses, but work flowing to existing contractors and suppliers.

The 1.4 million square feet of Industrial/Business Park and Economic Opportunity Campus operations will generate some 23,427 FTE worker years during the build-out period and provide stabilized employment for 4,276 permanent positions.

The nearly 521,400 square feet of commercial operations will generate some 16,411 FTE worker years from 2017-2034 and stabilized jobs for 1,490 persons.

The project will also require an estimated 113 worker years or maintenance and common element employment on a continual basis, and will generate some 14,717 worker years of off-site employment during build-out and a stabilized demand for 1469 FTE positions.

In aggregate, during the development of MRTP 68,022 worker years of employment will be created in construction and operations, on and off-site, with stabilized employment after completion of 7,347 jobs.

Wages paid to construction workers will total an estimated $456.7 million. Employment related to Park operations during build-out will total $2.21 billion including on-site ($1.51 billion) and off-site ($698.6 million), and stabilize at $285.5 million annually in 2034 and beyond.

At build-out the de facto population of MRTP will be some 2,765 persons of which 2,367 (or 86 percent) will be full-time residents. There will also be an average of 398 persons daily populating the community comprised of non-resident owners and their guests periodically using their "second" unit/home, and hotel guests.

Resident household income during build-out will total $708.5 million and average $74.2 million annually on a stabilized basis. Non-resident spending will total $377.3 million from 2017 through 2034, and average $29.6 million annually thereafter.

Discretionary expenditures into Maui businesses by the MRTP population are estimated at $802.4 million during construction and $74.2 million per year on a stabilized basis.

After completion of the community, the on-site businesses will generate an estimated $572.1 million in revenues/sales per year; the majority coming from the industrial/business park and campus operations. During the build-out period, activity will total some $6.17 billion in gross income.

With the exception of the hotel and maintenance & common element operations, MRTP business will be dominated by outside patronage. The project de facto population is estimated to create about eight percent of total on-site sales, the remaining 92 percent by customers residing elsewhere.

During the 19 years of build-out and absorption (2017-2034), MRTP will have a base economic impact on Maui of some $7.77

billion with a stabilized annual benefit of $900.7 million thereafter.

We note that not all of this spending will be "new" to Maui. A small portion, specifically the commercial demand created through intercept of non-project residents, represents a relocation of their patronage from other commercial locations. Similarly, there will be some businesses which are relocating to the Park for a variety of reasons, not newly created or an expansion outlet.

However, our demand calculations are based on overall growth in the Maui economy creating the need for new industrial, business parks and commercial spaces. So whether that new growth takes place in MRTP, or it is a new business filling the vacated space elsewhere, a similar level of economic expansion will take place on Maui. Our task is to identify the specific economics related to the development of the subject property.

We have also analyzed the impacts of the project for Maui and Statewide using the State Input-Output economic model Type II multipliers. These factors quantify the total Direct, Indirect and Induced "effects" of various forms of business and spending activity as it flows through the economy of the islands.

In every instance, application of the macro Input-Output multipliers resulted in higher dollar, employment and tax revenue indicators than in our subject-focused micro model which was designed to reflect Direct and primary Indirect impacts only.

Among the outputs using the State method:

- The $1.39 billion in cumulative MRTP construction costs will generate a total State Economic Output of $2.94 billion.

- Direct subject construction wage earnings of $456.7 million will yield another $278.6 million in statewide wage earnings.

- Indirect and induced State taxes associated with construction will total more than $165 million in addition to direct taxes paid by the project.

- Direct effect jobs created by MRTP construction employment will be 2.68 times the number of on-site workers, or a total of 17,315 worker years of employment. The total job multipliers from the construction activity as it spreads directly and indirectly across the islands will be 13.83 times the on-site employment, or more than 89,000 worker years during the build-out period.

- The $6.17 billion in cumulative MRTP business activity during the 19-year build-out period equates to a total State Economic Output of $12.91 billion. On a stabilized basis, the $572.1 million in annual business activity will result in $1.2 billion in total impact per year.

- Direct on-site wages paid by operating businesses of $1.51 billion during construction will yield another $1 billion in statewide wage earnings. Upon stabilization, the direct wages of $217 million annually equates to an additional $145 million in other wages.

- Indirect and induced State taxes associated with business operations will total $1 billion in addition to direct taxes paid by the project during build-out and more than $100 million more per year thereafter.

- Direct effect jobs created by MRTP business operations will be about 2.10 times the number of on-site workers, or a total of 98,400 worker years of employment from 2017 through 2034, and 12,343 annually after stabilization.

MRTP will have nominal impacts on the socio-economic aspects of Greater Kihei that relate to real property issues. Property values in the study area are largely driven by external, cyclical economic factors and cumulative mass, not any single new project.

The envisioned MRTP homes are, for the most part, to be moderately priced; below the average for single family and multi-family units in Kihei-Makena. They will have a diversity of scale and style that will be generally consistent with nearby residential development and with other proposed master planned projects in the study area.

The project will fit in well with the emerging and proposed mixed-uses in the Piilani Highway corridor. The residential component of the Park is designed to house any in-migration to Maui as a direct result of MRTP or its operating components.

## PUBLIC FISCAL COSTS/BENEFITS ASSOCIATED WITH THE PROJECT

The master summary table from the modeling process is presented in Exhibit V.

**Public Fiscal Benefits (Tax Revenues)**

Maui County and the State of Hawaii will receive millions of dollars in tax receipts from the construction and "operation" of MRTP, from numerous revenue sources.

For the County, the primary tax source will be from Real Property Taxes paid by the owners of the various Park components. The property tax receipts were estimated by applying prevailing tax rates against the projected market value of the finished inventory (total construction costs, plus underlying land value, and developer's profit). Appropriate allocations were made for homeowner exemptions, assumed to be $200,000 within the model.

We estimate the County will receive some $82.6 million in real property tax receipts during the 19-year build-out of the project, and annual collections of $16.9 million on a stabilized basis thereafter.

The County will also receive 10.2 percent of the $730,700 in annual Transient Accommodation Tax (TAT) collected by the stabilized business hotel operation, or an average of $74,531 per

year. The State receives 55.2 percent of the tax, the remainder split between Maui, Hawaii and Honolulu counties.

Secondary taxes associated with other daily activities in the subject community will contribute additional funds.

Real Property Taxes (RPT) and TAT typically generate about 74.2 percent of total County General Fund revenues, with secondary taxes and fees the forming the remainder. It is logical to assume the MRTP development and business activities will generate secondary taxes in proportion to RPT and TAT as does the overall Maui community.

The secondary Maui County receipts are equal to 33.8 percent of the RPT and TAT total (25.8% divided by 74.2%).

Application of this ratio to the MRTP property tax and TAT sums results in a cumulative total estimated County tax collection from the subject of $112.2 million during the initial construction and sales period, and $28.5 million annually on a stabilized basis.

Additionally the County will receive a minimum of $29.1 million in impact fees for parks, water service and wastewater service, or circa $23,200 per unit on average. Further fees may be imposed. These fees push the total County collections (primary taxes, secondary taxes and impact fees) to $141.3 million during the development period.

The State of Hawaii will receive an estimated $208.1 million in primary receipts from State Income Taxes from worker wages, resident household incomes and profits from operating businesses based on average statewide corporate and personal payments rates of 4.4 percent and 5.1 percent, respectively, applied against the economic model forecasts.

On an annualized basis after completion of the community in 2034, the State will generate income taxes of $20.9 million; the majority (81 percent) from personal returns.

The State will collect Gross Excise Taxes (GET) of 4.166 percent on the gross amount of building contracts, construction supplies, spending by workers and residents, and outside patronage at operating businesses in the Park during the 19-year construction and absorption period will total $382.3 million, and a stabilized amount of $44.7 million annually.

The State will also receive its share of the TAT generated by the business hotel.

Income Tax, GET and TAT generate about 82 percent of total State revenues, secondary taxes and fees the remainder. We anticipate MRTP activity will result in similar ratios of secondary taxes flowing from the Park relative to the primary sources quantified.

The secondary State receipts are equal to 22 percent of the Income, GET and TAT totals (18% divided by 82%).

Application of this ratio to the MRTP income tax, GET and TAT sums results in a cumulative total estimated tax collection from the subject of $747.1 million during the initial 19-year construction and sales period, and $80.4 million annually on a stabilized basis.

Additionally the State will receive a minimum of $5.4 million in Department of Education school impact fees, an average of $4,284 per housing unit. Further fees may be imposed. These fees push the total State collections (primary taxes, secondary taxes and impact fees) to $752.5 million during the development period.

**Public Fiscal Costs**

Having quantified the cumulative revenue benefits, the second step in public fiscal assessment is to quantify the probable costs of local government services which will be required directly due to, or in general support of, the project. This is done using a "per capita costs" method described and applied following.

By comparing the tax benefits (revenues) generated by the subject with the estimated costs of providing public services, the net fiscal impact of the development can be determined.

The most appropriate way to estimate governmental expenses associated with a major new project is on a "per capita basis". This is founded on the assumption that every individual in a community is equally responsible for all costs of governance regardless of the actual services they, their household, or business may avail themselves of.

This approach is founded on a commonweal concept. If a project results in the expansion of the community, the costs of governance generally rise proportionately, and the new development should bear the direct, indirect and implied government expenses, which is best reflected on a per person (or per capita) cost per year.

This method represents the maximum cost perspective in regards to estimating public costs for a modern, mixed-use project containing significant numbers of resident households, and is appropriate as most costs of government are related to individual living needs. In general, businesses pay (in fact, collect) taxes and people require services.

The State 2011-12 combined operating and capital budgets totals some $13.05 billion servicing a de facto population of 1,558,301 individuals (residents and tourists), or an average per capita expense of $8,373 per person in aggregate State spending.

Similarly, the County of Maui 2011-12 budgets will spend some $5.43 billion in operating and capital costs servicing a de facto population of 213,479 individuals, or an average per capita expense of $2,545 per person.

Application of these per capita figures to the stabilized projected de facto population of MRTP upon full absorption of 2,765 persons, results in total per capita costs of:

- $23.15 million to the State of Hawaii on an annual, stabilized basis with costs totaling $286.1 million during build-out; and,

- $7.03 million per year on average to the County of Maui upon completion, and an aggregate expense of $87 million from ground-breaking through 2034.

**Correlation of Public Costs and Net Fiscal Impact**

It is estimated the County of Maui will:

- Receive an aggregate total of $141.3 million in primary and secondary revenues and impact fees over the course of the 19-year construction period and $28.5 million thereafter on a stabilized annual basis.

- Expend $87 million in allocated per capita costs in servicing the project during its absorption period, and $7.03 million per year thereafter.

- Realize a net benefit of $25.3 million during the modeling time-frame, and a stabilized net "profit" margin of $21.5 million per year.

The State of Hawaii will:

- Receive an aggregate total of $752.5 million in primary and secondary tax revenues and impact fees during the construction period and $80.4 million thereafter on a stabilized annual basis.

- Spend $286.1 million in servicing the project during its absorption period on a per capita basis, and $23.15 million per year thereafter.

- Realize a net benefit of $466.3 million on a per capita basis during the modeling time-frame, and a stabilized net profit margin ranging of $57.3 million annually.

## LIMITING CONDITIONS AND ASSUMPTIONS

The research, analysis, conclusions, and certification for valuation or market studies performed by The Hallstrom Group, Inc. are subject to and influenced by the following:

- The report expresses the opinion of the signers as of the date stated in the letter of transmittal, and in no way has been contingent upon the reporting of specified values or findings. It is based upon the then present condition of the national and local economy and the then purchasing power of the dollar.

- Legal descriptions used within the report are taken from official documents recorded with the State of Hawaii, Bureau of Conveyances, or have been furnished by the client, and are assumed to be correct. No survey is made for purposes of the report.

- Any sketches, maps, plot plans, and photographs included in the report are intended only to show spatial relationships and/or assist the reader in visualizing the property. They are not measured surveys or maps and we are not responsible for their accuracy or interpretive quality.

- It is assumed that the subject property is free and clear of any and all encumbrances other than those referred to herein, and no responsibility is assumed for matters of a legal nature. The report is not to be construed as rendering any opinion of title, which is assumed to be good and marketable. No title information or data regarding easements which might adversely affect the use, access, or development of the property, other than that referenced in the report, was found or provided. The property is analyzed as though under responsible ownership and competent management.

- Any architectural plans and/or specifications examined assume completion of the improvements in general conformance with those documents in a timely and workmanlike manner.

- Preparation for, attendance, or testimony at any court or administrative hearing in connection with this report shall not be required unless prior arrangements have been made therefor.

- If the report contains an allocation of value between land and improvements, such allocation applies only under the existing program of utilization. The separate valuations for land and building must not be used in conjunction with any other purpose and are invalid if so used.

- If the report contains a valuation relating to a geographical portion or tract of real estate, the value reported for such geographical portion relates to such portion only and should not be construed as applying with equal validity to other portions of the larger parcel or tract; and the value reported for such geographical portion plus the value of all other geographical portions may or may not equal the value of the entire parcel or tract considered as an entity.

- If the report contains a valuation relating to an estate in land that is less than the whole fee simple estate, the value reported for such estate relates to a fractional interest only in the real estate involved, and the value of this fractional interest plus the value of all other fractional interest may or may not equal to the value of the entire fee simple estate considered as a whole.

- It is assumed that there are no hidden or inapparent conditions of the property, subsoil, or structures which would render it more or less valuable; we assume no responsibility for such conditions or for engineering which might be required to discover such factors.

- Nothing in the report should be deemed a certification or guaranty as to the structural and/or mechanical (electrical, heating, air-conditioning, and plumbing) soundness of the building(s) and associated mechanical systems, unless otherwise noted.

- Information, estimates, and opinions provided by third parties and contained in this report were obtained from sources considered reliable and believed to be true and

correct. However, no responsibility is assumed for possible misinformation.

- Possession of the report, or a copy thereof, does not carry with it the right of publication, and the report may not be used by any person or organization except the client without the previous written consent of the appraiser, and then only in its entirety. If the client releases or disseminates the reports to others without the consent of the appraiser, the client hereby agrees to hold the appraiser harmless, and to indemnify the analysts from any liability, damages, or losses which the analysts might suffer, for any reason whatsoever, by reason of dissemination of the report by the client. Further, if legal action is brought against the analyst by a party other than the client concerning the report or the opinions stated therein, the client agrees, in addition to indemnifying the analysts for any damages or losses, to defend said analysts in said action at client's expense. However, nothing herein shall prohibit the client or analysts from disclosing said report or opinions contained therein as may be required by applicable law.

- Disclosure of the contents of this report is governed by the By-Laws and Regulations of the Appraisal Institute. Neither all nor any part of the contents of this report (especially any conclusions as to value, the identity of the appraisers or the firm which they are connected, or any reference to the Appraisal Institute or to the MAI designation) shall be disseminated to the public through advertising media, public relations media, news media, sales media, or any public means of communication without the prior consent and approval of the appraisers.

- Unless otherwise stated in this report, the existence of hazardous material, which may or may not be present on the property, was not observed by the appraiser. The appraiser has no knowledge of the existence of such materials on or in the property. The appraiser, however, is not qualified to detect such substances. The presence of substances such as asbestos, urea-formaldehyde foam

insulation, or other potentially hazardous materials may affect the value of the property. The value estimate is predicated on the assumption that there is no such material on or in the property that would cause a loss in value. No responsibility is assumed for any such conditions, or for any expertise or engineering knowledge required to discover them. The client is urged to retain an expert in this field, if desired.

- The Americans with Disabilities Act (ADA) became effective January 26, 1992. We have not made a specific compliance survey and analysis of this property to determine whether or not it is in conformity with the various detailed requirements of the ADA. It is possible that a compliance survey together with a detailed analysis of the requirements of the ADA could reveal that the property is not in compliance with one or more of the requirements of the act. If so, this fact could have a negative effect upon the value of the property. We did not consider possible noncompliance with the requirements of ADA in estimating the value of the property.

- The function of this report is for the sole purpose(s) stated herein. It may not be used in connection with any proposed or future construction for a real estate syndicate(s), real estate investment trust(s) or limited partnership to solicit investors or limited partners, and may not be relied upon for such purposes.

- The appraiser's conclusion of value is based upon the assumption that there are no hidden or unapparent conditions of the property that might prevent buildability. The appraiser recommends that due diligence be conducted through the local building department or the municipality to investigate buildability and whether the property is suitable for its intended use. The appraiser makes no such representations, guarantees or warranties.

# CERTIFICATION

The undersigned does hereby certify that, to the best of his knowledge and belief, the statements of fact contained in this report are true and correct. It is further certified that the reported analyses, opinions, and conclusions are limited only by the reported assumptions and limiting conditions, and are his personal, impartial, and unbiased professional analyses, opinions, conclusions and recommendations. He further certifies that he has no present or prospective interest in the property that is the subject of this report, and has no personal interest with respect to the parties involved. He has no bias with respect to the property that is the subject of this report or the parties involved with this assignment. His engagement in this assignment was not contingent upon developing or reporting predetermined results. His compensation for completing this assignment is not contingent upon the development or reporting of a predetermined value or direction in value that favors the cause of the client, the amount of the value opinion, the attainment of a stipulated result, or the occurrence of a subsequent event directly related to the intended use of this report. The Hallstrom Group, Inc. has not previously appraised the subject property within the three years prior to this assignment. The analyses, opinions, and conclusions were developed, and this report has been prepared, in conformity with the requirements of the Code of Professional Ethics and Standards of Professional Appraisal Practice of the Appraisal Institute, and the Uniform Standards of Professional Appraisal Practice. The use of this report is subject to the requirements of the Appraisal Institute relating to review by duly authorized representatives. The undersigned certifies that he has made a personal visit to the property that is the subject of this report. No other persons provided significant real property consulting assistance other than the undersigned.

Tom W. Holliday

Tom W. Holliday

/as 5090_R01

# ADDENDA

TABLE I-1 EXHIBIT I

**QUANTIFICATION OF HOUSING UNIT DEMAND FOR THE KIHEI-MAKENA STUDY AREA 2012 to 2035**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**

| | Year-End 2011 | 2015 | 2020 | 2025 | 2030 | 2035 | Additional Units Required by 2035 |
|---|---|---|---|---|---|---|---|
| **Scenario One: Minimum Based on Planning Department Baseline Population Forecasts** | | | | | | | |
| **Resident Population** | 27,436 (1) | 30,597 | 33,227 | 35,962 | 38,757 | 41,750 | |
| **Average Household Size (2)** | 2.50 | 2.48 | 2.46 | 2.44 | 2.42 | 2.41 | |
| **Total Resident Units Required** | 10,974 | 12,338 | 13,507 | 14,739 | 16,015 | 17,324 | |
| **Vacancy Allowance** (3 % of resident unit demand) | 329 | 370 | 405 | 442 | 480 | 520 | |
| **Non-Resident Purchaser Allowance (3)** (20% of resident unit demand) | 2,195 | 2,468 | 2,701 | 2,948 | 3,203 | 3,465 | |
| **TOTAL MARKET UNIT DEMAND** | **13,498** | **15,175** | **16,614** | **18,128** | **19,699** | **21,308** | **7,760** |
| **Scenario Two: Maximum Based on Planning Department Historical Trend Run Population Forecasts** | | | | | | | |
| **Resident Population** | 27,436 (1) | 30,500 | 34,000 | 38,000 | 42,000 | 46,200 | |
| **Average Household Size (2)** | 2.50 | 2.46 | 2.43 | 2.40 | 2.37 | 2.35 | |
| **Total Resident Units Required** | 10,974 | 12,398 | 13,992 | 15,833 | 17,722 | 19,660 | |
| **Vacancy Allowance** (5% of resident unit demand) | 549 | 620 | 700 | 792 | 886 | 983 | |
| **Non-Resident Purchaser Allowance (3)** (25% of resident unit demand) | 2,744 | 3,100 | 3,498 | 3,958 | 4,430 | 4,915 | |
| **TOTAL MARKET UNIT DEMAND** | **14,267** | **16,118** | **18,189** | **20,583** | **23,038** | **25,557** | **12,009** |

**CONCLUDED HOUSING UNIT DEMAND RANGE**

| | Existing | 2012-2015 | 2016-2020 | 2021-2025 | 2026-2030 | 2031-2035 | Totals |
|---|---|---|---|---|---|---|---|
| **MINIMUM DEMAND** | | | | | | | |
| Periodic | (50) | 1,677 | 1,438 | 1,515 | 1,570 | 1,609 | 7,760 |
| Cumulative | (50) | 1,652 | 3,066 | 4,580 | 6,151 | 7,760 | |
| Average Annual Demand (4) | | 330 | 283 | 303 | 314 | 322 | |
| **MAXIMUM DEMAND** | | | | | | | |
| Periodic | 719 | 1,851 | 2,071 | 2,394 | 2,455 | 2,519 | 12,009 |
| Cumulative | 719 | 2,211 | 4,641 | 7,035 | 9,490 | 12,009 | |
| Average Annual Demand (4) | | 442 | 486 | 479 | 491 | 504 | |
| **MID-POINT DEMAND** | | | | | | | |
| Periodic | 335 | 1,764 | 1,755 | 1,954 | 2,013 | 2,064 | 9,885 |
| Cumulative | 335 | 1,931 | 3,853 | 5,808 | 7,820 | 9,885 | |
| Average Annual Demand (4) | | 386 | 384 | 391 | 403 | 413 | |

(1) According to the 2010 US Census, there were 26,810 residents in the Primary Study Area (Kihei and Wailea CDPs). Figure escalated to 2011 at compounded annual growth rate from 2000 to 2010 of 2.23 percent.
(2) Census reported average household size for Primary Study Area in 2010 was 2.499 persons (2.55 in Kihei and 2.20 in Wailea).
(3) There were 17,981 total "housing units" in the Primary Study Area in 2010 according to the Census, of which 4,433 were transient vacation rentals (DBEDT survey) resulting in a total residential unit count of 13,548 units in the study area Of these, 10,731 units (79.21%) were occupied by full-time resident households and 2,817 units (20.79%) were second-homes/part-time residences.
(4) Existing (or latent) demand is assumed absorbed evenly from 2012 though 2020.

Source: US Census, County of Maui Planning Dept "Socio-Economic Forecast: Report", Various and The Hallstrom Group, Inc.

TABLE I-2 EXHIBIT I

**STRIATED PROJECTIONS OF HOUSING UNIT DEMAND**
**BY SELLING PRICE IN KIHEI-MAKENA STUDYAREA 2012 TO 2035**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**
**Expressed in Constant 2012 Dollars**

| Period | Periodic Demand 2012 to 2015 | 2016 to 2020 | 2021 to 2025 | 2026 to 2030 | 2031 to 2035 | Total Demand 2012-2035 |
|---|---|---|---|---|---|---|
| **1. Minimum Demand Forecasts** | | | | | | |
| **Less Than $320,000 (1)** | **330** | **283** | **303** | **314** | **322** | **1,552** |
| Percent of Total Demand | 20.00% | 20.00% | 20.00% | 20.00% | 20.00% | 20.00% |
| **$320,000 to $640,000 (2)** | **413** | **339** | **348** | **345** | **338** | **1,784** |
| Percent of Total Demand | 25.00% | 24.00% | 23.00% | 22.00% | 21.00% | 22.99% |
| **$640,000 to $1,000,000** | **413** | **353** | **379** | **393** | **402** | **1,940** |
| Percent of Total Demand | 25.00% | 25.00% | 25.00% | 25.00% | 25.00% | 25.00% |
| **Over $1,000,000** | **496** | **438** | **485** | **518** | **547** | **2,484** |
| Percent of Total Demand | 30.00% | 31.00% | 32.00% | 33.00% | 34.00% | 32.01% |
| **Total Market Demand** | **1,652** | **1,414** | **1,515** | **1,570** | **1,609** | **7,760** |
| | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% |
| **2. Maximum Demand Forecasts** | | | | | | |
| **Less Than $320,000 (1)** | **442** | **486** | **479** | **491** | **504** | **2,402** |
| Percent of Total Demand | 20.00% | 20.00% | 20.00% | 20.00% | 20.00% | 20.00% |
| **$320,000 to $640,000 (2)** | **553** | **583** | **551** | **540** | **529** | **2,756** |
| Percent of Total Demand | 25.00% | 24.00% | 23.00% | 22.00% | 21.00% | 22.95% |
| **$640,000 to $1,000,000** | **553** | **608** | **599** | **614** | **630** | **3,002** |
| Percent of Total Demand | 25.00% | 25.00% | 25.00% | 25.00% | 25.00% | 25.00% |
| **Over $1,000,000** | **663** | **754** | **766** | **810** | **857** | **3,849** |
| Percent of Total Demand | 30.00% | 31.00% | 32.00% | 33.00% | 34.00% | 32.05% |
| **Total Market Demand** | **2,211** | **2,431** | **2,394** | **2,455** | **2,519** | **12,009** |
| | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% |

***Current Median Housing Prices On Maui (Year-End 2011 Average)***

| | |
|---|---|
| **Single Family Median Price** | $787,552 |
| **Multi-Family Average Price** | $485,874 |

Note: The estimated median household income for Maui in 2012 is $77,100 for a four-person household; the accepted median baseline.

(1) This price is considered "affordable" for households earning 80% of the median county household income ("Low Income").
(2) This price is considered "affordable" for households earning from 81% to 140% of county median (includes "Below Moderate" to "Gap Income" categories).

Source: Maui County, DBEDT, MLS and The Hallstrom Group, Inc.

TABLE I-3 EXHIBIT I

**ESTIMATE OF HOUSING PRICE AFFORDABILITY FOR MAUI RESIDENTS**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui , Hawaii**
**Assuming Family of Four, 4.5 Percent Mortgage Interest Rate**

***1. Based on HUD/Maui County Criteria for Three-Bedroom Single Family House***

| Grouping | Low Income | Below-Moderate to Moderate Income | Above-Moderate to Gap Group Income |
|---|---|---|---|
| **Household Income as a Percent of County Median** | **80% or less** | **81% to 120%** | **121% to 160%** |
| Gross Household Monthly Income, Using Maximum for Category (1) | $5,140 | $7,710 | $10,280 |
| Amount Available for Debt Service (2) | $1,542 | $2,313 | $3,084 |
| Maximum Mortgage Amount (3) | $304,331 | $456,496 | $608,662 |
| Down payment at 5% of Sales Price | $16,017 | $24,026 | $32,035 |
| **Total Affordable Purchase Price, Maximum for Category** | **$320,348** | **$480,522** | **$640,697** |
| **Indicated Affordable Price Range for Category (Rounded)** | **Up to $320,000** | **$320,000 to $480,000** | **$480,000 to $640,000** |
| **County Pricing Guidelines for Other Unit Sizes and Types (4)** | | | |
| ***Single Family*** | | | |
| One Bedroom House | $224,210 | $338,350 | $448,490 |
| Two Bedroom House | $272,255 | $406,425 | $544,595 |
| Three Bedroom House | **$320,300** | **$480,500** | **$640,700** |
| Four Bedroom House | $368,345 | $552,575 | $738,805 |
| ***Multi-Family*** | | | |
| One Bedroom Unit | $201,810 | $302,750 | $403,620 |
| Two Bedroom Unit | $245,055 | $367,625 | $490,110 |
| Three Bedroom Unit | $288,300 | $432,500 | $576,600 |
| Four Bedroom Unit | $331,545 | $497,375 | $663,090 |

***2. Based on Conventional Financing Criteria***

| Grouping | Low Income | Below-Moderate to Moderate Income | Above-Moderate to Gap Group Income |
|---|---|---|---|
| Gross Household Monthly Income | $5,140 | $7,710 | $10,280 |
| Maximum Allowable Housing Expense (4) | $1,439 | $2,159 | $2,878 |
| Maximum Mortgage Amount (5) | $284,002 | $426,102 | $568,005 |
| Down payment at 20% of Sales Price (6) | $71,001 | $106,526 | $142,001 |
| **Total Affordable Purchase Price** | **$355,003** | **$532,628** | **$710,006** |
| **Indicated Affordable Price Range for Category (Rounded)** | **Up to $355,000** | **$355,000 to $530,000** | **$530,000 to $710,000** |

**THE BANK OF HAWAII INTEREST RATE ON A STANDARD 30-YEAR FIXED MORTGAGE DURING REPORT PREPARATION WAS 3.738% APR.**

Note: Total Purchase Price estimate excludes any points associated with financing.

(1) Utilizing US HUD 2012 median household income estimate for Island of Maui of $77,100 annually for family of four.
(2) Based on Maui County mortgage affordability criteria at 30% of gross income, apart from any reserves.
(3) Assuming 4.5% annual interest and 30 year mortgage with 5% down payment, no discount points.
(4) Conventional financing with maximum monthly mortgage payment at 28% of gross income, apart from any reserves.
(5) Assuming 4.5% annual interest and 30 year mortgage, with 20% down payment.
(6) Conventional financing standard.

Source: Maui County Dept. of Housing and Human Concerns, and The Hallstrom Group, Inc.

TABLE I-4 EXHIBIT I

**DIVISION OF PROJECTED DEMAND BY UNIT TYPE**
**FOR HOUSING UNITS IN KIEHI-MAKENA STUDY AREA 2012 TO 2035**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**

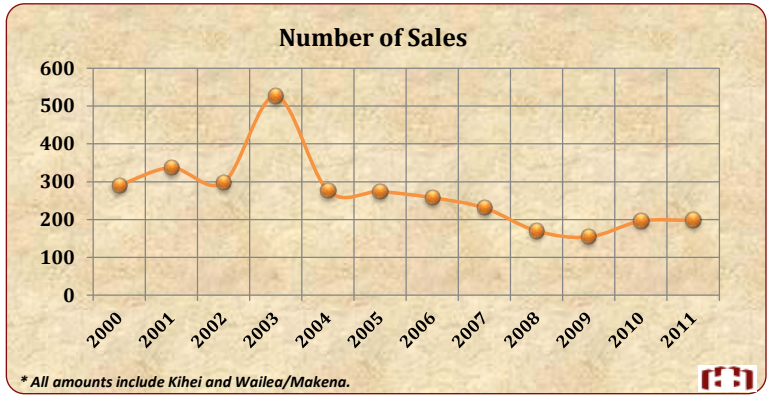
| | Periodic Demand (1) | | | | | Total Demand 2012-2035 | Comments |
|---|---|---|---|---|---|---|---|
| | 2012 to 2015 | 2016 to 2020 | 2021 to 2025 | 2026 to 2030 | 2031 to 2035 | | |
| ***1. Using Minimum Demand Projections*** | | | | | | | |
| Single Family Homes | 661 | 551 | 576 | 581 | 595 | 2,964 | The study area was among the first neighbor island regions to have significant numbers of "tract/spec" homes built relative to size of market, and this type of development has been the primary segment in the single family sector over the past two decades. |
| Percent of Total | 40% | 39% | 38% | 37% | 37% | 38% | |
| Single Family Lots | 330 | 269 | 273 | 267 | 257 | 1,396 | Prior to mid-80s, vacant lots were the primary single family development type. Now mainly limited to smaller and/or more upscale subdivisions. However, several major projects being proposed are expected to have significant lot offerings. |
| Percent of Total | 20% | 19% | 18% | 17% | 16% | 18% | |
| Multifamily Units | 661 | 594 | 667 | 722 | 756 | 3,400 | The primary residential development type in the makai/resort areas of the region, although the number of available and competitive sites has become somewhat limited. Need for affordable/workforce units will fuel continuing development as will demand for more moderate-priced vacation units. |
| Percent of Total | 40% | 42% | 44% | 46% | 47% | 44% | |
| **Total** | **1,652** | **1,414** | **1,515** | **1,570** | **1,609** | **7,760** | |
| | 100% | 100% | 100% | 100% | 100% | 100% | |
| ***2. Using Maximum Projections*** | | | | | | | |
| Single Family Homes | 884 | 948 | 910 | 908 | 932 | 4,582 | |
| Percent of Total | 40% | 39% | 38% | 37% | 37% | 38% | |
| Single Family Lots | 442 | 462 | 431 | 417 | 403 | 2,155 | |
| Percent of Total | 20% | 19% | 18% | 17% | 16% | 18% | |
| Multifamily Units | 884 | 1,021 | 1,053 | 1,129 | 1,184 | 5,272 | |
| Percent of Total | 40% | 42% | 44% | 46% | 47% | 44% | |
| **Total** | **2,211** | **2,431** | **2,394** | **2,455** | **2,519** | **12,009** | |
| | 100% | 100% | 100% | 100% | 100% | 100% | |
| ***Mid-Point*** | | | | | | | |
| Single Family Homes | 772 | 750 | 743 | 745 | 764 | **3,773** | |
| Single Family Lots | 386 | 365 | 352 | 342 | 330 | **1,776** | |
| Multifamily Units | 772 | 807 | 860 | 926 | 970 | **4,336** | |
| **Total** | **1,931** | **1,922** | **1,954** | **2,013** | **2,064** | **9,885** | |

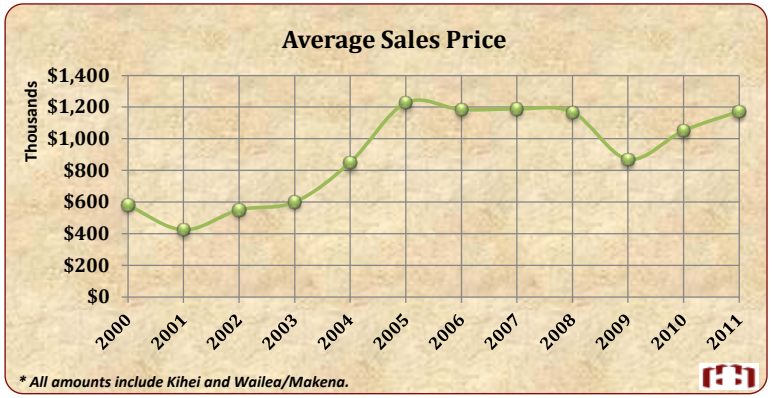
Source: The Hallstrom Group, Inc.

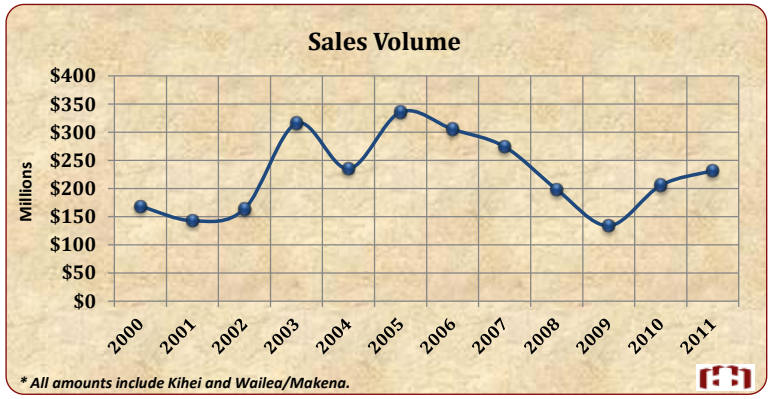
TABLE I-5 EXHIBIT I

**SUMMARY OF SUBJECT AREA MARKET ACTIVITY**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**

| SINGLE FAMILY | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Sales | 291 | 337 | 298 | 527 | 277 | 274 | 258 | 231 | 170 | 154 | 196 | 198 |
| Average Sales Price | $579,644 | $424,228 | $550,450 | $599,826 | $849,900 | $1,226,776 | $1,183,971 | $1,187,606 | $1,167,482 | $870,423 | $1,050,566 | $1,173,243 |
| Sales Volume | $168,676,462 | $142,964,749 | $164,034,105 | $316,108,384 | $235,422,430 | $336,136,498 | $305,464,404 | $274,337,002 | $198,471,941 | $134,045,068 | $205,910,942 | $232,302,164 |



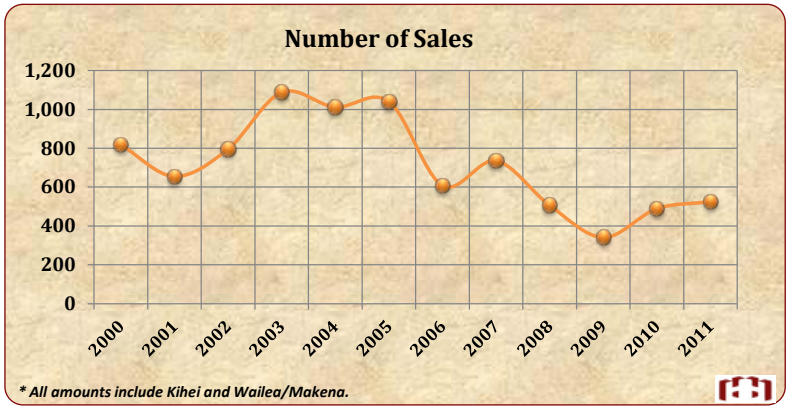



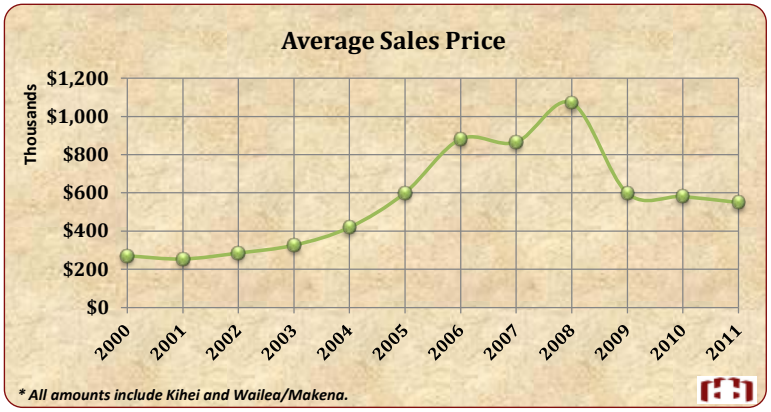

Source: Realtors Association of Maui as of February 16, 2012.

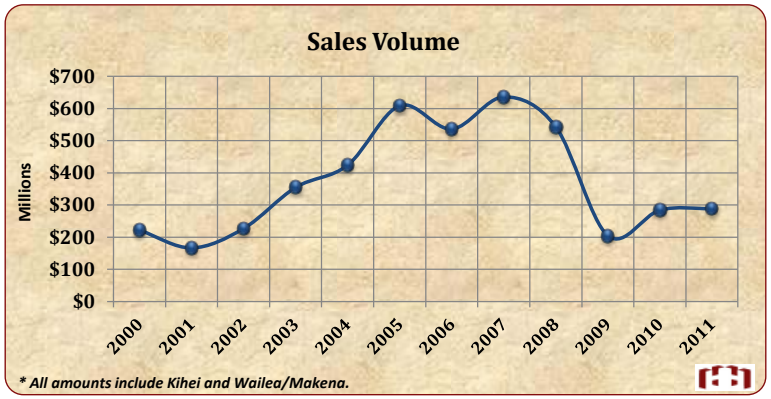
TABLE I-6 EXHIBIT I

**SUMMARY OF SUBJECT AREA MARKET ACTIVITY**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**

| CONDOMINIUM | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Sales | 818 | 655 | 795 | 1,087 | 1,011 | 1,040 | 608 | 735 | 506 | 341 | 489 | 525 |
| Average Sales Price | $271,237 | $254,476 | $285,572 | $326,559 | $419,764 | $600,913 | $882,436 | $865,897 | $1,072,460 | $599,731 | $581,505 | $550,318 |
| Sales Volume | $221,871,605 | $166,681,878 | $227,029,947 | $354,969,696 | $424,381,119 | $609,325,403 | $536,521,003 | $636,434,454 | $542,664,661 | $204,508,266 | $284,355,750 | $288,916,933 |



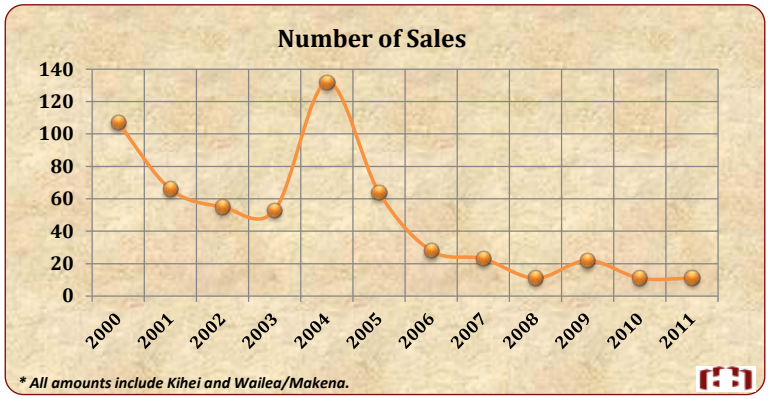



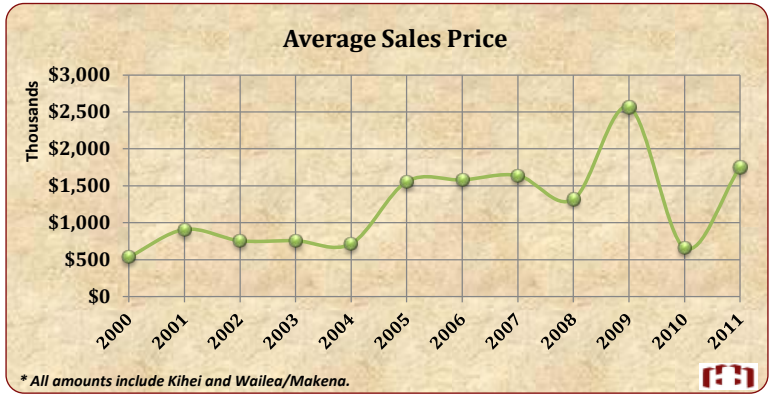

Source: Realtors Association of Maui as of February 16, 2012.

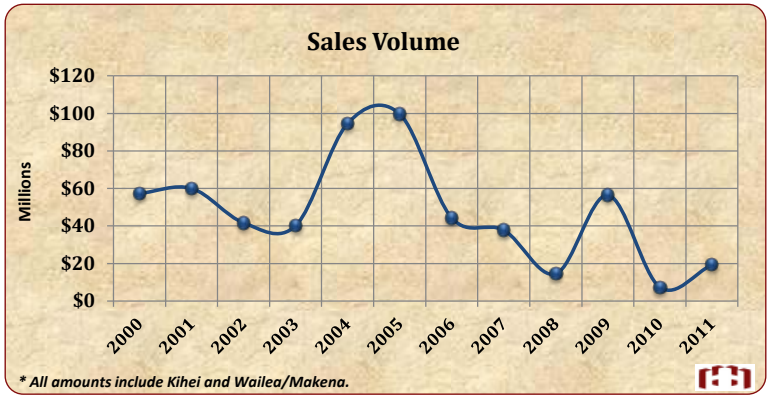
TABLE I-7 EXHIBIT I

**SUMMARY OF SUBJECT AREA MARKET ACTIVITY**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**

| VACANT LAND | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Sales | 107 | 66 | 55 | 53 | 132 | 64 | 28 | 23 | 11 | 22 | 11 | 11 |
| Avg. Sales Price | $535,640 | $909,152 | $757,055 | $757,726 | $717,613 | $1,556,578 | $1,579,711 | $1,639,054 | $1,317,409 | $2,564,659 | $658,409 | $1,755,068 |
| Sales Volume | $57,313,528 | $60,004,064 | $41,638,020 | $40,159,500 | $94,724,970 | $99,620,990 | $44,231,900 | $37,698,250 | $14,491,500 | $56,422,490 | $7,242,500 | $19,305,750 |



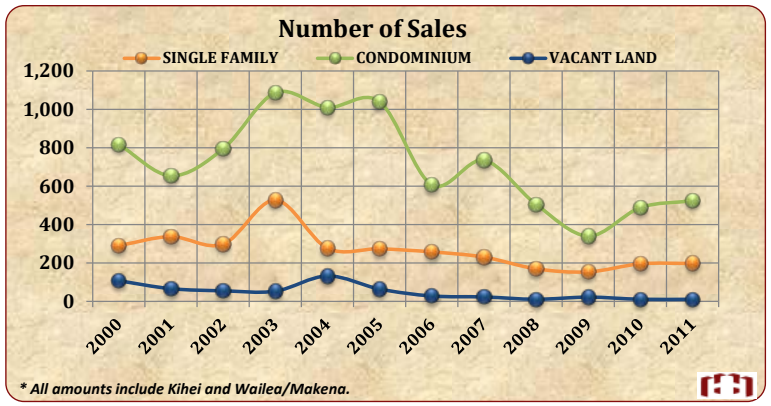



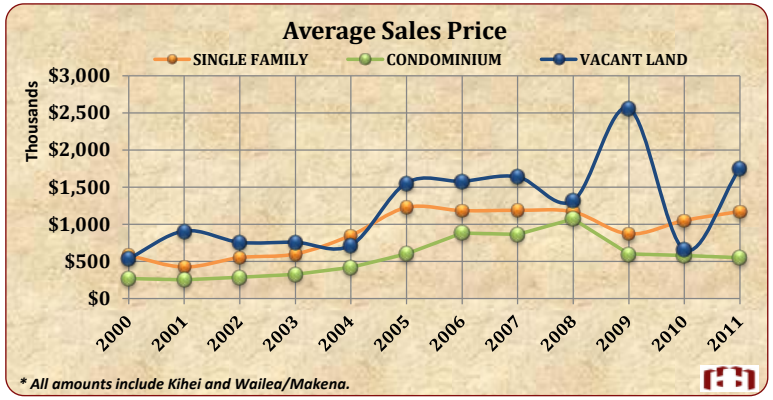

Source: Realtors Association of Maui as of February 16, 2012.

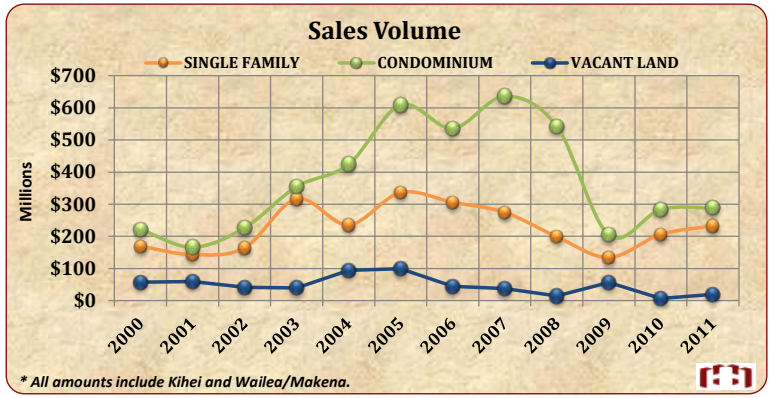
TABLE I-8 EXHIBIT I

## COMPRENHENSIVE SUMMARY OF SUBJECT AREA MARKET ACTIVITY
### Market Study of the Proposed Maui Tech Park Master Plan
### Kihei, Maui, Hawaii

| SINGLE FAMILY | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Sales | 291 | 337 | 298 | 527 | 277 | 274 | 258 | 231 | 170 | 154 | 196 | 198 |
| Average Sales Price | $579,644 | $424,228 | $550,450 | $599,826 | $849,900 | $1,226,776 | $1,183,971 | $1,187,606 | $1,167,482 | $870,423 | $1,050,566 | $1,173,243 |
| Sales Volume | $168,676,462 | $142,964,749 | $164,034,105 | $316,108,384 | $235,422,430 | $336,136,498 | $305,464,404 | $274,337,002 | $198,471,941 | $134,045,068 | $205,910,942 | $232,302,164 |
| **CONDOMINIUM** | | | | | | | | | | | | |
| Number of Sales | 818 | 655 | 795 | 1,087 | 1,011 | 1,040 | 608 | 735 | 506 | 341 | 489 | 525 |
| Average Sales Price | $271,237 | $254,476 | $285,572 | $326,559 | $419,764 | $600,913 | $882,436 | $865,897 | $1,072,460 | $599,731 | $581,505 | $550,318 |
| Sales Volume | $221,871,605 | $166,681,878 | $227,029,947 | $354,969,696 | $424,381,119 | $609,325,403 | $536,521,003 | $636,434,454 | $542,664,661 | $204,508,266 | $284,355,750 | $288,916,933 |
| **VACANT LAND** | | | | | | | | | | | | |
| Number of Sales | 107 | 66 | 55 | 53 | 132 | 64 | 28 | 23 | 11 | 22 | 11 | 11 |
| Average Sales Price | $535,640 | $909,152 | $757,055 | $757,726 | $717,613 | $1,556,578 | $1,579,711 | $1,639,054 | $1,317,409 | $2,564,659 | $658,409 | $1,755,068 |
| Sales Volume | $57,313,528 | $60,004,064 | $41,638,020 | $40,159,500 | $94,724,970 | $99,620,990 | $44,231,900 | $37,698,250 | $14,491,500 | $56,422,490 | $7,242,500 | $19,305,750 |




Source: Realtors Association of Maui as of February 16, 2012.

TABLE I-9 EXHIBIT I

**COMPARISON OF PROPOSED KIHEI-MAKENA STUDY AREA LONG-TERM RESIDENTIAL SUPPLY ESTIMATES**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**
**Estimates Exclude the Proposed Subject Units**

| Estimate Title | South Maui Development Projects Directed Growth Boundaries Map | Advisory Committee Final Recommendations |
|---|---|---|
| Purpose | To identify the extent of the proposed Directed Growth Boundaries in the Kihei-Makena region and the proposed development therein. | To support the on-going updating of the Kihei-Makena Community Plan |
| Prepared By | Long Range Planning Div. Dept. of Planning, Maui County | Maui General Plan Advisory Committee |
| ***Estimate of Approved/Proposed Future Supply*** | | |
| Perspective | **Within Proposed DGB** | **Within Community Plan Region** |
| **All Units in Study Area (1)** | | |
| Single Family | 3,959 | No Distinction by Unit Type |
| Multi Family | 3,793 | |
| **Total** | **7,752** | **5,784** (2) |
| **Resort-Residential Units (3)** | | |
| Single Family | 884 | |
| Multi Family | 832 | |
| **Total** | **1,716** | |
| **Net Resident-Oriented Housing Units (4)** | | |
| Single Family | 3,364 | |
| Multi Family | 3,175 | |
| **Total** | **6,539** | |

Note: Both estimates include proposed Resort-Residential units in the Wailea and Makena destination resorts that are not intended for, nor competitive with the resident-oriented housing sector.

(1) Excludes "Time Share/Hotel" Units. Only a portion of the proposed 2,417 unit Kaonoulu Village site is within the DGB. We estimate about 60 percent of the project area is within the DGB, and have allocated the units accordingly.
(2) GPAC Maps include only a portion of several projects including Kaonoulu Village and Ohukai Village, and/or reflect lower densities than proposed by the developer. We have made appropriate allowances.
(3) Proposed units in the Wailea and Makena destination resorts, and ocean-influenced projects between them.
(4) We estimate that 40 percent of the proposed Makena Inventory of lots (669) and multifamily units (436) will be competitive within the resident-oriented housing market sector along with 10 percent of the other proposed resort-residential inventory in the area.

Source: As cited, and The Hallstrom Group, Inc.

TABLE I-10 EXHIBIT I

**PROJECTION OF POTENTIAL SUBJECT UNIT ABSORPTION USING THE RESIDUAL METHOD BASED ON TOTAL DEMAND FOR RESIDENTIAL UNITS IN THE KIHEI-MAKENA STUDY AREA**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui Hawaii**
**Based on Proposed Units Within the Proposed Directed Growth Boundary for Kihei-Makena, Using Mid-Point Demand Estimates**

| Segment | TOTAL UNITS | Sales Period 2012-2015 | 2016-2020 | 2021-2025 | 2026-2030 | 2031-2035 | Total |
|---|---|---|---|---|---|---|---|
| ***Single Family (1)*** | | | | | | | |
| **Identified Supply (2,3)** | 3,414 | 700 | 850 | 750 | 750 | 364 | 3,414 |
| Market Share Percentage of Total Supply | | 61% | 55% | 52% | 52% | 35% | 51% |
| **Regional SF Lot/Home Demand (mid-point)** | **5,549** | **1,159** | **1,115** | **1,094** | **1,087** | **1,094** | **5,549** |
| **Shortage or (Excess) Supply** | **2,135** | **459** | **265** | **344** | **337** | **730** | **2,135** |
| **Potential Residual Subject SF Demand** | | | | | | | |
| at 95% Capture Rate | 2,028 | 436 | 252 | 327 | 320 | 694 | 2,028 |
| at 90% Capture Rate | 1,921 | 413 | 238 | 310 | 303 | 657 | 1,921 |
| ***Multi Family*** | | | | | | | |
| **Identified Supply (2,4)** | 3,220 | 450 | 700 | 700 | 700 | 670 | 3,220 |
| Market Share Percentage of Total Supply | | 39% | 45% | 48% | 48% | 65% | 49% |
| **Regional MF Unit Demand (mid-point)** | **4,336** | **772** | **807** | **860** | **926** | **970** | **4,336** |
| **Shortage or (Excess) Supply** | **1,116** | **322** | **107** | **160** | **226** | **300** | **1,116** |
| **Potential Residual Subject MF Demand** | | | | | | | |
| at 95% Capture Rate | 1,060 | 306 | 102 | 152 | 214 | 285 | 1,060 |
| at 90% Capture Rate | 1,004 | 290 | 97 | 144 | 203 | 270 | 1,004 |
| ***Total Single and Multi Family*** | | | | | | | |
| **Identified Supply** | 6,634 | 1,150 | 1,550 | 1,450 | 1,450 | 1,034 | 6,634 |
| Market Share Percentage of Total Supply | | 100% | 100% | 100% | 100% | 100% | 100% |
| **Regional Total Unit Demand (mid-point)** | **9,885** | **1,931** | **1,922** | **1,954** | **2,013** | **2,064** | **9,885** |
| **Shortage or (Excess) Supply** | **3,251** | **781** | **372** | **504** | **563** | **1,030** | **3,251** |
| **Potential Residual Subject Demand** | | | | | | | |
| at 95% Capture Rate | 3,088 | 742 | 354 | 479 | 534 | 979 | 3,088 |
| at 90% Capture Rate | 2,926 | 703 | 335 | 454 | 506 | 927 | 2,926 |

(1) Includes lots and finished homes.
(2) Timing of unit development based on information from numerous sources, including media articles, developer projections, Maui Affordable Residential Housing Study (12/2006), and logistic/market realities.
(3) Includes recently finished but unsold inventory totaling some 50 lots/homes.
(4) Includes recently finished but unsold inventory totaling some 45 units.

Source: Maui County, Developers/Agents, & The Hallstrom Group, Inc.

TABLE I-11 EXHIBIT I

**SUMMARY OF SUBJECT PROJECTED SINGLE FAMILY DEMAND LEVELS**
**USING THE MARKET SHARES METHOD**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**
**Assuming Sales/Pre-Sales of 750 Subject Lots/Homes to Begin in 2017**

**Scenario One: Using Minimum Demand Assumptions**

| Sales Year Date | Sales Year Period | Total Regional SF Demand | Effective Subject Share | Indicated Total Subject Absorption |
|---|---|---|---|---|
| 2017 | 1 | 248 | 15.00% | 37 |
| 2018 | 2 | 164 | 18.00% | 30 |
| 2019 | 3 | 164 | 20.00% | 33 |
| 2020 | 4 | 164 | 22.00% | 36 |
| 2021 | 5 | 164 | 22.00% | 36 |
| 2022 | 6 | 164 | 22.00% | 36 |
| 2023 | 7 | 170 | 22.00% | 37 |
| 2024 | 8 | 170 | 22.00% | 37 |
| 2025 | 9 | 170 | 22.00% | 37 |
| 2026 | 10 | 170 | 22.00% | 37 |
| 2027 | 11 | 170 | 22.00% | 37 |
| 2028 | 12 | 170 | 22.00% | 37 |
| 2029 | 13 | 170 | 22.00% | 37 |
| 2030 | 14 | 171 | 22.00% | 38 |
| 2031 | 15 | 171 | 22.00% | 38 |
| 2032 | 16 | 171 | 22.00% | 38 |
| 2033 | 17 | 171 | 22.00% | 38 |
| 2034 | 18 | 171 | 22.00% | 38 |
| 2035 | 19 | 171 | 22.00% | 38 |
| 2036 | 20 | 171 | 22.00% | 38 |
| 2037 | 21 | 171 | 10.50% | 18 |
| **Totals** | | **3,621** | **20.71%** | **750** |

**Scenario Two: Using Maximum Demand Assumptions**

| Sales Year Date | Sales Year Period | Total Regional SF Demand | Effective Subject Share | Indicated Total Subject Absorption |
|---|---|---|---|---|
| 2017 | 1 | 282 | 16.00% | 45 |
| 2018 | 2 | 282 | 19.00% | 54 |
| 2019 | 3 | 282 | 21.00% | 59 |
| 2020 | 4 | 282 | 23.00% | 65 |
| 2021 | 5 | 268 | 23.00% | 62 |
| 2022 | 6 | 268 | 23.00% | 62 |
| 2023 | 7 | 268 | 23.00% | 62 |
| 2024 | 8 | 268 | 23.00% | 62 |
| 2025 | 9 | 268 | 23.00% | 62 |
| 2026 | 10 | 265 | 23.00% | 61 |
| 2027 | 11 | 265 | 23.00% | 61 |
| 2028 | 12 | 265 | 23.00% | 61 |
| 2029 | 13 | 265 | 13.50% | 36 |
| **Totals** | | **3,528** | **21.25%** | **750** |

| | | | |
|---|---|---|---|
| **ANALYSIS MID-POINT** | | | |
| **16.5 Years** | **3,575** | **20.97%** | **750** |

Source: The Hallstrom Group, Inc.

TABLE I-12 EXHIBIT I

**SUMMARY OF SUBJECT PROJECTED MULTIFAMILY DEMAND LEVELS**
**USING THE MARKET SHARES METHOD**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**
**Assuming Sales/Pre-Sales of 500 Subject Units to Begin in 2017**

**Scenario One: Using Minimum Demand Assumptions**

| Sales Year Date | Sales Year Period | Total Regional MF Demand | Effective Subject Share | Indicated Total Subject Absorption |
|---|---|---|---|---|
| 2017 | 1 | 119 | 16.00% | 19 |
| 2018 | 2 | 119 | 19.00% | 23 |
| 2019 | 3 | 119 | 22.00% | 26 |
| 2020 | 4 | 119 | 24.00% | 28 |
| 2021 | 5 | 133 | 24.00% | 32 |
| 2022 | 6 | 133 | 24.00% | 32 |
| 2023 | 7 | 133 | 24.00% | 32 |
| 2024 | 8 | 133 | 24.00% | 32 |
| 2025 | 9 | 133 | 24.00% | 32 |
| 2026 | 10 | 144 | 24.00% | 35 |
| 2027 | 11 | 144 | 24.00% | 35 |
| 2028 | 12 | 144 | 24.00% | 35 |
| 2029 | 13 | 144 | 24.00% | 35 |
| 2030 | 14 | 144 | 24.00% | 35 |
| 2031 | 15 | 151 | 24.00% | 36 |
| 2032 | 16 | 151 | 23.00% | 35 |
| **Totals** | | **2,165** | **23.11%** | **500** |

**Scenario Two: Using Maximum Demand Assumptions**

| Sales Year Date | Sales Year Period | Total Regional MF Demand | Effective Subject Share | Indicated Total Subject Absorption |
|---|---|---|---|---|
| 2017 | 1 | 204 | 17.00% | 35 |
| 2018 | 2 | 204 | 20.00% | 41 |
| 2019 | 3 | 204 | 23.00% | 47 |
| 2020 | 4 | 204 | 25.00% | 51 |
| 2021 | 5 | 211 | 25.00% | 53 |
| 2022 | 6 | 211 | 25.00% | 53 |
| 2023 | 7 | 211 | 25.00% | 53 |
| 2024 | 8 | 211 | 25.00% | 53 |
| 2025 | 9 | 211 | 25.00% | 53 |
| 2026 | 10 | 226 | 25.00% | 56 |
| 2027 | 11 | 226 | 3.00% | 7 |
| **Totals** | | **2,322** | **21.54%** | **500** |

| | | | |
|---|---|---|---|
| **ANALYSIS MID-POINT** | | | |
| **13.1 Years** | **2,243** | **22.30%** | **500** |

Source: The Hallstrom Group, Inc.

TABLE II-1 EXHIBIT II

**SUMMARY OF EXISTING COMMERCIAL SPACE DEVELOPMENT IN HAWAII**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**
**As of 4th Quarter 2011**

| County | C& C of Honolulu | Maui | Kauai | Hawaii | State Totals |
|---|---|---|---|---|---|
| Resident Population | 909,071 | 146,306 | 64,786 | 180,820 | 1,300,983 |
| De Facto Population | 999,471 | 194,306 | 87,186 | 207,420 | 1,488,383 |
| ***1. Summary of Inventory*** | | | | | |
| Number of Major Retail Centers | 123 | 51 | 16 | 36 | 226 |
| Gross Leasable Area in Surveyed Major Centers (1) (Square Feet) | 10,163,544 | 2,435,030 | 510,977 | 1,702,867 | 14,812,418 |
| Other Gross Leasable Area in Major Centers (1) (Square Feet) | 6,392,087 | 1,440,911 | 708,012 | 1,407,651 | 9,948,661 |
| Other Gross Leasable Area in Other/Minor Projects (2) (Square Feet) | 3,900,000 | 625,000 | 318,000 | 882,000 | |
| **Total Estimated Commercial GLA** (Square Feet) | **20,455,631** | **4,500,941** | **1,536,989** | **3,992,518** | **24,761,079** |
| ***2. Per Capita Spatial Allowance*** ***(Square Feet per Person)*** | | | | | |
| Per Resident Population Member | 22.50 | 30.76 | 23.72 | 22.08 | 19.03 |
| Per De Facto Population Member | 20.47 | 23.16 | 17.63 | 19.25 | 16.64 |
| ***3. Surveyed Major Center Operating Overview*** | | | | | **State Averages** |
| Vacancy Rate | 4.2% | 9.3% | 18.1% | 6.4% | 5.7% |
| Estimated Vacant Square Feet of GLA | 428,380 | 236,308 | 93,426 | 148,161 | 908,775 |
| Avg. Monthly Base per Square Foot Rents Range (3) | | | | | |
| Low | $2.73 | $2.78 | $2.05 | $2.14 | $2.49 |
| High | $3.81 | $4.03 | $3.95 | $2.66 | $3.64 |
| Percentage Overage Rents Range (4) | | | | | |
| Low | 2.0% | 1.0% | 4.0% | 5.0% | 2.0% |
| High | 15.0% | 10.0% | 10.0% | 12.0% | 15.0% |
| Average Monthly per Square Foot Operating Expenses | $1.18 | $0.95 | $0.97 | $0.77 | $1.07 |
| Space Absorbed in 2011 | (91,449) | (11,297) | (18,263) | 19,858 | (101,151) |

(1) Complexes with circa 50,000 square feet and up.
(2) Includes smaller projects and hotels. Does not include space within mixed-use, multi-tenant buildings located in Light Industrial parks.
(3) Recent leases. Generally excludes "anchor" spaces and single-tenant buildings, which typically have lower rents.
(4) For properties and spaces with leases calling for percentage rents, which are generally paid to the extent they exceed base rents.

Source: CB Richard Ellis, State DBEDT and The Hallstrom Group, Inc.

TABLE II-2 EXHIBIT II

## QUANTIFICATION OF COMMERCIAL FLOOR SPACE DEMAND IN THE GENERAL STUDY AREA FROM 2012 TO 2035
### Market Study of the Proposed Maui Tech Park Master Plan
### Kihei, Maui, Hawaii

***Scenario One: Minimum Population Estimates and Growth Rates***

| Year | De Facto Population (1) Annual Growth Rate | De Facto Population (1) Forecast Total | X | Per Capita Demand in Square Feet | = | Total Resident Demand in Square Feet | X | Regional Capture Rate (2) | = | Net Regional Demand in Square Feet |
|---|---|---|---|---|---|---|---|---|---|---|
| Year-End 2011 | | 46,636 | | 23.00 | | 1,072,628 | | 65.0% | | 697,208 |
| 2015 | 1.57% | 50,597 | | 24.50 | | 1,239,627 | | 68.0% | | 842,946 |
| 2020 | 1.34% | 54,227 | | 26.00 | | 1,409,902 | | 71.0% | | 1,001,030 |
| 2025 | 1.29% | 57,962 | | 27.50 | | 1,593,955 | | 74.0% | | 1,179,527 |
| 2030 | 1.23% | 61,757 | | 29.00 | | 1,790,953 | | 77.0% | | 1,379,034 |
| 2035 | 1.21% | 65,750 | | 30.50 | | 2,005,375 | | 80.0% | | 1,604,300 |

***Scenario Two: Maximum Population Estimates and Growth Rates***

| Year | De Facto Population (1) Annual Growth Rate | De Facto Population (1) Forecast Total | X | Per Capita Demand in Square Feet | = | Total Resident Demand in Square Feet | X | Regional Capture Rate (2) | = | Net Regional Demand in Square Feet |
|---|---|---|---|---|---|---|---|---|---|---|
| Year-End 2011 | | 46,636 | | 23.00 | | 1,072,628 | | 65.0% | | 697,208 |
| 2015 | 1.53% | 50,500 | | 25.00 | | 1,262,500 | | 70.0% | | 883,750 |
| 2020 | 1.96% | 56,000 | | 27.00 | | 1,512,000 | | 75.0% | | 1,134,000 |
| 2025 | 1.94% | 62,000 | | 29.00 | | 1,798,000 | | 80.0% | | 1,438,400 |
| 2030 | 1.76% | 68,000 | | 31.00 | | 2,108,000 | | 85.0% | | 1,791,800 |
| 2035 | 1.67% | 74,200 | | 33.00 | | 2,448,600 | | 90.0% | | 2,203,740 |

***Indicated Projection Mid-Point***

| Year | De Facto Population (1) Annual Growth Rate | De Facto Population (1) Forecast Population | X | Per Capita Demand in Square Feet | = | Total Resident Demand in Square Feet | X | Regional Capture Rate | = | Net Regional Demand in Square Feet |
|---|---|---|---|---|---|---|---|---|---|---|
| Year-End 2011 | | 46,636 | | 23.00 | | 1,072,628 | | 65.0% | | 697,208 |
| 2015 | 1.55% | 50,549 | | 24.75 | | 1,251,075 | | 69.0% | | 863,242 |
| 2020 | 1.66% | 55,114 | | 26.50 | | 1,460,508 | | 73.0% | | 1,066,171 |
| 2025 | 1.62% | 59,981 | | 28.25 | | 1,694,463 | | 77.0% | | 1,304,737 |
| 2030 | 1.51% | 64,879 | | 30.00 | | 1,946,355 | | 81.0% | | 1,576,548 |
| 2035 | 1.46% | 69,975 | | 31.75 | | 2,221,706 | | 85.0% | | 1,888,450 |

(1) In 2011, the average daily visitor census on Maui was 48,000 persons. We have estimated that 40 percent of this total finds lodging in the study area, as the Kihei/Wailea corridor has 8,055 (or 39 percent) of the total visitor units on the island.

Source: The Hallstrom Group, Inc.

TABLE II-3 EXHIBIT II

## ESTIMATED TOTAL ADDITIONAL COMMERCIAL FLOOR SPACE AND ACREAGE DEMAND
## FOR THE GENERAL STUDY AREA 2012 TO 2035
### Market Study of the Proposed Maui Tech Park Master Plan
### Kihei, Maui, Hawaii

*Scenario One: Minimum*

| Year | Forecast Floor Space Demand (in Sq. Ft.) | Divided by FAR Allowance (1) | Resulting Land Area Demand (in Acres) |
|---|---|---|---|
| Year-End 2011 | 697,208 | | 72 |
| 2015 | 842,946 | 0.238 | 81 |
| 2020 | 1,001,030 | 0.238 | 97 |
| 2025 | 1,179,527 | 0.238 | 114 |
| 2030 | 1,379,034 | 0.238 | 133 |
| 2035 | 1,604,300 | 0.238 | 155 |

*Scenario Two: Maximum*

| Year | Forecast Floor Space Demand (in Sq. Ft.) | Divided by FAR Allowance (1) | Resulting Land Area Demand (in Acres) |
|---|---|---|---|
| Year-End 2011 | 697,208 | | 72 |
| 2015 | 883,750 | 0.238 | 85 |
| 2020 | 1,134,000 | 0.238 | 109 |
| 2025 | 1,438,400 | 0.238 | 139 |
| 2030 | 1,791,800 | 0.238 | 173 |
| 2035 | 2,203,740 | 0.238 | 213 |

**FINISHED FLOOR SPACE ANALYSIS (in Square Feet)**

| Periodic Additions Required (Sq. Ft.): | Minimum | Maximum |
|---|---|---|
| 2012 to 2015 | 145,738 | 186,542 |
| 2015 to 2020 | 158,084 | 250,250 |
| 2021 to 2025 | 178,496 | 304,400 |
| 2026 to 2030 | 199,507 | 353,400 |
| 2031 to 2035 | 225,266 | 411,940 |
| **Cumulative Additional Space Required:** | **907,092** | **1,506,532** |
| **Increase as a Percent of Existing Floor Space** | **130.10%** | **216.08%** |
| **Estimated Mid-Point Additional Space Required (2):** | | **1,206,812** |

**DEVELOPABLE LAND AREA ANALYSIS (in Acres)**

| Periodic Additions Required (Acres): | Minimum | Maximum |
|---|---|---|
| 2012 to 2015 | 9 | 13 |
| 2015 to 2020 | 15 | 24 |
| 2021 to 2025 | 17 | 29 |
| 2026 to 2030 | 19 | 34 |
| 2031 to 2035 | 22 | 40 |
| **Cumulative Additional Acreage Required** | **83** | **141** |
| **Increase as a Percent of Existing Acreage:** | **114.93%** | **195.23%** |
| **Estimated Mid-Point Additional Acreage Required (2):** | | **112** |

(1) Assuming average finished "Floor Area Ratio" of .28 for finished commercial development sites, and a net to gross ratio of 85 percent on the underlying site.

Source: The Hallstrom Group, Inc.

TABLE II-4 EXHIBIT II

**SUMMARY OF SUBJECT PROJECTED COMMERCIAL DEMAND LEVELS**
**USING THE MARKET SHARES METHOD**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**
**Assuming Pre-Leasing to Begin in 2017**

**Scenario One: Using Minimum Demand Assumptions**

| Sales Year Date | Sales Year Period | Total Regional Demand (in Square Feet) | Effective Subject Share | Indicated Total Subject Absorption (in Square Feet) |
|---|---|---|---|---|
| 2017 | 1 | 31,617 | 25.00% | 9,109 |
| 2018 | 2 | 31,617 | 30.00% | 9,485 |
| 2019 | 3 | 31,617 | 35.00% | 11,066 |
| 2020 | 4 | 31,617 | 35.00% | 11,066 |
| 2021 | 5 | 35,699 | 35.00% | 11,066 |
| 2022 | 6 | 35,699 | 35.00% | 11,066 |
| 2023 | 7 | 35,699 | 35.00% | 12,495 |
| 2024 | 8 | 35,699 | 35.00% | 12,495 |
| 2025 | 9 | 35,699 | 35.00% | 12,495 |
| 2026 | 10 | 39,901 | 35.00% | 12,495 |
| 2027 | 11 | 39,901 | 35.00% | 12,495 |
| 2028 | 12 | 39,901 | 35.00% | 13,965 |
| 2029 | 13 | 39,901 | 35.00% | 13,965 |
| 2030 | 14 | 39,901 | 35.00% | 13,965 |
| 2031 | 15 | 45,053 | 35.00% | 13,965 |
| 2032 | 16 | 45,053 | 35.00% | 13,965 |
| 2033 | 17 | 45,053 | 35.00% | 15,769 |
| 2034 | 18 | 45,053 | 35.00% | 15,769 |
| 2035 | 19 | 45,053 | 35.00% | 15,769 |
| **Totals** | | **729,737** | **33.23%** | **242,464** |

**Scenario Two: Using Maximum Demand Assumptions**

| Sales Year Date | Sales Year Period | Total Regional Demand (in Square Feet) | Effective Subject Share | Indicated Total Subject Absorption (in Square Feet) |
|---|---|---|---|---|
| 2017 | 1 | 50,050 | 30.00% | 13,991 |
| 2018 | 2 | 50,050 | 35.00% | 17,518 |
| 2019 | 3 | 50,050 | 40.00% | 20,020 |
| 2020 | 4 | 50,050 | 40.00% | 20,020 |
| 2021 | 5 | 60,880 | 40.00% | 20,020 |
| 2022 | 6 | 60,880 | 40.00% | 20,020 |
| 2023 | 7 | 60,880 | 40.00% | 24,352 |
| 2024 | 8 | 60,880 | 40.00% | 24,352 |
| 2025 | 9 | 60,880 | 40.00% | 24,352 |
| 2026 | 10 | 70,680 | 40.00% | 24,352 |
| 2027 | 11 | 70,680 | 40.00% | 24,352 |
| 2028 | 12 | 70,680 | 40.00% | 28,272 |
| 2029 | 13 | 70,680 | 40.00% | 28,272 |
| 2030 | 14 | 70,680 | 40.00% | 28,272 |
| 2031 | 15 | 82,388 | 40.00% | 28,272 |
| 2032 | 16 | 82,388 | 40.00% | 28,272 |
| 2033 | 17 | 82,388 | 40.00% | 32,955 |
| 2034 | 18 | 82,388 | 40.00% | 32,955 |
| 2035 | 19 | 82,388 | 40.00% | 32,955 |
| **Totals** | | **1,269,940** | **37.29%** | **473,574** |

| | | | |
|---|---|---|---|
| **ANALYSIS MID-POINT** | | | |
| **19.0 Years** | **999,839** | **35.81%** | **358,019** |

Source: The Hallstrom Group, Inc.

TABLE III-1 EXHIBIT III

**SUMMARY OF EXISTING INDUSTRIAL SPACE DEVELOPMENT IN HAWAII**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**
**As of Year-End 2011**

| County | C& C of Honolulu | Maui | Kauai | Hawaii | State Totals |
|---|---|---|---|---|---|
| Resident Population | 909,071 | 146,306 | 64,786 | 180,820 | 1,300,983 |
| De Facto Population | 999,471 | 192,444 | 87,186 | 207,420 | 1,486,521 |
| **Total Estimated Industrial GLA** (Square Feet) | **34,327,569** | **10,723,580** | **1,852,587** | **9,079,769** | **55,983,505** |
| ***2. Per Capita Spatial Allowance (Square Feet per Person)*** | | | | | |
| Per Resident Population Member | 37.76 | 73.30 | 28.60 | 50.21 | 43.03 |
| Per De Facto Population Member | 34.35 | 55.72 | 21.25 | 43.77 | 37.66 |
| ***3. General Market Operating Overview*** | | | | | **State Averages** |
| Vacancy Rate | 6.7% | 2.0% | 3.1% | 1.6% | 4.8% |
| Estimated Vacant Square Feet of GLA | 2,283,008 | 212,526 | 57,921 | 147,355 | 2,700,810 |
| Weighted Avg. Monthly Base per Square Foot Rents (1) | | | | | |
| Net | $0.94 | $1.08 | $0.74 | $0.92 | $0.95 |
| Gross | $1.32 | $1.42 | $1.07 | $1.25 | $1.31 |
| Average Monthly per Square Foot Operating Expenses (1) | $0.38 | $0.34 | $0.33 | $0.32 | $0.36 |
| Space Absorbed in 2011 | (166,350) | (74,764) (2) | 39,854 | 97,509 | (103,751) |

(1) Recent leases.
(2) Maui industrial space absorption was a positive 48,444 square feet in the fourth quarter of 2011.

Source: CB Richard Ellis, State DBEDT and The Hallstrom Group, Inc.

TABLE III-2 EXHIBIT III

**QUANTIFICATION OF INDUSTRIAL FLOOR SPACE DEMAND**
**ON THE ISLAND OF FROM 2012 TO 2035**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**

***Scenario One: Baseline General Plan Forecasts***

| Year | De Facto Population: Annual Growth Rate | De Facto Population: Forecast Total | X | Per Capita Demand in Square Feet | = | Total Resident Demand in Square Feet | X | Regional Capture Rate (2) | = | Net Regional Demand in Square Feet |
|---|---|---|---|---|---|---|---|---|---|---|
| Year-End 2011 | | 192,444 | | 55.75 | | 10,728,753 | | 100.0% | | 10,728,753 |
| 2015 | 0.93% | 201,800 | | 57.25 | | 11,553,050 | | 100.0% | | 11,553,050 |
| 2020 | 0.84% | 210,600 | | 59.25 | | 12,478,050 | | 100.0% | | 12,478,050 |
| 2025 | 0.85% | 219,900 | | 61.75 | | 13,578,825 | | 100.0% | | 13,578,825 |
| 2030 | 0.85% | 229,686 | | 64.25 | | 14,757,326 | | 100.0% | | 14,757,326 |
| 2035 | 0.83% | 239,600 | | 66.75 | | 15,993,300 | | 100.0% | | 15,993,300 |

***Scenario Two: Maximum Population Estimates and Growth Rates***

| Year | De Facto Population: Annual Growth Rate | De Facto Population: Forecast Total | X | Per Capita Demand in Square Feet | = | Total Resident Demand in Square Feet | X | Regional Capture Rate (2) | = | Net Regional Demand in Square Feet |
|---|---|---|---|---|---|---|---|---|---|---|
| Year-End 2011 | | 192,444 | | 55.75 | | 10,728,753 | | 100.0% | | 10,728,753 |
| 2015 | 1.09% | 203,500 | | 57.75 | | 11,752,125 | | 100.0% | | 11,752,125 |
| 2020 | 0.96% | 213,750 | | 60.25 | | 12,878,438 | | 100.0% | | 12,878,438 |
| 2025 | 0.94% | 224,300 | | 63.25 | | 14,186,975 | | 100.0% | | 14,186,975 |
| 2030 | 0.94% | 235,400 | | 66.75 | | 15,712,950 | | 100.0% | | 15,712,950 |
| 2035 | 0.93% | 246,900 | | 70.75 | | 17,468,175 | | 100.0% | | 17,468,175 |

***Indicated Projection Mid-Point***

| Year | De Facto Population: Annual Growth Rate | De Facto Population: Forecast Population | X | Per Capita Demand in Square Feet | = | Total Resident Demand in Square Feet | X | Regional Capture Rate | = | Net Regional Demand in Square Feet |
|---|---|---|---|---|---|---|---|---|---|---|
| Year-End 2011 | | 192,444 | | 55.75 | | 10,728,753 | | 100.0% | | 10,728,753 |
| 2015 | 1.01% | 202,650 | | 57.50 | | 11,652,375 | | 100.0% | | 11,652,375 |
| 2020 | 0.90% | 212,175 | | 59.75 | | 12,677,456 | | 100.0% | | 12,677,456 |
| 2025 | 0.89% | 222,100 | | 62.50 | | 13,881,250 | | 100.0% | | 13,881,250 |
| 2030 | 0.90% | 232,543 | | 65.50 | | 15,231,567 | | 100.0% | | 15,231,567 |
| 2035 | 0.88% | 243,250 | | 68.75 | | 16,723,438 | | 100.0% | | 16,723,438 |

Source: The Hallstrom Group, Inc.

TABLE III-3

EXHIBIT III

## ESTIMATED TOTAL ADDITIONAL INDUSTRIAL FLOOR SPACE AND ACREAGE DEMAND ON THE ISLAND OF MAUI 2012 TO 2035

Market Study of the Proposed Maui Tech Park Master Plan
Kihei, Maui, Hawaii

*Scenario One: Minimum*

| Year | Forecast Floor Space Demand (in Sq. Ft.) | Divided by FAR Allowance (1) | Resulting Land Area Demand (in Acres) |
|---|---|---|---|
| Year-End 2011 | 10,728,753 | | 974 |
| 2015 | 11,553,050 | 0.255 | 1,040 |
| 2020 | 12,478,050 | 0.255 | 1,123 |
| 2025 | 13,578,825 | 0.255 | 1,222 |
| 2030 | 14,757,326 | 0.255 | 1,329 |
| 2035 | 15,993,300 | 0.255 | 1,440 |

*Scenario Two: Maximum*

| Year | Forecast Floor Space Demand (in Sq. Ft.) | Divided by FAR Allowance (1) | Resulting Land Area Demand (in Acres) |
|---|---|---|---|
| Year-End 2011 | 10,728,753 | | 974 |
| 2015 | 11,752,125 | 0.255 | 1,058 |
| 2020 | 12,878,438 | 0.255 | 1,159 |
| 2025 | 14,186,975 | 0.255 | 1,277 |
| 2030 | 15,712,950 | 0.255 | 1,415 |
| 2035 | 17,468,175 | 0.255 | 1,573 |

### FINISHED FLOOR SPACE ANALYSIS (in Square Feet)

| Periodic Additions Required (Sq. Ft.): | Minimum | Maximum |
|---|---|---|
| 2012 to 2015 | 824,297 | 1,023,372 |
| 2015 to 2020 | 925,000 | 1,126,313 |
| 2021 to 2025 | 1,100,775 | 1,308,538 |
| 2026 to 2030 | 1,178,501 | 1,525,975 |
| 2031 to 2035 | 1,235,975 | 1,755,225 |
| **Cumulative Additional Space Required:** | **5,264,547** | **6,739,422** |
| **Increase as a Percent of Existing Floor Space** | **49.07%** | **62.82%** |
| **Estimated Mid-Point Additional Space Required (2):** | | **6,001,985** |

### DEVELOPABLE LAND AREA ANALYSIS (in Acres)

| Periodic Additions Required (Acres): | Minimum | Maximum |
|---|---|---|
| 2012 to 2015 | 66 | 84 |
| 2015 to 2020 | 83 | 101 |
| 2021 to 2025 | 99 | 118 |
| 2026 to 2030 | 106 | 137 |
| 2031 to 2035 | 111 | 158 |
| **Cumulative Additional Acreage Required** | **466** | **599** |
| **Increase as a Percent of Existing Acreage:** | **47.83%** | **61.46%** |
| **Estimated Mid-Point Additional Acreage Required (2):** | | **532** |

(1) Assuming average finished "Floor Area Ratio" of .30 for finished industrial development sites, and a net to gross ratio of 85 percent on the underlying site.

TABLE III-4

EXHIBIT III

**ALLOCATION OF PROJECTED INDUSTRIAL DEMAND BY REGION**
**ON ISLAND OF MAUI FROM 2012 THROUGH 2035**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**

| Region | | | Central Maui | | | South Maui | | | West Maui | | | Other Maui | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Periodic Additions Required (Sq. Ft.): | Minimum | Maximum | Percent of Total Demand | Minimum Demand in Square Feet | Maximum Demand in Square Feet | Percent of Total Demand | Minimum Demand in Square Feet | Maximum Demand in Square Feet | Percent of Total Demand | Minimum Demand in Square Feet | Maximum Demand in Square Feet | Percent of Total Demand | Minimum Demand in Square Feet | Maximum Demand in Square Feet |
| 2012 to 2015 | 824,297 | 1,023,372 | 60% | 494,578 | 614,023 | 27% | 222,560 | 276,310 | 10% | 82,430 | 102,337 | 3% | 24,729 | 30,701 |
| 2015 to 2020 | 925,000 | 1,126,313 | 55% | 508,750 | 619,472 | 30% | 277,500 | 337,894 | 12% | 111,000 | 135,158 | 3% | 27,750 | 33,789 |
| 2021 to 2025 | 1,100,775 | 1,308,538 | 50% | 550,388 | 654,269 | 35% | 385,271 | 457,988 | 12% | 132,093 | 157,025 | 3% | 33,023 | 39,256 |
| 2026 to 2030 | 1,178,501 | 1,525,975 | 45% | 530,325 | 686,689 | 40% | 471,400 | 610,390 | 12% | 141,420 | 183,117 | 3% | 35,355 | 45,779 |
| 2031 to 2035 | 1,235,975 | 1,755,225 | 45% | 556,189 | 789,851 | 40% | 494,390 | 702,090 | 12% | 148,317 | 210,627 | 3% | 37,079 | 52,657 |
| **Cumulative Additional Space Required** | **5,264,547** | **6,739,422** | | **2,640,229** | **3,364,304** | | **1,851,121** | **2,384,672** | | **615,260** | **788,263** | | **157,936** | **202,183** |

| | Subject Capture Rate | Minimum | Maximum | Midpoint |
|---|---|---|---|---|
| 2012-2015 | 30% | 66,768 | 82,893 | 74,831 |
| 2016-2020 | 50% | 138,750 | 168,947 | 153,848 |
| 2021-2025 | 60% | 231,163 | 274,793 | 252,978 |
| 2026-2030 | 70% | 329,980 | 427,273 | 378,627 |
| 2031-2035 | 75% | 370,792 | 526,568 | 448,680 |
| | | **1,137,453** | **1,480,473** | **1,308,963** |

Source: The Hallstrom Group, Inc.

TABLE IV-1 EXHIBIT IV

**PROPOSED DEVELOPMENT SCHEDULE AND ESTIMATED CONSTRUCTION COSTS**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**
**All Amounts Expressed in Constant 2012 Dollars**

| | Development and Sales Period | | | | | | Totals During Build-Out |
|---|---|---|---|---|---|---|---|
| | 2013 to 2015 | 2016 to 2020 | 2021 to 2025 | 2026-2030 | 2031-2034 | Economic Opportunity Expansion Area | |
| **Project Increment** | | Phase I (2015 to 2024) | | Phase II (2025 to 2034) | | (Assumed in 2034) | |
| **Infrastructure Emplacement** | | $108,325,500 | $64,450,000 | | | $24,179,607 | **$196,955,107** |
| **Commercial Construction (1)** | | $49,454,600 | $57,242,900 | $34,316,750 | $28,420,600 | | **$169,434,850** |
| **Industrial/Business Park Construction (2)** | $22,500,000 (In Entitled Area) | $42,924,000 | $75,894,000 | $113,587,500 | $89,032,800 | $120,000,000 | **$463,938,300** |
| **Residential Product** | | | | | | | |
| **Single Family Homes (3)** | | $138,990,000 | $147,465,000 | $137,295,000 | | | **$423,750,000** |
| **Townhomes (4)** | | $27,710,000 | $27,710,000 | $26,080,000 | | | **$81,500,000** |
| **Multifamily Units (5)** | | $18,700,000 | $18,700,000 | $17,600,000 | | | **$55,000,000** |
| **TOTAL PERIODIC CONSTRUCTION COSTS** | **$22,500,000** | **$386,104,100** | **$391,461,900** | **$328,879,250** | **$117,453,400** | **$144,179,607** | **$1,390,578,257** |
| **Contractor Profits** | $2,250,000 | $38,610,410 | $39,146,190 | $32,887,925 | $11,745,340 | $14,417,961 | **$139,057,826** |
| **Supplier Profits** | $900,000 | $15,444,164 | $15,658,476 | $13,155,170 | $4,698,136 | $5,767,184 | **$55,623,130** |

(1) Estimated "All-in" development cost of $325 per square foot.
(2) Estimated "All-in" development cost of $300 per square foot (combination of $275 per sq. ft. for industrial and $375 per sq. ft. for business park/office).
(3) Estimated at average cost of $565,000, assuming average size of 1,800 square feet at cost of $300 per sq. ft., with $25,000 site/landscaping costs. The selling price is estimated at from $700,000 to $950,000, which is considered as "market" priced homes.
(4) Estimated at average cost of $352,000, assuming average size of 1,100 square feet at cost of $260 per sq. ft., with $40,000 common element site and amenity costs. The selling price is estimated at from $400,000 to $550,000, which would qualify as affordable for the "moderate income" to "gap group" households with incomes at 100% to 140% of median household income levels.
(5) Estimated at average cost of $220,000, assuming average size of 750 square feet at cost of $260 per sq. ft., with $40,000 common element site and amenity costs. The selling price is estimated at from $300,000 to $400,000, which would qualify as affordable for the "low income" to "moderate" households with incomes at "less than 80%" to 100% of median household income levels.

Source: The Hallstrom Group, Inc.

TABLE IV-2

EXHIBIT IV

**ESTIMATED YEARLY FULL-TIME EQUIVALENT EMPLOYMENT POSITIONS CREATED BY DEVELOPMENT**
**ASSUMING HISTORICAL ECONOMIC GROWTH TRENDS**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**

| | Development and Sales Period | | | | | | Totals During Build-Out | |
|---|---|---|---|---|---|---|---|---|
| Construction Employment (1) | 2013 to 2015 | 2016 to 2020 | 2021 to 2025 | 2026-2030 | 2031-2034 | Economic Opportunity Expansion Area | | |
| **Project Increment** | | Phase I (2015 to 2024) | | Phase II (2025 to 2034) | | (Assumed in 2034) | | |
| **Infrastructure Emplacement** | | 271 | 161 | | | 60 | **492** | |
| **Commercial Construction** | | 247 | 286 | 172 | 142 | | **847** | |
| **Industrial/Business Park Construction** | 113 (In Entitled Area) | 215 | 379 | 568 | 445 | 600 | **2,320** | |
| **Residential Construction** | | | | | | | | |
| **Single Family Homes** | | 695 | 737 | 686 | | | **2,119** | |
| **Townhouses** | | 139 | 139 | 130 | | | **408** | |
| **Multifamily Units** | | 94 | 94 | 88 | | | **275** | |
| **Total Periodic Construction Jobs** | **113** | **1,660** | **1,796** | **1,644** | **587** | **660** | **6,461** | |
| **On-Going Business Employment** | | | | | | | | **Stabilized Annually** |
| **Commercial Worker Years (2)** | | 1,087 | 3,432 | 5,444 | 6,448 | | **16,411** | |
| **Total FYE Jobs in Place at End of Period** | | 435 | 938 | 1,240 | 1,490 | | **1,490** | **1,490** |
| **Industrial/Business Park/Campus Worker Years (3)** | 214 | 1,600 | 3,782 | 6,945 | 10,886 | | **24,427** | |
| **Total FYE Jobs in Place at End of Period** | 214 | 623 | 1,346 | 2,428 | 3,276 | 1,000 | **4,276** | **4,276** |
| **Maintenance & Common Element (4)** | | 117 | 291 | 416 | 416 | | **1,241** | |
| **Total FYE Jobs in Place at End of Period** | | 63 | 96 | 113 | 113 | | **113** | **113** |
| **Total Periodic On-Going Business Jobs** | **429** | **3,862** | **9,789** | **16,473** | **22,516** | | **42,079** | |
| **Total FYE Jobs in Place at End of Period** | **214** | **1,120** | **2,380** | **3,780** | **4,878** | **1,000** | **5,878** | **5,878** |
| **Off-Site Employment (5)** | 135 | 1,380 | 2,896 | 4,529 | 5,776 | 250 | **14,967** | |
| **Total FYE Jobs in Place at End of Period** | 54 | 280 | 595 | 945 | 1,219 | 250 | **1,469** | **1,469** |
| **TOTAL PERIODIC WORKER YEARS** | **676** | **6,902** | **14,481** | **22,646** | **28,879** | **1,250** | **63,507** | |
| **TOTAL END-OF-PERIOD PERMANENT JOBCOUNT** | **268** | **1,400** | **2,975** | **4,725** | **6,097** | **1,250** | **7,347** | **7,347** |

(1) Infrastructure construction employment estimated at 1 worker-year for every $400,000 in costs. Vertical construction (all types) employment estimated at 1 worker-year for every $200,000 in costs.
(2) Employment estimated at 1 full-time-equivalent worker for every 350 square feet of gross floor area. First stores opening in 2017.
(3) Employment estimated at 1 full-time-equivalent worker for every 400 square feet of gross floor area. First businesses opening in 2017
(4) Includes Park common element administration, security and maintenance staff of 14 jobs. Assumes five condominium projects with operational staff of 6 persons each, and ratio of one full-time-equivalent maintenance/repair worker for every 20 units.
(5) Estimated at one cumulative off-site employment position for every four on site positions.

Source: Hallstrom Group, Inc.

TABLE IV-3

EXHIBIT IV

**ESTIMATED YEARLY EMPLOYEE WAGES CREATED BY DEVELOPMENT**
**ASSUMING HISTORICAL ECONOMIC GROWTH TRENDS**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**
**All Amounts Expressed in Constant 2012 Dollars**

| | Development and Sales Period | | | | | | Totals During Build-Out | |
|---|---|---|---|---|---|---|---|---|
| **Construction Wages (1)** | **2013 to 2015** | **2016 to 2020** | **2021 to 2025** | **2026-2030** | **2031-2034** | **Economic Opportunity Expansion Area** | | |
| **Project Increment** | | **Phase I (2015 to 2024)** | | **Phase II (2025 to 2034)** | | **(Assumed in 2034)** | | |
| **Infrastructure Emplacement** | | $20,503,851 | $12,199,096 | | | $4,576,716 | **$37,279,663** | |
| **Commercial Construction** | | $18,721,533 | | $12,990,949 | | | **$31,712,482** | |
| **Industrial/Business Park Construction** | $8,517,600 (In Entitled Area) | $16,249,309 | $28,730,433 | $42,999,684 | $33,704,257 | $45,427,200 | **$175,628,483** | |
| **Residential Construction** | | | | | | | | |
| **Single Family Homes** | | $52,616,054 | $55,824,350 | $51,974,395 | | | **$160,414,800** | |
| **Townhouses** | | $10,489,898 | $10,489,898 | $9,872,845 | | | **$30,852,640** | |
| **Multifamily Units** | | $7,079,072 | $7,079,072 | $6,662,656 | | | **$20,820,800** | |
| **Total Periodic Construction Wages** | **$8,517,600** | **$125,659,717** | **$114,322,849** | **$124,500,529** | **$33,704,257** | **$50,003,916** | **$456,708,868** | |
| **On-Going Business Wages** | | | | | | | | **Stabilized Annually** |
| **Commercial (2)** | | $36,879,002 | $116,444,852 | $184,722,191 | $218,790,140 | | **$509,985,140** | **$46,287,665** |
| **Industrial/Business Park/Campus Area (3)** | $8,290,286 | $61,917,242 | $146,299,156 | $268,677,763 | $421,157,084 | $38,688,000 | **$945,029,531** | **$165,414,523** |
| **Maintenance & Common Element (4)** | | $5,455,164 | $13,599,986 | $19,434,386 | $19,434,386 | | **$57,923,923** | **$5,250,960** |
| **Total Periodic On-Going Business Wages** | **$8,290,286** | **$104,251,408** | **$276,343,994** | **$472,834,340** | **$659,381,611** | **$38,688,000** | **$1,512,938,594** | **$216,953,148** |
| **Off-Site Employment Wages (4)** | $6,313,654 | $64,432,459 | $135,181,554 | $211,404,512 | $269,584,864 | $11,668,800 | **$698,585,843** | **$68,585,006** |
| **TOTAL PERIODIC WAGES** | **$23,121,540** | **$294,343,584** | **$525,848,397** | **$808,739,381** | **$962,670,732** | **$100,360,716** | **$2,668,233,305** | **$285,538,154** |

(1) Average annual wage for full-time-equivalent construction worker (all trades) at $75,712 ($35.26/hour X 2,080 hours).
(2) Average annual wage for full-time-equivalent retail trade worker at $31,075 ($14.94/hour).
(3) Average annual wage for full-time-equivalent industrial/business park worker estimated at $38,688 ($18.60/hour) based on average wage for manufacturing, trade, wholesale and financial workers.
(4) Average annual wage for full-time-equivalent general worker at $46,675 ($22.44/hour), the average wage for all "Total Private Workers" in the state.

Wages taken from State of Hawaii "Hawaii Workforce Infonet" "Data and Publications>Hours and Earnings" for January 2012.

Source: Hallstrom Group, Inc.

TABLE IV-4 EXHIBIT IV

**ESTIMATED DE FACTO POPULATION, RESIDENT HOUSEHOLD INCOME AND DISCRETIONARY EXPENDITURES**
**ASSUMING HISTORICAL ECONOMIC GROWTH TRENDS**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**
**All Amounts Expressed in Constant 2012 Dollars**

| | Development and Sales Period | | | | |
|---|---|---|---|---|---|
| | 2013 to 2015 | 2016 to 2020 | 2021 to 2025 | 2026-2030 | 2031-2034 |
| Project Increment | | Phase I (2013 to 2022) | | Phase II (2023 to 2032) | |
| | | | | | Stabilized |
| **Hotel Guests (1)** | | 174 | 180 | 180 | **180** |
| **Residential Product (2)** | | | | | |
| **Single Family Homes** | | | | | |
| Number of Sales Periodically | | 246 | 261 | 243 | **0** |
| Cumulative Sales | | 246 | 507 | 750 | **750** |
| Resident Units | | 185 | 196 | 182 | **0** |
| Percent of Total Homes | | 75% | 75% | 75% | **75%** |
| Non-Resident Units | | 62 | 65 | 61 | **0** |
| Percent of Total Homes | | 25% | 25% | 25% | **25%** |
| Resident Population (3) | | 470 | 969 | 1,433 | **1,433** |
| Non-Resident Population (4) | | 53 | 109 | 161 | **161** |
| **Townhouses** | | | | | |
| Number of Sales Periodically | | 85 | 85 | 80 | **0** |
| Cumulative Sales | | 85 | 170 | 250 | **250** |
| Resident Units | | 197 | 209 | 194 | **0** |
| Percent of Total Townhouses | | 80% | 80% | 80% | **80%** |
| Non-Resident Units | | 49 | 52 | 49 | **0** |
| Percent of Total Townhouses | | 20% | 20% | 20% | **20%** |
| Resident Population (5) | | 160 | 320 | 470 | **470** |
| Non-Resident Population (6) | | 13 | 27 | 40 | **40** |
| **Multifamily Units** | | | | | |
| Number of Sales Periodically | | 85 | 85 | 80 | **0** |
| Cumulative Sales | | 85 | 170 | 250 | **250** |
| Resident Units | | 221 | 235 | 219 | **0** |
| Percent of Total Units | | 90% | 90% | 90% | **90%** |
| Non-Resident Units | | 25 | 26 | 24 | **0** |
| Percent of Total Units | | 10% | 10% | 10% | **10%** |
| Resident Population (7) | | 157 | 315 | 463 | **463** |
| Non-Resident Population (8) | | 6 | 12 | 17 | **17** |
| **Total Resident Population** | | 787 | 1,604 | 2,367 | **2,367** |
| **Total Non-Resident Population** | | 246 | 327 | 398 | **398** |
| **TOTAL DE FACTO POPULATION** | | **1,034** | **1,931** | **2,765** | **2,765** |
| **RESIDENT HOUSEHOLD INCOME (9)** | | | | | |
| Annually (at end of period) | | **$24,680,744** | **$50,259,892** | **$74,175,841** | **$74,175,841** |
| Periodic | | **$61,701,861** | **$187,351,590** | **$311,089,333** | **$148,351,683** |
| **NON-RESIDENT SPENDING (10)** | | | | | |
| Annually (at end of period) | | **$22,343,543** | **$26,437,885** | **$29,647,125** | **$29,647,125** |
| Periodic | | **$55,858,859** | **$121,953,572** | **$140,212,526** | **$59,294,250** |
| **TOTAL DISCRETIONARY EXPENDITURES (11)** | | | | | |
| Annually (at end of period) | | **$37,151,990** | **$56,593,820** | **$74,152,630** | **$74,152,630** |
| Periodic | | **$92,879,975** | **$234,364,526** | **$326,866,125** | **$148,305,260** |

(1) Guests of 150-room business hotel opening in 2020, reaching operating stabilization in 2023 at 80 percent occupancy with average party size of 1.5 persons.
(2) Resident households estimated to have overall average size of 2.46 persons, the mid-point between 2010 census for Kihei-Makena with an average household size of 2.50 and the projected average size of 2.42 persons by 2025 when sell-out will be substantially completed.
(3) Single family households estimated to have average size of 2.6 persons, with average occupancy of 98%.
(4) Non- resident single family parties estimated to have average size of 2.86 persons (resident size plus 10%), with average occupancy of 30%.
(5) Townhome households estimated to have average size of 2.4 persons, with average occupancy of 98%.
(6) Non- resident townhome parties estimated to have average size of 2.64 persons (resident size plus 10%), with average occupancy of 30%.6
(7) Multifamily households estimated to have average size of 2.1 persons, with average occupancy of 98%.
(8) Non- resident multifamily parties estimated to have average size of 2.31 persons (resident size plus 10%), with average occupancy of 30%.
(9) The median household income for Maui is estimated at $77,100 for 2012.
(10) Hotel guests expenditures at $180 per person per day (Maui average for 2011). Non-resident users of the homes/units at $125 per day.
(11) Includes 60% of resident household income and 100 percent of non-resident spending.

Source: The Hallstrom Group, Inc.

TABLE IV-5

EXHBIT IV

**PROJECTED ON-SITE OPERATING ECONOMIC ACTIVITY**
**ASSUMING HISTORICAL ECONOMIC GROWTH TRENDS**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**
**All Amounts Expressed in Constant 2012 Dollars**

| | Development and Sales Period | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2013 to 2015 | 2016 to 2020 | 2021 to 2025 | 2026 to 2030 | 2031 to 2035 | Economic Opportunity Expansion Area | Totals During Build-Out | Stabilized Annually |
| **Project Increment** | Phase I (2013 to 2022) | | | Phase II (2023 to 2032) | | (Assumed in 2034) | | |
| ***Business Hotel*** | | $27,275,326 | $50,951,526 | $50,951,526 | $20,380,610 | | **$149,558,989** | **$10,190,305** |
| **In-Project De Facto Population Patronage %** | | 100% | 100% | 100% | 100% | | **100%** | **100%** |
| **Outside Project Patronage Expenditures** | | $0 | $0 | $0 | $0 | | **$0** | **$0** |
| ***Commercial Businesses (1)*** | | $228,252,000 | $720,702,000 | $1,143,285,000 | $573,136,800 | | **$2,665,375,800** | **$163,753,371** |
| **In-Project De Facto Population Patronage %** | | 12% | 10% | 8% | 7% | | **9%** | **15%** |
| **Outside Project Patronage Expenditures** | | $200,861,760 | $648,631,800 | $1,051,822,200 | $533,017,224 | | **$2,418,828,539** | **$139,190,366** |
| ***Industrial/Business Park Businesses (2)*** | $11,402,971 | $232,843,429 | $697,792,000 | $1,419,626,286 | $822,980,571 | **$160,000,000** | **$3,344,645,257** | **$395,137,306** |
| **In-Project De Facto Population Patronage %** | 0% | 1% | 2% | 2% | 2% | **2%** | **1%** | **2%** |
| **Outside Project Patronage Expenditures** | $11,402,971 | $230,514,994 | $683,836,160 | $1,391,233,760 | $806,520,960 | **$156,800,000** | **$3,297,820,224** | **$387,234,560** |
| | (In Entitled Area) | | | | | | | |
| ***Maintenance & Common Element (3)*** | | $1,464,000 | $2,498,400 | $3,000,000 | $3,000,000 | | **$9,962,400** | **$3,000,000** |
| **In-Project De Facto Population Patronage %** | | 100% | 100% | 100% | 100% | | **100%** | **100%** |
| **Outside Project Patronage Expenditures** | | $0 | $0 | $0 | $0 | | **$0** | **$0** |
| ***Total Economic Activity*** | | | | | | | | |
| **In-Project De Facto Population Patronage** | $0 | $58,458,001 | $139,475,966 | $173,806,852 | $79,959,798 | **$3,200,000** | **$454,900,616** | **$45,656,057** |
| **% of Total Activity** | 0.0% | 11.9% | 9.5% | 6.6% | 5.6% | **2.0%** | **7.4%** | **8.0%** |
| **Outside Project Patronage Spending** | $11,402,971 | $431,376,754 | $1,332,467,960 | $2,443,055,960 | $1,339,538,184 | **$156,800,000** | **$5,714,641,830** | **$526,424,926** |
| **% of Total Activity** | 100.0% | 88.1% | 90.5% | 93.4% | 94.4% | **98.0%** | **92.6%** | **92.0%** |
| **TOTAL PERIODIC PROJECT GROSS REVENUES** | **$11,402,971** | **$489,834,755** | **$1,471,943,926** | **$2,616,862,812** | **$1,419,497,982** | **$160,000,000** | **$6,169,542,446** | **$572,080,983** |

(1) Estimated based on average annual sales of $650 per square foot.
(2) Estimated based on average annual sales of $400 per square foot.
(7) Estimated at $2,400 per unit/home per year.

Source: Hallstrom Group, Inc.

TABLE IV-6

EXHIBIT IV

**SUMMARY OF ECONOMIC IMPACTS ASSOCIATED WITH DEVELIOPMENT**
**ASSUMING HISTORIC ECONOMIC GROWTH TRENDS**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**
**All Amounts Expressed in Constant 2012 Dollars**

| | Development and Sales Period | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2013 to 2015 | 2016 to 2020 | 2021 to 2025 | 2026 to 2030 | 2031 to 2034 | Economic Opportunity Expansion Area | Totals During Build-Out | Stabilized Annually |
| Project Increment | | Phase I (2015 to 2024) | | Phase II (2025 to 2034) | | (Assumed in 2034) | | |
| ***Construction Activity*** | | | | | | | | |
| Construction Wages | $8,517,600 | $125,659,717 | $114,322,849 | $124,500,529 | $33,704,257 | $50,003,916 | **$456,708,868** | |
| Contractor Profits | $2,250,000 | $38,610,410 | $39,146,190 | $32,887,925 | $11,745,340 | $14,417,961 | **$139,057,826** | |
| Supplier Profits | $900,000 | $15,444,164 | $15,658,476 | $13,155,170 | $4,698,136 | $5,767,184 | **$55,623,130** | |
| Other Construction Costs | $10,832,400 | $206,389,809 | $222,334,385 | $158,335,626 | $67,305,667 | $73,990,546 | **$739,188,433** | |
| Total Construction Impact | **$22,500,000** | **$386,104,100** | **$391,461,900** | **$328,879,250** | **$117,453,400** | **$144,179,607** | **$1,390,578,257** | |
| ***Project De Facto Population Spending*** | | | | | | | | |
| On-Site Spending | | $58,458,001 | $139,475,966 | $173,806,852 | $79,959,798 | $3,200,000 | **$454,900,616** | $43,179,899 |
| Off-Site Spending | | $34,421,974 | $94,888,560 | $153,059,274 | $68,345,462 | $156,800,000 | **$507,515,270** | $34,172,731 |
| Total Project Population Impact | | $92,879,975 | $234,364,526 | $326,866,125 | $148,305,260 | $160,000,000 | **$962,415,886** | **$74,152,630** |
| ***Outside Patronage Spending*** | **$11,402,971** | **$431,376,754** | **$1,332,467,960** | **$2,443,055,960** | **$1,339,538,184** | **$156,800,000** | **$5,714,641,830** | **$826,569,092** |
| TOTAL BASE ECONOMIC IMPACT | **$33,902,971** | **$910,360,829** | **$1,958,294,386** | **$3,098,801,335** | **$1,605,296,844** | **$160,000,000** | **$7,766,656,365** | **$903,921,722** |

Source: Hallstrom Group, Inc.

TABLE V-1 EXHIBIT V

**PUBLIC FISCAL COSTS/BENEFITS SUMMARY TABLE**
**ASSUMING HISTORICAL ECONOMIC GROWTH TRENDS**
**Market Study of the Proposed Maui Tech Park Master Plan**
**Kihei, Maui, Hawaii**
**All Amounts Expressed in Constant 2012 Dollars**

| | Development and Sales Period | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Development Period** | **2013 to 2015** | **2016 to 2020** | **2021 to 2025** | **2026 to 2030** | **2031 to 2034** | **Economic Opportunity Expansion Area** | **Totals During Build-Out Period** | **Stabilized Annually After Build-out** |
| **Project Increment** | | **Phase I (2015 to 2024)** | | **Phase II (2025 to 2034)** | | **(Assumed in 2034)** | | |
| **PUBLIC BENEFITS (Revenues)** | | | | | | | | |
| **1. REAL PROPERTY TAXES** | **$252,154** | **$11,200,363** | **$21,768,299** | **$32,512,485** | **$15,546,154** | **$1,344,824** | **$82,624,279** | **$16,890,978** |
| **2. STATE INCOME TAXES** | | | | | | | | |
| Taxable Personal Income | $23,121,540 | $356,045,445 | $713,199,986 | $1,119,828,713 | $1,111,022,415 | $100,360,716 | $3,423,578,815 | **$359,713,995** |
| Taxable Corporate Profits | $1,455,297 | $54,388,933 | $152,674,859 | $266,290,591 | $143,594,146 | $143,968,313 | $762,372,138 | **$57,208,098** |
| Personal Taxes Paid | $1,179,199 | $18,158,318 | $36,373,199 | $57,111,264 | $56,662,143 | $5,118,397 | $174,602,520 | **$18,345,414** |
| Corporate Taxes Paid | $64,033 | $2,393,113 | $6,717,694 | $11,716,786 | $6,318,142 | $6,334,606 | $33,544,374 | **$2,517,156** |
| **TOTAL STATE INCOME TAXES** | **$1,243,232** | **$20,551,431** | **$43,090,893** | **$68,828,050** | **$62,980,286** | **$11,453,002** | **$208,146,894** | **$20,862,570** |
| **3. STATE GROSS EXCISE TAX** | | | | | | | | |
| Taxable Transactions | | | | | | | | |
| Construction Contracts | $22,500,000 | $386,104,100 | $391,461,900 | $328,879,250 | $117,453,400 | $144,179,607 | $1,390,578,257 | |
| Worker Disposable Income Purchases | $13,872,924 | $176,606,150 | $315,509,038 | $485,243,629 | $577,602,439 | $60,216,430 | $1,629,050,610 | $171,322,892 |
| De Facto Population Discretionary Expenditures (on/off site) | | $92,879,975 | $234,364,526 | $326,866,125 | $148,305,260 | $3,200,000 | $805,615,886 | $74,152,630 |
| Non-Resident Patronage Expenditures | $11,402,971 | $431,376,754 | $1,332,467,960 | $2,443,055,960 | $1,339,538,184 | $156,800,000 | $5,714,641,830 | $826,569,092 |
| **Total Taxable Transactions** | **$47,775,895** | **$1,086,966,980** | **$2,273,803,424** | **$3,584,044,964** | **$2,182,899,283** | **$364,396,036** | **$9,539,886,582** | **$1,072,044,614** |
| **TOTAL STATE EXCISE TAX** | **$1,990,678** | **$45,290,653** | **$94,742,567** | **$149,336,402** | **$90,954,864** | **$15,183,290** | **$382,315,165** | **$44,668,883** |
| **4. Transient Accommodations Tax** | | | | | | | | |
| Taxable Lodging Revenues | $0 | $21,357,897 | $39,497,307 | $39,497,307 | $31,597,846 | | $131,950,357 | $7,899,461 |
| **TOTAL TRANSIENT ACCOMMODATIONS TAX** | **$0** | **$1,975,605** | **$3,653,501** | **$3,653,501** | **$2,922,801** | | **$514,265,521** | **$730,700** |
| **TOTAL GROSS PUBLIC REVENUES** | | | | | | | | |
| **To County of Maui (Item #1 and 10.2% of #4)** | **$252,154** | **$11,401,875** | **$22,140,957** | **$32,885,142** | **$15,844,280** | **$1,344,825** | **$83,869,231** | **$16,965,509** |
| **Adjustment for Other Proportional Taxes (1)** | **1.34** | **1.34** | **1.34** | **1.34** | **1.34** | **1.34** | **1.34** | **1.68** |
| **Adjusted Maui County Revenues (2)** | **$337,383** | **$15,255,709** | **$29,624,600** | **$44,000,319** | **$21,199,646** | **$1,799,375** | **$112,217,031** | **$28,502,055** |
| **Plus Impact Fees** | **$0** | **$9,677,250** | **$10,029,150** | **$9,377,100** | **$0** | | **$29,083,500** | |
| **Total County of Maui Receipts** | **$337,383** | **$24,932,959** | **$39,653,750** | **$53,377,419** | **$21,199,646** | **$1,799,375** | **$141,300,531** | **$28,502,055** |
| **To State (Items #2, #3 & 55.2% of #4)** | **$3,233,910** | **$66,932,618** | **$139,850,193** | **$220,181,184** | **$155,548,536** | **$26,636,292** | **$612,382,733** | **$65,934,800** |
| **Adjustment for Other Proportional Taxes (3)** | **1.22** | **1.22** | **1.22** | **1.22** | **1.22** | **1.22** | **1.22** | **1.22** |
| **Adjusted State Revenues** | **$3,945,370** | **$81,657,794** | **$170,617,235** | **$268,621,045** | **$189,769,214** | **$32,496,276** | **$747,106,934** | **$80,440,455** |
| **Plus Impact Fees (4)** | **$0** | **$1,770,830** | **$1,854,230** | **$1,730,440** | **$0** | | **$5,355,500** | |
| **Total State of Hawaii Receipts** | **$3,945,370** | **$83,428,624** | **$172,471,465** | **$270,351,485** | **$189,769,214** | **$32,496,276** | **$752,462,434** | **$80,440,455** |
| **AGGREGATE TAX REVENUES** | **$4,282,753** | **$98,684,333** | **$202,096,065** | **$314,351,804** | **$210,968,860** | **$34,295,651** | **$864,679,465** | **$108,942,511** |
| **PUBLIC COSTS (Expenses)** | | | | | | | | |
| **By County of Maui** | **$0** | **$13,150,378** | **$24,568,950** | **$35,172,410** | **$14,068,964** | **$0** | **$86,960,702** | **$7,034,482** |
| **By State of Hawaii** | **$0** | **$43,271,346** | **$80,844,178** | **$115,734,886** | **$46,293,954** | **$0** | **$286,144,364** | **$23,146,977** |
| **TOTAL PUBLIC COSTS** | **$0** | **$56,421,724** | **$105,413,127** | **$150,907,296** | **$60,362,918** | **$0** | **$373,105,066** | **$30,181,459** |
| **TOTAL NET PUBLIC BENEFITS** | | | | | | | | |
| **To County of Maui** | **$337,383** | **$2,105,331** | **$5,055,650** | **$8,827,909** | **$7,130,682** | **$1,799,375** | **$25,256,329** | **$21,467,573** |
| **To State of Hawaii** | **$3,945,370** | **$40,157,278** | **$91,627,288** | **$154,616,599** | **$143,475,259** | **$32,496,276** | **$466,318,070** | **$57,293,478** |
| **AGGREGATE NET BENEFITS** | **$4,282,753** | **$42,262,609** | **$96,682,938** | **$163,444,508** | **$150,605,942** | **$34,295,651** | **$491,574,399** | **$78,761,051** |

Note: 34.6% of the TAT goes to the counties of Hawaii, Kauai and Honolulu.

(1) Real Property Taxes comprise 68.1 percent of General Fund revenues in the proposed 2012-13 Maui County budget, and TAT receipts 6.1 percent. Other revenue items 25.3 percent of the total, or 33.8 percent of the RPT and TAT amount.
(2) For parks, water service and wastewater service. Additional per unit impact fees may be assessed.
(3) In recent fiscal years, Gross Excise, Income Taxes and the State's share of TAT have averaged circa 82 percent of total State revenues; other revenue items 18 percent, or 22 percent of the three identified primary taxes.
(4) For schools. Additional per unit impact fees may be assessed.

**Source: The Hallstrom Group, Inc.**

THE HALLSTROM GROUP INC.

REAL ESTATE
CONSULTANTS
& APPRAISERS

## PROFESSIONAL BACKGROUND AND SERVICES

The Hallstrom Group, Inc. is a Honolulu based independent professional organization that provides a wide scope of real estate consulting services throughout the State of Hawaii with particular emphasis on valuation studies. The purpose of the firm is to assist clients in formulating realistic real estate decisions. It provides solutions to complex issues by delivering thoroughly researched, objective analyses in a timely manner. Focusing on specific client problems and needs, and employing a broad range of tools including after-tax cash flow simulations and feasibility analyses, the firm minimizes the financial risks inherent in the real estate decision making process.

The principals and associates of the firm have been professionally trained, are experienced in Hawaiian real estate, and are actively associated with the Appraisal Institute and the Counselors of Real Estate, nationally recognized real estate appraisal and counseling organizations.

The real estate appraisals prepared by The Hallstrom Group accomplish a variety of needs and function to provide professional value opinions for such purposes as mortgage loans, investment decisions, lease negotiations and arbitrations, condemnations, assessment appeals, and the formation of policy decisions. Valuation assignments cover a spectrum of property types including existing and proposed resort and residential developments, industrial properties, high-rise office buildings and condominiums, shopping centers, subdivisions, apartments, residential leased fee conversions, special purpose properties, and vacant acreage, as well as property assemblages and portfolio reviews.

Market studies are research-intensive, analytical tools oriented to provide insight into investment opportunities and development challenges, and range in focus from highest and best use determinations for a specific site or improved property, to an evaluation of multiple (present and future) demand and supply characteristics for long-term, mixed-use projects. Market studies are commissioned for a variety of purposes where timely market information, insightful trends analyses, and perceptive conceptual conclusions or recommendations are critical. Uses include the formation of development strategies, bases for capital commitment decisions, evidence of appropriateness for state and county land use classification petitions, fiscal and social impact evaluations, and the identification of alternative economic use/conversion opportunities.

ARBITRATION
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## PROFESSIONAL QUALIFICATIONS OF THOMAS W. HOLLIDAY

**Business Affiliation**

| | |
|---|---|
| Senior Appraiser/ Analyst | The Hallstrom Group, Inc.<br>Honolulu, Hawaii<br>Since 1980 |
| Former Staff Appraiser | Davis-Baker Appraisal Co.<br>Avalon, Santa Catalina Island, California |

**Education**

- B.A. (Communications/Journalism) 1978 California State, University at Fullerton
- SREA Course 201- Principles of Income Property Appraising
- Expert witness testimony before State of Hawaii Land Use Commission and various state and county boards and agencies since 1983.
- Numerous professional seminars and clinics
- Contributing author to Hawaii Real Estate Investor, Honolulu Star Bulletin

On January 1, 1991, the American Institute of Real Estate Appraisers (AIREA) and the Society of Real Estate Appraisers (SREA) consolidated, forming the Appraisal Institute (AI).

**Recent Neighbor Island Assignments**

- Market Study, Economic Impact Analyses and Public Costs/ Benefits (Fiscal Impact) Assessments

Big Island
-- Kamakana Villages (Mixed-Use Residential Development)
-- W.H. Shipman Ltd, Master Plan (Various Urban Uses)
-- Nani Kahuku Aina (Mixed-Use Resort Community
-- Kona Kai Ola (Mixed-Use Resort Community)
-- Waikoloa Highlands (Residential)
-- Waikoloa Heights (Mixed-Use Residential Development)

Kauai
-- Village at Poipu (Resort/Residential)
-- Ocean Bay Plantation (Resort/Residential)
-- Waipono/Puhi (Mixed-Use Planned Development)
-- Eleele Commercial Expansion (Commercial)

Maui
-- Upcountry Town Center (Mixed-Use Project)
-- Maui Lani (Mixed-Use Community)
-- Honuaula (Mixed-Use Community)
-- Maui Business Park, Phase II (Industrial/Commercial)
-- Kapalua Mauka (Master Planned Community)
-- Hailiimaile (Mixed-Use Master Planned Community)
-- Pulelehua (Master Planned Community)
-- Westin Kaanapali Ocean Villas Expansion (Resort/ Timeshare)

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APPENDIX I

Assessment of the Potential Impacts on Groundwater Resources

# Assessment of the Potential Impact on Groundwater Resources of the Proposed Expansion of the Maui Research and Technology Park in Kihei, Maui

*Prepared for:*

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*Prepared by:*

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560 N. Nimitz Hwy. - Suite 213
Honolulu, Hawaii 96817

March 2012

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## Introduction

This report presents an assessment of the potential impact on groundwater resources of the proposed expansion of the Maui Research and Technology Park (MRTP). The plan of the MRTP expansion is shown on Figure 1. The presently developed portion of the Employment Core obtains its water supply from the Maui County Department of Water Supply (DWS). The DWS system is the preferred source of supply for the proposed MRTP expansion. However, due to its current source limitations, DWS can only commit to supplying the existing and planned portion of the Employment Core outlined in red on Figure 1. As an alternative to supply by DWS, MRTP has proposed a privately owned and operated system to supply the remainder of the Employment Core and the other four development areas.

## Proposed Sources of Supply

In order to limit the potable supply required for the MRTP expansion that will not be supplied by DWS, a private dual system is proposed. Potable water will be supplied using brackish groundwater treated to potable quality by reverse osmosis (RO) filtration. Most of the non-potable water for irrigation use will be wastewater treated to R-1 quality at the County's Kihei Wastewater Treatment Plant (WWTP). This R-1 supply would be supplemented by (untreated) brackish groundwater when needed.

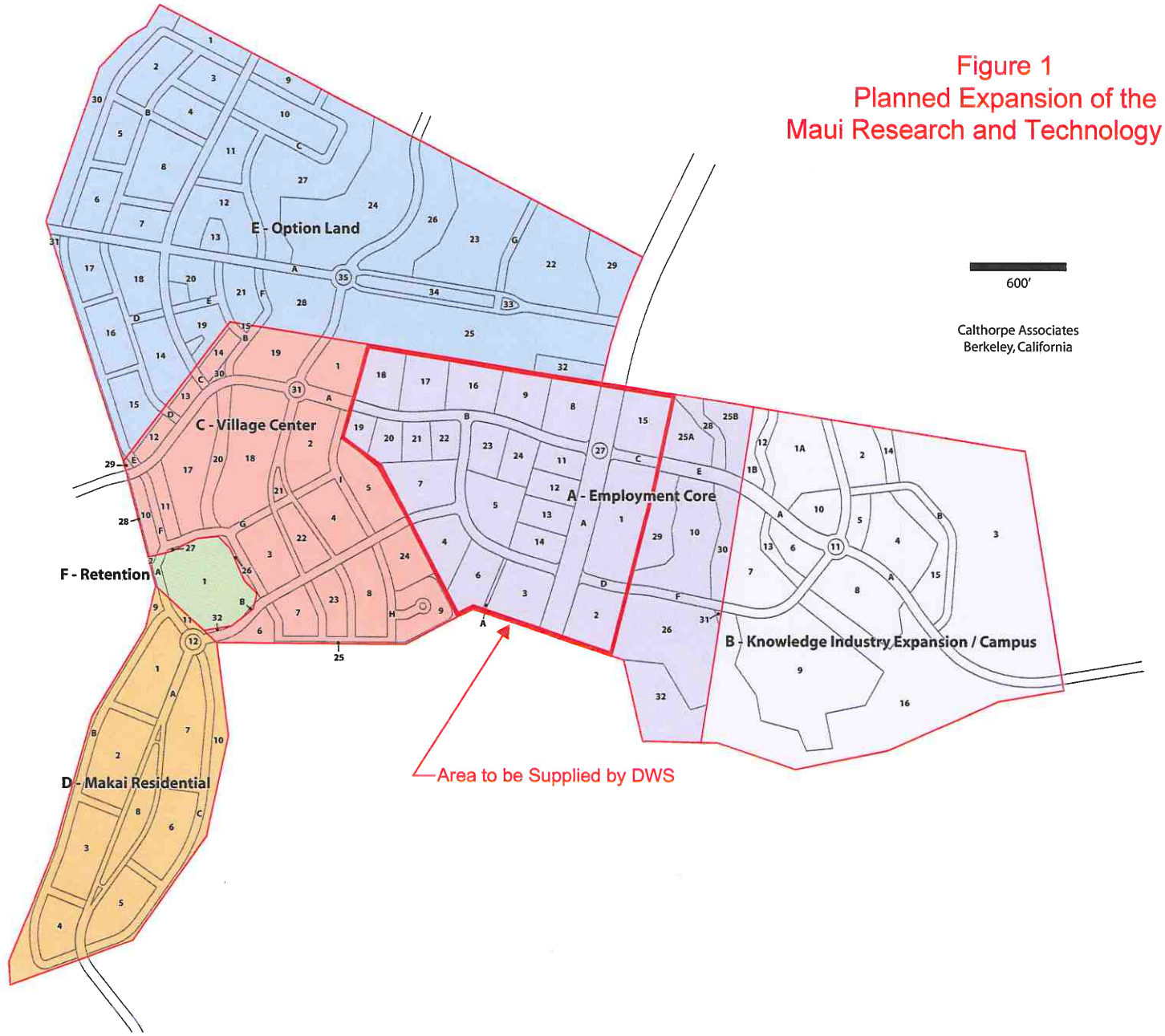
## Projected Water Supply Requirements

Projected water supply requirements for the private dual system were compiled using Maui DWS unit use rate design criteria and splitting these amounts into potable and non-potable use components using the dual system guidelines prepared by the Honolulu Board of Water Supply. These results are presented for the project's two development phases on Tables 1 and 2. A summary of these compilations is also provided below. About 68 percent of the total required supply would be potable and the remaining 32 percent would be non-potable for irrigation use.

**Summary of the Average Potable and Non-Potable Irrigation Requirements for the Portion of the MRTP Expansion Not Supplied by DWS**

| Phase | Developed Area | Average Demands (GPD) | |
|---|---|---|---|
| | | Potable | Non-Potable Irrigation |
| 1 | Employment Core | 18,877 | 19,609 |
| | Village Center | 225,743 | 114,854 |
| | Makai Residential | 211,260 | 25,660 |
| | Retention | -- | 9,632 |
| | Total for Phase 1 | 455,880 | 169,755 |
| 2 | Knowledge Exp / Campus | 40,084 | 59,460 |
| | Option Land | 302,101 | 144,114 |
| | Total for Phase 2 | 342,185 | 203,574 |
| Totals for Both Phases | | 798,065 | 373,329 |

# Figure 1
# Planned Expansion of the Maui Research and Technology Park




o_11-32 | 5 March-12

Table 1

Projections of Required Potable and Irrigation Supply for
Phase 1 of the Expansion of the Maui Research and Technology Park

| Development Area | Land Use | Area | | Number of Units | Potable | | Non-Potable | |
|---|---|---|---|---|---|---|---|---|
| | | Acres | $Ft^2$ | | Unit Use Rate ( GPD / Unit ) | Amount ( GPD ) | Unit Use Rate ( GPD / Unit ) | Amount ( GPD ) |
| Employment Core (Portion Not Supplied by DWS) | Employment | 15.7 | 224,730 | -- | 84 / 1000 $Ft^2$ | 18,877 | 56 / 1000 $Ft^2$ | 12,585 |
| | Open Space (PI) | 3.2 | -- | -- | -- | -- | 1700 / Ac. | 5,440 |
| | Roads | 1.8 | -- | -- | -- | -- | 880 / Ac. | 1,584 |
| | Totals | 20.7 | 224,730 | 0 | -- | 18,877 | -- | 19,609 |
| Village Center | Hotel | 2.1 | 60,000 | 150 | 203 / Unit | 30,450 | 147 / Unit | 22,050 |
| | Mixed Use | 8.9 | 109,200 | -- | 84 / 1000 $Ft^2$ | 9,173 | 56 / 1000 $Ft^2$ | 6,115 |
| | SF Residential | 11.1 | -- | 100 | 6000 / Unit | 60,000 | -- | -- |
| | MF Residential | 9.9 | -- | 300 | 386 / Unit | 115,800 | 174 / Unit | 52,200 |
| | Civic | 10.1 | 100,000 | -- | 84 / 1000 $Ft^2$ | 8,400 | 56 / 1000 $Ft^2$ | 5,600 |
| | Park | 3.2 | -- | -- | 600 / Acre | 1,920 | 3400 / Ac. | 10,880 |
| | Open Space (FI) | 0.4 | -- | -- | -- | -- | 3400 / Ac. | 1,360 |
| | Open Space (PI) | 0.75 | -- | -- | -- | -- | 1700 / Ac. | 1,275 |
| | Retention (PI) | 1.9 | -- | -- | -- | -- | 1700 / Ac. | 3,230 |
| | Roads | 13.8 | -- | -- | -- | -- | 880 / Ac. | 12,144 |
| | Totals | 62.15 | 269,200 | 550 | -- | 225,743 | -- | 114,854 |
| Makai Residential | SF Residential | 21.0 | -- | 350 | 600 / Unit | 210,000 | -- | -- |
| | Park | 2.1 | -- | -- | 600 / Acre | 1,260 | 3400 / Ac. | 7,140 |
| | Open Space (FI) | 0.2 | -- | -- | -- | -- | 3400 / Ac. | 680 |
| | Open Space (PI) | 4.8 | -- | -- | -- | -- | 1700 / Ac. | 8,160 |
| | Roads | 11.0 | -- | -- | -- | -- | 880 / Ac. | 9,680 |
| | Totals | 39.1 | 0 | 350 | -- | 211,260 | -- | 25,660 |
| Drainage Retention | Open Space (PI) | 5.5 | -- | -- | -- | -- | 1700 / Ac. | 9,350 |
| | Roads | 0.32 | -- | -- | -- | -- | 880 / Ac. | 282 |
| | Totals | 5.82 | 0 | 0 | | | | 9,632 |
| Totals for Phase 1 | | 127.8 | 493,930 | 900 | | 455,880 | | 169,755 |

Table 2

Projections of Required Potable and Irrigation Supply for
Phase 2 of the Expansion of the Maui Research and Technology Park

| Development Area | Land Use | Area | | Number of Units | Potable | | Non-Potable | |
|---|---|---|---|---|---|---|---|---|
| | | Acres | $Ft^2$ | | Unit Use Rate ( GPD / Unit ) | Amount ( GPD ) | Unit Use Rate ( GPD / Unit ) | Amount ( GPD ) |
| Knowledge Industry Expansion Campus | Employment | 40.9 | 188,272 | -- | 84 / 1000 $Ft^2$ | 15,815 | 56 / 1000 $Ft^2$ | 10,543 |
| | Mixed Use / Flex | 2.2 | 33,200 | -- | 84 / 1000 $Ft^2$ | 2,789 | 56 / 1000 $Ft^2$ | 1,859 |
| | Employment (Reserve) | 11.4 | -- | -- | 1800 / Ac. | 20,520 | 1200 / Ac. | 13,680 |
| | Park | 1.6 | -- | -- | 600 / Ac. | 960 | 3400 / Ac. | 5,440 |
| | Traffic Circle (FI) | 0.2 | -- | -- | -- | -- | 3400 / Ac. | 680 |
| | Open Space (PI) | 12.1 | -- | -- | -- | -- | 1700 / Ac. | 20,570 |
| | Roads | 7.6 | -- | -- | -- | -- | 880 / Ac. | 6,688 |
| | Totals | 76.0 | 221,472 | 0 | -- | 40,084 | -- | 59,460 |
| Option Land | SF Residential | 28.6 | -- | 300 | 600 / Unit | 180,000 | -- | -- |
| | MF Residential | 5.9 | -- | 179 | 386 / Unit | 69,094 | 174 / Unit | 31,146 |
| | Employment | 26.5 | 403,718 | -- | 84 / 1000 $Ft^2$ | 33,867 | 56 / 1000 $Ft^2$ | 22,578 |
| | Employment (Reserve) | 8.0 | -- | -- | 1800 / Ac. | 14,400 | 1200 / Ac. | 9,600 |
| | Parks | 7.9 | -- | -- | 600 / Ac. | 4,740 | 3400 / Ac. | 26,860 |
| | Traffic Circle (FI) | 0.2 | -- | -- | -- | -- | 3400 / Ac. | 680 |
| | Open Space (PI) | 18.9 | -- | -- | -- | -- | 1700 / Ac. | 32,130 |
| | Roads | 24.0 | -- | -- | -- | -- | 880 / Ac. | 21,120 |
| | Totals | 120.0 | 403,718 | 479 | -- | 302,101 | -- | 144,114 |
| Totals for Phase 2 | | 196.0 | 625,190 | 479 | | 342,185 | | 203,574 |

**Description of the Potable Supply Alternatives**

Two alternatives for brackish well development to feed the RO treatment plant are being considered. One is an array of five wells (one as standby) at 580-foot elevation on land inland of the MRTP site owned by Haleakala Ranch. It should be noted that implementation of this alternative would require an agreement with Haleakala Ranch. At present, no such agreement has been reached. The other alternative is an array of five wells at lower elevation and within the MRTP development site. Each of these alternatives is described below.

Brackish Wells at 580-Foot Elevation. Infrastructure for this alternative is shown schematically and as it would be located in the field on Figures 2 and 3. Based on results of the nearby Maui Highlands wells (State Nos. 4424-01 and 4425-01), chlorides from these wells are likely to be on the order of 350 to 400 milligrams per liter (mg/l). For this salinity level, the RO product recovery is expected to be about two-thirds of the brackish supply. The remaining third would be the RO concentrate which would be disposed of in downgradient disposal wells.

The number of wells and their pump capacities have been sized to provide the maximum day requirement (defined as 1.5 times the average amounts in Tables 1 and 2) with one well as standby. For the two-thirds product recovery rates, this translates to an ultimate requirement of five wells, each with a 360 GPM pump capacity. A 240 GPM RO treatment train would be matched to each well pump, including the standby well pump.

Onsite Brackish Wells. The option to put the brackish RO feedwater supply wells onsite is illustrated on Figures 4 and 5. At this lower elevation, the well water salinity will be higher (chlorides of 500 to 600 mg/l), resulting in a lower, 60 percent RO product recovery rate. To provide the required supply, capacities of all five well pumps would be 400 GPM, each matched to a 240 GPM RO treatment train.

**Description of the Non-Potable Irrigation System**

The required maximum day irrigation supply capacity is projected to be 0.1698 MGD (118 GPM) at the end of Phase 1 and 0.3733 MGD (260 GPM) at the completion of both development phases. The primary source of supply will be R-1 reclaimed wastewater from the Kihei WWTP delivered as shown on Figures 2 through 5. The project's wastewater will be delivered to this WWTP for treatment. Even with this addition, an adequate R-1 supply from the County can not be assured, particularly during extended dry periods of maximum irrigation use. When an R-1 shortfall occurs, the standby brackish supply well would provide the needed supplemental supply for the non-potable system.

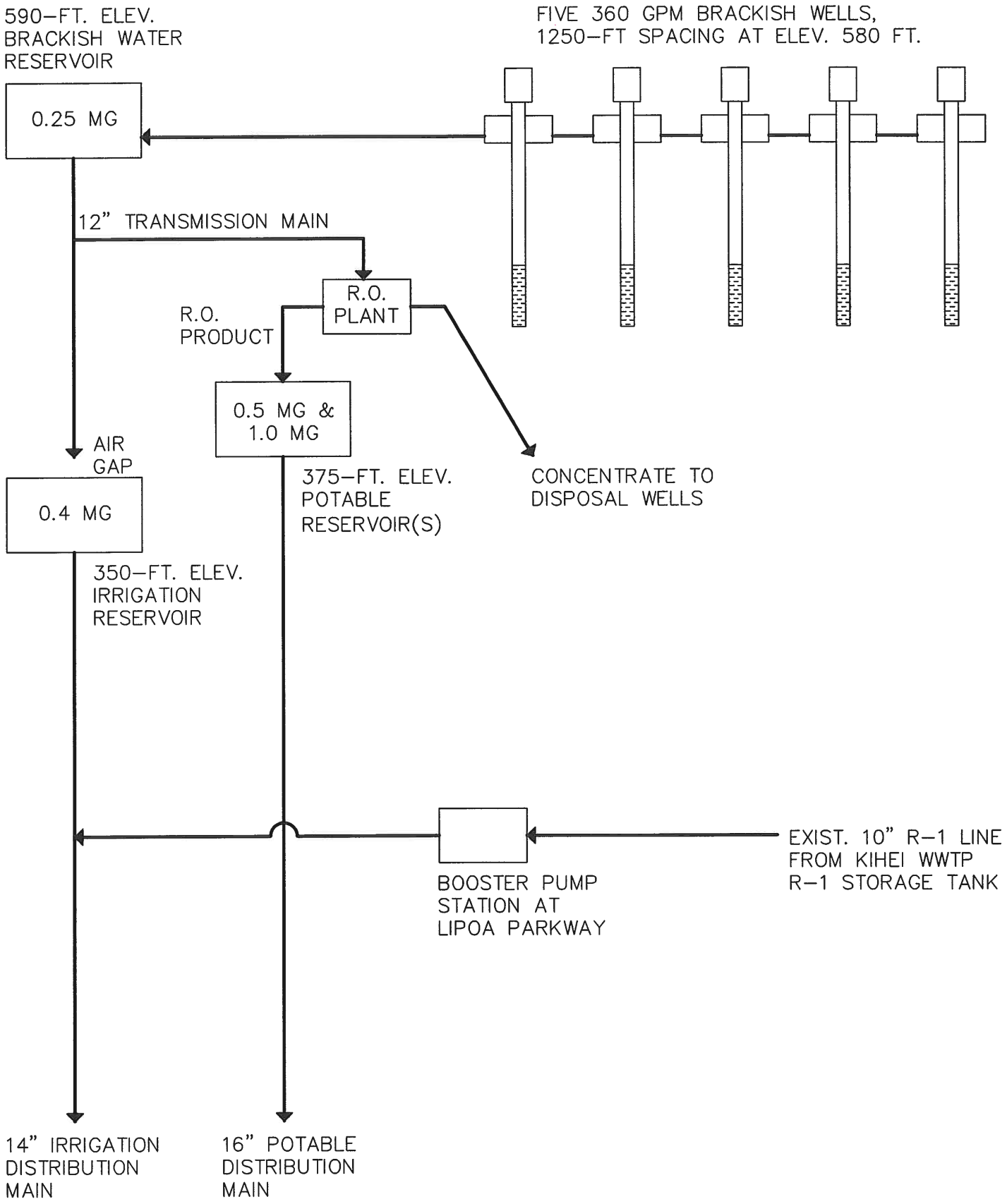
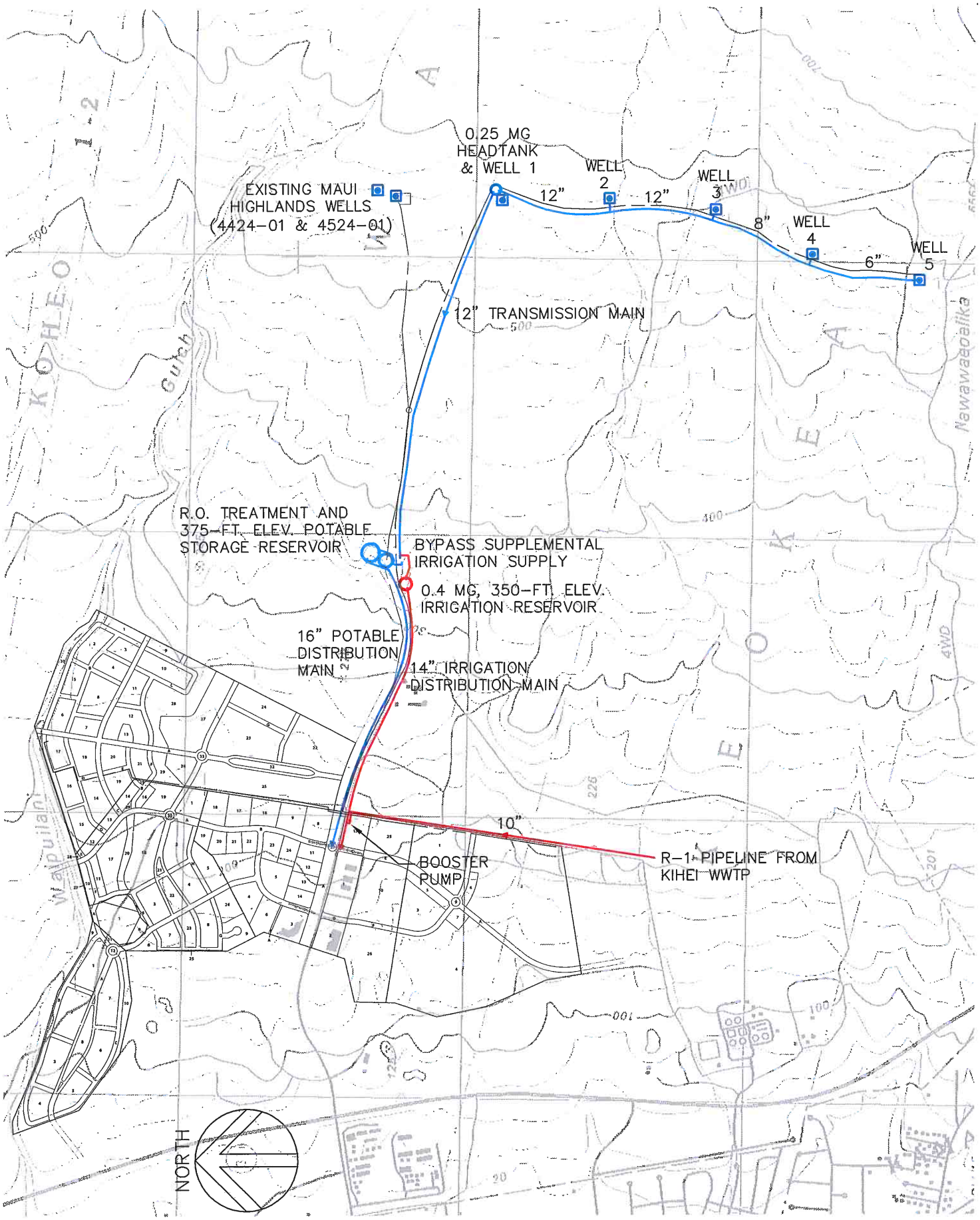



**FIGURE 2**
**SCHEMATIC OF THE OFFSITE BRACKISH WELLS ALTERNATIVE**




GRAPHIC SCALE:

1500' 750' 0 1500' 3000'

**FIGURE 3**

**LAYOUT OF THE ALTERNATIVE WITH OFFSITE BRACKISH WELLS**

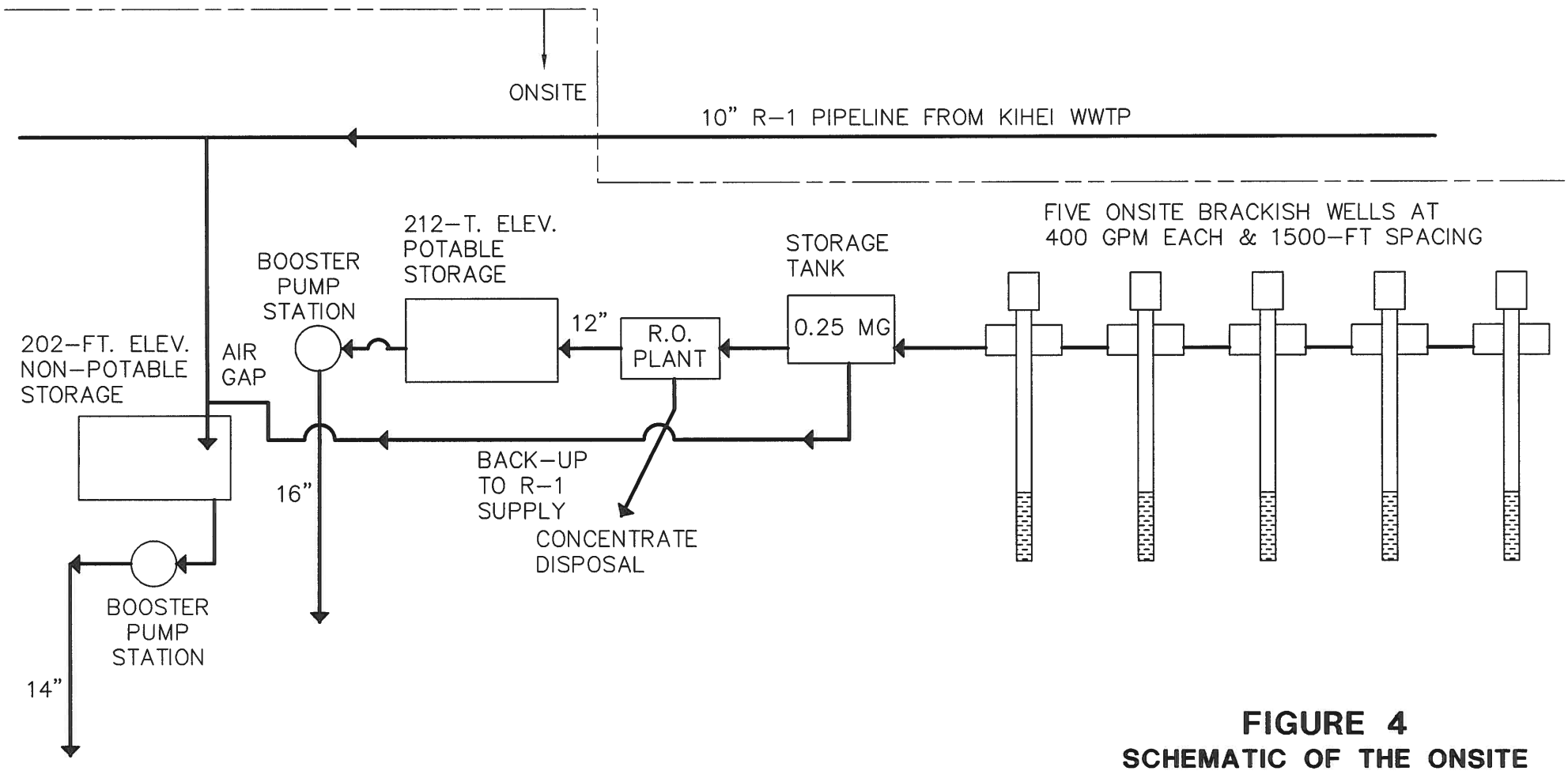
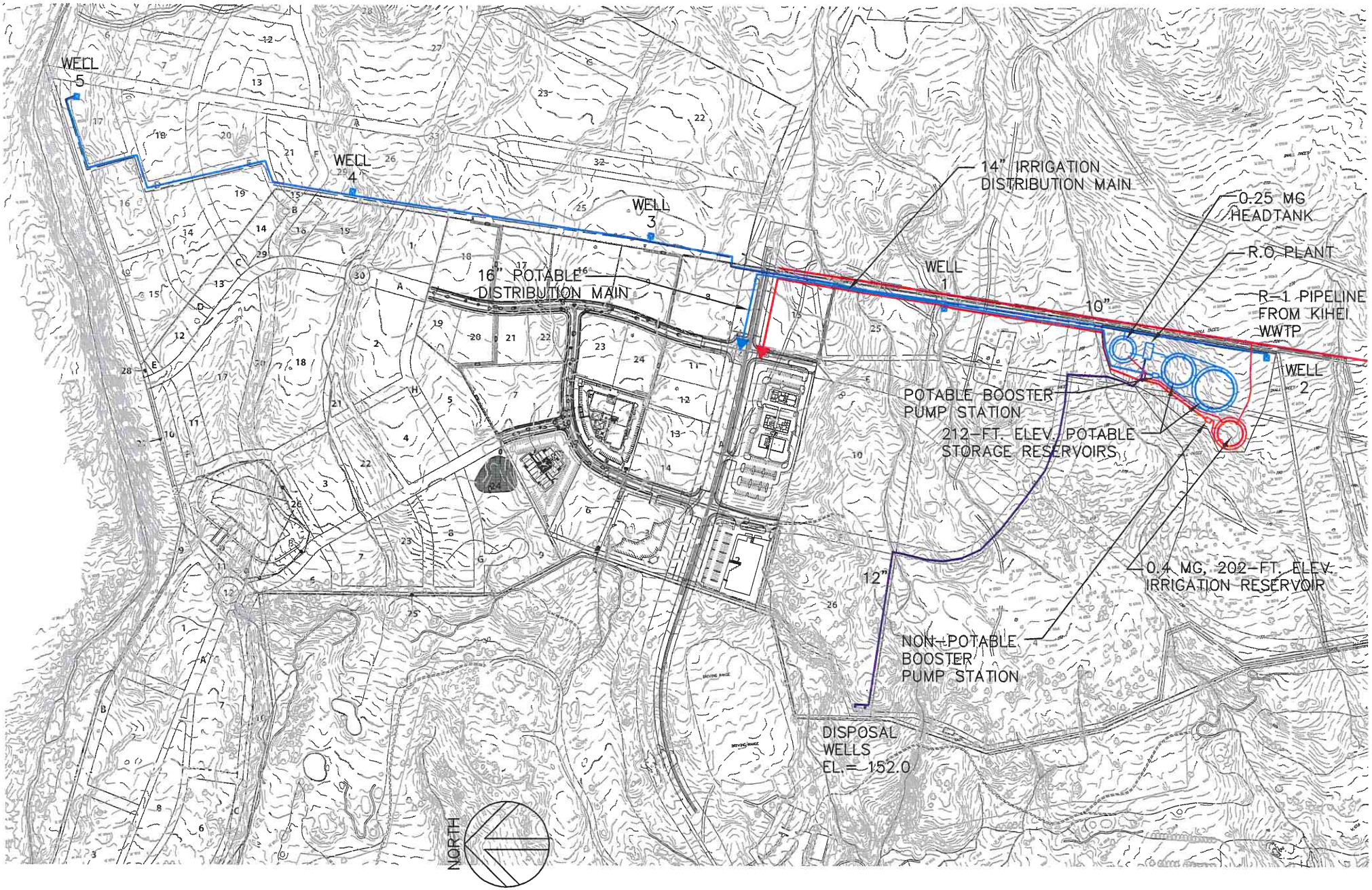



**FIGURE 4**
**SCHEMATIC OF THE ONSITE WELLS ALTERNATIVE**




GRAPHIC SCALE:

800' 400' 0 800' 1600'

# FIGURE 5
## LAYOUT OF THE ALTERNATIVE WITH ONSITE WELLS

**Potential Changes in the Groundwater Flowrate**

Aspects of the project's development that will impact the underlying groundwater resource will consist of: withdrawal of brackish groundwater for RO treatment for potable use; disposal of the RO concentrate in downgradient disposal wells; withdrawal of brackish groundwater to supplement the R-1 irrigation supply; percolation of excess applied irrigation in landscaped areas; and the change in quantity and/or quality of onsite rainfall recharge. These aspects are described and quantified as year-round average amounts in the sections following.

Present Groundwater Flowrate Beneath the Project Site. Groundwater beneath the project site occurs as a brackish basal lens overlying saline groundwater at depth and in hydraulic contact with seawater offshore. This groundwater body has been named as the Kamaole Aquifer by the State Commission on Water Resource Management (CWRM). The most recent, detailed, and therefore reliable estimate of this aquifer's rate of recharge and resulting groundwater flowrate is in U.S. Geological Survey Scientific Investigations Report 2007-5103 (Engott & Vana, 2007). It puts the aquifer's total recharge at about 37 MGD, equivalent to an average of about 3.4 MGD per coastal mile of the aquifer. Present pumpage in the aquifer is on the order of four to five MGD, most of it occurring for golf course irrigation in the Wailea-Makena area to the south and unlikely to significantly influence the rate of flow beneath the MRTP site. Relative to the potentially impacted, mauka-to-makai corridor of groundwater flowrate, the alternative with offsite wells will impact a 1.9-mile wide corridor, beneath which the groundwater flowrate is on the order of 6.5 MGD. The alternative with onsite wells would impact a narrower, 1.5-mile wide corridor with an estimated 5.1 MGD of underlying groundwater flowrate.

Design Criteria Versus Actual Water Use. Projected water supply requirements compiled in Tables 1 and 2 are design numbers which are used to size water system infrastructure components. If compiled appropriately, these design amounts are typically somewhat greater than actual water use. However, for the purposes of this assessment, it is assumed that actual water use is exactly equal to the required supply amounts in Tables 1 and 2.

Water Use in the DWS-Supplied Portion of the Employment Core. The DWS-supplied portion of the Employment Core will ultimately consist of 671.000 square feet of employment floor area, 11 acres of roads, and a 0.2-acre traffic circle. Using DWS design criteria for the Employment Core, the amount supplied by DWS would ultimately amount to 93,940 GPD. Using the non-potable system to irrigate the roads and traffic circle, this supply would ultimately amount to 10,360 GPD.

R-1 and Brackish Groundwater Supply for the Non-Potable Irrigation System. As indicated previously, the County cannot commit to being able to supply the MRTP expansion's entire non-potable supply with R-1 reclaimed wastewater from its Kihei WWTP. For the purposes of this assessment, it is

assumed that two-thirds of the non-potable supply is R-1 wastewater and the other third is brackish groundwater.

Irrigation Return. A portion of the water used for landscape irrigation will percolate below the plant root zone and ultimately reach the underlying groundwater. For the purpose of this assessment, it is assumed that the fraction reaching groundwater is 10 percent of the applied irrigation.

Onsite Rainfall Recharge. Average annual rainfall over the project site is about 12 inches. As a first order approximation, about one-third of this, equivalent to a relatively modest 0.12 MGD over the 400-acre project site, becomes groundwater recharge. Development will create impervious surfaces which will locally increase runoff. However, County Storm Drainage Standards require the installation of retention/detention basins so that peak runoff rates from the property are not increased due to development. Retention/detention storage designed for this purpose will do an excellent job of retaining essentially all runoff from lesser rainfall occurrences. Given this fact and the modest amount of present rainfall recharge, a reasonable approximation for this assessment is that the change in onsite rainfall recharge due to the development will be negligible.

Resulting Change in the Groundwater Flowrate Beneath the Project Site. Based on the foregoing, an estimate of the change of the groundwater flowrate beneath the project site due to its development is presented on Table 3. Calculations are presented for the two well development alternatives being considered, an array of wells offsite at 580-foot elevation and an array of wells within the project site. The resulting reductions in groundwater flowrate are relatively significant. For the offsite wells impacting a wider mauka-makai corridor, the estimated average flowrate reduction is 13.6 percent. Over the narrower corridor of the onsite wells alternative, the estimated reduction is 17.3 percent.

**Potential Changes in Groundwater Quality**

Changes to the groundwater flowrate, both as drafts from wells and returns by various processes, will also remove and add nutrients (nitrogen and phosphorus) which will ultimately discharge into the marine environment. To estimate these nutrient loading changes to the marine environment, the following assumptions have been made:

- Based on results of the nearby Maui Highlands wells and others, groundwater pumped by wells in either well field will have concentrations of 1.1 mg/l as nitrogen and 0.06 mg/l as phosphorus.
- The RO process will remove essentially all of the nitrogen and phosphorus from the feedwater supply and put it into the concentrate delivered to the disposal wells.
- R-1 reclaimed wastewater from the Kihei WWTP will have concentrations of 15 mg/l as nitrogen and 5 mg/l as phosphorus.

Table 3

Estimated Changes in the Groundwater Flowrate
Due to the Maui Research and Technology Park Expansion

| Component of Groundwater Withdrawal and Return | Well Alternatives | |
|---|---|---|
| | 580-Foot Elevation ( MGD ) | Onsite ( MGD ) |
| Pre-Development Groundwater Flowrate | 6.5 | 5.1 |
| Drafts From Groundwater by Wells | | |
| RO Feedwater Supply | 1.1971 | 1.3302 |
| Supplement to the Non-Potable Supply | 0.1279 | 0.1279 |
| Total Draft of Groundwater | 1.3250 | 1.4581 |
| Returns to Groundwater by Various Processes | | |
| RO Concentrate into Disposal Wells | 0.3990 | 0.5321 |
| Irrigation Return (10% of Applied) | | |
| Originating as R-1 Effluent | 0.0256 | 0.0256 |
| Groundwater Supplement to N-P System | 0.0128 | 0.0128 |
| Employment Core Supplied by DWS | 0.0038 | 0.0038 |
| Total Return to Groundwater | 0.4412 | 0.5743 |
| Post-Development Groundwater Flowrate : Amount | 5.6162 | 4.2162 |
| : % Decrease | 13.6 | 17.3 |

- While the amount of post-development rainfall recharge will be essentially the same as pre-development, it will have increases of nitrogen and phosphorus amounting to 0.3 and 0.06 mg/l, respectively.

- Fertilizer applications in landscaped areas will average three pounds per 1000 $ft^2$ per year of nitrogen and 0.5 pounds per year of phosphorus. Of these applied amounts, 10 percent of the nitrogen and two percent of the phosphorus will be carried with the excess applied irrigation water below the root zone.

- For all water percolating to the groundwater below, natural processes similar to a trickling filter will remove 80 percent of the dissolved nitrogen and 95 percent of the dissolved phosphorus. These removal rates are actually less than the natural removal rates occurring to the Kealakehe WWTP effluent which is disposed of in a shallow pit and ultimately enters the marine environment at the inland end of Honokohau Harbor in Kona on the Big Island. At that location, vertical travel through the vadose zone is only about 50 feet and the movement in groundwater to discharge into the upper end of the harbor is about 3500 feet. At MRTP, the drop through the vadose zone and the travel distance to shoreline discharge are substantially greater.

Based on the foregoing set of assumptions, Table 4 presents a compilation of changes to the amount of nitrogen and phosphorus carried by groundwater into the marine environment. For either of the well supply alternatives, the estimated increases of nitrogen and phosphorus are less than one percent.

**Potential Impacts to Downgradient Users of the Groundwater Resource**

In the area downgradient of the MRTP expansion's wells and development area (the corridor from Kihei Beach Park on the north to Kaloma Park on the south), there are 24 existing wells. Available information on these wells from the files of the CWRM is compiled in Table 5. Blanks in the table indicate items of information that are not on file with the CWRM. Many of the wells or more than 60 years old and obviously no longer in use. Several were drilled as test holes for observation and are not used for supply. However, none of the well owners or operators, even for the more recently drilled wells, reports their water use to the CWRM as required by their permits.

In the absence of information on actual use, it has been concluded that only the four wells that are shaded on Table 5 are actively used. For three of the wells (Nos. 4427-09, 14, and 16), their use amounts have been estimated assuming that 50 percent of their TMK gross areas are irrigated landscaping and that the irrigation averages 3000 GPD/acre as a year-round average. For the fourth well (No. 4427-08), it is assumed that its 40 GPM pump operates an average of six hours a day as a year-round average. For these assumptions, the combined average use of these four wells is approximated to be 40,000 GPD.

Table 4

Estimated Changes to the Nitrogen and Phosphorus in Groundwater
Discharged into the Marine Environment

| Component of Flow | Wells at 580-Foot Elevation | | | Onsite Wells | | |
|---|---|---|---|---|---|---|
| | Flowrate ( MGD ) | Nitrogen ( lbs / day ) | Phosphorus ( lbs / day ) | Flowrate ( MGD ) | Nitrogen ( lbs / day ) | Phosphorus ( lbs / day ) |
| Pre-Development Groundwater Flow | 6.5 | 55.044 | 3.002 | 5.1 | 45.188 | 2.355 |
| Drafts From Groundwater | | | | | | |
| • As RO Feedwater | 1.1971 | 10.982 | 0.599 | 1.3302 | 12.203 | 0.666 |
| • To Supplement Non-Potable Irrigation | 0.1279 | 1.173 | 0.064 | 0.1279 | 1.173 | 0.064 |
| Total Draft From Groundwater | 1.3250 | 12.155 | 0.663 | 1.458 | 13.376 | 0.730 |
| Direct Delivery Back to Groundwater as RO Concentrate | 0.3990 | 10.982 | 0.599 | 0.5321 | 12.203 | 0.666 |
| Percolation of Excess Landscape Irrigation Back to Groundwater | | | | | | |
| • Supplied as R-1 Effluent | 0.0256 | 1.179 | 0.058 | 0.0256 | 1.179 | 0.058 |
| • Supplied as Brackish Groundwater | 0.0128 | 0.293 | 0.003 | 0.0128 | 0.293 | 0.003 |
| • Supplied by DWS | 0.0038 | 0.087 | 0.001 | 0.0038 | 0.087 | 0.001 |
| Total Irrigation Return | 0.0422 | 1.559 | 0.062 | 0.0422 | 1.559 | 0.062 |
| On-Site Rainfall Recharge | No Change | 0.060 | 0.003 | No Change | 0.060 | 0.003 |
| Post Development : Amount | 5.6162 | 55.490 | 3.003 | 4.2162 | 45.574 | 2.356 |
| : Percent Change | - 13.6% | + 0.8% | + 0.03% | - 17.3% | + 0.9% | + 0.04% |

Table 5

Listing of the 24 Downgradient Wells that May be
Impacted by the Maui Research and Technology Park Expansion

| State Well No. | Well Name | Year Drilled | Casing Diameter ( In. ) | Ground Elevation ( Feet MSL ) | Total Depth ( Feet ) | Static Water Level ( Feet MSL ) | Chlorides ( MG/L ) | Drawdown @ GPM ( Feet @ GPM ) | Installed Pump Capacity ( GPM ) | Indicated Use |
|---|---|---|---|---|---|---|---|---|---|---|
| 4426-01 | Kihei Injection TH | 1972 | 2 | | 203 | | | | | Unused |
| 4426-02 | Kihei Injection | 1974 | 18 | 109 | 230 | 4.0 | | 4.2 @ 2200 | | Disposal (?) |
| 4426-03 | Kihei MRTP | 1990 | 8 | 124 | 157 | 1.9 | 370 | 0.0 @ 30 | | Unused |
| 4427-01 | TMK 3-9-05:52 | | | | | | | | | Irrigation |
| 4427-02 | TMK 3-2-02:08 | 1945 | 8 | | 30 | | 575 | ? @ 16 | | Unused |
| 4427-03 | Medo | 1948 | 10 | | 22 | | | | | Unused |
| 4427-04 | TMK 3-9-11:38 | 1949 | 8 | | 24 | | | | | Irrigation |
| 4427-05 | TMK 3-9-02:02 | 1950 | 8 | | 82 | | | | | Unused |
| 4427-06 | Kihei Fire B1 | 2009 | 2 | | 16 | | | | | Observation |
| 4427-07 | Kihei Fire B2 | 2009 | 2 | | 40 | | | | | Observation |
| 4427-08 | Kihei Fire B3 | 2009 | 2 | | 70 | | | | | Observation |
| 4427-09 | Kihei Baptist Chapel | 1978 | 20 | | 15 | | | | | Irrigation |
| 4527-01 | TMK 3-9-02:36 | 1945 | 6 | | 30 | | | 2 @ 250 | 120 | Not Known |
| 4527-02 | TMK 3-9-02:32 | 1946 | 8 | | 35 | | 522 | ? @ 20 | | Not Known |
| 4527-03 | TMK 3-9-01:02 | 1947 | 8 | | 20 | | | | | Unused |
| 4527-04 | TMK 3-9-08: ? | 1948 | 7 | | 47 | | | | | Unused |
| 4527-05 | TMK 3-9-08: ? | 1948 | | | 70 | | | | | Unused |
| 4527-06 | TMK-3-9-01:09 | 1948 | 6 | | 28 | | 540 | | | Not Known |
| 4527-07 | TMK 3-9-23:30 | 1949 | 8 | | 42 | | | | | Unused |
| 4527-08 | Kihei - Piilani | 1990 | 10 | 41 | 71 | 0.8 | 420 | 0.3 @ 25 | 40 | Irrigation |
| 4527-12 | Waiohuli 1 | 1989 | 60 | | 20 | | | | | Abandon / Sealed |
| 4527-14 | Kauhale Makai | 2001 | 6 | 9 | 86 | 1.7 | 2900 | 5.8 @ 100 | 150 | Irrigation |
| 4527-16 | St. Theresa Church | 2007 | 6 | | 45 | | 300 | | 60 | Irrigation |
| 4527-17 | Kihei | | 66 | | 11 | | | | | Unused |

Notes: 1. Information from the files of the State Commission on Water Resource Management (CWRM). Blank spaces indicate that the information is not in the CWRM files.
2. Wells that may still be in use are shaded.

In this mauka/makai corridor of potential impact, the groundwater flowrate is about 6.5 MGD. Discounting the project's return of RO concentrate which will be delivered into the transition zone below the basal lens, the project's net draft of groundwater from the "usable" portion of the basal lens would be 1.28 MGD for the offsite wells alternative and 1.42 MGD for the onsite wells (refer back to Table 3). Using the higher number and adding the 40,000 GPD in downgradient wells results in a total draft of 1.46 MGD or about 22 percent of the groundwater flowrate in this mauka/makai corridor.

For a thin basal lens such as exists in this area, the CWRM sets the sustainable yield at 44 percent of the groundwater flowrate. By that measure, the MRTP expansion's use of groundwater would be well within the CWRM's definition of the sustainable supply. Even if a more conservative 33 percent as the sustainable supply, the prospective use of groundwater should be sustainable. However, the active downgradient wells are in nearshore locations where some salinity increase to their pumped water as a result of pumpage of the MRTP's proposed wells is likely to occur. Based on experience elsewhere, that expectable salinity increase may be on the order of 10 percent.

# Final Environmental Impact Statement

Prepared in Support of a Consolidated Application for Community Plan Amendment and Change in Zoning

**PROJECT ASSESSMENT APPICATION VOLUME IV (Appendix J – Appendix S)**

## Applicant:

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## Prepared by:

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## Accepting Authority:

Land Use Commission
Department of Business, Economic Development & Tourism
State of Hawaii

**March 2013**

# MAUI RESEARCH & TECHNOLOGY PARK MASTER PLAN UPDATE

# FINAL ENVIRONMENTAL IMPACT STATEMENT

# FOR
# MAUI RESEARCH & TECHNOLOGY PARK
# MASTER PLAN UPDATE

## PREPARED IN SUPPORT OF A CONSOLIDATED APPLICATION FOR COMMUNITY PLAN AMENDMENT AND CHANGE IN ZONING APPLICATION

## PROJECT ASSESSMENT APPLICATION VOLUME IV (APPENDIX J – APPENDIX S)


Applicant:
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Department of Business, Economic Development & Tourism
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March 2013

APPENDIX J
Impacts on Agriculture

# *MAUI RESEARCH & TECHNOLOGY PARK MASTER PLAN UPDATE: IMPACTS ON AGRICULTURE*

# *MAUI RESEARCH & TECHNOLOGY PARK MASTER PLAN UPDATE: IMPACTS ON AGRICULTURE*

*PREPARED FOR:*
**Maui R&T Partners, LLC**

*PREPARED BY:*
**Decision Analysts Hawai‘i, Inc.**

**May 2011**

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# EXECUTIVE SUMMARY

## 1. PROPOSED DEVELOPMENT

Maui R&T Partners, LLC proposes to update the Maui Research & Technology Park Master Plan ("the Project"). The update will include (1) expanding the Park's urban-designated land by about 253 acres (from about 158 acres to about 411 acres), and (2) broadening lot sizes and permitted uses. The Park includes an additional 21 acres of agricultural land that will remain in agriculture, but which is not part of the Master Plan Update.

## 2. AGRICULTURAL CONDITIONS

The Project expansion area has high solar radiation, but the poor soils, low soil ratings, and lack of irrigation water indicate that the property is poorly suited for growing commercial field crops.

## 3. IMPACT ON CATTLE OPERATIONS, HALEAKALĀ RANCH

### a. Impact of the Project on Haleakalā Ranch Cattle Operations

Development of the Project will remove about 102 acres of grazing land from Haleakalā Ranch, or about 0.44% of the 23,000 acres of their grazing land. The corresponding reduction in feed produced from all of the Ranch's grazing land will be about 0.22%. The lower percentage for feed reflects the fact that the arid Kīhei lands have lower yields than *mauka* pastures.

While Kīhei pastures are important for winter cattle grazing, the Ranch anticipates that this relatively small reduction in feed will have no significant affect on the Ranch's cattle operations, including no significant impact on the size of their herd, production, revenues, employment or payroll. The Ranch has sufficient lands to move its cattle to other pastures.

### b. Cumulative Impact on Haleakalā Ranch Cattle Operations

Over the next 20 years or so, planned and proposed projects on file with the County could result in the development of about 419 acres that are now used by Haleakalā Ranch to graze cattle, including about 102 acres for the Project and about 317 acres for other projects. All of this land is located in Kīhei within the Urban Growth Boundary. This loss amounts to about 1.82% of the Ranch's grazing land, or about 0.91% of the available feed.

The Ranch regards a 0.91% loss in feed as too small to have a significant effect on its cattle operations. Again, the Ranch has sufficient lands to move its cattle to other pastures. Even if the Ranch were operated at its maximum carrying capacity and replacement pastures were not available, the impact would be small: about 15.5 fewer breeding cows, about 11.6 fewer calves per year, about $4,600 less in annual revenues, and the loss of about 30% of one job.

### c. Mitigating Measures

As discussed above, the Project in combination with other projects will result in an insignificant impact on Haleakalā Ranch cattle operations. In view of this finding, mitigation measures for the impact of the Project on the Ranch's cattle operations are not recommended.

## 4. IMPACT ON ALGAE OPERATIONS, BIOREAL INC.

To the south on land abutting the Project are the facilities of BioReal Inc. As recently as 2009, BioReal grew microalgae to produce astaxanthin, an antioxidant which is believed to have a number of health benefits for humans.

The BioReal operations in Kīhei closed for reasons unrelated to the Project. In view of this closure, the Project will not impact any algae operations.

## 5. IMPACT ON SEED OPERATIONS, MONSANTO HAWAIʻI

### a. Impact on Seed-Corn Operations

Farther south of the Project are Monsanto Hawaiʻi seed-corn operations. Monsanto owns about 310 acres, of which about 100 acres are farmed.

Project construction and operations are not expected to impact Monsanto's seed-corn operations. Also, nuisance complaints by Park tenants and employees about Monsanto's farm operations—e.g., noise from farm equipment, drifting of crop-protection products during occasional applications, and dust from fields—are not expected to be significant and,

as a result, are not expected to require changes in Monsanto's seed-corn operations. Reasons for this assessment include:

— Long distances between farm operations and Park buildings (over 0.25 mile) and Park homes (over 1 mile).

— Project employees will work in enclosed air-conditioned buildings.

— Project residents will be buffered from farm operations by Project buildings, trees and shrubbery.

— Prevailing tradewinds blow *makai* and not toward the Park.

— As specified by requirements on product labels, Monsanto modifies or suspends the application of crop-protection products during adverse weather conditions (e.g., strong winds that blow towards homes and businesses).

### b. Mitigating Measures

Even though nuisance complaints from Park tenants and employees about Monsanto's nearby farm operations are not anticipated, it is recommended that Park tenants and employees be informed that they will be working and/or living near farm operations. This information should be included in promotional brochures and websites, and in sales and rental contracts. With this information, future tenants and employees are more likely to accept that nearby farm operations are part of the character of the community.

In any case, Hawai'i's Right-to-Farm Act gives farmers the right to farm if they were operating before neighboring properties were developed, provided that the farm activity does not threaten public health or safety.

## 6. IMPACT ON THE GROWTH OF DIVERSIFIED CROP FARMING

The Project will result in a small loss of low-quality agricultural land (about 253 acres) of which there is a large supply on Maui, but will not affect the supply of good farmland of which there is also a large supply. Consequently, the Project will have no impact on the growth of diversified crop farming.

## 7. OFFSETTING BENEFITS

The loss of 253 acres of low-quality agricultural land will be offset by the following benefits of the Project:

— Construction Activity

- Construction jobs associated with Project development.
- Indirect jobs generated by purchases of goods and services by construction companies and families of construction workers.
- State tax revenues (excise taxes, personal income taxes, corporate income taxes, etc.) paid by construction companies and workers, and by companies and families supported by construction activity.

— Operations

- On-site jobs associated with research and technology, office operations, and retail operations.
- Off-site jobs generated by purchases of goods and services by Project businesses and residents.
- Housing for Maui residents.
- State tax revenues (excise taxes, personal income taxes, corporate income taxes, etc.) paid by Project businesses and residents, as well as by off-site businesses and residents supported by Project operations.
- County tax revenues (property taxes, etc.) paid by Project businesses and residents, as well as by off-site businesses and residents supported by Project operations.

## 8. CONSISTENCY WITH STATE AND COUNTY POLICIES

### a. Availability of Lands for Agriculture

The *Hawai'i State Constitution*, the *Hawai'i State Plan*, the *State Agriculture Functional Plan*, the *County of Maui 2030 General Plan,* the County's *Maui Island Plan (Draft),* and the County's *Kīhei-Mākena Community Plan* call directly or implicitly for preserving the economic viability of plantation agriculture and promoting the growth of diversified agriculture. To accomplish this, an adequate supply of agriculturally suitable lands and water must be assured.

With regard to plantation agriculture, the Project site is not and never was part of a sugarcane or pineapple plantation.

With regard to diversified crop farming, there is no current or recent farming on the property. The Project will result in a small loss of low-quality agricultural land of which there is a large supply on Maui, but will not affect the supply of good farmland of which

there is also a large supply. Consequently, the Project will have no impact on the growth of diversified crop farming.

With regard to ranching, about 150 acres of the Project site are used for grazing cattle. However, feed production is low due to arid conditions. Also, the acreage loss is too small to affect cattle operations.

**b. Conservation of Agricultural Lands**

In addition to the above, State and County policies call for conserving and protecting prime agricultural lands, including protecting farmland from urban development.

The Project will result in no loss of prime agricultural lands. All of the soils in the expansion area have an LSB rating of "E," which is the lowest LSB rating.

**c. State Districting**

The Project expansion area is within the State Agricultural District. However, the developer is filing a petition with the State Land Use Commission for a District Boundary Amendment to redesignate the expansion area to the "Urban" District.

**d. Kīhei-Mākena Community Plan**

Most of the Project site is currently designated "Project District" in the *Kīhei-Mākena Community Plan*. However, a Community Plan Amendment will be sought to bring the entire Park site into a community plan designation that better aligns with the vision of the Master Plan Update and anticipated changes to the Maui County Code, Chapter 19.33, *Kīhei Research & Technology Park District.* This will involve amending the Community Plan to re-designate about 39 acres from "Agriculture" to "Project District." Also, changes will be sought to the language of Chapter 19.33 to allow for a more diversified development that better aligns with the Master Plan Update.

**e. County Zoning**

Most of the expansion area is zoned "Agriculture." Full development of the Project will require appropriate rezoning.

# MAUI RESEARCH & TECHNOLOGY PARK MASTER PLAN UPDATE: IMPACTS ON AGRICULTURE

## 1. INTRODUCTION

Maui R&T Partners, LLC proposes to update the Maui Research & Technology Park Master Plan ("the Project"). The update will include (1) expanding the Park's urban-designated land by about 253 acres (from about 158 acres to about 411 acres), and (2) broadening lot sizes and permitted uses. The Park includes an additional 21 acres of agricultural land that will remain in agriculture, but which are not part of the Master Plan Update.

This report addresses the impacts on agriculture of developing the Project. The material below gives the following information: the Project location, description, and required approvals; the agricultural conditions at the Project site; potential crops; locational advantages and disadvantages for agriculture; surrounding land uses; the impacts of the Project on cattle, algae, and seed-corn operations; the impact of the Project on the growth of diversified crop farming; benefits of the Project that would offset adverse agricultural impacts; and consistency of the Project with State and County agricultural policies related to agricultural land. Appendix A provides State and County goals, objectives, policies and guidelines related to agricultural lands. Relevant maps are at the end of the report.

## 2. PROJECT LOCATION, DESCRIPTION AND REQUIRED APPROVALS

### a. Project Location and TMKs

The Maui Research and Technology Park is located in Kīhei, on Maui's south side (see Figures 1 and 2). The Tax Map Keys for the existing and updated Park site are: (2) 2-2-024:1-9, 14-17, 31, 34 and a portion of (2) 2-2-002:54 (see Figure 3).

### b. Project Description

The vision for the Park is to transform it from its current single-use large-lot research and technology campus into an integrated and mixed-use community that is focussed around a regional high-technology employment base. The overall concept diagram for the Project is shown in Figure 4, and includes the following elements:

— Knowledge-based industry expansion along Līpoa Parkway which takes advantage of existing infrastructure and subdivided lots.

— A mix of office, housing, civic, retail and park uses within a "Village Center" comprising approximately 58 acres of the site.

— Residential units on approximately 100 acres to the east and west of the Village Center, within easy walking distance of schools, retail, and services.

— Long-term expansion opportunities on approximately 217 acres of land within the existing employment core and to the south and east.

**c. Required Approvals**

State Land Use District Boundary Amendment

The Project will require State redistricting of about 253 acres from the Agricultural District to the Urban District (see Figure 5). In addition, the Project will require amendments to the conditions placed upon the 158 acres that are already in the Urban District.

Community Plan Amendment

The Park is located within the Kīhei-Mākena Community Plan region. The majority of the Project is designated Project District 6 (R&T Park) in the Community Plan, with a portion designated *Public/Quasi-public* (see Figure 6). A Community Plan Amendment will be required to bring the Project site into a community plan designation that better aligns with the vision of the Master Plan Update and anticipated changes to the Maui County Code (MCC), Chapter 19.33, *Kīhei Research & Technology Park District.* This will involve amending the Community Plan to re-designate about 39 acres from "Agriculture" to "Project District." Also, changes will be sought to the language of Chapter 19.33 to allow for a more diversified development that better aligns with the Master Plan Update.

In Figure 6, the grey area to the south of the Project and abutting it, and which is outside the red Project Site boundary, is part of the Park but is not part of the Master Plan Update. As mentioned in Section 1, this area is the 21 acres of agricultural land that will remain in agriculture.

Change in Zoning

The Project will similarly require a Change in County Zoning in order to bring the entire Park site into the *Kīhei Research and Technology Park District* (MCC Chapter 19.33) —particularly the portions currently zoned Agricultural (see Figure 7).

## 3. AGRICULTURAL CONDITIONS

### a. Soil Type and Characteristics

According to the soil survey by the Natural Resources Conservation Service (NRCS), formerly known as the Soil Conservation Service, the Project expansion area includes a single soil type (see Figure 8):

— WID2: Waiakoa extremely stony silty clay loam, 7 to 15% slopes

For this soil type, runoff is medium; the erosion hazard is severe, with about 50% of the suface layer having been removed by erosion in most areas; and stones cover 3 to 15% of the surface. WID2 is used for pasture and wildlife habitat.

### b. Soil Ratings

Three classification systems are commonly used to rate soils in Hawai'i: (1) Land Capability Grouping, (2) Agricultural Lands of Importance to the State of Hawai'i, and (3) Overall Productivity Rating.

Land Capability Grouping (NRCS Rating)

The 1972 Land Capability Grouping by the NRCS rates soils according to eight levels, ranging from the highest classification level "I" to the lowest "VIII."

Soil type WID2 has a rating of VIIs. Class VII soils have very severe limitations that make them unsuitable for cultivation and restrict their use largely to pasture or range, woodland, or wildlife habitat. The subclassification "s" indicates that the soils have an unfavorable texture, or are extremely rocky or stony.

Agricultural Lands of Importance in the State of Hawai'i (ALISH)

ALISH ratings were developed in 1977 by the NRCS, the University of Hawai'i College (UH) of Tropical Agriculture and Human Resources, and the State Department of Agriculture. This system classifies land into three broad categories: (a) Prime agricultural land which is land that is best-suited for the production of crops because of its ability to sustain high yields with relatively little input and with the least damage to the environment; (b) Unique agricultural land which is non-Prime agricultural land used for the production of specific high-value crops; and (c) Other agricultural land which is non-Prime and non-Unique agricultural land that is important to the production of crops.

As shown in Figure 9, all of the expansion area for the Project is rated as "Unclassified," indicating that the area has poor soils for growing crops.

Overall Productivity Rating (LSB Rating)

In 1972, the UH Land Study Bureau (LSB) developed the Overall Productivity Rating, which classifies soils according to five levels, with "A" representing the class of highest productivity and "E" the lowest.

All of the soils in the expansion area are rated "E" (see Figure 10).

Summary Evaluation of Soil Quality

All three rating systems indicated that the expansion area for the Project has poor soils for growing crops.

**c. Elevation and Slopes**

The Project site ranges in elevation from about 60 feet to about 260 feet, with an average slope of less than 5%.

**d. Climatic Conditions**

Hawai'i has a mild *semi*tropical climate that is due primarily to three factors: (1) Hawai'i's mid-Pacific location near the Tropic of Cancer, (2) the surrounding warm ocean waters that vary little in temperature between the winter and summer seasons, and (3) the prevailing northeasterly tradewinds that bring air having temperatures that are close to those of the surrounding waters. But because Haleakalā blocks the tradewinds, Kīhei has a semiarid climate.

Solar Radiation

The Project site receives considerable sunshine, with average daily insulation of about 500 calories per square centimeter.

Rainfall

Annual rainfall in Kīhei averages less than 15 inches. Most of this rainfall occurs during the winter rainy season (October through April), while the summer months (May through September) are hot and dry.

Temperatures

Temperature in Kīhei range from an average low of 64°F in the winter to an average high of 87°F in the summer.

Winds

The prevailing tradewinds blow from north to south across the isthmus and out to sea at a mean speed of about 11 miles per hour in the winter and 15 miles per hour in the summer.

### e. Irrigation Water

The expansion area has no existing water system for irrigating crops.

### f. Road Access

Dirt roads provide access to the property from Pi‘ilani Highway and Līpoa Parkway (see Figure 5).

### g. Summary

The Project expansion area has high solar radiation, but the poor soils, low soil ratings, and lack of irrigation water indicate that the property is poorly suited for growing commercial field crops.

## 4. POTENTIAL CROPS

The Project expansion area is unsuitable for most commercial field crops grown in Hawai‘i. Nevertheless, the nearby seed-corn operation indicates that high-value crops could be grown provided that the land is cleared of rocks, *kiawe*, grasses and weeds; the soil is amended; and reclaimed water is obtained from the nearby wastewater treatment plant. Also, crops which do not require good soil—such as hydroponic crops and algae—could be grown provided that water is obtained.

It should be noted, however, that Kīhei has a large supply of low-quality agricultural land similar to that of the Project expansion area (see Section 10). Also, high-quality farmland is available in Central and West Maui due to past closures of sugarcane and pineapple plantations.

## 5. LOCATIONAL ADVANTAGES AND DISADVANTAGES FOR FARMING

### a. Maui Island Market

Farmers in Central Maui are well-situated for supplying the Maui Island market because of the short trucking distance to Kahului, which is the island's commercial, industrial, distribution and transportation center. While the Maui Island market is significant, it is comparatively small: in 2008, Maui County had a *de facto* population of about 181,600 residents and visitors.

### b. Honolulu Market

All farmers on Maui are at a disadvantage in competing against farmers on O'ahu for supplying the Honolulu market due to the interisland shipping costs, delays and extra handling. In comparing barge and air-cargo services, shipping by barge is less expensive and larger loads can be shipped, but the shipments are slow and infrequent. Air service is faster and frequent, but it is far more expensive and capacities are limited.

In 2008, O'ahu had a *de facto* population of about 934,300 residents and visitors. Thus, the Honolulu market is over five times larger than the Maui market.

### c. Mainland Market

Compared to Hawai'i, the mainland market is enormous: in 2010, the U.S. population totaled 308.7 million. In supplying this market with products that can be carried by container ship because they have long shelf-lives (e.g., canned fruit), farmers on Maui are competitive with farmers on O'ahu and the other islands. Even though freight from Maui must first be barged to Honolulu then transferred onto a container ship, Matson's overseas shipping service includes inter-island barge service at no additional fee: except for some minor port charges, Matson charges a common fare for all islands.

In the case of fresh products that must be shipped by air to the mainland because of their short shelf-lives, farmers on Maui are at a disadvantage compared to farmers on O'ahu because most mainland air cargo is shipped via the Honolulu International Airport. Compared to farmers on O'ahu, Maui farmers encounter additional costs, delays, and handling for interisland air-cargo service and for transferring the fresh products from small interisland aircraft to large overseas aircraft.

However, overseas air-cargo service from Maui has improved somewhat because the current generation of aircraft can depart from the short runway at Kahului with a full load of passengers and a full load of cargo in the hold. This direct service allows farmers on Maui to

be more competitive in mainland markets. However, the lift capacity from Maui is limited by the number of direct flights.

In the U.S. mainland market, farmers in Hawai'i must also compete against farmers on the mainland and in Mexico, Central and South America, the Caribbean, Australia, New Zealand, Southeast Asia, etc. Most of the competing farm areas have lower production and delivery costs than Hawai'i does. Competing against Mexico is particularly difficult given the North America Free Trade Agreement (NAFTA) and Mexico's proximity to major U.S. markets.

### d. Summary

In terms of location, farmers in Central Maui are well-situated to supply the small Maui Island market. And compared to other farmers in Hawai'i, they can also compete reasonably well in supplying mainland markets, as long as their products have long shelf-lives and so can be shipped by surface vessel.

However, compared to farmers on O'ahu, they are at a disadvantage in supplying the Honolulu market. Furthermore, they are at a disadvantage supplying mainland markets if their products have short shelf-lives and so must be shipped by air. Also, farmers on Maui are at a disadvantage in competing against the low-cost producers who supply mainland markets.

## 6. SURROUNDING LAND USES

To the north and abutting the Project are cattle grazing lands of Haleakalā Ranch (see Figure 2). About a quarter mile farther north and extending inland are the grazing lands of Ka‘ono‘ulu Ranch. Also to the north across Ka‘ono‘ulu Gulch are the proposed new South Maui High School and Ka‘ono‘ulu Village (see Figure 4).

To the east are additional cattle grazing lands of Haleakala Ranch.

To the south are more Haleakalā Ranch cattle grazing lands, facilities of a former algae operation on land that abuts the Project, a nearby Monsanto seed-corn operation, and the County's Kīhei Wastewater Reclamation Facility.

To the west and abutting the Project is the Elleair Maui Golf Course. Across Pi‘ilani Highway are the developed lands of Kīhei Town, including single- and multi-family subdivisions, the Kīhei Community Center, Pi‘ilani Shopping Village, South Maui Community Park as well as industrial and public/quasi-public developments.

## 7. IMPACT ON CATTLE OPERATIONS, HALEAKALĀ RANCH

### a. Haleakalā Ranch Cattle Operations

Incorporated in 1888, Haleakalā Ranch is the oldest and largest cattle ranch on Maui. The Ranch, which is family-owned, has about 23,000 acres used for grazing cattle, about 1,700 breeding cows, and about 30 employees involved with cattle operations.

Until the late 1980s, the land that is now part of the Maui Research & Technology Park was used for Haleakalā Ranch cattle-grazing operations. The expansion area for the Park and other Kīhei lands are still used for grazing cattle.

To increase the available feed, the Kīhei lands were planted in buffelgrass in the early 1900s. Buffelgrass is a drought-resistant grass that is able to survive the dry summer months in Kīhei. Native to Africa, this grass was introduced to improve cattle forage in many tropical and subtropical regions of the world. Cattle grazing on Kīhei pastures occurs in the winter months when the grass is more plentiful following winter rains. The number of cattle on these lands and the duration of their grazing depend upon the amount of rainfall. Due to the arid conditions, annual per-acre yields of forage from Kīhei pastures are about 50% of those for the Ranch as a whole.

### b. Impact of the Project on Haleakalā Ranch Cattle Operations

Development of the Project will remove about 102 acres of grazing land from Haleakalā Ranch, or about 0.44% of the 23,000 acres of their grazing land. The corresponding reduction in feed produced from all of the Ranch's grazing land will be about 0.22% (0.44% x 50% adjustment for the lower yields from the Kīhei pastures).

While Kīhei pastures are important for winter cattle grazing, the Ranch anticipates that this relatively small reduction in feed will have no significant affect on the Ranch's cattle operations, including no significant impact on the size of their herd, production, revenues, employment or payroll. The Ranch has sufficient lands to move its cattle to other pastures.

### c. Cumulative Impact on Haleakalā Ranch Cattle Operations

Over the next 20 years or so, planned and proposed projects on file with the County could result in the development of about 419 acres that are now used to graze cattle by Haleakalā Ranch, including about 102 acres for the Project and about 317 acres for other projects. All of this land is located in Kīhei within the Urban Growth Boundary. This loss amounts to about 1.82% of the Ranch's grazing land (419 acres ÷ 23,000 acres), or about 0.91% of the available feed (1.82% x 50% adjustment for the lower yields from the Kīhei pastures).

The Ranch regards a 0.91% loss in feed as too small to have a significant effect on its cattle operations. Again, the Ranch has sufficient lands to move its cattle to other pastures. Even if the Ranch were operated at its maximum carrying capacity and replacement pastures were not available, the impact would be small: about 15.5 fewer breeding cows (about 0.91% x about 17,000 cows), about 11.6 fewer calves per year (about 75% x the number of cows), about $4,600 less in annual revenues (about $400 x the number of calves), and the loss of about 30% of one job (0.91% x 30 jobs).

### d. Mitigating Measures

As discussed above, the Project in combination with other projects will result in an insignificant impact on Haleakalā Ranch cattle operations. In view of this finding, mitigation measures for the impact of the Project on the Ranch's cattle operations are not recommended.

## 8. IMPACT ON ALGAE OPERATIONS, BIOREAL INC.

### a. Algae Operations

To the south on 21 acres abutting the Project are the facilities of BioReal Inc., a subsidiary of the Japanese pharmaceutical company Fuji Chemical Industry Co., Ltd. (see Figure 2). As recently as 2009, BioReal grew microalgae to produce astaxanthin, an antioxidant which is believed to have a number of health benefits for humans. Astaxanthin is also produced by Cyanotech on the Big Island.

This parcel is part of the Park but it is not part of the Master Plan Update.

### b. Impact on Algae Operations

The BioReal operations in Kīhei closed for reasons unrelated to the Project. In view of this closure, the Project will not impact any algae operations.

## 9. IMPACT ON SEED-CORN OPERATIONS, MONSANTO HAWAIʻI

### a. Monsanto Seed-Corn Operations

Farther south of the Project are Monsanto Hawaiʻi seed-corn operations (see Figure 2). Monsanto leased the land in the mid-1990s and, at considerable expense and time, cleared the land of rocks, *kiawe*, grasses and weeds; added amendments to improve soil quality; and installed water lines to irrigate fields with water supplied by the Kīhei Wastewater Reclamation Facility. In 2009, Monsanto purchased the 310-acre parcel, of which about 100 acres are

farmed. The size of the parcel provides the option of expanding field operations beyond 100 acres, although Monsanto has no current plans to expand.

Even though the land was rough unimproved rangeland having poor soil-quality, Monsanto chose to locate seed-corn operations in Kīhei because of the high solar radiation, isolation of the fields, and availability of reclaimed water.

**b. Impact on Seed-Corn Operations**

Project construction and operations are not expected to impact Monsanto's seed-corn operations. However, the potential of nuisance complaints about normal farm operations—tractor and truck noises, dust blown from fields, drifting of crop-protection products during occasional applications (e.g., fertilizers, soil amendments, dust-control agents, pesticides, etc.)—are a concern to farmers because complaints can force them to change their farm practices. This issue is discussed below.

At full development, the northernmost field used for growing seed corn will be about 0.25 mile from the southeast corner of the Project (see Figure 2). A "Knowledge Industry Expansion/Campus" is planned for this area (see Figure 4), and future employees will work in air-conditioned buildings. The nearest homes within the Project will be over 1 mile away from the Monsanto fields, and will be buffered from farm operations by distance and by Project buildings, trees and shrubbery. In comparison, some existing homes in Kīhei are about 0.35 mile *makai* of the Monsanto's fields. If Monsanto were to expand its farm operations, the distances from fields to Park buildings and homes would not change inasmuch as Monsanto currently farms up to the northern boundary of its property.

The prevailing tradewinds blow *makai*. Thus, during these tradewind conditions, the Park will <u>not</u> be downwind from farm operations. However, the Park will be downwind from farm operations during the occasional Kona winds.

Noise from Monsanto's farm equipment is not expected to cause a problem at the Park because the noise will be attenuated by (1) the long distances from the farm to Park buildings and homes, (2) enclosed air-conditioned buildings that will house workers, and (3) Project buildings and vegetation that will be located between the farm and Project homes.

Dust from the Monsanto farm will be blown *makai* during prevailing tradewind conditions. But, during the occasional strong Kona winds, dust from the farm will be blown toward the Park. The dust problems will be limited by the same factors which limit noise problems: long distances from the farm to Project buildings and homes, enclosed air-conditioned buildings for workers, and buildings and vegetation between the farm and homes.

During occasional application of crop-protection products, such products are not expected to drift from the Monsanto farm to the Park because (1) prevailing tradewinds blow *makai*, and (2) as specified by requirements on product labels, Monsanto modifies or suspends the application of crop-protection products during adverse weather conditions (e.g., strong winds that blow towards homes and businesses). Even if crop-protection products were to drift toward the Park, they are not expected to reach Park employees and residents for the same reasons that noise will be attenuated: long distances from the farm to Project buildings and homes, enclosed air-conditioned buildings for workers, and buildings and vegetation between the farm and homes.

In view of the above findings, nuisance complaints by Park tenants and employees about Monsanto's farm operations are not expected to be significant and, as a result, are not expected to require changes in Monsanto's seed-corn operations.

### c. Mitigating Measures

Even though nuisance complaints from Park tenants and employees about Monsanto's nearby farm operations are not anticipated, it is recommended that Park tenants and employees be informed that they will be working and/or living near farm operations. This information should be included in promotional brochures and websites, and in sales and rental contracts. With this information, future tenants and employees are more likely to accept that nearby farm operations are part of the character of the community.

In any case, Hawai'i's Right-to-Farm Act gives farmers the right to farm if they were operating before neighboring properties were developed, provided that the farm activity does not threaten public health or safety.

## 10. IMPACT ON THE GROWTH OF DIVERSIFIED CROP FARMING

The Project will commit about 253 acres of land now in the Agricultural District to a non-agricultural use. However, as summarized in Subsection 3.g, this land is poorly suited for growing commercial field crops due to poor soils and the lack of water for irrigating crops. All of the soils in the expansion area have an LSB rating of "E," which is the lowest LSB rating (see Subsection 3.b). Farming of typical field crops would require soil amendments and a source of affordable irrigation water.

Maui has a large supply of low-quality agricultural land, including about 20,000 acres *mauka* of Kīhei that is similar in quality to the land that will be used for the Project. And since 1990, the contraction and eventual closure of Pioneer Mill (sugarcane) and Maui

Pineapple Co. released over 19,000 acres of good farmland in Central and West Maui. While some of this former plantation land was planted in other crops (e.g., seed corn and coffee) and some was developed for homes, most of it remains available for farming. For comparison, the entire County has about 1,700 acres in food crops that are grown for the Hawai‘i market, including about 400 acres in vegetables and melons, about 300 acres in fruits other than pineapple, and about 1,000 acres in pineapple.

In summary, the Project will result in a small loss of low-quality agricultural land of which there is a large supply on Maui, but will not affect the supply of good farmland of which there is also a large supply. Consequently, the Project will have no impact on the growth of diversified crop farming.

## 11. OFFSETTING BENEFITS

The loss of 253 acres of low-quality agricultural land will be offset by the following benefits of the Project:

— Construction Activity

- Construction jobs associated with Project development.
- Indirect jobs generated by purchases of goods and services by construction companies and families of construction workers.
- State tax revenues (excise taxes, personal income taxes, corporate income taxes, etc.) paid by construction companies and workers, and by companies and families supported by construction activity.

— Operations

- On-site jobs associated with research and technology, office operations, and retail operations.
- Off-site jobs generated by purchases of goods and services by Project businesses and residents.
- Housing for Maui residents.
- State tax revenues (excise taxes, personal income taxes, corporate income taxes, etc.) paid by Project businesses and residents, as well as by off-site businesses and residents supported by Project operations.
- County tax revenues (property taxes, etc.) paid by Project businesses and residents, as well as by off-site businesses and residents supported by Project operations.

## 12. CONSISTENCY WITH STATE AND COUNTY POLICIES

### a. Availability of Lands for Agriculture

The *Hawai'i State Constitution*, the *Hawai'i State Plan*, the *State Agriculture Functional Plan*, the *County of Maui 2030 General Plan,* the County's *Maui Island Plan (Draft),* and the County's *Kīhei-Mākena Community Plan* call directly or implicitly for preserving the economic viability of plantation agriculture and promoting the growth of diversified agriculture. To accomplish this, an adequate supply of agriculturally suitable lands and water must be assured.

With regard to plantation agriculture, the Project site is not and never was part of a sugarcane or pineapple plantation.

With regard to diversified crop farming, there is no current or recent farming on the property. The Project will result in a small loss of low-quality agricultural land of which there is a large supply on Maui, but will not affect the supply of good farmland of which there is also a large supply. Consequently, the Project will have no impact on the growth of diversified crop farming.

With regard to ranching, about 102 acres of the Project site are used for grazing cattle. However, feed production is low due to arid conditions. Also, the acreage loss will be too small to affect cattle operations.

### b. Conservation of Agricultural Lands

In addition to the above, State and County policies call for conserving and protecting prime agricultural lands, including protecting farmland from urban development.

The Project will result in no loss of prime agricultural lands. All of the soils in the expansion area have an LSB rating of "E," which is the lowest LSB rating (see Subsection 3.b).

### c. State Districting

The Project expansion area is within State Agricultural District (see Figure 5). However, Maui R&T Partners, LLC is filing a petition with the State Land Use Commission for a District Boundary Amendment to redesignate the expansion to the "Urban" District.

### d. Kīhei-Mākena Community Plan

Most of the Project site is currently designated "Project District" in the *Kīhei-Mākena Community Plan*. However, a Community Plan Amendment will be sought to bring the

entire Park site into a community plan designation that better aligns with the vision of the Master Plan Update and anticipated changes to the MCC, Chapter 19.33, *Kīhei Research & Technology Park District.* This will involve amending the Community Plan to re-designate about 39 acres from "Agriculture" to "Project District."

**e. County Zoning**

Most of the expansion area is zoned "Agriculture" (see Figure 7). Full development of the Project will require appropriate rezoning.

## 13. REFERENCES

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# APPENDIX

# APPENDIX A

## STATE AND COUNTY GOALS, OBJECTIVES, POLICIES AND GUIDELINES RELATED TO AGRICULTURAL LANDS

### 1. HAWAI'I STATE CONSTITUTION (Article XI, Section 3):

> …to conserve and protect agricultural lands, promote diversified agriculture, increase agricultural self-sufficiency and assure the availability of agriculturally suitable lands…

### 2. HAWAI'I STATE PLAN (Chapter 226, Hawaii Revised Statutes, as amended):

**Section 226-7 Objectives and policies for the economy--agriculture.**

(a) Planning for the State's economy with regard to agriculture shall be directed towards achievement of the following objectives:

(1) Viability in Hawaii's sugar and pineapple industries.

(2) Growth and development of diversified agriculture throughout the State.

(3) An agriculture industry that continues to constitute a dynamic and essential component of Hawaii's strategic, economic, and social well-being.

(b) To achieve the agricultural objectives, it shall be the policy of the State to:

(2) Encourage agriculture by making best use of natural resources.

(10) Assure the availability of agriculturally suitable lands with adequate water to accommodate present and future needs.

(16) Facilitate the transition of agricultural lands in economically nonfeasible agricultural production to economically viable agricultural uses.

**Section 226-103 Economic priority guidelines.**

(c) Priority guidelines to promote the continued viability of the sugar and pineapple industries:

(1) Provide adequate agricultural lands to support the economic viability of the sugar and pineapple industries.

(d) Priority guidelines to promote the growth and development of diversified agriculture and aquaculture:

(1) Identify, conserve, and protect agricultural and aquacultural lands of importance and initiate affirmative and comprehensive programs to promote economically productive agricultural and aquacultural uses of such lands.

(10) Support the continuation of land currently in use for diversified agriculture.

**Section 226-104 Population growth and land resources priority guidelines.**

(b) Priority guidelines for regional growth distribution and land resource utilization:

(2) Make available marginal or non-essential agricultural lands for appropriate urban uses while maintaining agricultural lands of importance in the agricultural district.

## 3. AGRICULTURAL STATE FUNCTIONAL PLAN (1991)

(Functional plans are guidelines for implementing the State Plan. They are approved by the Governor, but not adopted by the State Legislature.)

Objective H: Achievement of Productive Agricultural Use of Lands Most Suitable and Needed for Agriculture.

Policy H(2): Conserve and protect important agricultural lands in accordance with the Hawaii State Constitution.

Action H(2)(a): Propose enactment of standards and criteria to identify, conserve, and protect important agricultural lands and lands in agricultural use.

Action H(2)(c): Administer land use district boundary amendments, permitted land uses, infrastructure standards, and other planning and regulatory functions on important agricultural lands and lands in agricultural use, so as to ensure the availability of agriculturally suitable lands and promote diversified agriculture.

## 4. COUNTY OF MAUI 2030 GENERAL PLAN, COUNTYWIDE POLICY PLAN (2010)

**Countywide goals, objectives, policies and actions**

**F. Strengthen the Local Economy**

**Objective**

2. Diversify and expand sustainable forms of agriculture and aquaculture.

**Policies**

b. Prioritize the use of agricultural land to feed the local population, and promote the use of agriculture lands for sustainable and diversified agricultural activities.

c. Support ordinances, programs, and policies that keep agricultural land and water available and affordable to farmers.

**Implementing Actions**

c. Create agricultural parks in areas distant from genetically modified crops.

**J. Promote Sustainable Land Use and Growth Management**

**Objective**

2. Improve planning for and management of agricultural lands and rural areas.

**Policies**

a. Protect prime, productive, and potentially productive agricultural lands to maintain the islands' agricultural and rural identities and economies.

c. Discourage developing or subdividing agriculturally designated lands when non-agricultural activities would be primary uses.

**Implementing Actions**

a. Inventory and protect prime, productive, and potentially productive agricultural lands from competing non-agricultural land uses.

## 5. MAUI ISLAND PLAN, GENERAL PLAN 2030, DRAFT (2009)

**Core Values**

E. Preserve rural and agricultural lands and encourage sustainable agriculture.

**Agricultural Lands**

**Goal**

7.1 Maui Island will have a prosperous agricultural industry and will protect agricultural lands.

**Objective**

7.1.1 Significantly reduce the loss of prime and productive agricultural lands.

**Policies**

7.1.1.a Allow limited clustering of development on prime and productive agricultural lands identified on Maui Island Plan Map #7-1 when approved as a Conservation Site Design (CSD) through regulations.

7.1.1.b Require the review and approval of Conservation Site Design (CSD) plans prior to the subdivision of prime and productive agricultural lands identified on Maui Island Plan Map # 7-1.

7.1.1.c Discourage developing or subdividing Prime, Productive or Important agricultural lands for residential uses in which the residence would be

the primary use and any agricultural activities would be secondary uses.

7.1.1.e Focus urban growth, to the extent practicable, away from Prime, Productive or Important Agricultural Lands identified on Maui Island Plan Map #7-1.

7.1.1.f Strongly discourage the conversion of Prime, Productive or Important Agricultural Lands identified on Maui Island Plan Map #7-1 to rural or urban use, unless justified during the General Plan update, when other overriding factors are present.

7.1.1.h Protect Prime, Productive or Important Agricultural Lands identified on Maui Island Plan Map #7-1 from development through the use of TDR/PDR, tax credits, and easement programs.

7.1.1.j Require all major developments adjacent to agricultural lands to provide an appropriate and site-specific agricultural protection buffer as part of a required site plan.

7.1.1.k Support agricultural protection zoning as a vital component of an agricultural land preservation program.

## 6. COUNTY OF MAUI, KĪHEI-MĀKENA COMMUNITY PLAN (1998)

***LAND USE***

***Objectives and Policies***

p. Prevent urbanization of important agricultural lands

r. Allow special permits in the State Agricultural Districts to accommodate unusual yet reasonable uses including: (1) limited agriculturally related commercial, public and quasi-public uses serving the immediate community; (2) uses clearly accessory or subordinate to a principal agricultural use on the property; (3) public facility uses such as utility installations or landfills whose location depends on technical considerations; and (4) extractive industries, such as quarrying, where the operation would not adversely affect the environment or surrounding agricultural uses.

**ECONOMIC ACTIVITY**

**Objectives and Policies**

e. Provide for the preservation and enhancement of important agricultural lands for a variety of agricultural activities, including sugar cane, diversified agriculture and aquaculture.

## 7. REFERENCES

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# FIGURES

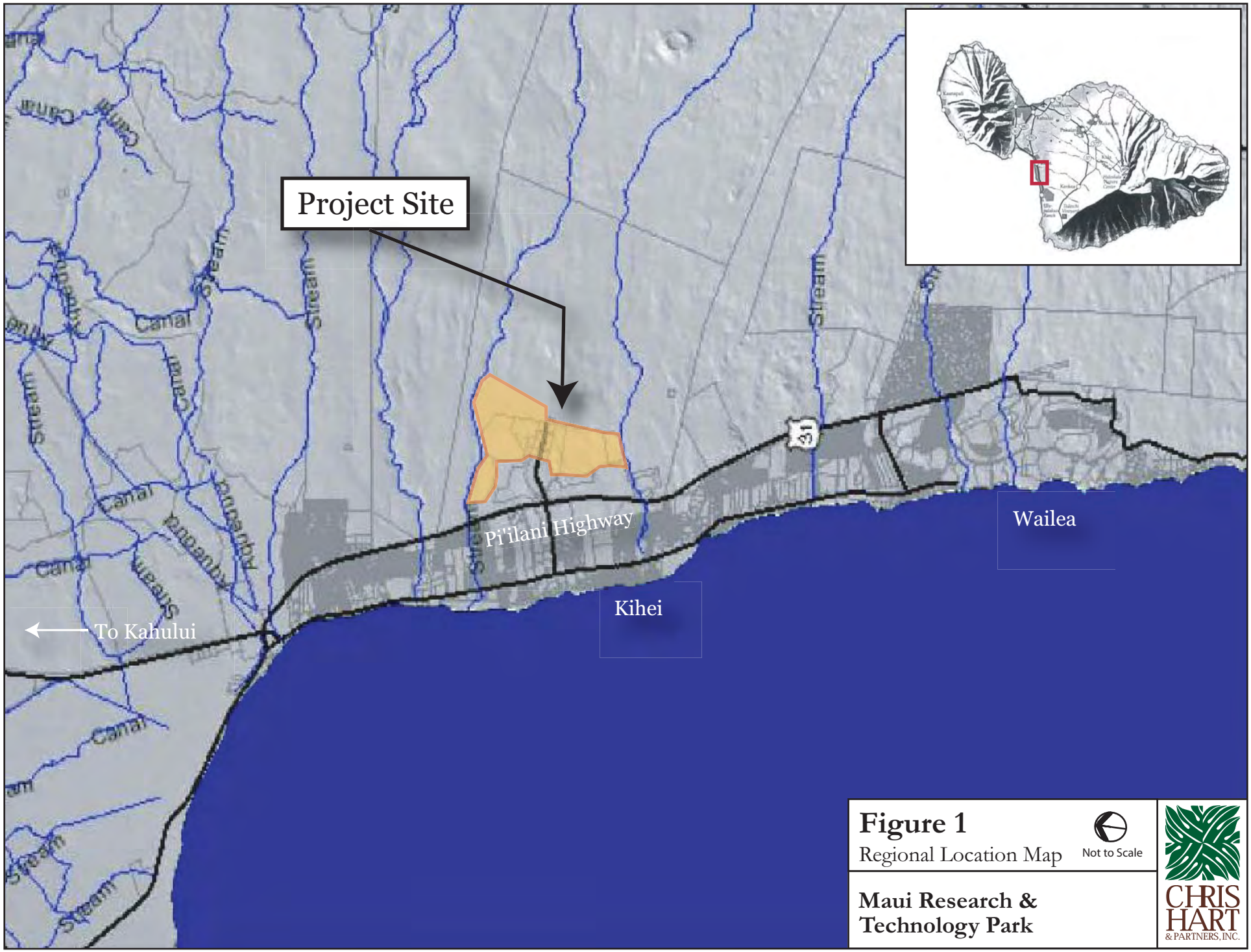


**Figure 1**
Regional Location Map

Not to Scale

**Maui Research & Technology Park**

CHRIS HART & PARTNERS, INC.

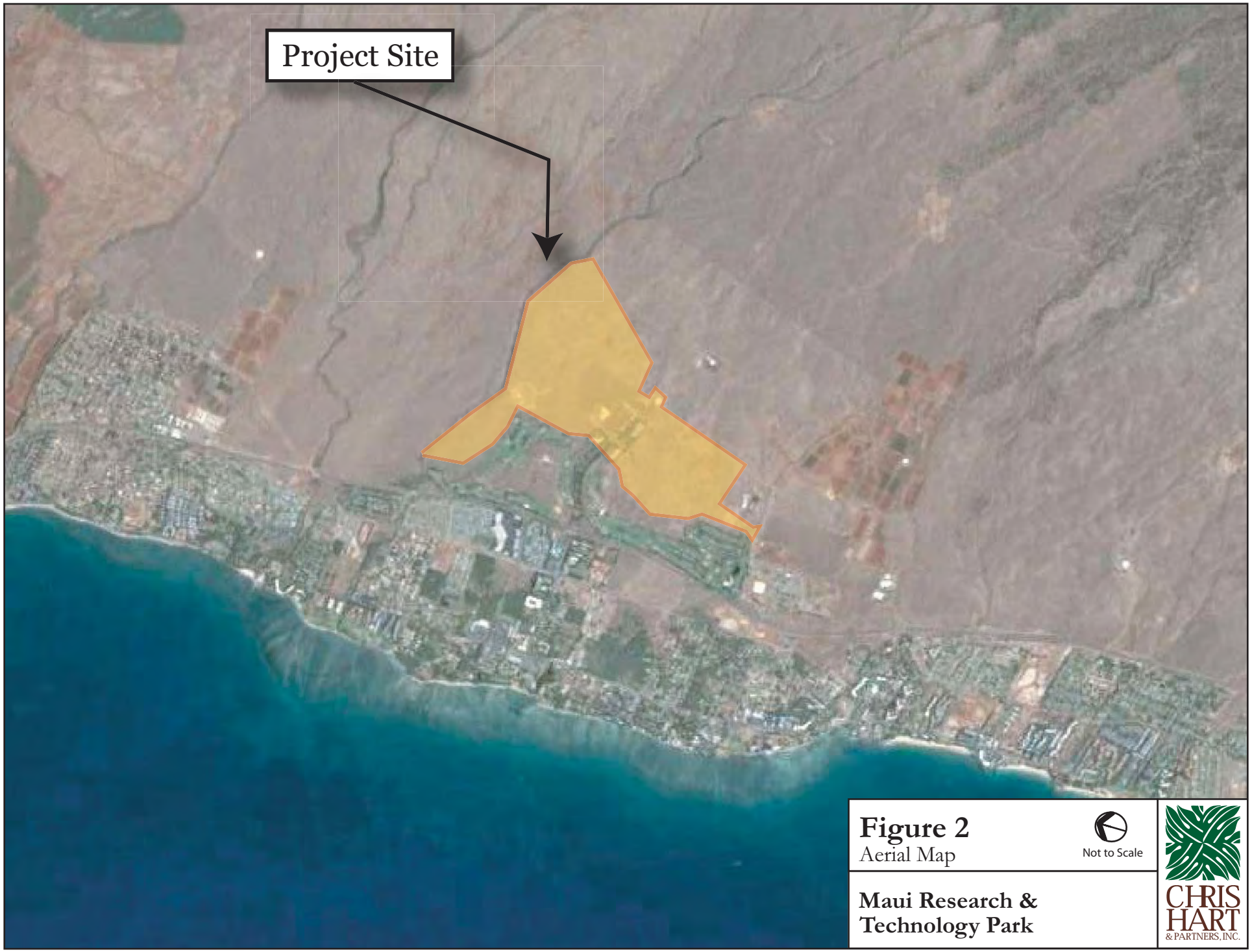


**Figure 2**
Aerial Map

Not to Scale

**Maui Research & Technology Park**

CHRIS HART & PARTNERS, INC.

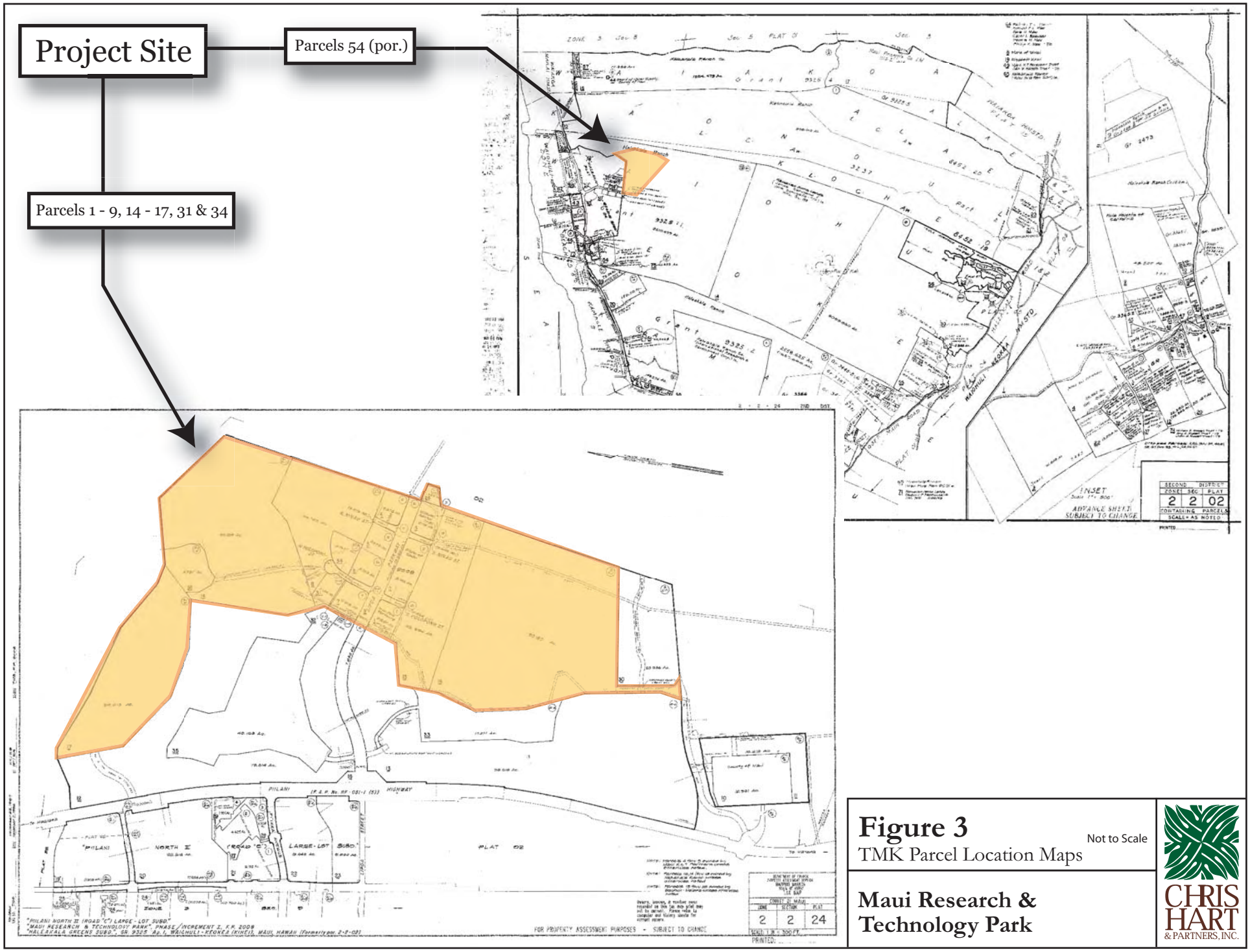


**Figure 3**
TMK Parcel Location Maps

Not to Scale

**Maui Research & Technology Park**

CHRIS HART & PARTNERS, INC.

# Maui Research & Technology Park

## OVERALL CONCEPT DIAGRAM

**LEGEND**

- Project Boundary
- Mixed-Use
- Knowledge Industry
- Knowledge Industry Expansion
- Residential & Expansion
- Open Space / Parks

**FIGURE NO. 4**
**OVERALL CONCEPT DIAGRAM**
MAUI RESEARCH & TECHNOLOGY PARK
Kihei, Maui, Hawaii

March 20, 2012

0' 400' 800'

Mauka
Makai

Maui R & T Partners, LLC
Maui, Hawaii

Calthorpe Associates
Berkeley, California

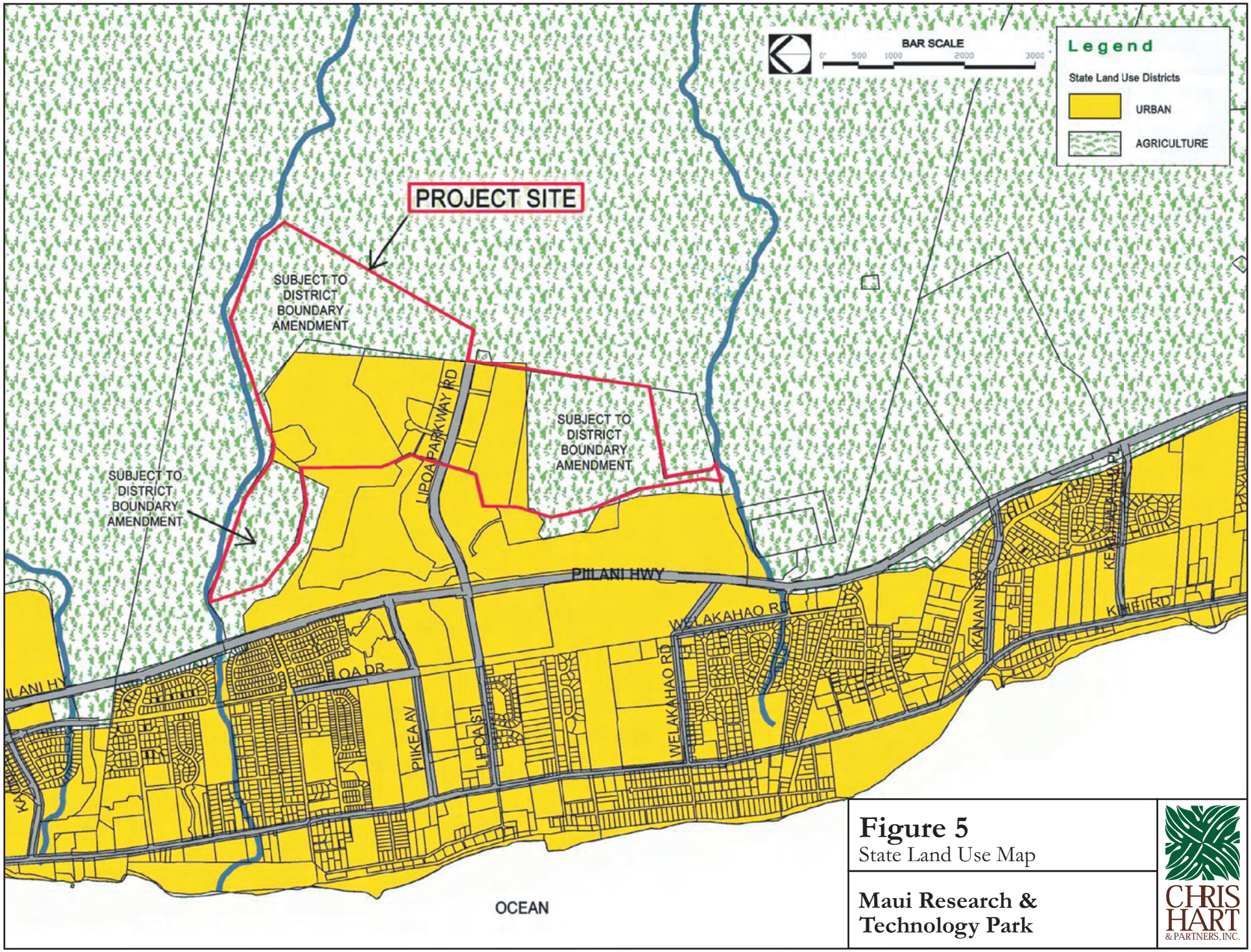


**Figure 5**
State Land Use Map

**Maui Research & Technology Park**

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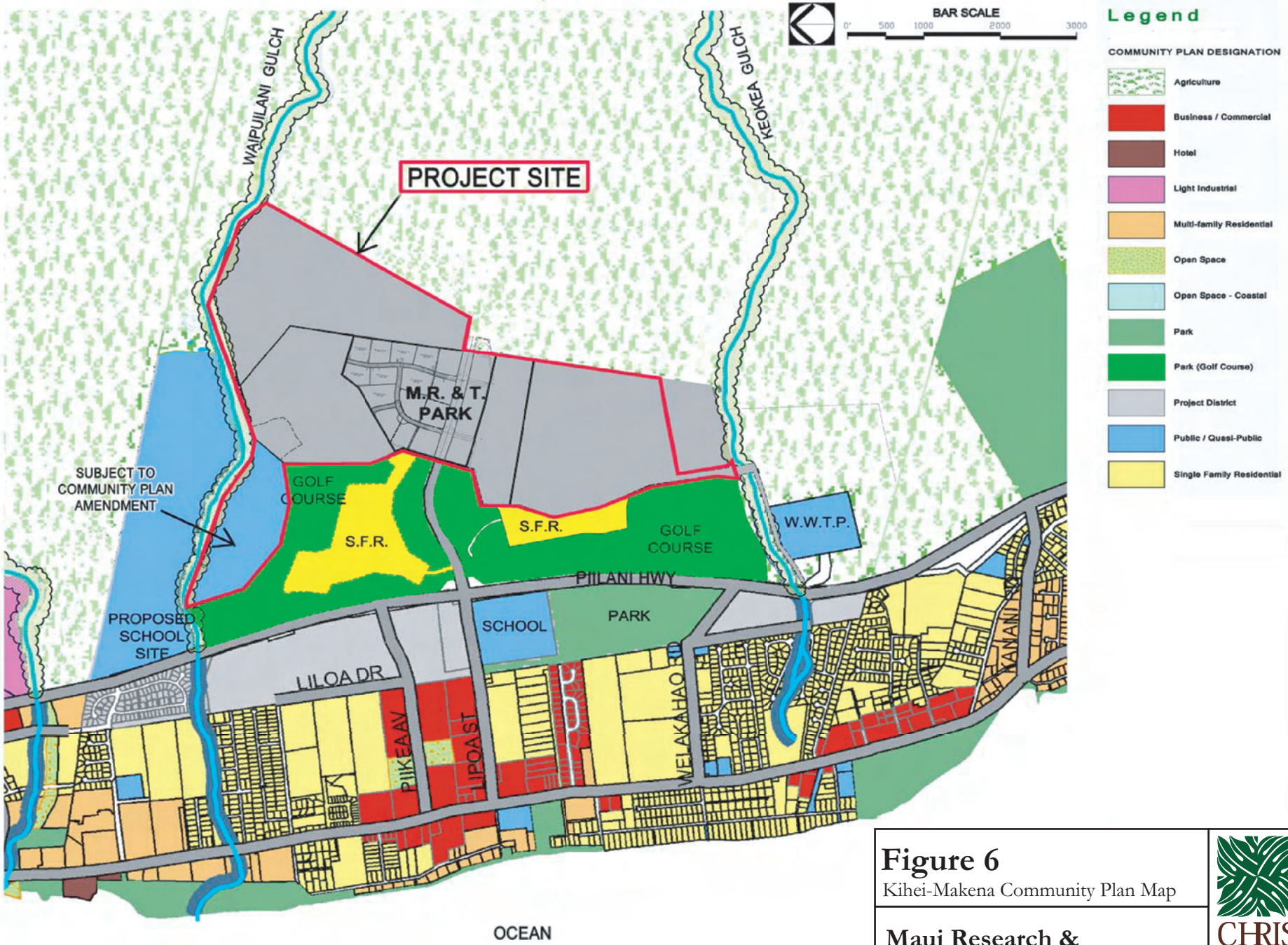


**Figure 6**
Kihei-Makena Community Plan Map

**Maui Research & Technology Park**

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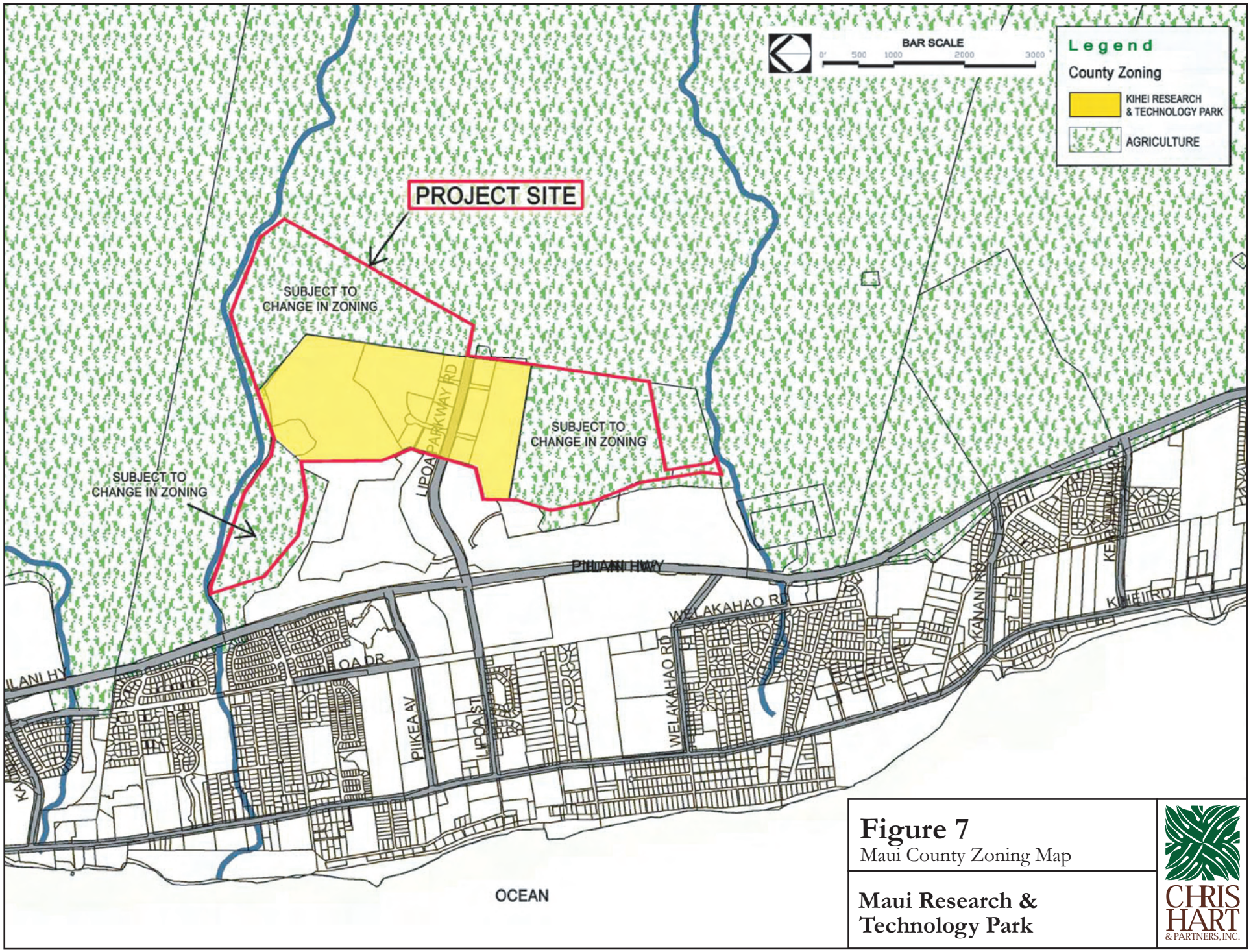


**Figure 7**
Maui County Zoning Map

**Maui Research & Technology Park**

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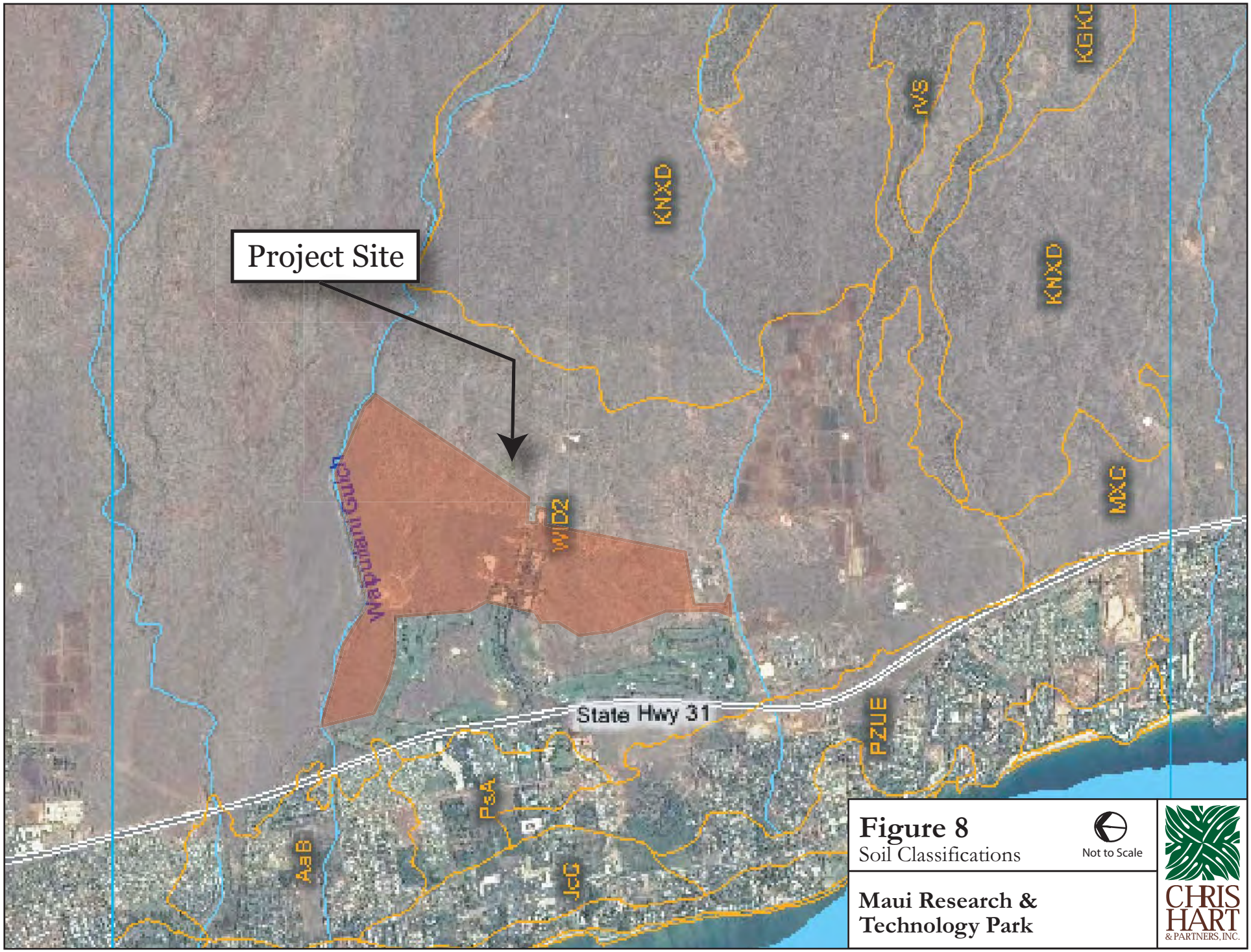


**Figure 8**
Soil Classifications

Not to Scale

**Maui Research & Technology Park**

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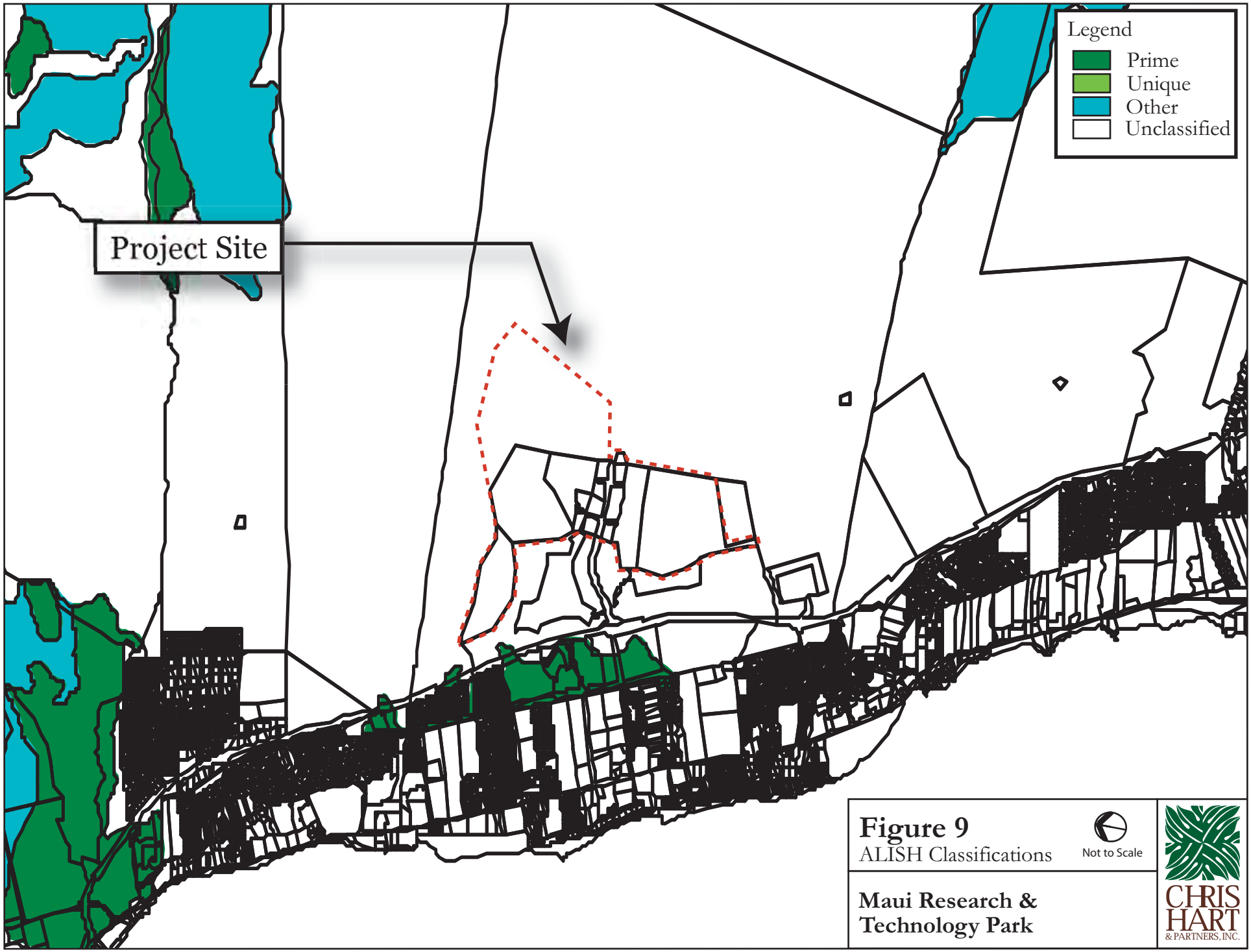


**Figure 9**
ALISH Classifications

**Maui Research & Technology Park**

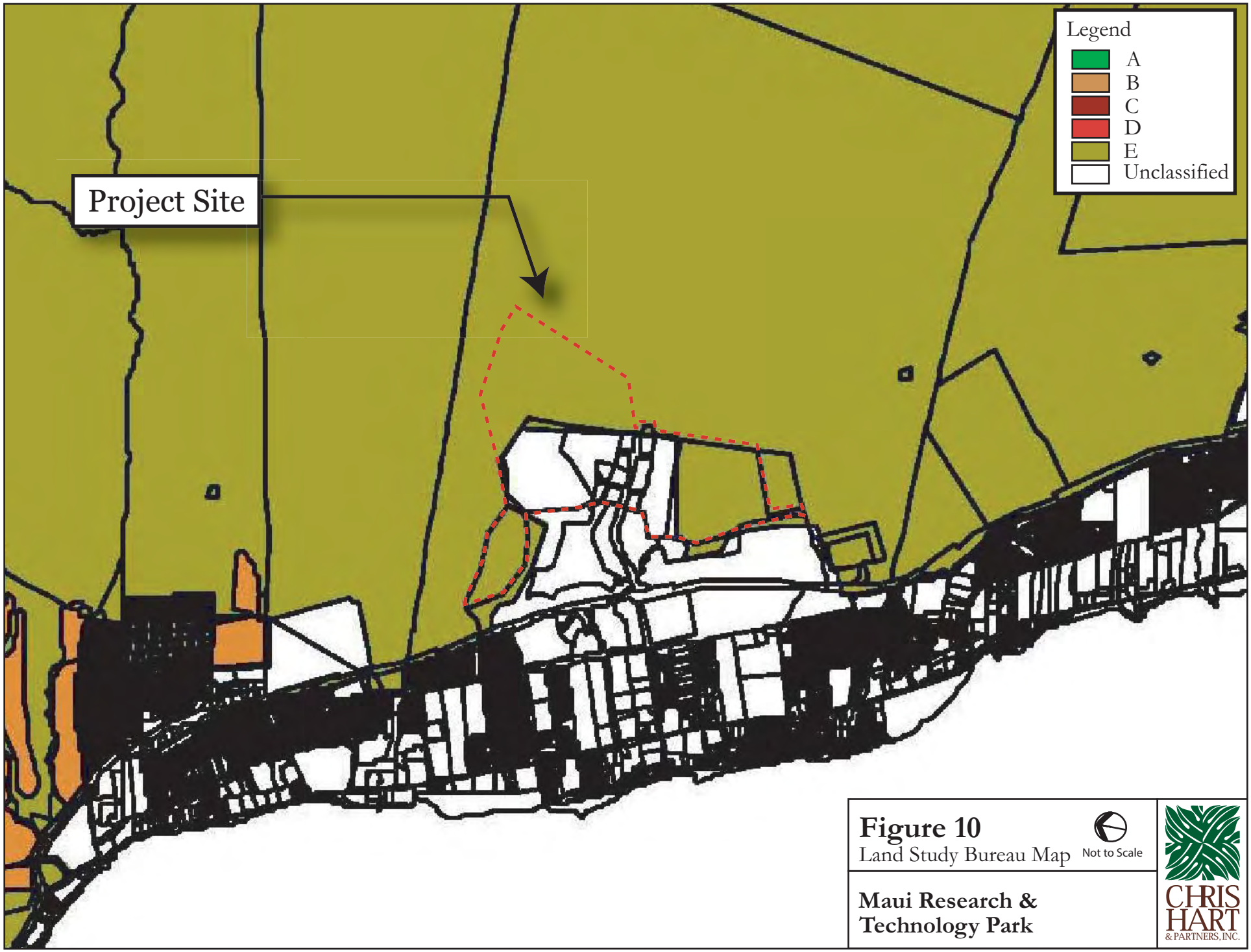


**Figure 10**
Land Study Bureau Map

Not to Scale

**Maui Research & Technology Park**

CHRIS HART & PARTNERS, INC.

APPENDIX K
Air Quality Study

# AIR QUALITY STUDY

# FOR THE PROPOSED

# MAUI RESEARCH & TECHNOLOGY PARK MASTER PLAN UPDATE

**KIHEI, MAUI, HAWAII**

**Prepared for:**

**Maui Research & Technology Partners, LLC**

**May 2012**


**B.D. NEAL & ASSOCIATES**

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## 1.0 SUMMARY

Maui Research & Technology Partners, LLC is proposing a Master Plan Update for the Maui Research & Technology Park at Kihei, Maui. The proposed project will consist of two phases which include a total of up to about 2,000,000 square feet of commercial and retail space, 1,250 residential units, a 150-room hotel and a school. This study examines the potential short- and long-term air quality impacts that could occur as a result of construction and use of the proposed facilities and suggests mitigative measures to reduce any potential air quality impacts where possible and appropriate.

Both federal and state standards have been established to maintain ambient air quality. At the present time, seven parameters are regulated including: particulate matter, sulfur dioxide, hydrogen sulfide, nitrogen dioxide, carbon monoxide, ozone and lead. Hawaii air quality standards are 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 elevation near sea level and by nearby mountains. Haleakala shelters the area from the northeast trade winds, and local winds (such as land/sea breezes and upslope/downslope winds) affect the wind flow in the area much of the time. Temperatures in the project area are generally very consistent and warm with average daily temperatures ranging from about 63°F to 86°F. Rain-

fall in the project area is minimal with an average of only about 12 inches per year.

Except for periodic impacts from volcanic emissions (vog) and possibly occasional localized impacts from traffic congestion and local agricultural sources, the present air quality of the project area is believed to be relatively good. There is very little air quality monitoring data from the Department of Health for the project area, but the limited data that are available suggest that concentrations are generally well within state and national air quality standards.

If the proposed project is given the necessary approvals to proceed, it may be inevitable that some short- and/or long-term impacts on air quality will occur either directly or indirectly as a consequence of project construction and use. Short-term impacts from fugitive dust will likely occur during the project construction phases. 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 project. During worst-case conditions, model results indicated that present 1-hour and 8-hour carbon monoxide concentrations are well within both the state and the national ambient air quality standards. In the year 2034 without the project, carbon monoxide concentrations were predicted to decrease (improve) somewhat in the project area despite an increase in traffic volumes, and worst-case concentrations should remain well within air quality standards. This is primarily due to the assumed retirement of older motor vehicles with less efficient emission control equipment with the passage of time. With the project in the year 2034 after full build-out and with the mauka collector road, carbon monoxide concentrations compared to the without-project case were projected to be slightly lower (better), and worst-case concentrations should remain well within air quality standards. With or without the project, carbon monoxide concentrations in the project area during the next 20 years will likely decrease (improve) somewhat compared to existing concentrations. 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. The estimated electrical power requirement amounts to about 24 megawatts; thus it is not insignificant. Quantitative estimates of these potential impacts were not made, but based on the estimated demand level and assuming that power continues to be derived mostly from fuel oil, sulfur dioxide emissions could increase by about 275 tons per year and nitrogen oxides emissions could increase by about 93 tons per year. Renewable energy sources, if developed, could reduce these emissions substantially. Incorporating energy conservation design features and promoting energy conservation programs within the proposed development could also serve to reduce any associated emissions. Presently, all solid waste on Maui is landfilled, and any associated air pollution emissions are relatively negligible. Nevertheless, promoting conservation and recycling programs within the proposed development could serve to further reduce any associated impacts.

## 2.0 INTRODUCTION

Maui Research & Technology Partners, LLC is proposing a Master Plan Update for the Maui Research & Technology Park (MRTP) at Kihei on the island of Maui. The 432-acre project site is located in Kihei mauka of Piilani Highway near Lipoa Street (see Figure 1 for project location). Presently, the MRTP is approximately 10 percent built-out with about 175,000 square feet of structures in five buildings with a total of approximately 400 employees. The proposed Master Plan Update will be implemented in two phases. Phase 1 will consist of adding 723,000 square feet of commercial space plus an additional 100,000 square feet of retail space, 750 residential units, a 150-room hotel, and a 102,000 square-foot school. Phase 2 will include an additional 1,000,000 square feet

of commercial space and an additional 500 residential units. Full build-out of the project is expected to be achieved by 2034.

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 affect the air quality of a given location. Wind, temperature, atmospheric turbulence, mixing height and rainfall all influence air quality. Although the climate of Hawaii is relatively moderate throughout most of the state, significant differences in these parameters may occur from one location to another. Most differences in regional and local climates within the state are caused by the mountainous topography.

The topography of Maui is dominated by the great volcanic masses of Haleakala (10,023 feet) and the West Maui Mountains (5,788 feet). The island consists entirely of the slopes of these mountains and of a connecting isthmus. Haleakala is still considered to be an active volcano and last erupted about 1790. The project site is located in the isthmus area between the West Maui Mountains and Haleakala at an elevation of about 200 feet.

Maui lies well within the belt of northeasterly trade winds generated by the semi-permanent Pacific high pressure cell to the north and east. Because the project area is located on the leeward side of Haleakala, it is sheltered much of the time from the northeast trade winds. Occasionally, when the trade winds are more northerly, the winds will sweep through the valley between the mountains and into the Kihei area. Local winds such as land/sea breezes and/or upslope/downslope winds also influence the wind pattern for the area. During the daytime, winds can typically be expected to move onshore because of seabreeze and/or upslope effects or because of the aerodynamic cavity caused by the trade winds flowing around Haleakala. At night, winds are often drainage winds that move downslope from Haleakala and out to sea.

During winter, occasional strong winds from the south or southwest occur in association with the passage of winter storm systems.

Air pollution emissions from motor vehicles, the formation of photochemical smog and smoke plume rise all depend in part on air temperature. Colder temperatures tend to result in higher emissions of contaminants from automobiles but lower concentrations of photochemical smog and ground-level concentrations of air pollution from elevated plumes. In Hawaii, the annual and daily variation of temperature depends to a large degree on elevation above sea level, distance inland and exposure to the trade winds. Average temperatures at locations near sea level generally are warmer than those at higher elevations. Areas exposed to the trade winds tend to have the least temperature variation, while inland and leeward areas often have the most. The project site's lower elevation and leeward location results in warmer temperatures compared with many other parts of the island. At Puunene, which is a few miles to the north of the project area and at an elevation of about 130 feet, average daily minimum and maximum temperatures are 63°F and 86°F, respectively [1]. Temperatures at the project site can be expected to be similar to this or slightly cooler due to the slightly higher elevation.

Small scale, random motions in the atmosphere (turbulence) cause air pollutants to be dispersed as a function of distance or time from the point of emission. Turbulence is caused by both mechanical and thermal forces in the atmosphere. It is often measured and described in terms of Pasquill-Gifford stability class. Stability class 1 is the most turbulent and class 6 is the least. Thus, air pollution dissipates the best during stability class 1 conditions and the worst when stability class 6 prevails. In the Pukualani area, stability classes 5 or 6 typically occur during

the nighttime or early morning hours when temperature inversions form due to radiational cooling or to drainage flow from the nearby mountains. 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 3,000 feet (1,000 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 climate of the project area is relatively dry due to the leeward location. Historical records from Kihei show that this area of Maui averages about only 12 inches of precipitation per year with the summer months being the driest [1].

## 5.0 PRESENT AIR QUALITY

Present air quality in the project area is mostly affected by air pollutants from vehicular, industrial, natural and/or agricultural sources. Table 2 presents an air pollutant emission summary for the island of Maui for calendar year 1993. This is the most recent year for which an island-wide emission inventory is 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, most of the manmade particulate and sulfur oxides emissions on Maui originate from point sources, such as power plants and other fuel-burning industries. Nitrogen oxides emissions are roughly equally divided between point sources and area sources (mostly motor vehicle traffic). The majority of carbon monoxide emissions occur from area sources (motor vehicle traffic and sugar cane burning), while hydrocarbons are emitted mainly from point sources. Emissions today are probably higher than those shown in the table, but the proportional relationships are likely about the same.

The largest sources of air pollution in the immediate project area are most likely agricultural operations and automobile traffic using local roadways. Emissions from these sources consist primarily of particulate, carbon monoxide and nitrogen oxides. Power plants burning diesel fuel are located several miles away. These sources mostly emit sulfur dioxide, nitrogen oxides and particulate. Volcanic emissions from distant natural sources on the Big Island also affect the air quality at times during kona wind conditions. By the time the volcanic emissions reach the project area, they consist mostly of fine particulate sulfate.

The State Department of Health operates a network of air quality monitoring stations at various locations around the state, but

only very limited data are available for Maui Island. The only air quality data for the project area consists of particulate measurements collected at Kihei. Table 3 summarizes the data from the Kihei monitoring station. Annual second-highest 24-hour PM-10 particulate concentrations (which are most relevant to the air quality standards) ranged from 60 to 93 $\mu g/m^3$ between 2006 and 2008. Average annual concentrations ranged from 20 to 26 $\mu g/m^3$. One exceedance of the state standard was recorded during 2007. This was considered an exceptional event due to a brush fire nearby. Monitoring of PM-10 at the Kihei monitoring station was discontinued in 2009.

As indicated in Table 3, PM-2.5 particulate is also monitored at the Kihei monitoring station. Annual 24-hour $98^{th}$ percentile PM-2.5 particulate concentrations (which are most relevant to the air quality standards) ranged from 10 to 16 $\mu g/m^3$ between 2006 and 2010. Average annual concentrations ranged from 4 to 6 $\mu g/m^3$. One relatively high value was flagged during 2006 due to fireworks. No exceedances of the state standard were recorded during this period.

Given the limited air pollution sources in the area, it is likely that air pollution concentrations are near natural background levels most of the time, except possibly for locations adjacent to agricultural operations or near traffic-congested intersections. Present concentrations of carbon monoxide in the project area are estimated later in this study based on computer modeling of motor vehicle emissions.

## 6.0 SHORT-TERM IMPACTS OF PROJECT

Short-term direct and indirect impacts on air quality could potentially occur due to project construction. For a project of this nature, there are two potential types of air pollution emissions that could directly result in short-term air quality impacts during project construction: (1) fugitive dust from vehicle movement and soil excavation; and (2) exhaust emissions from on-site construction equipment. Indirectly, there also could be short-term impacts from slow-moving construction equipment traveling to and from the project site, from a temporary increase in local traffic caused by commuting construction workers, and from the disruption of normal traffic flow caused by lane closures of adjacent roadways.

Fugitive dust emissions may arise from the grading and dirt-moving activities associated with site clearing and preparation work. The emission rate for fugitive dust emissions from construction activities is difficult to estimate accurately. This is because of its elusive nature of emission and because the potential for its generation varies greatly depending upon the type of soil at the construction site, the amount and type of dirt-disturbing activity taking place, the moisture content of exposed soil in work areas, and the wind speed. The EPA [2] has provided a rough estimate for uncontrolled fugitive dust emissions from construction activity of 1.2 tons per acre per month under conditions of "medium" activity, moderate soil silt content (30%), and precipitation/evaporation (P/E) index of 50. Uncontrolled fugitive dust emissions at the project site would likely be somewhere near that level, depending on the amount of rainfall that occurs. In any case, State of Hawaii Air Pollution Control Regulations [3] prohibit visible emissions of fugitive dust from

construction activities at the property line. Thus, an effective dust control plan for the project construction phase is essential.

Adequate fugitive dust control can usually be accomplished by the establishment of a frequent watering program to keep bare-dirt surfaces in construction areas from becoming significant sources of dust. In dust-prone or dust-sensitive areas, other control measures such as limiting the area that can be disturbed at any given time, applying chemical soil stabilizers, mulching and/or using wind screens may be necessary. Control regulations further stipulate that open-bodied trucks be covered at all times when in motion if they are transporting materials that could be blown away. Haul trucks tracking dirt onto paved streets from unpaved areas is often a significant source of dust in construction areas. Some means to alleviate this problem, such as road cleaning or tire washing, may be appropriate. Paving of parking areas and/or establishment of landscaping as early in the construction schedule as possible can also lower the potential for fugitive dust emissions. Monitoring dust at the project property line could be considered to quantify and document the effectiveness of dust control measures.

On-site mobile and stationary construction equipment also will emit air pollutants from engine exhausts. The largest of this equipment is usually diesel-powered. Nitrogen oxides emissions from diesel engines can be relatively high compared to gasoline-powered equipment, but the 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 will also likely obstruct the normal flow of traffic at times to such an extent that overall vehicular emissions in the project area will temporarily increase. The only means to alleviate this problem will be to attempt to keep roadways open during peak traffic hours and to move heavy construction equipment and workers to and from construction areas during periods of low traffic volume. Thus, most potential short-term air quality impacts from project construction can be mitigated.

## 7.0 LONG-TERM IMPACTS OF PROJECT

### 7.1 Roadway Traffic

After construction is completed, use of the proposed facilities will result in increased motor vehicle traffic in the project area, potentially causing long-term impacts on ambient air quality. Motor vehicles with gasoline-powered engines are significant sources of carbon monoxide. They also emit nitrogen oxides and other contaminates.

Federal air pollution control regulations require that new motor vehicles be equipped with emission control devices that reduce emissions significantly compared to a few years ago. In 1990, the President signed into law the Clean Air Act Amendments. This legislation required further emission reductions, which have been phased in since 1994. More recently, 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 are retired and 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, three scenarios were selected for the carbon monoxide modeling study: (1) year 2011 with present conditions, (2) year 2034 without the project, and (3) year 2034 with the project. To begin the modeling study of the three scenarios, critical receptor areas in the vicinity of the project were identified for analysis. Generally speaking, roadway intersections are the primary concern because of traffic congestion and because of the increase in vehicular emissions associated with traffic queuing. For this study, several of the key intersections identified in the traffic study were also selected for air quality analysis. These included the following five intersections:

- Piilani Highway at East Waipuilani Road
- Piilani Highway at Piikea Avenue
- Piilani Highway at East Lipoa Street
- Piilani Highway at East Welakahao Road (north)
- Piilani Highway at East Welakahao Road (south)

The traffic impact report for the project [4] describes the existing and projected future traffic conditions and laneage configurations of these intersections in detail. In performing the air quality impact analysis, it was assumed that all recommended traffic mitigation measures would be implemented.

The main objective of the modeling study was to estimate maximum 1-hour average carbon monoxide concentrations for each of the three scenarios studied. To evaluate the significance of the estimated concentrations, a comparison of the predicted values for each scenario can be made. Comparison of the estimated values to the national and state AAQS was also used to provide another measure of significance.

Maximum carbon monoxide concentrations typically coincide with peak traffic periods. The traffic impact assessment report evaluated morning and afternoon peak traffic periods. These same periods were evaluated in the air quality impact assessment.

The EPA computer model MOBILE6.2 [5] 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 34.3% light-duty gasoline-powered automobiles, 52.8% 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.

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 [6] currently recommend that the computer model CAL3QHC [7] be used to assess carbon monoxide concentrations at roadway intersections, or in areas where its use has previously been established, CALINE4 [8] may be used. Until a few years ago, CALINE4 was used extensively in Hawaii to assess air quality impacts at roadway intersections. In December 1997, the California Department of Transportation recommended that the intersection mode of CALINE4 no longer be used because it was thought the model has become outdated. Studies have shown that CALINE4 may tend to over-predict maximum concentrations in some situations. Therefore, CAL3QHC was used for the subject analysis.

CAL3QHC was developed for the U.S. EPA to simulate vehicular movement, vehicle queuing and atmospheric dispersion of vehicular emissions near roadway intersections. It is designed to predict 1-hour average pollutant concentrations near roadway intersections based on input traffic and emission data, roadway/receptor geometry and meteorological conditions.

Although CAL3QHC is intended primarily for use in assessing atmospheric dispersion near signalized roadway intersections, it can also be used to evaluate unsignalized intersections. This is accomplished by manually estimating queue lengths and then applying the same techniques used by the model for signalized intersections. Currently, only two of the study intersections are signalized: Piilani Highway at Piikea Avenue and Piilani Highway at East Lipoa Street. For the future scenario without the project, in accordance with the traffic report, this was assumed to remain the case. For the future scenario with the project, it was assumed that the intersection of Piilani Highway and East Welakahao Road (south) would also 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 three scenarios. This implies that pedestrian sidewalks either already exist or are assumed to exist in the future. All receptor heights were placed at 1.8 meters above ground to simulate levels within the normal human breathing zone.

Input meteorological conditions for this study were defined to provide "worst-case" results. One of the key meteorological inputs is atmospheric stability category. For these analyses, atmospheric stability category 6 was assumed for the morning cases, while atmospheric stability category 4 was assumed for the afternoon cases. These are the most conservative stability categories that are generally used for estimating worst-case pollutant dispersion within suburban areas for these periods. A surface roughness length of 100 cm and a mixing height of 1000 meters were used in all cases. Worst-case wind conditions were defined as a wind speed of 1 meter per second with a wind direction resulting in the highest predicted concentration. Concentration estimates were calculated at wind directions of every 5 degrees.

Existing background concentrations of carbon monoxide in the project vicinity are believed to be at low levels. Thus, background contributions of carbon monoxide from sources or roadways not directly considered in the analysis were accounted for by adding a background concentration of 0.5 ppm to all predicted concentrations for 2011. 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 for 2011 and for each of the two future alternatives that were studied. 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 worst-case 1-hour concentration for the present (2011) scenario was 4.7 parts per million (ppm), and this occurred during the morning at the intersection of Piilani Highway and Piikea Avenue. Worst-case values for other locations and times ranged from 2.0 to 4.5 ppm. These concentrations are well within both the national AAQS of 35 ppm and the state standard of 9 ppm.

In the year 2034 without the proposed project, the predicted highest worst-case 1-hour concentration occurred during the morning at the intersection of Piilani Highway and East Lipoa Street with a value of 4.6 ppm. Other concentrations for this scenario at other times and locations ranged between 1.6 and 4.5 ppm. Without the project, carbon monoxide concentrations in the year 2034 were predicted to decrease somewhat at most locations in the project area compared to the existing case. Although traffic volumes are expected to be higher than the existing case, this will be offset by the retirement of older motor vehicles with less

efficient emission control equipment. Worst-case carbon monoxide concentrations should remain well within the state and federal standards for this scenario.

Similar to the 2034 without-project scenario, the highest worst-case concentration with the project in the year 2034 was predicted to occur during the morning at the intersection of Piilani Highway and East Lipoa Street. A worst-case 1-hour concentration of 4.4 ppm was predicted to occur at this location and time. Worst-case concentrations at other locations and times ranged between about 1.5 4.0 ppm. In the year 2034 with the project, carbon monoxide concentrations in the project area were generally predicted to decrease compared to the without project scenario at most of the locations studied, but it should be noted that these two alternatives are not directly comparable. This is because the traffic analysis assumes a mauka collector road for the 2034 with-project case. A mauka collector road is not assumed for the 2034 without-project scenario. The predicted worst-case 1-hour concentrations for the 2034 with-project alternative at all locations studied continued to remain well within both the national and state 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 recent study based on

modeling [9] concluded that 1-hour to 8-hour persistence factors could typically be expected to range from about 0.4 to 0.5. EPA guidelines [10] recommend using a value of 0.6 to 0.7 unless a locally derived persistence factor is available. Recent monitoring data for Honolulu reported by the Department of Health [11] suggest that this factor may range between about 0.35 and 0.55 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. However, it should be noted that the 8-hour concentration estimates are generally less reliable than the 1-hour values due to the prediction methodology involved.

The resulting estimated worst-case 8-hour concentrations are indicated in Table 5. For the 2011 scenario, the estimated worst-case 8-hour carbon monoxide concentrations for the study locations ranged from 1.6 to 2.4 ppm, with the highest concentration occurring at the intersection of Piilani Highway and Piikea Avenue. The estimated worst-case concentrations for the existing case were well within both the national limit of 9 ppm and the state standard of 4.4 ppm.

For the 2034 without project scenario in comparison to the existing case, worst-case concentrations generally decreased slightly or remained about the same. Concentrations ranged from 1.4 ppm to 2.3 ppm with the highest concentration occurring at the intersection of Piilani Highway and East Lipoa Street. All predicted 8-hour concentrations for this scenario were well within both the national and the state AAQS.

For the 2034 with-project scenario in comparison to the 2034 without-project case, worst-case concentrations decreased slightly at the intersections studied, but as noted in the table, the with-project case assumes a mauka collector road whereas the without-project case does not. Worst-case concentrations ranged from 1.2 ppm to 2.2 ppm with the highest concentration occurring at the intersection of Piilani Highway and East Lipoa Street. All predicted 8-hour concentrations for this scenario were well within both the national and the state AAQS.

Conservativeness of Estimates

The results of this study reflect several assumptions that were made concerning both traffic movement and worst-case meteorological conditions. One such assumption concerning worst-case meteorological conditions is that a wind speed of 1 meter per second with a steady direction for 1 hour will occur. A steady wind of 1 meter per second blowing from a single direction for an hour is extremely unlikely and may occur only once a year or less. With wind speeds of 2 meters per second, for example, computed carbon monoxide concentrations would be only about half the values given above. The 8-hour estimates are also conservative in that it is unlikely that anyone would occupy the assumed receptor sites (within 3 m of the roadways) for a period of 8 hours.

## 7.2 Electrical Demand

The proposed project also will cause indirect air pollution emissions from power generating facilities as a consequence of electrical power usage. The peak electrical demand of the project when fully developed is expected to reach about 24 megawatts [12]. Assuming the average demand is approximately one-half the peak demand, the annual electrical demand of the

project will reach approximately 105 million kilowatt-hours. Electrical power for the project will most probably be provided mainly by oil-fired generating facilities, but some of the project power may also be derived from photovoltaic systems, wind power or other alternative energy sources, especially if the state's initiative for renewable energy is realized. In order to meet the electrical power needs of the proposed project, power generating facilities will likely be required to burn more fuel and hence more air pollution will be emitted at these facilities. Given in Table 6 are estimates of the indirect air pollution emissions that would result from the project electrical demand assuming all power is provided by burning more fuel oil at local power plants. These values can be compared to the island-wide emission estimates for 1993 given in Table 2. The estimated indirect emissions from project electrical demand amount to about 4 percent or less of the present air pollution emissions occurring on Maui Island if all power is assumed to be derived from oil.

### 7.3 Solid Waste Disposal

Solid waste generated by the proposed development when fully completed and occupied is not expected to exceed about 7,785 tons per year assuming a waste diversion rate of 30 percent is achieved [12]. Currently, all solid waste on the island is buried at solid waste landfills. Thus, assuming this continues to be the method for solid waste disposal, the only associated air pollution emissions that will occur will be from trucking the waste to the landfill and burying it. These emissions should be relatively minor.

## 8.0 CONCLUSIONS AND RECOMMENDATIONS

### Existing Conditions

Although very little ambient air quality data are available to characterize existing conditions, it is likely that state and federal ambient air quality standards are currently being met in the project area, except perhaps for occasional exceedances of the stringent state carbon monoxide standards within small areas near traffic-congested locations. Locations adjacent to large-scale agricultural activities may also be occasionally affected by dust.

### Short-Term Impacts and Mitigation

The major potential short-term air quality impact of the project will occur from the emission of fugitive dust during construction phases. 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.

**Long-Term Impacts and Mitigation**

After construction of the proposed project is completed and it is fully occupied, carbon monoxide concentrations in the project area should remain nearly unchanged with or without the project compared to the existing case, and worst-case concentrations should remain well within both the state and the national ambient air quality standards. Implementing any air quality mitigation measures for long-term traffic-related impacts is probably unnecessary and unwarranted.

The electrical demand of the project, which is estimated at about 24 megawatts, is not inconsequential compared to the current island-wide electric power generation. Supplying the project with electric power will result in indirect (off site) emissions of air pollution at electric utility facilities. Emissions of sulfur dioxide would be the most significant if most of the power is provided from fuel oil. If the state’s goals for renewable energy are achieved, any air pollution emissions from supplying the project with electric power could be substantially reduced.

Nevertheless, indirect emissions from project electrical demand could likely be reduced somewhat by incorporating energy-saving features into project design requirements. This might include the use of solar water heaters; using energy-efficient lighting system; designing building space so that window positions maximize indoor light without unduly increasing indoor heat; using landscaping where feasible to provide afternoon shade to cut down on the use of air conditioning; installation of insulation and double-glazed doors to reduce the effects of the sun and heat; providing movable, controlled openings for ventilation at opportune times; and possibly installing automated room occupancy sensors.

Any long-term impacts on air quality due to indirect emissions from the disposal of solid waste materials generated by the project will likely be small assuming all solid waste on Maui continues to be landfilled. Any solid waste related air pollution could likely be reduced somewhat by the promotion of conservation and recycling programs within the proposed development.

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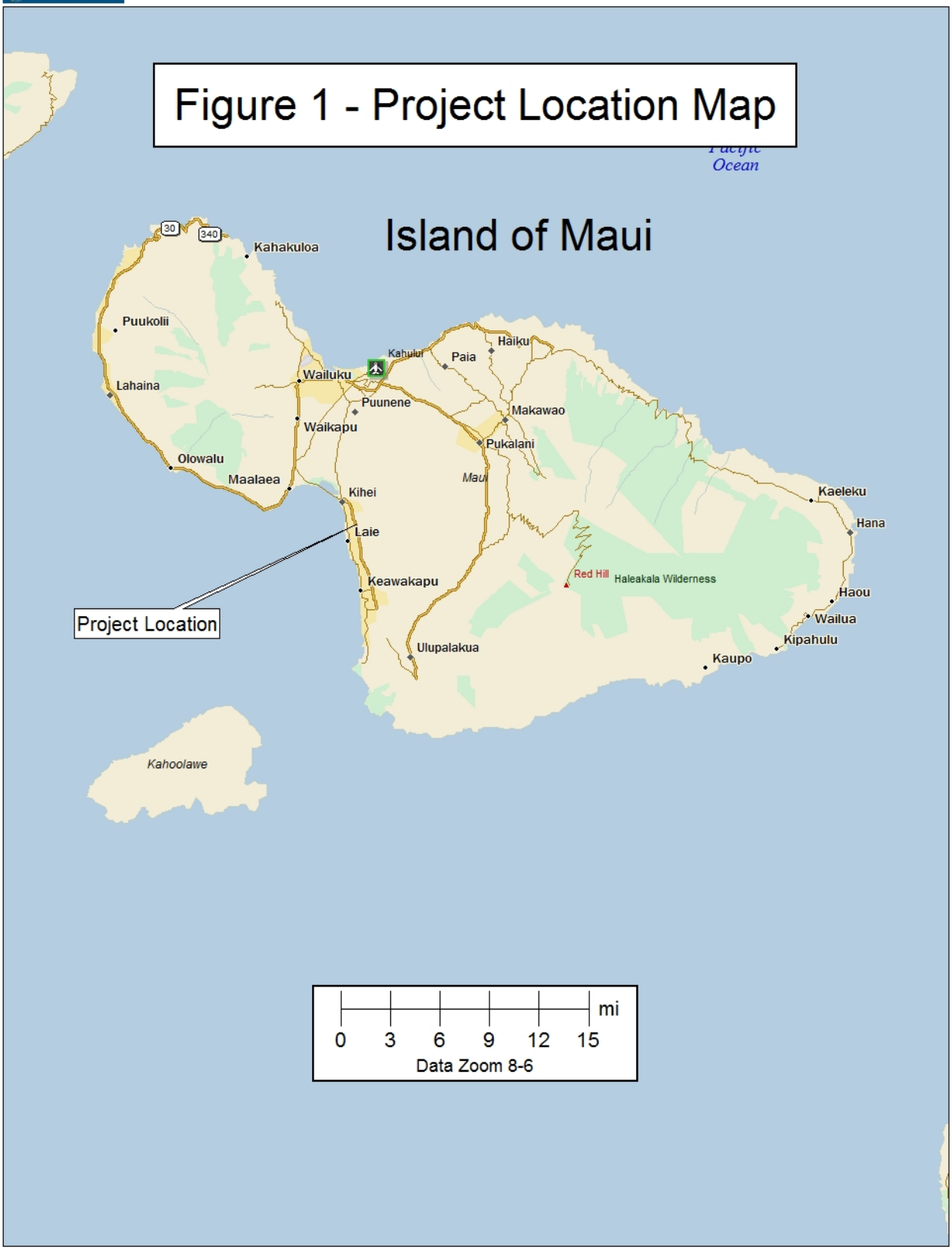
# Figure 1 - Project Location Map

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MN (9.8° E)

**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 | - | - | 0.025[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 MAUI, 1993**

| Air Pollutant | Point Sources (tons/year) | Area Sources (tons/year) | Total (tons/year) |
|---|---|---|---|
| Particulate | 63,275 | 7,030 | 70,305 |
| Sulfur Oxides | 6,419 | nil | 6,419 |
| Nitrogen Oxides | 7,312 | 8,618 | 15,930 |
| Carbon Monoxide | 4,612 | 20,050 | 24,662 |
| Hydrocarbons | 1,991 | 234 | 2,225 |

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 MAUI RESEARCH & TECHNOLOGY PARK PROJECT**

| Parameter / Location | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| **Particulate (PM-10) / Kihei** | | | | | |
| 24-Hour Averaging Period: | | | | | |
| No. of Samples | 337 | 326 | 331 | - | - |
| Highest Concentration ($\mu g/m^3$) | 72 | 281[a] | 78 | - | - |
| 2nd Highest Concentration ($\mu g/m^3$) | 66 | 93 | 60 | - | - |
| No. of State AAQS Exceedances | 0 | 1[a] | 0 | - | - |
| Annual Average Concentration ($\mu g/m^3$) | 22 | 26 | 20 | - | - |
| **Particulate (PM-2.5) / Kihei** | | | | | |
| 24-Hour Averaging Period: | | | | | |
| No. of Samples | 109 | 78 | 58 | 358 | 332 |
| Highest Concentration ($\mu g/m^3$) | 30[b] | 11 | 16 | 26 | 24 |
| 98th Percentile Concentration ($\mu g/m^3$) | 10 | 10 | 15 | 16 | 14 |
| No. of State AAQS Exceedances | 0 | 0 | 0 | 0 | 0 |
| Annual Average Concentration ($\mu g/m^3$) | 5 | 5 | 6 | 4 | 5 |

[a]**Exceptional event (brush fire)**

[b]**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 MAUI RESEARCH & TECHNOLOGY PARK PROJECT (parts per million)**

| Roadway Intersection | Year/Scenario | | | | | |
|---|---|---|---|---|---|---|
| | 2011/Present | | 2034/Without Project | | 2034/With Project[a] | |
| | AM | PM | AM | PM | AM | PM |
| Piilani Highway at East Waipuilani Road | 4.2 | 2.4 | 4.0 | 2.1 | 3.0 | 1.7 |
| Piilani Highway at Piikea Avenue | 4.7 | 2.9 | 4.5 | 2.6 | 4.0 | 2.5 |
| Piilani Highway at East Lipoa Street | 4.5 | 2.9 | 4.6 | 2.4 | 4.4 | 2.7 |
| Piilani Highway at E. Welakahao Rd (North) | 3.1 | 2.0 | 2.9 | 1.6 | 2.5 | 1.5 |
| Piilani Highway at E. Welakahao Rd (South) | 3.3 | 2.0 | 2.9 | 1.6 | 2.6 | 1.6 |

Hawaii State AAQS: 9
National AAQS: 35

[a]Assumes mauka collector road.

**Table 5**

**ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR MAUI RESEARCH & TECHNOLOGY PARK PROJECT (parts per million)**

| Roadway Intersection | Year/Scenario | | |
|---|---|---|---|
| | 2011/Present | 2034/Without Project | 2034/With Project[a] |
| Piilani Highway at East Waipuilani Road | 2.1 | 2.0 | 1.5 |
| Piilani Highway at Piikea Avenue | 2.4 | 2.2 | 2.0 |
| Piilani Highway at East Lipoa Street | 2.2 | 2.3 | 2.2 |
| Piilani Highway at E. Welakahao Rd (North) | 1.6 | 1.4 | 1.2 |
| Piilani Highway at E. Welakahao Rd (South) | 1.6 | 1.4 | 1.3 |

Hawaii State AAQS: 4.4
National AAQS: 9

[a]Assumes mauka collector road.

**Table 6**

**ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM MAUI RESEARCH & TECHNOLOGY PARK ELECTRICAL DEMAND[a]**

| Air Pollutant | Emission Rate (tons/year) |
|---|---|
| Particulate | 8 |
| Sulfur Dioxide | 275 |
| Carbon Monoxide | 20 |
| Nitrogen Oxides | 93 |

[a]Based on U.S. EPA emission factors for utility boilers [2]. Assumes demand of 105 million kw-hrs per year of electrical power use, 33% energy conversion efficiency and low-sulfur distillate oil used to generate power.

APPENDIX K-1
Letter from Air Quality Consultant

**B.D. NEAL & ASSOCIATES**

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February 25, 2013

Attn: Mr. Brett Davis
Chris Hart and Partners, Inc.
115 N. Market St.
Wailuku, HI 96793

Subject: Maui Research & Technology Park
Review of Air Quality Study (Rev. 1)

Dear Mr. Davis:

I have reviewed the Traffic Impact Analysis Report (TIAR) dated February 2013 for the subject project and compared this to the TIAR prepared previously in February 2012. The February 2012 TIAR was the basis for the analysis of traffic-related air quality impacts that we prepared for this project in May 2012. Although the revised TIAR includes additional roadway intersections and additional future scenarios, the expected future traffic volumes with or without the project have not changed significantly. Hence, although the air quality study for this project has not been revised to specifically reflect the revised TIAR, based on the relatively small differences in the expected traffic volumes, it is unlikely that the air quality results and conclusions would change significantly. That is, we would expect that carbon monoxide concentrations along roadways in the project area will remain well within state and federal ambient air quality standards with or without the project at least through the year 2034.

Based on my review of the updated traffic study dated February 2013, it is my professional opinion that further air quality analysis for this project is unnecessary because it is unlikely that the air quality results and conclusions would change significantly. Please call me if you would like to discuss this matter further.

Very truly yours,

Barry D. Neal
Certified Consulting
Meteorologist

APPENDIX L
Acoustic Study

# ACOUSTIC STUDY FOR THE MAUI RESEARCH AND TECHNOLOGY PARK KIHEI, MAUI

Prepared for:

**MAUI R&T PARTNERS, LLC**

Prepared by:

**Y. EBISU & ASSOCIATES**
**1126 12th Avenue, Room 305**
**Honolulu, Hawaii 96816**

**APRIL 2012**

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## CHAPTER I. SUMMARY

The existing and future traffic noise levels in the vicinity of the planned Maui Research and Technology Park in Kihei, Maui were evaluated for their potential impacts and their relationship to current FHA/HUD noise standards for noise sensitive land uses. The traffic noise level increases along the roadways servicing the project site (see Figure 1) were calculated. Significant increases in traffic noise levels at noise sensitive properties are not expected to occur as a result of project traffic following project build-out by CY 2024 and 2034.

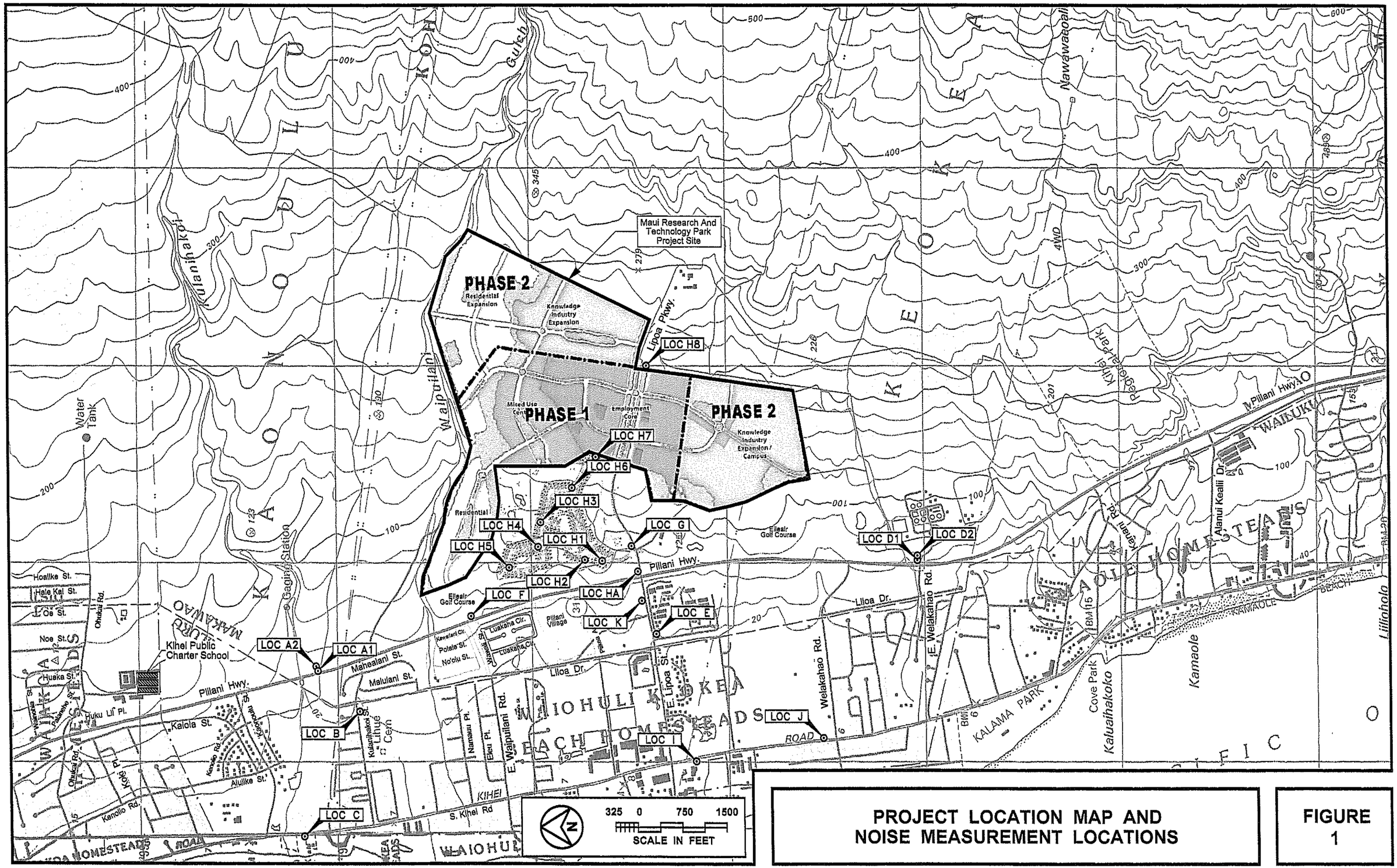
Along Piilani Highway fronting the project site, traffic noise levels of approximately 70 DNL are expected to increase to approximately 71 DNL at 100 foot distance from the centerline by CY 2024 as a result of project and non-project traffic. By CY 2034, traffic noise levels along Piilani Highway are expected to be reduced to existing noise levels following completion of the proposed north-south collector road on the mauka side of the project site.

The largest increases (1.4 to 7.7 DNL) in project related traffic noise are predicted to occur along Lipoa Parkway, East Welakahao Street east of Piilani Highway, and along Lipoa Street west of Piilani Highway. Adverse traffic noise impacts along Lipoa Parkway and East Welakahao Street are not expected to occur since noise sensitive developments are not planned to be located along those two roadways. The noise sensitive buildings along Lipoa Street west of Piilani Highway have adequate setback distances from Lipoa Street, such that predicted CY 2024 and CY 2034 traffic noise levels should remain in the "Moderate Exposure, Normally Acceptable" category at these buildings. For these reasons, traffic noise mitigation measures should not be required.

The project site is planned such that noise sensitive residential uses of the project are situated at very large setback distances from Piilani Highway, where existing and future traffic noise levels are predicted to be less than 60 DNL. The large buffer distances to the highway will allow for the use of naturally ventilated buildings on the project site.

The dominant traffic noise sources in the project environs will continue to be traffic along Piilani Highway and South Kihei Road. In addition, the addition of the proposed north-south collector road mauka of the project will increase the existing background ambient noise levels at the mauka end of the project site and along the proposed corridors of the collector road and connecting roadways.

Unavoidable, but temporary, noise impacts may occur during construction of the proposed project, particularly during the excavation and earth moving activities on the project site. Because construction activities are predicted to be audible within the project site and at nearby properties, the quality of the acoustic environment may be degraded to unacceptable levels during periods of construction. Mitigation measures to




**PROJECT LOCATION MAP AND NOISE MEASUREMENT LOCATIONS**

**FIGURE 1**

reduce construction noise to inaudible levels will not be practical in all cases, but the use of quiet equipment and compliance with State Department of Health construction noise regulations are recommended as standard mitigation measures.

## CHAPTER II. PURPOSE

The primary objective of this study was to describe the existing and future traffic noise levels in the environs of the proposed Maui Research and Technology Park in Kihei on the island of Maui. Traffic forecasts for 2024 and 2034 were used. Traffic noise level increases and impacts associated with the proposed development were to be determined within the project site as well as along the public roadways which are expected to service the project traffic. A specific objective was to determine future traffic noise level increases associated with both project and non-project traffic, and the potential noise impacts associated with these increases.

Impacts from on-site activities and short term construction noise at the project site were also included as noise study objectives. Recommendations for minimizing identified 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 (such as FHA/HUD) to assess environmental noise is the Day-Night Average Sound Level (DNL). This descriptor incorporates a 24-hour average of instantaneous A-Weighted Sound Levels as read on a standard Sound Level Meter. 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. A more complete list of noise descriptors is provided in APPENDIX B to this report.

Table 1, derived from Reference 1, presents current federal noise standards and acceptability criteria for residential land uses. Table 2, also extracted from Reference 1, presents the general effects of noise on people in residential use situations. Land use compatibility guidelines for various levels of environmental noise as measured by the DNL descriptor system are shown in Figure 2 (from Reference 2). 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. In the project area, traffic noise levels associated with Piilani Highway and South Kihei Road are typically greater than 65 DNL along the Right-of-Way due to the relatively large volumes of traffic on these major thoroughfares.

For purposes of determining noise acceptability for funding assistance from federal agencies (FHA/HUD and VA), an exterior noise level of 65 DNL or less is considered acceptable for residences. This standard is applied nationally (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, and as recommended in Reference 4, a lower level of 55 DNL is considered as the "Unconditionally Acceptable" (or "Near-Zero Risk") level of exterior 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.

On the island of Maui, the State Department of Health (DOH) regulates noise from construction activities through the issuance of permits for allowing excessive

## TABLE 1

## EXTERIOR NOISE EXPOSURE CLASSIFICATION (RESIDENTIAL LAND USE)

| NOISE EXPOSURE CLASS | DAY–NIGHT SOUND LEVEL | EQUIVALENT SOUND LEVEL | FEDERAL (1) STANDARD |
|---|---|---|---|
| Minimal Exposure | Not Exceeding 55 DNL | Not Exceeding 55 Leq | Unconditionally Acceptable |
| Moderate Exposure | Above 55 DNL But Not Above 65 DNL | Above 55 Leq But Not Above 65 Leq | Acceptable(2) |
| Significant Exposure | Above 65 DNL But Not Above 75 DNL | Above 65 Leq But Not Above 75 Leq | Normally Unacceptable |
| Severe Exposure | Above 75 DNL | Above 75 Leq | Unacceptable |

Notes: (1) Federal Housing Administration, Veterans Administration, Department of Defense, and Department of Transportation.

(2) FHWA uses the Leq instead of the Ldn descriptor. For planning purposes, both are equivalent if: (a) heavy trucks do not exceed 10 percent of total traffic flow in vehicles per 24 hours, and (b) traffic between 10:00 PM and 7:00 AM does not exceed 15 percent of average daily traffic flow in vehicles per 24 hours. The noise mitigation threshold used by FHWA for residences is 67 Leq.

# TABLE 2

## EFFECTS OF NOISE ON PEOPLE
## (Residential Land Uses Only)

| EFFECTS[1] / DAY-NIGHT AVERAGE SOUND LEVEL IN DECIBELS | Hearing Loss | Speech Interference | | Annoyance[2] | Average Community Reaction[4] | General Community Attitude Towards Area |
|---|---|---|---|---|---|---|
| | | Indoor | Outdoor | | | |
| | Qualitative Description | %Sentence Intelligibility | Distance in Meters for 95% Sentence Intelligibility | % of Population Highly Annoyed[3] | | |
| 75 and above | May Begin to Occur | 98% | 0.5 | 37% | Very Severe | Noise is likely to be the most important of all adverse aspects of the community environment. |
| 70 | Will Not Likely Occur | 99% | 0.9 | 25% | Severe | Noise is one of the most important adverse aspects of the community environment. |
| 65 | Will Not Occur | 100% | 1.5 | 15% | Significant | Noise is one of the important adverse aspects of the community environment. |
| 60 | Will Not Occur | 100% | 2.0 | 9% | Moderate to Slight | Noise may be considered an adverse aspect of the community environment. |
| 55 and below | Will Not Occur | 100% | 3.5 | 4% | | Noise considered no more important than various other environmental factors. |

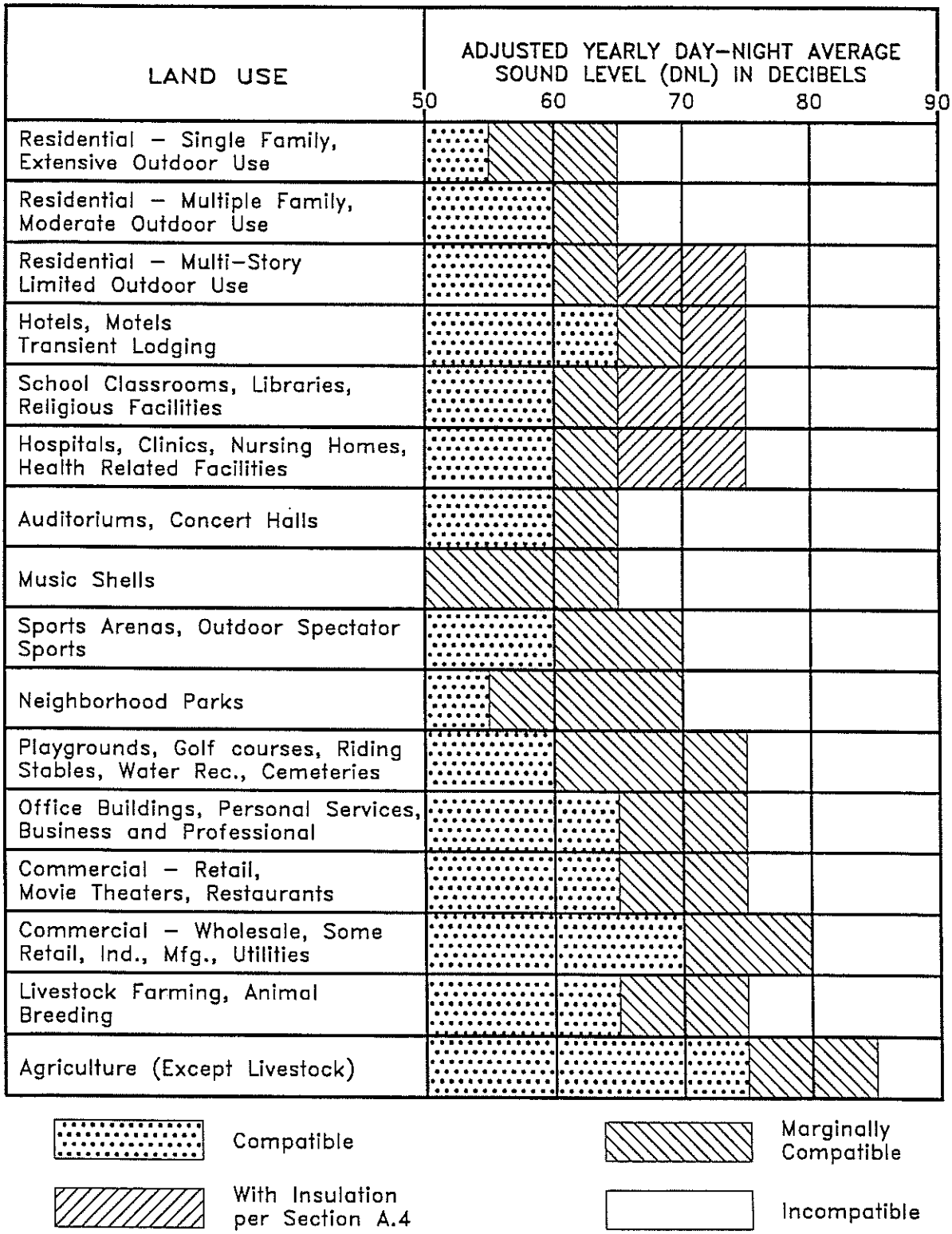
1. "Speech Interference" data are drawn from the following tables in EPA's "Levels Document": Table 3, Fig. D-1, Fig. D-2, Fig. D-3. All other data from National Academy of Science 1977 report "Guidelines for Preparing Environmental Impact Statements on Noise, Report of Working Group 69 on Evaluation of Environmental Impact of Noise."

2. Depends on attitudes and other factors.

3. The percentages of people reporting annoyance to lesser extents are higher in each case. An unknown small percentage of people will report being "highly annoyed" even in the quietest surroundings. One reason is the difficulty all people have in integrating annoyance over a very long time.

4. Attitudes or other non-acoustic factors can modify this. Noise at low levels can still be an important problem, particularly when it intrudes into a quiet environment.

NOTE: Research implicates noise as a factor producing stress-related health effects such as heart disease, high-blood pressure and stroke, ulcers and other digestive disorders. The relationships between noise and these effects, however, have not as yet been quantified.




LAND USE COMPATIBILITY WITH YEARLY AVERAGE DAY-NIGHT AVERAGE SOUND LEVEL (DNL) AT A SITE FOR BUILDINGS AS COMMONLY CONSTRUCTED.
(Source: American National Standards Institute S12.9-1998/Part 5)

**FIGURE 2**

noise during limited time periods. State DOH noise regulations are expressed in maximum allowable property line noise limits rather than DNL (see Reference 5). Although they are not directly comparable to noise criteria expressed in DNL, State DOH noise limits for residential, commercial, and industrial lands equate to approximately 55, 60, and 76 DNL, respectively.

## CHAPTER IV. GENERAL STUDY METHODOLOGY

Existing traffic noise levels were measured at twelve locations (A1, A2, B, C, D1, D2, E, F, G. I, J, and K) along public roadways in the project environs to provide a basis for developing the project's traffic noise contributions along the roadways which will service the proposed development. In addition, existing background noise levels were obtained at nine locations (HA and H1 through H8) within the existing Hokulani and proposed project areas to validate the traffic noise model used for predicting future traffic noise levels from Piilani Highway within the project area. The locations of the measurement sites are shown in Figure 1. Noise measurements were performed during the months of September 2011 and April 2012. The results of the traffic noise measurements were compared with calculations of existing traffic noise levels to validate the computer model used. The traffic noise measurement results along the public roadways, and their comparisons with computer model predictions of existing traffic noise levels are summarized in Table 3.

Traffic noise calculations for the existing conditions as well as noise predictions for the Years 2024 and 2034 were performed using the Federal Highway Administration (FHWA) Traffic Noise Model (Reference 6). Traffic data entered into the noise prediction model were: roadway and receiver locations; hourly traffic volumes; average vehicle speeds; estimates of traffic mix; and "Loose Soil" propagation loss factor. The traffic data and forecasts for the project (Reference 7), plus the spot traffic counts obtained during the noise measurement periods were the primary sources of data inputs to the model. Appendices C1 through C3 summarize the AM and PM peak hour traffic volumes for CY 2011, 2024, and 2034 which were used to model existing and future traffic noise along the streets in the vicinity of the project site. For existing and future traffic along the streets in the vicinity of the project site, it was assumed that the average noise levels, or Leq(h), during the AM or PM peak traffic hour were equal to the 24-hour DNL along those roadways. This assumption was based on computations of both the hourly Leq and the 24-hour DNL of traffic noise on Piilani Highway (see Figure 3) using Hawaii State Department of Transportation hourly traffic counts from Reference 8.

Traffic noise calculations for both the existing and future conditions in the project environs were developed for ground level receptors with and without the benefit of shielding from natural terrain features or man made obstructions. Traffic noise levels were also calculated for future conditions with and without the proposed project. The forecasted changes in traffic noise levels over existing levels were calculated with and without the project, and noise impact risks evaluated. The relative contributions of non-project and project traffic to the total noise levels were also calculated, and an evaluation of possible traffic noise impacts was made.

Calculations of average exterior and interior noise levels from construction activities were performed for typical naturally ventilated and air conditioned dwellings. Predicted noise levels were compared with existing background ambient noise levels, and the potential for noise impacts was assessed.

# TABLE 3

## 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) |
|---|---|---|---|---|---|---|---|
| A1. 60 FT from the center-line of Piilani Highway (9/12/11) | 0634 TO 0734 | 55 | 2,358 | 29 | 17 | 74.2 | 72.9 |
| A2. 120 FT from the center-line of Piilani Highway (9/12/11) | 0634 TO 0734 | 55 | 2,358 | 29 | 17 | 67.7 | 68.0 |
| B. 50 FT from the center-line of Kulanihakoi Street (9/12/11) | 0757 TO 0857 | 35 | 152 | 2 | 0 | 57.9 | 55.9 |
| C. 50 FT from the center-line of South Kihei Road (9/12/11) | 0917 TO 1017 | 40 | 802 | 13 | 7 | 64.6 | 64.8 |
| A1. 60 FT from the center-line of Piilani Highway (9/12/11) | 1539 TO 1639 | 55 | 2,832 | 28 | 10 | 74.0 | 73.5 |
| A2. 120 FT from the center-line of Piilani Highway (9/12/11) | 1539 TO 1639 | 55 | 2,832 | 28 | 10 | 68.0 | 68.3 |

# TABLE 3 (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) |
|---|---|---|---|---|---|---|---|
| D1. 75 FT from the center-line of Piilani Highway (9/13/11) | 0646 TO 0746 | 55 | 1,863 | 18 | 35 | 72.0 | 69.4 |
| D2. 150 FT from the center-line of Piilani Highway (9/13/11) | 0646 TO 0746 | 55 | 1,863 | 18 | 35 | 62.1 | 62.5 |
| E. 50 FT from the center-line of Lipoa Street (9/13/11) | 0809 TO 0909 | 35 | 402 | 6 | 12 | 61.7 | 61.1 |
| F. 78 FT from the center-line of Piilani Highway (9/13/11) | 1030 TO 1130 | 53 | 1,950 | 34 | 31 | 69.7 | 69.7 |
| D1. 75 FT from the center-line of Piilani Highway (9/13/11) | 1540 TO 1640 | 53 | 2,356 | 21 | 15 | 71.4 | 69.8 |
| D2. 150 FT from the center-line of Piilani Highway (9/13/11) | 1540 TO 1640 | 53 | 2,356 | 21 | 15 | 62.5 | 62.4 |

# TABLE 3 (CONTINUED)

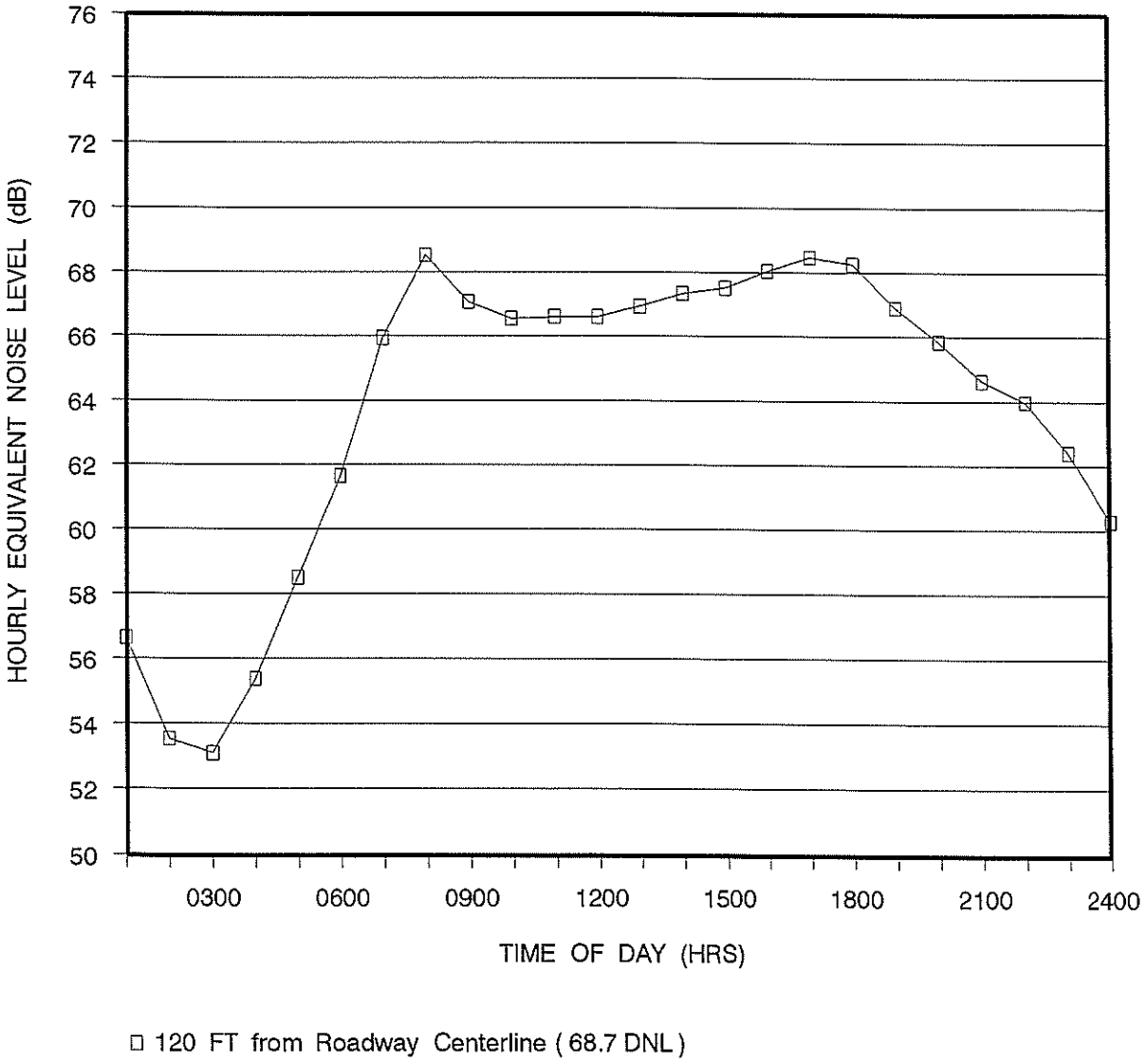
# TRAFFIC AND BACKGROUND NOISE MEASUREMENT RESULTS

| LOCATION | Time of Day (HRS) | Ave. Speed (MPH) | Hourly Traffic Volume AUTO | M.TRUCK | H.TRUCK | Measured Leq (dB) | Predicted Leq (dB) |
|---|---|---|---|---|---|---|---|
| K. 50 FT from the center-line of Lipoa Street (4/16/12) | 0653 TO 0753 | 25 | 870 | 9 | 20 | 62.8 | 62.7 |
| G. 50 FT from the center-line of Lipoa Parkway (4/16/12) | 0802 TO 0902 | 35 | 149 | 0 | 0 | 56.5 | 57.0 |
| I. 50 FT from the center-line of S. Kihei Road (4/16/12) | 0923 TO 1023 | 38 | 1,234 | 24 | 7 | 66.7 | 66.6 |
| J. 50 FT from the center-line of S. Kihei Road (4/16/12) | 1448 TO 1548 | 38 | 1,387 | 22 | 5 | 66.8 | 67.0 |
| G. 50 FT from the center-line of Lipoa Parkway (4/16/12) | 1559 TO 1659 | 35 | 121 | 1 | 0 | 59.5 *<br>57.5 ** | 57.1 |

Notes:
* With siren contribution included.
** With siren contribution deleted.

## FIGURE 3

## HOURLY VARIATIONS OF TRAFFIC NOISE AT 120 FT SETBACK DISTANCE FROM THE CENTERLINE OF PIILANI HIGHWAY BETWEEN MOKULELE HWY. AND LIPOA ST. (STA. B74003100000; APRIL 21, 2009)



## V. EXISTING ACOUSTICAL ENVIRONMENT

The existing background ambient noise levels within the project site are relatively low at the mauka (east) end and moderate on the makai (west) end of the site. Traffic along Piilani Highway controls the background noise levels at the makai end of the project site, and diminishes to inaudible levels at the mauka end of the project site. On the makai side of Piilani Highway, existing traffic noise levels also diminish with increasing distances from Piilani Highway, and are controlled by the traffic on connector roads and South Kihei Road in areas between Piilani Highway and the shoreline.

Traffic and background ambient noise measurements along the public roadways in the project environs were obtained in September 2011 and April 2012 at twelve locations (A1, A2, B, C, D1, D2, E, F, G, I, J, and K) in the project environs. These locations are shown in Figure 1. The results of these traffic and background ambient noise measurements are summarized in Table 3, with measurement locations identified in Figure 1. The measurement locations were typically located at street level. As shown in Table 3, correlation between measured and predicted traffic noise levels was good. The Traffic Noise Model's "Loose Soil" and "Field Grass" propagation loss factors were used to obtain the good correlation.

Calculations of existing traffic noise levels along the public roadways in the project environs during the AM or PM peak traffic hours are presented in Table 4. 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. In Table 4, the Leq values shown also represent the DNL values for the roadways shown. The existing setback distances from the roadways' centerlines to their associated 65 and 75 DNL contours were also calculated as shown in Table 5. The contour line setback distances do not take into account noise shielding effects or the additive contributions of traffic noise from intersecting street sections.

The existing traffic noise levels in the project environs along Piilani Highway are in the "Significant Exposure, Normally Unacceptable" category, and at or greater than 65 DNL at the first row of existing homes on the makai side of the highway. The existing traffic noise levels in the project environs along South Kihei Road are in the "Significant Exposure, Normally Unacceptable" categories, and at or greater than 65 DNL within 61 to 67 feet of the roadway's centerline. Along the lower volume connector streets, existing traffic noise levels are in the "Moderate Exposure, Acceptable" category, and less than 65 DNL at 50 feet or greater distance from the roadways' centerlines.

The existing background noise levels at the project site were estimated by measuring existing background noise levels within the Hokulani project (Locations H1 through H7) and at the mauka end of Lipoa Parkway (Location H8). These measurements were used in conjunction with the FHWA Traffic Noise Model to calculate existing traffic noise level contributions from Piilani Highway at various

# TABLE 4

## EXISTING (CY 2011) TRAFFIC VOLUMES AND NOISE LEVELS ALONG ROADWAYS IN PROJECT AREA (AM OR PM PEAK HOUR)

| LOCATION | SPEED (MPH) | TOTAL VPH | ****** VOLUMES (VPH) ******** AUTOS | M TRUCKS | H TRUCKS | 50' Leq | 100' Leq | 200' Leq |
|---|---|---|---|---|---|---|---|---|
| Piilani Hwy., N. of E. Waipulani Rd. (PM) | 55 | 3,233 | 3,181 | 36 | 16 | 75.2 | 70.3 | 64.5 |
| Piilani Hwy., Between E. Waipulani Rd. & Piikea Ave. (PM) | 55 | 3,174 | 3,123 | 35 | 16 | 75.1 | 70.2 | 64.5 |
| Piilani Hwy., Between Piikea Ave. & E. Lipoa St. (PM) | 55 | 2,993 | 2,948 | 30 | 15 | 74.8 | 70.0 | 64.2 |
| Piilani Hwy., Between E. Lipoa St. & Welakahao Rd. (PM) | 55 | 2,595 | 2,556 | 26 | 13 | 74.2 | 69.3 | 63.6 |
| Piilani Hwy., Between Welakahao Rd. & E. Welakahao St. (PM) | 55 | 2,406 | 2,346 | 24 | 36 | 74.2 | 69.3 | 63.6 |
| Piilani Hwy., S. of E. Welakahao St. (PM) | 55 | 2,377 | 2,341 | 24 | 12 | 73.8 | 69.0 | 63.2 |
| S. Kihei Rd., N. of Piikea Ave. (PM) | 40 | 1,251 | 1,218 | 20 | 13 | 66.8 | 61.0 | 55.0 |
| S. Kihei Rd., Between Piikea Ave. & E. Lipoa St. (PM) | 40 | 1,453 | 1,415 | 23 | 15 | 67.4 | 61.6 | 55.7 |
| S. Kihei Rd., S. of E. Lipoa St. (PM) | 38 | 1,594 | 1,560 | 26 | 8 | 66.9 | 61.1 | 55.1 |
| S. Kihei Rd., N. of Welakahao Rd. (PM) | 38 | 1,518 | 1,486 | 24 | 8 | 66.7 | 60.9 | 54.9 |
| S. Kihei Rd., S. of Welakahao Rd. (PM) | 38 | 1,562 | 1,529 | 25 | 8 | 66.9 | 61.0 | 55.0 |
| Hookena St., E. of Piilani Hwy. (PM) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| E. Waipulani Rd., W. of Piilani Hwy. (PM) | 30 | 140 | 138 | 2 | 0 | 53.0 | 46.8 | 41.8 |
| Piikea Ave., Between Piilani Hwy. & Liloa St. (PM) | 30 | 988 | 974 | 13 | 1 | 62.2 | 55.8 | 50.6 |
| Piikea Ave., Between Liloa St. & S. Kihei Rd. (PM) | 30 | 701 | 691 | 9 | 1 | 60.1 | 54.7 | 48.7 |
| Lipoa Pkwy., E. of Piilani Hwy. (PM) | 35 | 223 | 220 | 3 | 0 | 58.8 | 53.2 | 47.0 |
| E. Lipoa St., Between Piilani Hwy. & Liloa Dr. (AM) | 25 | 765 | 747 | 10 | 8 | 59.6 | 53.8 | 49.3 |
| E. Lipoa St., Between Liloa Dr. & S. Kihei Rd. (PM) | 30 | 604 | 590 | 8 | 6 | 60.0 | 54.0 | 48.5 |
| Welakahao Rd., W. of Piilani Hwy. (PM) | 30 | 510 | 502 | 7 | 1 | 58.8 | 53.4 | 47.5 |
| Welakahao Rd., E. of S. Kihei Rd. (PM) | 30 | 308 | 304 | 4 | 0 | 56.5 | 51.0 | 45.0 |
| E. Welakahao St., E. of Piilani Hwy. (AM) | 30 | 67 | 66 | 1 | 0 | 49.7 | 43.4 | 37.5 |

# TABLE 5

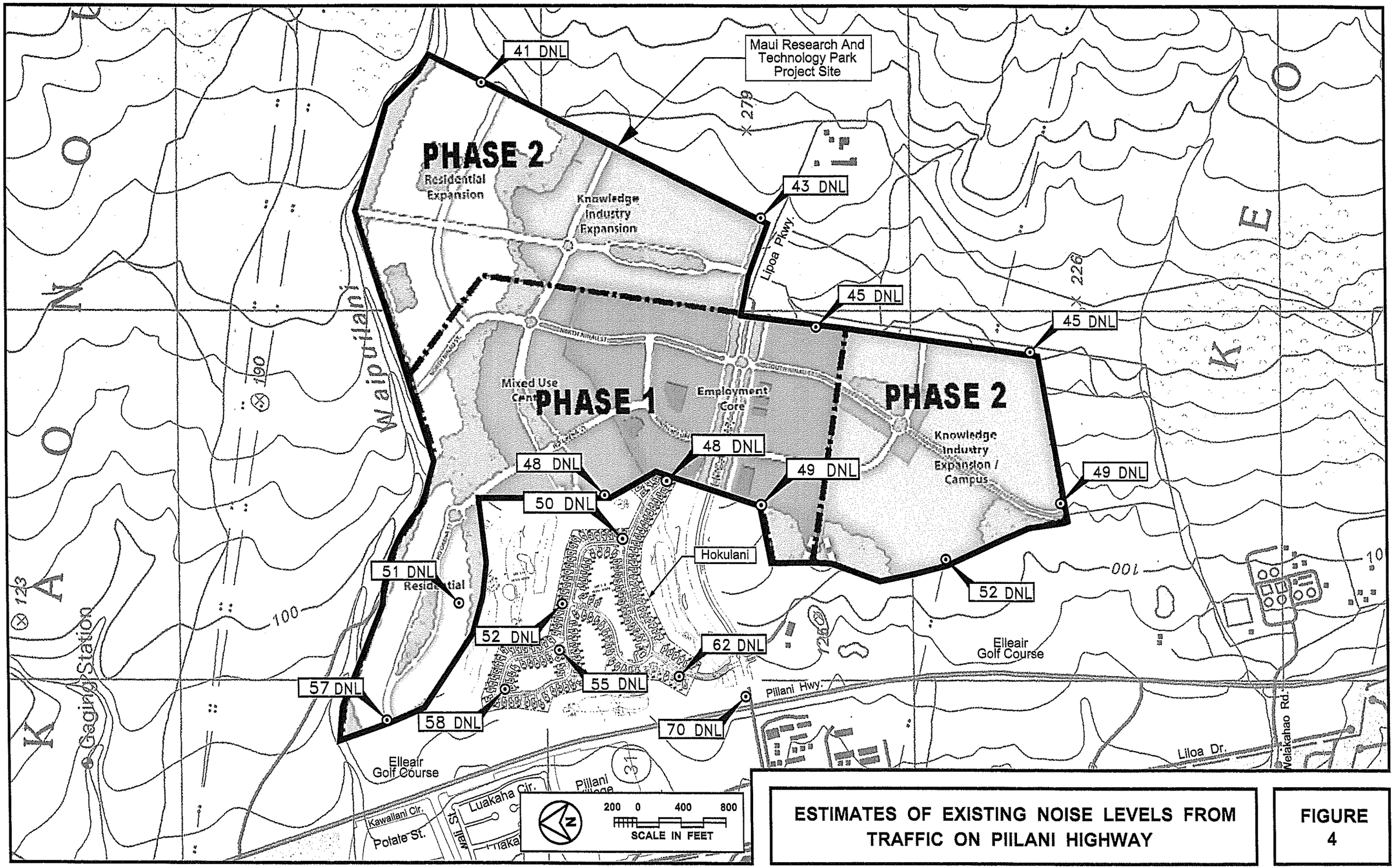
## EXISTING AND CY 2024 DISTANCES TO 65 AND 75 DNL CONTOURS

| STREET SECTION | 65 DNL SETBACK (FT) EXISTING | 65 DNL SETBACK (FT) CY 2024 | 75 DNL SETBACK (FT) EXISTING | 75 DNL SETBACK (FT) CY 2024 |
|---|---|---|---|---|
| Piilani Hwy., N. of E. Waipulani Rd. | 188 | 217 | 51 | 60 |
| Piilani Hwy., Between E. Waipulani Rd. & Piikea Ave. | 188 | 212 | 51 | 59 |
| Piilani Hwy., Between Piikea Ave. & E. Lipoa St. | 182 | 202 | 49 | 55 |
| Piilani Hwy., Between E. Lipoa St. & Welakahao Rd. | 169 | 173 | 45 | 46 |
| Piilani Hwy., Between Welakahao Rd. & E. Welakahao St. | 169 | 177 | 45 | 47 |
| Piilani Hwy., S. of E. Welakahao St. | 161 | 167 | 42 | 44 |
| S. Kihei Rd., N. of Piikea Ave. | 62 | 64 | 19 | 19 |
| S. Kihei Rd., Between Piikea Ave. & E. Lipoa St. | 67 | 69 | 20 | 21 |
| S. Kihei Rd., S. of E. Lipoa St. | 63 | 65 | 19 | 20 |
| S. Kihei Rd., N. of Welakahao Rd. | 61 | 64 | 19 | 19 |
| S. Kihei Rd., S. of Welakahao Rd. | 63 | 65 | 19 | 20 |
| Hookena St., E. of Piilani Hwy. | N/A | 15 | N/A | < 12 |
| E. Waipulani Rd., W. of Piilani Hwy. | 13 | 13 | < 12 | < 12 |
| Piikea Ave., Between Piilani Hwy. & Liloa St. | 37 | 39 | 13 | 13 |
| Piikea Ave., Between Liloa St. & S. Kihei Rd. | 27 | 27 | < 12 | < 12 |
| Lipoa Pkwy., E. of Piilani Hwy. | 23 | 60 | < 12 | 17 |
| E. Lipoa St., Between Piilani Hwy. & Liloa Dr. | 26 | 32 | < 12 | < 12 |
| E. Lipoa St., Between Liloa Dr. & S. Kihei Rd. | 28 | 29 | < 12 | < 12 |
| Welakahao Rd., W. of Piilani Hwy. | 23 | 23 | < 12 | < 12 |
| Welakahao Rd., E. of S. Kihei Rd. | 17 | 17 | < 12 | < 12 |
| E. Welakahao St., E. of Piilani Hwy. | < 12 | < 12 | < 12 | < 12 |

**Notes:**

(1) All setback distances are from the roadways' centerlines.
(2) See Tables 4 and 6-1 for traffic volume, speed, and mix assumptions.
(3) Setback distances are for ground level receptors.

locations within the Hokulani and Maui Research and Technology Project sites. The results of these existing traffic noise calculations are shown in Figure 4. From Figure 4, existing traffic noise levels on the project site are estimated to range from 49 to 57 DNL at the westernmost (makai) corners of the project site to 41 to 45 DNL at the easternmost (mauka) corners of the project site.




**ESTIMATES OF EXISTING NOISE LEVELS FROM TRAFFIC ON PIILANI HIGHWAY**

**FIGURE 4**

## CHAPTER VI. FUTURE NOISE ENVIRONMENT

Predictions of future traffic noise levels were made using the traffic volume assignments of Reference 7 for CY 2024 and 2034 with and without the proposed project. The future projections of project plus non-project traffic noise levels for CY 2034 also included traffic on a new 2-lane or 4-lane, north-south, collector road located to the east (mauka) of the project site. Appendices C1 through C3 summarize the AM and PM peak hour traffic volumes for 2024 and 2034 which were used to model future traffic noise along the streets in the vicinity of the project site.

Future traffic noise levels at distances of 50, 100, and 200 feet from the centerlines of the roadways which would service the project are shown in Tables 6-1, 6-2, and 6-3 for the AM or PM peak hours of traffic, under the Build Alternative. Predicted increases in the setback distances to the 65 and 75 DNL contours are shown in Tables 5 and 7. The separate non-project and project traffic noise contributions for the Build Alternatives for 2024 and 2034 are shown in Table 8.

From Table 8, increases in future traffic noise levels of 0.5 to 1.1 DNL are expected along Piilani Highway in the project environs between CY 2011 and 2024 as a result of project traffic. The growth in non-project traffic by CY 2024 is predicted to result in traffic noise level increases of 0.0 to 0.2 DNL along Piilani Highway. Similar increases in future traffic noise levels due to non-project traffic are predicted to occur along South Kihei Road by CY 2024, with project traffic adding 0.0 to 0.1 DNL to the non-project noise levels by CY 2024. The largest increase (7.7 DNL) in traffic noise level is anticipated to occur along Lipoa Parkway east of Piilani Highway, and is primarily associated with project traffic. The next largest increase (1.4 DNL) in traffic noise due to project traffic is anticipated to occur along Lipoa Street between Piilani Highway and Liloa Drive. Predicted increases in traffic noise by CY 2024 due to project traffic along the other remaining roadways in the project environs are 0.1 DNL or less.

From Tables 9-1 and 9-2, future traffic noise levels are expected to decline along Piilani Highway in the project environs between CY 2011 and 2034 as a result of the transfer of north-south traffic from Piilani Highway to the proposed north-south collector road located mauka of the project site. The amount of the decreases in future traffic noise by CY 2034 range from 0.5 to 0.9 DNL, and are identical for the 2-lane and 4-lane collector roads. With the addition of the proposed north-south collector road located mauka of the project site, CY 2034 traffic noise levels along Piilani Highway and with the project are predicted to be similar to CY 2011 (or existing) levels. Predicted increases in project-related traffic noise levels along South Kihei Road by CY 2034 are slightly higher (by 0.1 DNL) than those predicted by CY 2024. Non-project traffic are anticipated to be the cause of traffic noise increases along South Kihei Road between CY 2024 and CY 2034. The addition of the proposed north-south collector road will slightly reduce the predicted increases in CY 2034 traffic noise levels along Lipoa Parkway and Lipoa Street mauka of Liloa Drive. A relatively large increase (4.9 DNL) in project related traffic noise levels along East Welakahao Street east of Piilani Highway is anticipated by CY 2034.

# TABLE 6-1

## FUTURE (CY 2024) TRAFFIC VOLUMES AND NOISE LEVELS ALONG ROADWAYS IN PROJECT AREA (AM OR PM PEAK HOUR, BUILD)

| LOCATION | SPEED (MPH) | TOTAL VPH | ****** VOLUMES (VPH) ******** AUTOS | M TRUCKS | H TRUCKS | 50' Leq | 100' Leq | 200' Leq |
|---|---|---|---|---|---|---|---|---|
| Piilani Hwy., N. of E. Waipulani Rd. (AM) | 55 | 4,233 | 4,165 | 47 | 21 | 76.3 | 71.5 | 65.7 |
| Piilani Hwy., Between E. Waipulani Rd. & Piikea Ave. (AM) | 55 | 4,074 | 4,009 | 45 | 20 | 76.2 | 71.3 | 65.5 |
| Piilani Hwy., Between Piikea Ave. & E. Lipoa St. (AM) | 55 | 3,683 | 3,628 | 37 | 18 | 75.7 | 70.9 | 65.1 |
| Piilani Hwy., Between E. Lipoa St. & Welakahao Rd. (AM) | 55 | 2,746 | 2,705 | 27 | 14 | 74.4 | 69.6 | 63.8 |
| Piilani Hwy., Between Welakahao Rd. & E. Welakahao St. (AM) | 55 | 2,594 | 2,529 | 26 | 39 | 74.5 | 69.7 | 64.0 |
| Piilani Hwy., S. of E. Welakahao St. (AM) | 55 | 2,550 | 2,511 | 26 | 13 | 74.1 | 69.3 | 63.5 |
| S. Kihei Rd., N. of Piikea Ave. (PM) | 40 | 1,348 | 1,313 | 22 | 13 | 67.1 | 61.3 | 55.3 |
| S. Kihei Rd., Between Piikea Ave. & E. Lipoa St. (PM) | 40 | 1,555 | 1,514 | 25 | 16 | 67.7 | 61.9 | 56.0 |
| S. Kihei Rd., S. of E. Lipoa St. (PM) | 38 | 1,702 | 1,666 | 27 | 9 | 67.2 | 61.4 | 55.4 |
| S. Kihei Rd., N. of Welakahao Rd. (PM) | 38 | 1,657 | 1,622 | 27 | 8 | 67.1 | 61.3 | 55.3 |
| S. Kihei Rd., S. of Welakahao Rd. (PM) | 38 | 1,701 | 1,665 | 27 | 9 | 67.2 | 61.4 | 55.4 |
| Hookena St., E. of Piilani Hwy. (AM) | 35 | 150 | 148 | 2 | 0 | 55.2 | 49.7 | 43.5 |
| E. Waipulani Rd., W. of Piilani Hwy. (PM) | 30 | 140 | 138 | 2 | 0 | 53.0 | 46.8 | 41.8 |
| Piikea Ave., Between Piilani Hwy. & Liloa St. (PM) | 30 | 1,134 | 1,118 | 15 | 1 | 62.7 | 56.4 | 51.2 |
| Piikea Ave., Between Liloa St. & S. Kihei Rd. (PM) | 30 | 701 | 691 | 9 | 1 | 60.1 | 54.7 | 48.7 |
| Lipoa Pkwy., E. of Piilani Hwy. (PM) | 35 | 1,300 | 1,282 | 17 | 1 | 66.4 | 60.9 | 54.8 |
| E. Lipoa St., Between Piilani Hwy. & Liloa Dr. (AM) | 25 | 1,178 | 1,151 | 15 | 12 | 61.4 | 55.7 | 51.1 |
| E. Lipoa St., Between Liloa Dr. & S. Kihei Rd. (PM) | 30 | 634 | 620 | 8 | 6 | 60.2 | 54.1 | 48.6 |
| Welakahao Rd., W. of Piilani Hwy. (PM) | 30 | 510 | 502 | 7 | 1 | 58.8 | 53.4 | 47.5 |
| Welakahao Rd., E. of S. Kihei Rd. (PM) | 30 | 308 | 304 | 4 | 0 | 56.5 | 51.0 | 45.0 |
| E. Welakahao St., E. of Piilani Hwy. (AM) | 30 | 67 | 66 | 1 | 0 | 49.7 | 43.4 | 37.5 |

## TABLE 6-2

## FUTURE (CY 2034) TRAFFIC VOLUMES AND NOISE LEVELS ALONG ROADWAYS IN PROJECT AREA WITH 2-LANE COLLECTOR (AM OR PM PEAK HOUR, BUILD)

| LOCATION | SPEED (MPH) | TOTAL VPH | ****** VOLUMES (VPH) ******** AUTOS | M TRUCKS | H TRUCKS | 50' Leq | 100' Leq | 200' Leq |
|---|---|---|---|---|---|---|---|---|
| Piilani Hwy., N. of E. Waipulani Rd. (AM) | 55 | 3,371 | 3,317 | 37 | 17 | 75.4 | 70.5 | 64.7 |
| Piilani Hwy., Between E. Waipulani Rd. & Piikea Ave. (AM) | 55 | 3,380 | 3,326 | 37 | 17 | 75.4 | 70.5 | 64.7 |
| Piilani Hwy., Between Piikea Ave. & E. Lipoa St. (AM) | 55 | 3,193 | 3,145 | 32 | 16 | 75.1 | 70.2 | 64.5 |
| Piilani Hwy., Between E. Lipoa St. & Welakahao Rd. (AM) | 55 | 2,333 | 2,298 | 23 | 12 | 73.7 | 68.9 | 63.1 |
| Piilani Hwy., Between Welakahao Rd. & E. Welakahao St. (AM) | 55 | 2,238 | 2,182 | 22 | 34 | 73.9 | 69.0 | 63.3 |
| Piilani Hwy., S. of E. Welakahao St. (AM) | 55 | 2,096 | 2,065 | 21 | 10 | 73.3 | 68.4 | 62.6 |
| S. Kihei Rd., N. of Piikea Ave. (PM) | 40 | 1,512 | 1,473 | 24 | 15 | 67.6 | 61.8 | 55.8 |
| S. Kihei Rd., Between Piikea Ave. & E. Lipoa St. (PM) | 40 | 1,737 | 1,692 | 28 | 17 | 68.2 | 62.4 | 56.4 |
| S. Kihei Rd., S. of E. Lipoa St. (PM) | 38 | 1,899 | 1,860 | 30 | 9 | 67.7 | 61.9 | 55.8 |
| S. Kihei Rd., N. of Welakahao Rd. (PM) | 38 | 1,862 | 1,823 | 30 | 9 | 67.6 | 61.8 | 55.8 |
| S. Kihei Rd., S. of Welakahao Rd. (PM) | 38 | 1,906 | 1,866 | 30 | 10 | 67.7 | 61.9 | 55.9 |
| Hookena St., E. of Piilani Hwy. (PM) | 35 | 153 | 151 | 2 | 0 | 55.3 | 49.8 | 43.6 |
| E. Waipulani Rd., W. of Piilani Hwy. (PM) | 30 | 140 | 138 | 2 | 0 | 53.0 | 46.8 | 41.8 |
| Piikea Ave., Between Piilani Hwy. & Liloa St. (PM) | 30 | 1,275 | 1,257 | 17 | 1 | 63.3 | 56.9 | 51.6 |
| Piikea Ave., Between Liloa St. & S. Kihei Rd. (PM) | 30 | 701 | 691 | 9 | 1 | 60.1 | 54.7 | 48.7 |
| Lipoa Pkwy., E. of Piilani Hwy. (PM) | 35 | 769 | 758 | 10 | 1 | 64.2 | 58.7 | 52.6 |
| E. Lipoa St., Between Piilani Hwy. & Liloa Dr. (AM) | 25 | 1,154 | 1,127 | 15 | 12 | 61.4 | 55.6 | 51.1 |
| E. Lipoa St., Between Liloa Dr. & S. Kihei Rd. (PM) | 30 | 648 | 634 | 8 | 6 | 60.3 | 54.2 | 48.7 |
| Welakahao Rd., W. of Piilani Hwy. (PM) | 30 | 576 | 568 | 7 | 1 | 59.3 | 53.9 | 47.9 |
| Welakahao Rd., E. of S. Kihei Rd. (PM) | 30 | 308 | 304 | 4 | 0 | 56.5 | 51.0 | 45.0 |
| E. Welakahao St., E. of Piilani Hwy. (AM) | 30 | 213 | 210 | 3 | 0 | 54.8 | 48.4 | 42.5 |
| 2-Lane Mauka Collector N. of Project (AM) | 55 | 1,231 | 1,213 | 12 | 6 | 70.5 | 64.7 | 58.2 |
| 2-Lane Mauka Collector S. of Project (AM) | 55 | 854 | 841 | 9 | 4 | 68.9 | 63.2 | 56.7 |

## TABLE 6-3

## FUTURE (CY 2034) TRAFFIC VOLUMES AND NOISE LEVELS ALONG ROADWAYS IN PROJECT AREA WITH 4-LANE COLLECTOR (AM OR PM PEAK HOUR, BUILD)

| LOCATION | SPEED (MPH) | TOTAL VPH | ****** VOLUMES (VPH) ******** AUTOS | M TRUCKS | H TRUCKS | 50' Leq | 100' Leq | 200' Leq |
|---|---|---|---|---|---|---|---|---|
| Piilani Hwy., N. of E. Waipulani Rd. (AM) | 55 | 3,371 | 3,317 | 37 | 17 | 75.4 | 70.5 | 64.7 |
| Piilani Hwy., Between E. Waipulani Rd. & Piikea Ave. (AM) | 55 | 3,380 | 3,326 | 37 | 17 | 75.4 | 70.5 | 64.7 |
| Piilani Hwy., Between Piikea Ave. & E. Lipoa St. (AM) | 55 | 3,193 | 3,145 | 32 | 16 | 75.1 | 70.2 | 64.5 |
| Piilani Hwy., Between E. Lipoa St. & Welakahao Rd. (AM) | 55 | 2,333 | 2,298 | 23 | 12 | 73.7 | 68.9 | 63.1 |
| Piilani Hwy., Between Welakahao Rd. & E. Welakahao St. (AM) | 55 | 2,238 | 2,182 | 22 | 34 | 73.9 | 69.0 | 63.3 |
| Piilani Hwy., S. of E. Welakahao St. (AM) | 55 | 2,096 | 2,065 | 21 | 10 | 73.3 | 68.4 | 62.6 |
| S. Kihei Rd., N. of Piikea Ave. (PM) | 40 | 1,513 | 1,474 | 24 | 15 | 67.6 | 61.8 | 55.8 |
| S. Kihei Rd., Between Piikea Ave. & E. Lipoa St. (PM) | 40 | 1,739 | 1,694 | 28 | 17 | 68.2 | 62.4 | 56.4 |
| S. Kihei Rd., S. of E. Lipoa St. (PM) | 38 | 1,901 | 1,861 | 30 | 10 | 67.7 | 61.9 | 55.9 |
| S. Kihei Rd., N. of Welakahao Rd. (PM) | 38 | 1,864 | 1,825 | 30 | 9 | 67.6 | 61.8 | 55.8 |
| S. Kihei Rd., S. of Welakahao Rd. (PM) | 38 | 1,908 | 1,867 | 31 | 10 | 67.7 | 61.9 | 55.9 |
| Hookena St., E. of Piilani Hwy. (PM) | 35 | 153 | 151 | 2 | 0 | 55.3 | 49.8 | 43.6 |
| E. Waipulani Rd., W. of Piilani Hwy. (PM) | 30 | 140 | 138 | 2 | 0 | 53.0 | 46.8 | 41.8 |
| Piikea Ave., Between Piilani Hwy. & Liloa St. (PM) | 30 | 1,275 | 1,257 | 17 | 1 | 63.3 | 56.9 | 51.6 |
| Piikea Ave., Between Liloa St. & S. Kihei Rd. (PM) | 30 | 701 | 691 | 9 | 1 | 60.1 | 54.7 | 48.7 |
| Lipoa Pkwy., E. of Piilani Hwy. (PM) | 35 | 839 | 827 | 11 | 1 | 64.6 | 59.0 | 52.9 |
| E. Lipoa St., Between Piilani Hwy. & Liloa Dr. (AM) | 25 | 1,225 | 1,197 | 16 | 12 | 61.6 | 55.8 | 51.2 |
| E. Lipoa St., Between Liloa Dr. & S. Kihei Rd. (PM) | 30 | 655 | 639 | 9 | 7 | 60.5 | 54.4 | 49.0 |
| Welakahao Rd., W. of Piilani Hwy. (PM) | 30 | 581 | 572 | 8 | 1 | 59.4 | 53.9 | 48.0 |
| Welakahao Rd., E. of S. Kihei Rd. (PM) | 30 | 308 | 304 | 4 | 0 | 56.5 | 51.0 | 45.0 |
| E. Welakahao St., E. of Piilani Hwy. (AM) | 30 | 213 | 210 | 3 | 0 | 54.8 | 48.4 | 42.5 |
| 4-Lane Mauka Collector N. of Project (AM) | 55 | 1,368 | 1,347 | 14 | 7 | 71.5 | 66.5 | 60.9 |
| 4-Lane Mauka Collector S. of Project (AM) | 55 | 886 | 873 | 9 | 4 | 69.6 | 64.6 | 59.0 |

## TABLE 7

## CY 2034 DISTANCES TO 65 AND 75 DNL CONTOURS WITH 2- OR 4-LANE COLLECTOR

| STREET SECTION | 65 DNL SETBACK (FT) | | 75 DNL SETBACK (FT) | |
|---|---|---|---|---|
| | 2-LANE COL. | 4-LANE COL. | 2-LANE COL. | 4-LANE COL. |
| Piilani Hwy., N. of E. Waipulani Rd. | 193 | 193 | 53 | 53 |
| Piilani Hwy., Between E. Waipulani Rd. & Piikea Ave. | 193 | 193 | 53 | 53 |
| Piilani Hwy., Between Piikea Ave. & E. Lipoa St. | 188 | 188 | 51 | 51 |
| Piilani Hwy., Between E. Lipoa St. & Welakahao Rd. | 159 | 159 | 41 | 41 |
| Piilani Hwy., Between Welakahao Rd. & E. Welakahao St. | 163 | 163 | 43 | 43 |
| Piilani Hwy., S. of E. Welakahao St. | 150 | 150 | 39 | 39 |
| S. Kihei Rd., N. of Piikea Ave. | 68 | 68 | 21 | 21 |
| S. Kihei Rd., Between Piikea Ave. & E. Lipoa St. | 73 | 73 | 22 | 22 |
| S. Kihei Rd., S. of E. Lipoa St. | 69 | 69 | 21 | 21 |
| S. Kihei Rd., N. of Welakahao Rd. | 68 | 68 | 21 | 21 |
| S. Kihei Rd., S. of Welakahao Rd. | 69 | 69 | 21 | 21 |
| Hookena St., E. of Piilani Hwy. | 15 | 15 | < 12 | < 12 |
| E. Waipulani Rd., W. of Piilani Hwy. | 13 | 13 | < 12 | < 12 |
| Piikea Ave., Between Piilani Hwy. & Liloa St. | 42 | 42 | 14 | 14 |
| Piikea Ave., Between Liloa St. & S. Kihei Rd. | 27 | 27 | < 12 | < 12 |
| Lipoa Pkwy., E. of Piilani Hwy. | 45 | 48 | 13 | 14 |
| E. Lipoa St., Between Piilani Hwy. & Liloa Dr. | 33 | 33 | < 12 | < 12 |
| E. Lipoa St., Between Liloa Dr. & S. Kihei Rd. | 29 | 30 | < 12 | < 12 |
| Welakahao Rd., W. of Piilani Hwy. | 24 | 25 | < 12 | < 12 |
| Welakahao Rd., E. of S. Kihei Rd. | 17 | 17 | < 12 | < 12 |
| E. Welakahao St., E. of Piilani Hwy. | 17 | 17 | < 12 | < 12 |
| 2-Lane Mauka Collector N. of Project | 96 | N/A | 29 | N/A |
| 2-Lane Mauka Collector S. of Project | 80 | N/A | 24 | N/A |
| 4-Lane Mauka Collector N. of Project | N/A | 120 | N/A | 31 |
| 4-Lane Mauka Collector S. of Project | N/A | 95 | N/A | 24 |

# TABLE 8

## CALCULATIONS OF PROJECT AND NON-PROJECT TRAFFIC NOISE CONTRIBUTIONS ( CY 2024 ) ( DNL )

| STREET SECTION | NOISE LEVEL INCREASE DUE TO: NON-PROJECT TRAFFIC | PROJECT TRAFFIC |
|---|---|---|
| Piilani Hwy., N. of E. Waipulani Rd. | 0.1 | 1.1 |
| Piilani Hwy., Between E. Waipulani Rd. & Piikea Ave. | 0.2 | 0.9 |
| Piilani Hwy., Between Piikea Ave. & E. Lipoa St. | 0.0 | 0.9 |
| Piilani Hwy., Between E. Lipoa St. & Welakahao Rd. | -0.2 | 0.5 |
| Piilani Hwy., Between Welakahao Rd. & E. Welakahao St. | -0.1 | 0.5 |
| Piilani Hwy., S. of E. Welakahao St. | -0.2 | 0.5 |
| S. Kihei Rd., N. of Piikea Ave. | 0.2 | 0.1 |
| S. Kihei Rd., Between Piikea Ave. & E. Lipoa St. | 0.2 | 0.1 |
| S. Kihei Rd., S. of E. Lipoa St. | 0.3 | 0.0 |
| S. Kihei Rd., N. of Welakahao Rd. | 0.3 | 0.1 |
| S. Kihei Rd., S. of Welakahao Rd. | 0.4 | 0.0 |
| E. Waipulani Rd., W. of Piilani Hwy. | 0.0 | 0.0 |
| Piikea Ave., Between Piilani Hwy. & Liloa St. | 0.6 | 0.0 |
| Piikea Ave., Between Liloa St. & S. Kihei Rd. | 0.0 | 0.0 |
| Lipoa Pkwy., E. of Piilani Hwy. | 0.0 | 7.7 |
| E. Lipoa St., Between Piilani Hwy. & Liloa Dr. | 0.5 | 1.4 |
| E. Lipoa St., Between Liloa Dr. & S. Kihei Rd. | 0.0 | 0.1 |
| Welakahao Rd., W. of Piilani Hwy. | 0.0 | 0.0 |
| Welakahao Rd., E. of S. Kihei Rd. | 0.0 | 0.0 |
| E. Welakahao St., E. of Piilani Hwy. | 0.1 | -0.1 |

# TABLE 9-1

## CALCULATIONS OF PROJECT AND NON-PROJECT TRAFFIC NOISE CONTRIBUTIONS ( CY 2034 ) ( DNL WITH 2-LANE COLLECTOR )

| STREET SECTION | NOISE LEVEL INCREASE DUE TO: NON-PROJECT TRAFFIC | PROJECT TRAFFIC |
|---|---|---|
| Piilani Hwy., N. of E. Waipulani Rd. | 0.7 | -0.5 |
| Piilani Hwy., Between E. Waipulani Rd. & Piikea Ave. | 0.8 | -0.5 |
| Piilani Hwy., Between Piikea Ave. & E. Lipoa St. | 0.6 | -0.4 |
| Piilani Hwy., Between E. Lipoa St. & Welakahao Rd. | 0.4 | -0.8 |
| Piilani Hwy., Between Welakahao Rd. & E. Welakahao St. | 0.4 | -0.7 |
| Piilani Hwy., S. of E. Welakahao St. | 0.3 | -0.9 |
| S. Kihei Rd., N. of Piikea Ave. | 0.7 | 0.1 |
| S. Kihei Rd., Between Piikea Ave. & E. Lipoa St. | 0.7 | 0.1 |
| S. Kihei Rd., S. of E. Lipoa St. | 0.7 | 0.1 |
| S. Kihei Rd., N. of Welakahao Rd. | 0.8 | 0.1 |
| S. Kihei Rd., S. of Welakahao Rd. | 0.8 | 0.1 |
| E. Waipulani Rd., W. of Piilani Hwy. | 0.0 | 0.0 |
| Piikea Ave., Between Piilani Hwy. & Liloa St. | 1.0 | 0.1 |
| Piikea Ave., Between Liloa St. & S. Kihei Rd. | 0.0 | 0.0 |
| Lipoa Pkwy., E. of Piilani Hwy. | 0.0 | 5.5 |
| E. Lipoa St., Between Piilani Hwy. & Liloa Dr. | 0.8 | 1.0 |
| E. Lipoa St., Between Liloa Dr. & S. Kihei Rd. | 0.0 | 0.2 |
| Welakahao Rd., W. of Piilani Hwy. | 0.0 | 0.5 |
| Welakahao Rd., E. of S. Kihei Rd. | 0.0 | 0.0 |
| E. Welakahao St., E. of Piilani Hwy. | 0.1 | 4.9 |

# TABLE 9-2

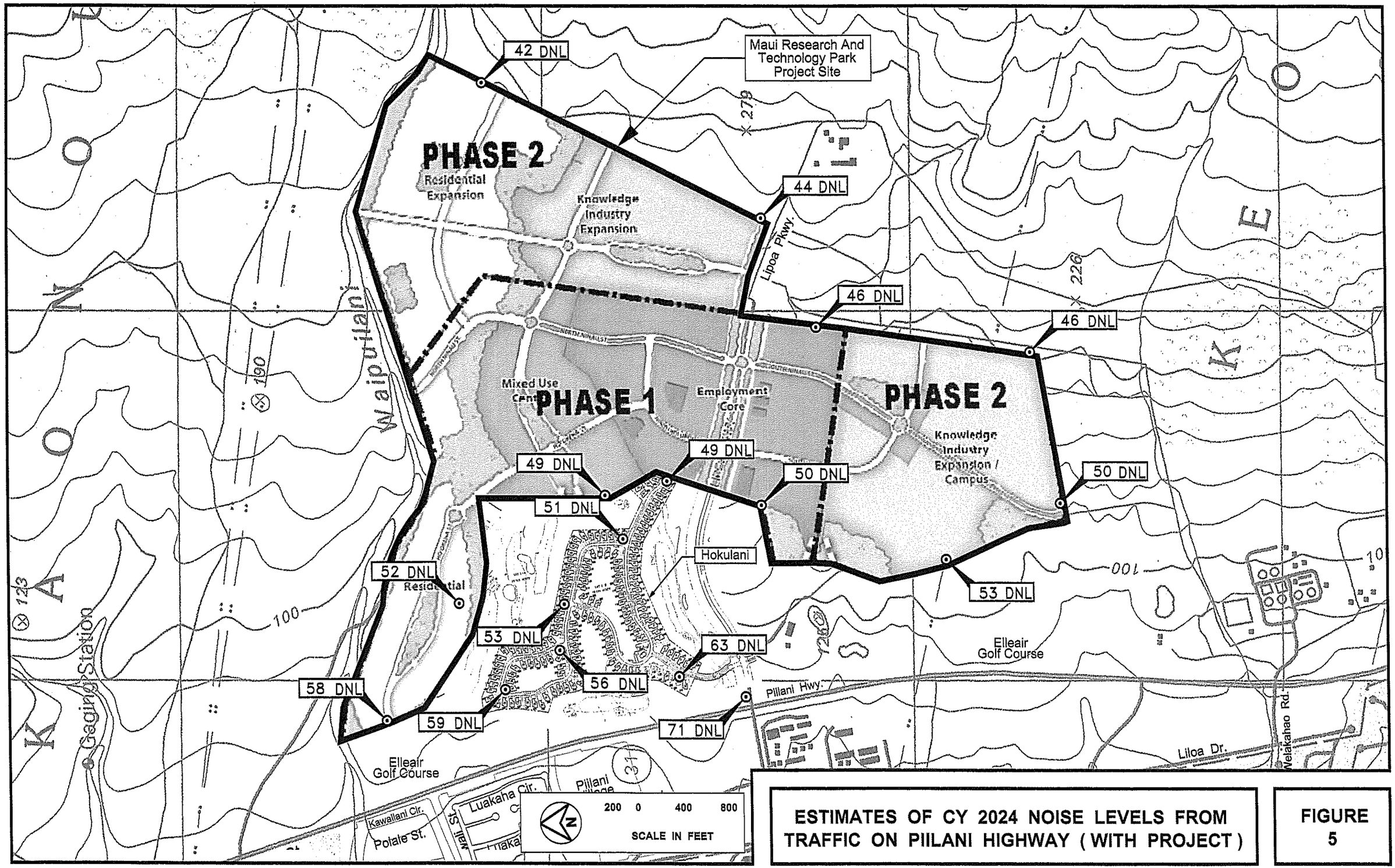
## CALCULATIONS OF PROJECT AND NON-PROJECT TRAFFIC NOISE CONTRIBUTIONS ( CY 2034 ) ( DNL WITH 4-LANE COLLECTOR )

| STREET SECTION | NOISE LEVEL INCREASE DUE TO: NON-PROJECT TRAFFIC | PROJECT TRAFFIC |
|---|---|---|
| Piilani Hwy., N. of E. Waipulani Rd. | 0.7 | -0.5 |
| Piilani Hwy., Between E. Waipulani Rd. & Piikea Ave. | 0.8 | -0.5 |
| Piilani Hwy., Between Piikea Ave. & E. Lipoa St. | 0.6 | -0.4 |
| Piilani Hwy., Between E. Lipoa St. & Welakahao Rd. | 0.4 | -0.8 |
| Piilani Hwy., Between Welakahao Rd. & E. Welakahao St. | 0.4 | -0.7 |
| Piilani Hwy., S. of E. Welakahao St. | 0.3 | -0.9 |
| S. Kihei Rd., N. of Piikea Ave. | 0.7 | 0.1 |
| S. Kihei Rd., Between Piikea Ave. & E. Lipoa St. | 0.7 | 0.1 |
| S. Kihei Rd., S. of E. Lipoa St. | 0.7 | 0.1 |
| S. Kihei Rd., N. of Welakahao Rd. | 0.8 | 0.1 |
| S. Kihei Rd., S. of Welakahao Rd. | 0.8 | 0.1 |
| E. Waipulani Rd., W. of Piilani Hwy. | 0.0 | 0.0 |
| Piikea Ave., Between Piilani Hwy. & Liloa St. | 1.0 | 0.1 |
| Piikea Ave., Between Liloa St. & S. Kihei Rd. | 0.0 | 0.0 |
| Lipoa Pkwy., E. of Piilani Hwy. | 0.0 | 5.8 |
| E. Lipoa St., Between Piilani Hwy. & Liloa Dr. | 0.8 | 1.2 |
| E. Lipoa St., Between Liloa Dr. & S. Kihei Rd. | 0.0 | 0.4 |
| Welakahao Rd., W. of Piilani Hwy. | 0.0 | 0.5 |
| Welakahao Rd., E. of S. Kihei Rd. | 0.0 | 0.0 |
| E. Welakahao St., E. of Piilani Hwy. | 0.1 | 4.9 |

The dominant traffic noise sources in the project environs will continue to be traffic along Piilani Highway and South Kihei Road. Also, the addition of the proposed north-south collector road mauka of the project will increase the existing background ambient noise levels at the mauka end of the project site and along the proposed corridors of the collector road and connecting roadways. The predicted traffic noise levels at 50, 100, and 200 feet setback distances from the 2-lane and 4-lane collector roads are shown in Tables 6-2 and 6-3 under the Build Alternative. The predicted setback distances to the 65 and 75 DNL contours from the centerlines of the collector road for the 2-lane and 4-lane alternatives are shown in Table 7, but need to be refined following finalization of the cross sections of the collector road.

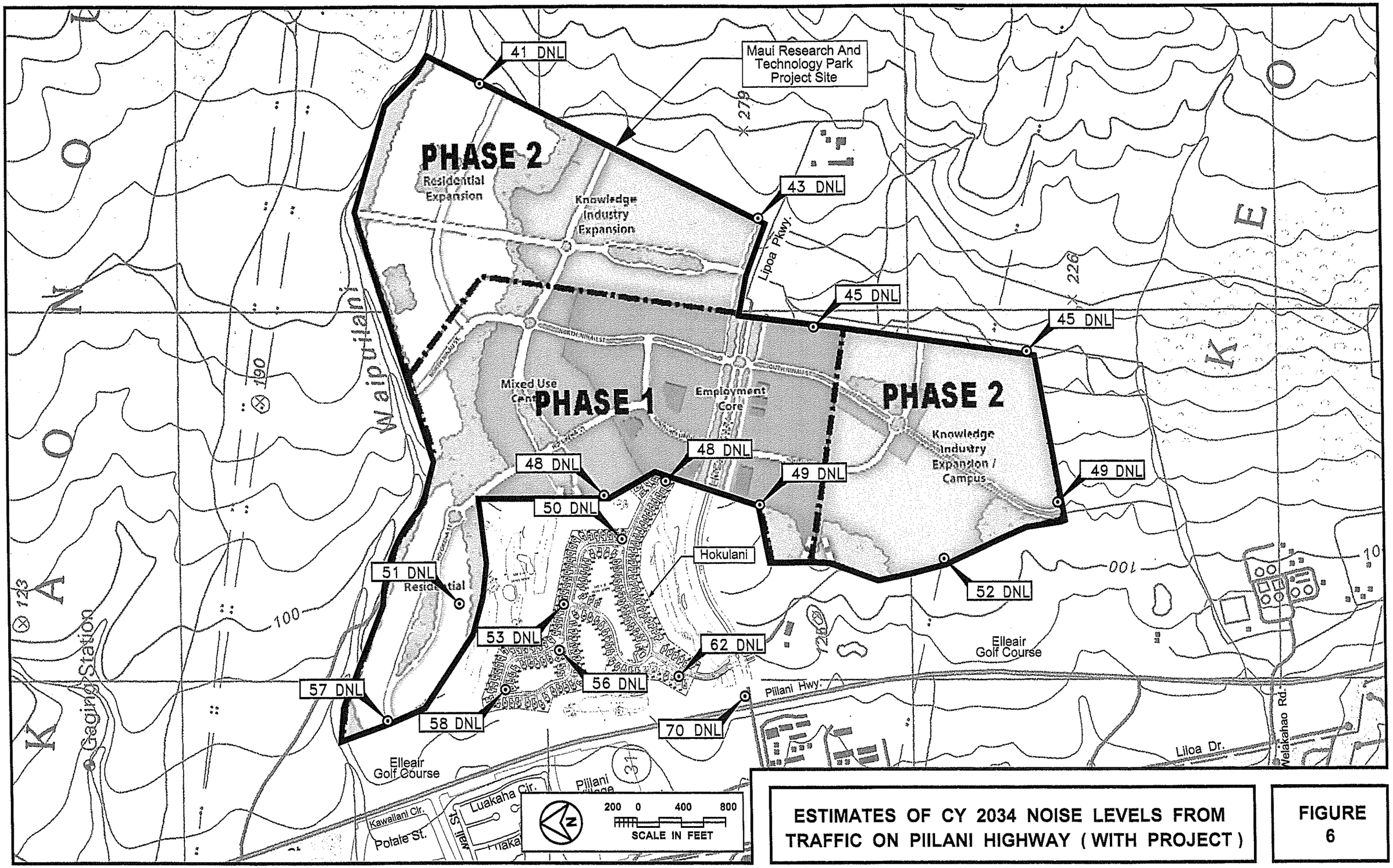
Figures 5 and 6 depict the predicted traffic noise contributions from Piilani Highway in CY 2024 and CY 2034 under the Build Alternative, but do not include the traffic noise contributions from the proposed north-south collector road. The traffic noise levels shown in Figures 5 and 6 will probably increase from the values shown, particularly at the locations near the mauka side of the project (which will be closer to the proposed north-south collector road).

From Figures 5 and 6, future noise levels on the project site from traffic on Piilani Highway are estimated to range from 49 to 58 DNL at the westernmost (makai) corners of the project site to 41 to 46 DNL at the easternmost (mauka) corners of the project site. Because predicted future traffic noise levels from Piilani Highway are very low at the mauka side of the project site, it is expected that traffic noise from the proposed collector road will be the dominant noise source on that side of the project site. Approximately 300 to 415 feet of buffer space between the collector road and the project site will be required to reduce the collector road noise component to approximately 55 DNL.




**ESTIMATES OF CY 2024 NOISE LEVELS FROM TRAFFIC ON PIILANI HIGHWAY ( WITH PROJECT )**

**FIGURE 5**




**ESTIMATES OF CY 2034 NOISE LEVELS FROM TRAFFIC ON PIILANI HIGHWAY ( WITH PROJECT )**

**FIGURE 6**

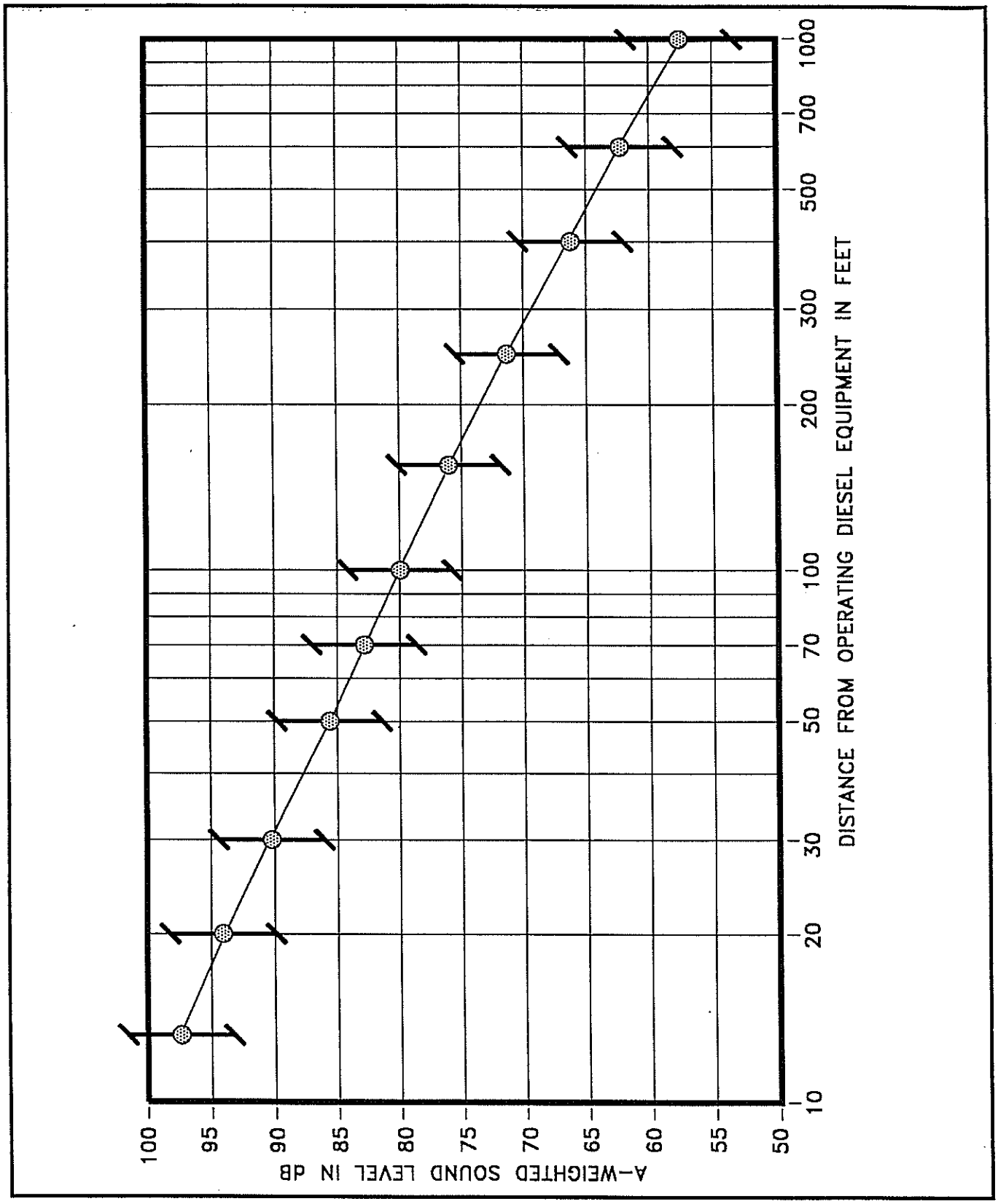
## CHAPTER VII. DISCUSSION OF PROJECT-RELATED NOISE IMPACTS AND POSSIBLE MITIGATION MEASURES

Traffic Noise. Existing traffic noise levels along Piilani Highway and South Kihei Road are very high, and are expected to remain so through CY 2024 and 2034. Traffic noise impacts along those two roadways will continue to occur at noise sensitive receptors which are not provided with noise mitigation measures such as sound attenuating walls and/or closure and air conditioning.

Project related traffic along Piilani Highway and South Kihei Road are not expected to cause significant increases in future traffic noise levels. Increases in future traffic noise levels along Piilani Highway resulting from project traffic are expected to range from 0.3 to 1.0 DNL by CY 2024. By 2034, with the completion of the mauka collector road, these increases will be eliminated, and traffic noise levels along Piilani Highway is expected to return to CY 2011 levels. The largest increases (1.2 to 7.7 DNL) in project related traffic noise are predicted to occur along Lipoa Parkway, East Welakahao Street east of Piilani Highway, and along Lipoa Street west of Piilani Highway. Adverse traffic noise impacts along Lipoa Parkway and East Welakahao Street are not expected to occur since noise sensitive developments are not planned to be located along those two roadways. The noise sensitive buildings along Lipoa Street west of Piilani Highway have adequate setback distances from Lipoa Street, such that predicted CY 2024 and CY 2034 traffic noise levels should remain in the "Moderate Exposure, Normally Acceptable" category at these buildings. For these reasons, traffic noise mitigation measures should not be required.

General 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 exterior noise from construction activity (excluding pile driving activity) at various distances from the job site are shown in Figure 7. The impulsive noise levels of impact pile drivers are approximately 15 dB higher than the levels shown in Figure 7, while the intermittent noise levels of vibratory pile drivers are at the upper end of the noise level ranges depicted in the figure.

Figure 7 is useful for predicting exterior noise levels at short distances (within 100 FT) from the work when visual line of sight exists between the construction equipment and the receptor. Direct line-of-sight distances from the construction equipment to existing residential buildings will range from 50 FT to 4,200 FT, with corresponding average noise levels of 86 to 46 dBA (plus or minus 5 dBA). Typical levels of construction noise inside naturally ventilated and air conditioned structures are approximately 10 and 20 dB less, respectively, than the levels shown in Figure 7.




**ANTICIPATED RANGE OF CONSTRUCTION NOISE LEVELS VS. DISTANCE**

**FIGURE 7**

The existing residences at the east end of the Hokulani development (at Location H7) are the closest existing residences to the potential construction activities within the project site. The highest noise levels from construction activities of 75 to 85 dBA are expected to occur during earthwork and site preparation activities near the mauka end of the Hokulani development. The noise from construction activities on the project site will be audible at long distances from the Hokulani residences due to the relatively low (40 to 55 dBA) background noise levels within the Hokulani development.

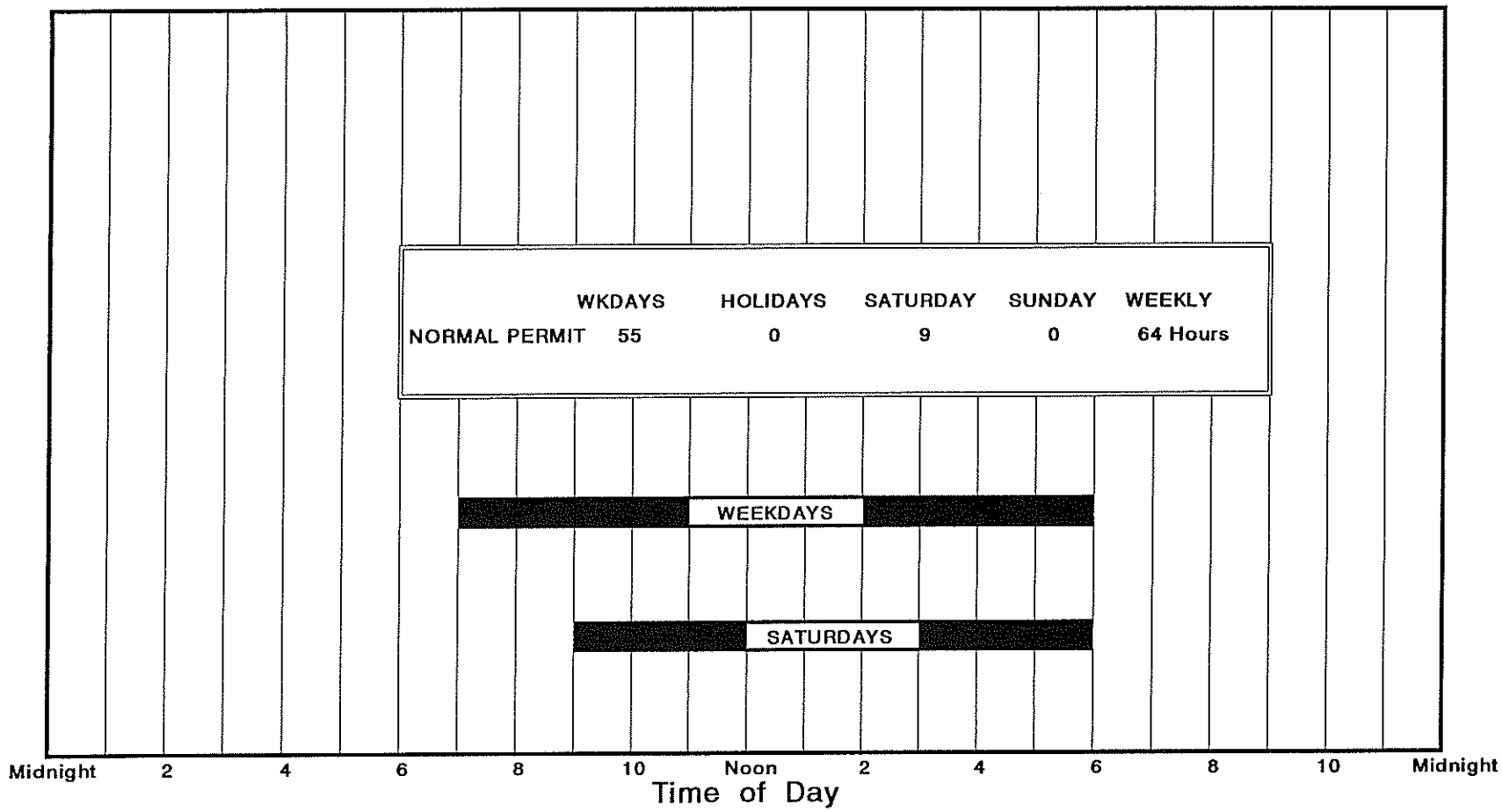
The existing residences across Piilani Highway west of the project site may also hear the construction activities within the project site. The highest noise levels from construction activities of 60 to 65 dBA are expected to occur at these residences during earthwork and site preparation activities at the northwest corner of the project site. The noise from construction activities will decrease and be masked by traffic noise along Piilani Highway at these residences along Piilani Highway as project construction activities move toward the east end of the project site. Adverse impacts from construction noise are not expected to be in the "public health and welfare" category due to the temporary nature of the work, and due to the administrative controls available for regulation of construction noise. Instead, these impacts will probably be limited to the temporary degradation of the quality of the acoustic environment in the immediate vicinity of the project site.

Mitigation of construction noise to inaudible levels will not be practical in all cases due to the intensity of construction noise sources (80 dBA at 100 FT distance), and due to the exterior nature of the work (rock breaking, grading and earth moving, trenching, concrete pouring, hammering, etc.). The use of properly muffled construction equipment should be required on the job site.

Peak airborne noise levels from pile diving may be as much as 15 dBA greater than noise levels shown in Figure 7 for non-impulsive (steady) construction noise sources. Although the pile driving can produce more intense noise levels, each pulse is of short individual duration (less than one second). Therefore, its impact on speech communication is not as severe as that of a steady source of the same noise level.

Severe noise impacts are not expected to occur inside air conditioned structures which are beyond 200 FT from the project construction site. Inside naturally ventilated structures, interior noise levels (with windows or doors opened) are estimated to range between 65 to 53 dBA at 200 FT to 600 FT distances from the construction site. Closure of all doors and windows facing the construction site would generally reduce interior noise levels by an additional 5 to 10 dBA.

The incorporation of State Department of Health construction noise limits and curfew times, which are applicable throughout the State of Hawaii (Reference 5), is another noise mitigation measure which is normally applied to construction activities. Figure 8 depicts the normally permitted hours of construction. Noisy construction activities are not allowed on Sundays and holidays, during the early morning, and during the late evening and nighttime periods under the DOH permit procedures.




AVAILABLE WORK HOURS UNDER DOH PERMIT PROCEDURES FOR CONSTRUCTION NOISE

FIGURE 8

## 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) "Traffic Impact Analysis; Maui Research and Technology Park;" Parsons Brinckerhoff, Inc.; February 2012.

(8) Hourly Traffic Counts At Station B74003100000, Piilani Highway - Mokulele Highway To Lipoa Street; Hawaii State Department of Transportation; April 21, 2009.

# 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).

## 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,

## 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 C1

## SUMMARY OF BASE YEAR AND YEAR 2024 TRAFFIC VOLUMES

| ROADWAY LANES | **** CY 2011 ***** AM VPH | PM VPH | CY 2024 (NO BUILD) AM VPH | PM VPH | CY 2024 (BUILD) AM VPH | PM VPH |
|---|---|---|---|---|---|---|
| Piilani Hwy., N. of E. Waipulani (NB) | 1,306 | 1,627 | 1,442 | 1,676 | 1,828 | 2,131 |
| Piilani Hwy., N. of E. Waipulani (SB) | 1,767 | 1,606 | 1,990 | 1,661 | 2,405 | 1,830 |
| Two-Way | 3,073 | 3,233 | 3,432 | 3,337 | 4,233 | 3,961 |
| Piilani Hwy., Between E. Waipulani & Piikea (NB) | 1,322 | 1,670 | 1,481 | 1,729 | 1,722 | 1,997 |
| Piilani Hwy., Between E. Waipulani & Piikea (SB) | 1,713 | 1,504 | 1,938 | 1,564 | 2,353 | 1,733 |
| Two-Way | 3,035 | 3,174 | 3,419 | 3,293 | 4,074 | 3,730 |
| Piilani Hwy., Between Piikea & E. Lipoa (NB) | 1,184 | 1,579 | 1,330 | 1,593 | 1,495 | 1,788 |
| Piilani Hwy., Between Piikea & E. Lipoa (SB) | 1,539 | 1,414 | 1,773 | 1,386 | 2,188 | 1,555 |
| Two-Way | 2,723 | 2,993 | 3,103 | 2,979 | 3,683 | 3,343 |
| Piilani Hwy., Between E. Lipoa & Welakahao (NB) | 1,070 | 1,403 | 1,175 | 1,353 | 1,235 | 1,377 |
| Piilani Hwy., Between E. Lipoa & Welakahao (SB) | 1,166 | 1,192 | 1,378 | 1,055 | 1,511 | 1,212 |
| Two-Way | 2,236 | 2,595 | 2,553 | 2,407 | 2,746 | 2,588 |
| Piilani Hwy., Between Welakahao & E. Welakahao (NB) | 985 | 1,377 | 1,082 | 1,323 | 1,142 | 1,347 |
| Piilani Hwy., Between Welakahao & E. Welakahao (SB) | 1,116 | 1,029 | 1,319 | 895 | 1,452 | 1,052 |
| Two-Way | 2,101 | 2,406 | 2,401 | 2,217 | 2,594 | 2,398 |
| Piilani Hwy., S. of E. Welakahao (NB) | 965 | 1,353 | 1,063 | 1,308 | 1,123 | 1,332 |
| Piilani Hwy., S. of E. Welakahao (SB) | 1,089 | 1,024 | 1,294 | 895 | 1,427 | 1,052 |
| Two-Way | 2,054 | 2,377 | 2,357 | 2,203 | 2,550 | 2,384 |
| S. Kihei Rd., N. of Piikea (NB) | 467 | 675 | 523 | 719 | 534 | 731 |
| S. Kihei Rd., N. of Piikea (SB) | 503 | 576 | 550 | 610 | 567 | 617 |
| Two-Way | 970 | 1,251 | 1,073 | 1,329 | 1,101 | 1,348 |
| S. Kihei Rd., Between Piikea & E. Lipoa (NB) | 494 | 733 | 545 | 773 | 556 | 785 |
| S. Kihei Rd., Between Piikea & E. Lipoa (SB) | 449 | 720 | 500 | 763 | 517 | 770 |
| Two-Way | 942 | 1,453 | 1,045 | 1,536 | 1,073 | 1,555 |
| S. Kihei Rd., S. of E. Lipoa (NB) | 466 | 747 | 513 | 783 | 526 | 788 |
| S. Kihei Rd., S. of E. Lipoa (SB) | 416 | 847 | 471 | 908 | 475 | 914 |
| Two-Way | 882 | 1,594 | 984 | 1,691 | 1,001 | 1,702 |
| S. Kihei Rd., N. of Welakahao (NB) | 503 | 750 | 565 | 811 | 578 | 816 |
| S. Kihei Rd., N. of Welakahao (SB) | 412 | 768 | 485 | 835 | 490 | 841 |
| Two-Way | 915 | 1,518 | 1,050 | 1,646 | 1,068 | 1,657 |

## APPENDIX C1 (CONTINUED)

## SUMMARY OF BASE YEAR AND YEAR 2024 TRAFFIC VOLUMES

| ROADWAY LANES | **** CY 2011 ***** | | CY 2024 (NO BUILD) | | CY 2024 (BUILD) | |
|---|---|---|---|---|---|---|
| | AM VPH | PM VPH | AM VPH | PM VPH | AM VPH | PM VPH |
| S. Kihei Rd., S. of Welakahao (NB) | 455 | 746 | 517 | 807 | 530 | 812 |
| S. Kihei Rd., S. of Welakahao (SB) | 432 | 816 | 505 | 883 | 510 | 889 |
| Two-Way | 887 | 1,562 | 1,022 | 1,690 | 1,040 | 1,701 |
| Hookena St., E. of Piilani (EB) | N/A | N/A | N/A | N/A | 40 | 16 |
| Hookena St., E. of Piilani (WB) | N/A | N/A | N/A | N/A | 110 | 130 |
| Two-Way | N/A | N/A | N/A | N/A | 150 | 146 |
| E. Waipulani Rd., W. of Piilani (EB) | 30 | 10 | 30 | 10 | 30 | 10 |
| E. Waipulani Rd., W. of Piilani (WB) | 76 | 130 | 76 | 130 | 76 | 130 |
| Two-Way | 106 | 140 | 106 | 140 | 106 | 140 |
| Piikea Ave., Between Piilani & Liloa (EB) | 364 | 464 | 418 | 538 | 418 | 538 |
| Piikea Ave., Between Piilani & Liloa (WB) | 397 | 524 | 452 | 596 | 452 | 596 |
| Two-Way | 760 | 988 | 870 | 1,134 | 870 | 1,134 |
| Piikea Ave., Between Liloa & S. Kihei (EB) | 183 | 288 | 183 | 288 | 183 | 288 |
| Piikea Ave., Between Liloa & S. Kihei (WB) | 224 | 413 | 224 | 413 | 224 | 413 |
| Two-Way | 406 | 701 | 406 | 701 | 407 | 701 |
| Lipoa Pkwy., E. of Piilani (EB) | 179 | 102 | 179 | 102 | 864 | 381 |
| Lipoa Pkwy., E. of Piilani (WB) | 21 | 121 | 21 | 121 | 436 | 610 |
| Two-Way | 200 | 223 | 200 | 223 | 1,300 | 991 |
| E. Lipoa St., Between Piilani & Liloa (EB) | 326 | 319 | 363 | 352 | 573 | 437 |
| E. Lipoa St., Between Piilani & Liloa (WB) | 439 | 359 | 488 | 398 | 605 | 536 |
| Two-Way | 765 | 678 | 851 | 750 | 1,178 | 973 |
| E. Lipoa St., Between Liloa & S. Kihei (EB) | 246 | 283 | 246 | 283 | 276 | 295 |
| E. Lipoa St., Between Liloa & S. Kihei (WB) | 277 | 321 | 277 | 321 | 293 | 340 |
| Two-Way | 523 | 604 | 523 | 604 | 569 | 634 |
| Welakahao Rd., W. of Piilani (EB) | 174 | 189 | 174 | 189 | 174 | 189 |
| Welakahao Rd., W. of Piilani (WB) | 139 | 321 | 139 | 321 | 139 | 321 |
| Two-Way | 313 | 510 | 313 | 510 | 313 | 510 |
| Welakahao Rd., E. of S. Kihei (EB) | 96 | 122 | 96 | 122 | 96 | 122 |
| Welakahao Rd., E. of S. Kihei (WB) | 136 | 186 | 136 | 186 | 136 | 186 |
| Two-Way | 232 | 308 | 232 | 308 | 232 | 308 |
| E. Welakahao St., E. of Piilani (EB) | 37 | 8 | 37 | 8 | 37 | 8 |
| E. Welakahao St., E. of Piilani (WB) | 30 | 27 | 30 | 27 | 30 | 27 |
| Two-Way | 67 | 35 | 67 | 35 | 67 | 35 |

## APPENDIX C2

## SUMMARY OF BASE YEAR AND YEAR 2034 TRAFFIC VOLUMES (2-LANE MAUKA COLLECTOR)

| ROADWAY LANES | **** CY 2011 ***** AM VPH | PM VPH | CY 2034 (NO BUILD) AM VPH | PM VPH | CY 2034 (BUILD) AM VPH | PM VPH |
|---|---|---|---|---|---|---|
| Piilani Hwy., N. of E. Waipulani (NB) | 1,306 | 1,627 | 1,654 | 1,949 | 1,471 | 1,819 |
| Piilani Hwy., N. of E. Waipulani (SB) | 1,767 | 1,606 | 2,276 | 1,865 | 1,900 | 1,496 |
| Two-Way | 3,073 | 3,233 | 3,930 | 3,814 | 3,371 | 3,315 |
| Piilani Hwy., Between E. Waipulani & Piikea (NB) | 1,322 | 1,670 | 1,696 | 1,990 | 1,470 | 1,773 |
| Piilani Hwy., Between E. Waipulani & Piikea (SB) | 1,713 | 1,504 | 2,225 | 1,773 | 1,910 | 1,464 |
| Two-Way | 3,035 | 3,174 | 3,921 | 3,763 | 3,380 | 3,237 |
| Piilani Hwy., Between Piikea & E. Lipoa (NB) | 1,184 | 1,579 | 1,517 | 1,807 | 1,291 | 1,624 |
| Piilani Hwy., Between Piikea & E. Lipoa (SB) | 1,539 | 1,414 | 2,037 | 1,571 | 1,902 | 1,342 |
| Two-Way | 2,723 | 2,993 | 3,554 | 3,378 | 3,193 | 2,966 |
| Piilani Hwy., Between E. Lipoa & Welakahao (NB) | 1,070 | 1,403 | 1,327 | 1,521 | 1,075 | 1,246 |
| Piilani Hwy., Between E. Lipoa & Welakahao (SB) | 1,166 | 1,192 | 1,571 | 1,142 | 1,258 | 987 |
| Two-Way | 2,236 | 2,595 | 2,898 | 2,662 | 2,333 | 2,233 |
| Piilani Hwy., Between Welakahao & E. Welakahao (NB) | 985 | 1,377 | 1,227 | 1,487 | 975 | 1,287 |
| Piilani Hwy., Between Welakahao & E. Welakahao (SB) | 1,116 | 1,029 | 1,485 | 927 | 1,263 | 761 |
| Two-Way | 2,101 | 2,406 | 2,712 | 2,414 | 2,238 | 2,048 |
| Piilani Hwy., S. of E. Welakahao (NB) | 965 | 1,353 | 1,209 | 1,480 | 963 | 1,234 |
| Piilani Hwy., S. of E. Welakahao (SB) | 1,089 | 1,024 | 1,463 | 932 | 1,133 | 770 |
| Two-Way | 2,054 | 2,377 | 2,672 | 2,412 | 2,096 | 2,004 |
| S. Kihei Rd., N. of Piikea (NB) | 467 | 675 | 586 | 804 | 597 | 822 |
| S. Kihei Rd., N. of Piikea (SB) | 503 | 576 | 614 | 679 | 652 | 690 |
| Two-Way | 970 | 1,251 | 1,200 | 1,483 | 1,249 | 1,512 |
| S. Kihei Rd., Between Piikea & E. Lipoa (NB) | 494 | 733 | 605 | 857 | 616 | 875 |
| S. Kihei Rd., Between Piikea & E. Lipoa (SB) | 449 | 720 | 560 | 851 | 569 | 862 |
| Two-Way | 942 | 1,453 | 1,164 | 1,708 | 1,184 | 1,737 |
| S. Kihei Rd., S. of E. Lipoa (NB) | 466 | 747 | 569 | 866 | 576 | 874 |
| S. Kihei Rd., S. of E. Lipoa (SB) | 416 | 847 | 527 | 1,016 | 532 | 1,025 |
| Two-Way | 882 | 1,594 | 1,096 | 1,882 | 1,108 | 1,899 |
| S. Kihei Rd., N. of Welakahao (NB) | 503 | 750 | 633 | 916 | 640 | 924 |
| S. Kihei Rd., N. of Welakahao (SB) | 412 | 768 | 545 | 929 | 550 | 938 |
| Two-Way | 915 | 1,518 | 1,178 | 1,845 | 1,190 | 1,862 |
| S. Kihei Rd., S. of Welakahao (NB) | 455 | 746 | 585 | 912 | 592 | 920 |
| S. Kihei Rd., S. of Welakahao (SB) | 432 | 816 | 565 | 977 | 570 | 986 |
| Two-Way | 887 | 1,562 | 1,150 | 1,889 | 1,162 | 1,906 |

## APPENDIX C2 (CONTINUED)

## SUMMARY OF BASE YEAR AND YEAR 2034 TRAFFIC VOLUMES (2-LANE MAUKA COLLECTOR)

| ROADWAY LANES | **** CY 2011 ***** | | CY 2034 (NO BUILD) | | CY 2034 (BUILD) | |
|---|---|---|---|---|---|---|
| | AM VPH | PM VPH | AM VPH | PM VPH | AM VPH | PM VPH |
| Hookena St., E. of Piilani (EB) | N/A | N/A | N/A | N/A | 16 | 33 |
| Hookena St., E. of Piilani (WB) | N/A | N/A | N/A | N/A | 59 | 120 |
| Two-Way | N/A | N/A | N/A | N/A | 75 | 153 |
| E. Waipulani Rd., W. of Piilani (EB) | 30 | 10 | 30 | 10 | 30 | 10 |
| E. Waipulani Rd., W. of Piilani (WB) | 76 | 130 | 76 | 130 | 76 | 130 |
| Two-Way | 106 | 140 | 106 | 140 | 106 | 140 |
| Piikea Ave., Between Piilani & Liloa (EB) | 364 | 464 | 465 | 601 | 554 | 601 |
| Piikea Ave., Between Piilani & Liloa (WB) | 397 | 524 | 499 | 657 | 499 | 674 |
| Two-Way | 760 | 988 | 964 | 1,258 | 1,053 | 1,275 |
| Piikea Ave., Between Liloa & S. Kihei (EB) | 183 | 288 | 183 | 288 | 212 | 288 |
| Piikea Ave., Between Liloa & S. Kihei (WB) | 224 | 413 | 224 | 413 | 224 | 413 |
| Two-Way | 406 | 701 | 406 | 701 | 435 | 701 |
| E. Lipoa St., E. of Piilani (EB) | 179 | 102 | 179 | 102 | 547 | 299 |
| E. Lipoa St., E. of Piilani (WB) | 21 | 121 | 21 | 121 | 222 | 443 |
| Two-Way | 200 | 223 | 200 | 223 | 769 | 742 |
| E. Lipoa St., Between Piilani & Liloa (EB) | 326 | 319 | 395 | 380 | 500 | 517 |
| E. Lipoa St., Between Piilani & Liloa (WB) | 439 | 359 | 529 | 431 | 655 | 584 |
| Two-Way | 765 | 678 | 924 | 810 | 1,154 | 1,101 |
| E. Lipoa St., Between Liloa & S. Kihei (EB) | 246 | 283 | 246 | 283 | 262 | 300 |
| E. Lipoa St., Between Liloa & S. Kihei (WB) | 277 | 321 | 277 | 321 | 293 | 348 |
| Two-Way | 523 | 604 | 523 | 604 | 555 | 648 |
| Welakahao Rd., W. of Piilani (EB) | 174 | 189 | 174 | 189 | 263 | 189 |
| Welakahao Rd., W. of Piilani (WB) | 139 | 321 | 139 | 321 | 139 | 387 |
| Two-Way | 313 | 510 | 313 | 510 | 402 | 576 |
| Welakahao Rd., E. of S. Kihei (EB) | 96 | 122 | 96 | 122 | 96 | 122 |
| Welakahao Rd., E. of S. Kihei (WB) | 136 | 186 | 136 | 186 | 136 | 186 |
| Two-Way | 232 | 308 | 232 | 308 | 232 | 308 |
| E. Welakahao St., E. of Piilani (EB) | 37 | 8 | 37 | 8 | 165 | 20 |
| E. Welakahao St., E. of Piilani (WB) | 30 | 27 | 30 | 27 | 48 | 98 |
| Two-Way | 67 | 35 | 67 | 35 | 213 | 118 |
| 2-Lane Mauka Collector N. of Project (NB) | N/A | N/A | N/A | N/A | 485 | 617 |
| 2-Lane Mauka Collector N. of Project (SB) | N/A | N/A | N/A | N/A | 746 | 436 |
| Two-Way | N/A | N/A | N/A | N/A | 1,231 | 1,053 |
| 2-Lane Mauka Collector S. of Project (NB) | N/A | N/A | N/A | N/A | 382 | 395 |
| 2-Lane Mauka Collector S. of Project (SB) | N/A | N/A | N/A | N/A | 472 | 392 |
| Two-Way | N/A | N/A | N/A | N/A | 854 | 787 |

## APPENDIX C3

## SUMMARY OF BASE YEAR AND YEAR 2034 TRAFFIC VOLUMES (4-LANE MAUKA COLLECTOR)

| ROADWAY LANES | **** CY 2011 ***** AM VPH | PM VPH | CY 2034 (NO BUILD) AM VPH | PM VPH | CY 2034 (BUILD) AM VPH | PM VPH |
|---|---|---|---|---|---|---|
| Piilani Hwy., N. of E. Waipulani (NB) | 1,306 | 1,627 | 1,654 | 1,949 | 1,471 | 1,819 |
| Piilani Hwy., N. of E. Waipulani (SB) | 1,767 | 1,606 | 2,276 | 1,865 | 1,900 | 1,496 |
| Two-Way | 3,073 | 3,233 | 3,930 | 3,814 | 3,371 | 3,315 |
| Piilani Hwy., Between E. Waipulani & Piikea (NB) | 1,322 | 1,670 | 1,696 | 1,990 | 1,470 | 1,773 |
| Piilani Hwy., Between E. Waipulani & Piikea (SB) | 1,713 | 1,504 | 2,225 | 1,773 | 1,910 | 1,464 |
| Two-Way | 3,035 | 3,174 | 3,921 | 3,763 | 3,380 | 3,237 |
| Piilani Hwy., Between Piikea & E. Lipoa (NB) | 1,184 | 1,579 | 1,517 | 1,807 | 1,291 | 1,624 |
| Piilani Hwy., Between Piikea & E. Lipoa (SB) | 1,539 | 1,414 | 2,037 | 1,571 | 1,902 | 1,342 |
| Two-Way | 2,723 | 2,993 | 3,554 | 3,378 | 3,193 | 2,966 |
| Piilani Hwy., Between E. Lipoa & Welakahao (NB) | 1,070 | 1,403 | 1,327 | 1,521 | 1,075 | 1,246 |
| Piilani Hwy., Between E. Lipoa & Welakahao (SB) | 1,166 | 1,192 | 1,571 | 1,142 | 1,258 | 987 |
| Two-Way | 2,236 | 2,595 | 2,898 | 2,662 | 2,333 | 2,233 |
| Piilani Hwy., Between Welakahao & E. Welakahao (NB) | 985 | 1,377 | 1,227 | 1,487 | 975 | 1,290 |
| Piilani Hwy., Between Welakahao & E. Welakahao (SB) | 1,116 | 1,029 | 1,485 | 927 | 1,263 | 761 |
| Two-Way | 2,101 | 2,406 | 2,712 | 2,414 | 2,238 | 2,050 |
| Piilani Hwy., S. of E. Welakahao (NB) | 965 | 1,353 | 1,209 | 1,480 | 963 | 1,234 |
| Piilani Hwy., S. of E. Welakahao (SB) | 1,089 | 1,024 | 1,463 | 932 | 1,133 | 770 |
| Two-Way | 2,054 | 2,377 | 2,672 | 2,412 | 2,096 | 2,004 |
| S. Kihei Rd., N. of Piikea (NB) | 467 | 675 | 586 | 804 | 597 | 824 |
| S. Kihei Rd., N. of Piikea (SB) | 503 | 576 | 614 | 679 | 658 | 689 |
| Two-Way | 970 | 1,251 | 1,200 | 1,483 | 1,255 | 1,513 |
| S. Kihei Rd., Between Piikea & E. Lipoa (NB) | 494 | 733 | 605 | 857 | 616 | 878 |
| S. Kihei Rd., Between Piikea & E. Lipoa (SB) | 449 | 720 | 560 | 851 | 575 | 861 |
| Two-Way | 942 | 1,453 | 1,164 | 1,708 | 1,190 | 1,739 |
| S. Kihei Rd., S. of E. Lipoa (NB) | 466 | 747 | 569 | 866 | 580 | 874 |
| S. Kihei Rd., S. of E. Lipoa (SB) | 416 | 847 | 527 | 1,016 | 532 | 1,027 |
| Two-Way | 882 | 1,594 | 1,096 | 1,882 | 1,112 | 1,901 |
| S. Kihei Rd., N. of Welakahao (NB) | 503 | 750 | 633 | 916 | 644 | 924 |
| S. Kihei Rd., N. of Welakahao (SB) | 412 | 768 | 545 | 929 | 550 | 940 |
| Two-Way | 915 | 1,518 | 1,178 | 1,845 | 1,194 | 1,864 |
| S. Kihei Rd., S. of Welakahao (NB) | 455 | 746 | 585 | 912 | 596 | 920 |
| S. Kihei Rd., S. of Welakahao (SB) | 432 | 816 | 565 | 977 | 570 | 988 |
| Two-Way | 887 | 1,562 | 1,150 | 1,889 | 1,166 | 1,908 |

APPENDIX C3 (CONTINUED)

SUMMARY OF BASE YEAR AND YEAR 2034
TRAFFIC VOLUMES (4-LANE MAUKA COLLECTOR)

| ROADWAY LANES | **** CY 2011 ***** AM VPH | PM VPH | CY 2034 (NO BUILD) AM VPH | PM VPH | CY 2034 (BUILD) AM VPH | PM VPH |
|---|---|---|---|---|---|---|
| Hookena St., E. of Piilani (EB) | N/A | N/A | N/A | N/A | 16 | 33 |
| Hookena St., E. of Piilani (WB) | N/A | N/A | N/A | N/A | 59 | 120 |
| Two-Way | N/A | N/A | N/A | N/A | 75 | 153 |
| E. Waipulani Rd., W. of Piilani (EB) | 30 | 10 | 30 | 10 | 30 | 10 |
| E. Waipulani Rd., W. of Piilani (WB) | 76 | 130 | 76 | 130 | 76 | 130 |
| Two-Way | 106 | 140 | 106 | 140 | 106 | 140 |
| Piikea Ave., Between Piilani & Liloa (EB) | 364 | 464 | 465 | 601 | 554 | 601 |
| Piikea Ave., Between Piilani & Liloa (WB) | 397 | 524 | 499 | 657 | 499 | 674 |
| Two-Way | 760 | 988 | 964 | 1,258 | 1,053 | 1,275 |
| Piikea Ave., Between Liloa & S. Kihei (EB) | 183 | 288 | 183 | 288 | 212 | 288 |
| Piikea Ave., Between Liloa & S. Kihei (WB) | 224 | 413 | 224 | 413 | 224 | 413 |
| Two-Way | 406 | 701 | 406 | 701 | 435 | 701 |
| E. Lipoa St., E. of Piilani (EB) | 179 | 102 | 179 | 102 | 620 | 294 |
| E. Lipoa St., E. of Piilani (WB) | 21 | 121 | 21 | 121 | 219 | 490 |
| Two-Way | 200 | 223 | 200 | 223 | 839 | 784 |
| E. Lipoa St., Between Piilani & Liloa (EB) | 326 | 319 | 395 | 380 | 573 | 512 |
| E. Lipoa St., Between Piilani & Liloa (WB) | 439 | 359 | 529 | 431 | 652 | 631 |
| Two-Way | 765 | 678 | 924 | 810 | 1,225 | 1,143 |
| E. Lipoa St., Between Liloa & S. Kihei (EB) | 246 | 283 | 246 | 283 | 272 | 301 |
| E. Lipoa St., Between Liloa & S. Kihei (WB) | 277 | 321 | 277 | 321 | 293 | 354 |
| Two-Way | 523 | 604 | 523 | 604 | 565 | 655 |
| Welakahao Rd., W. of Piilani (EB) | 174 | 189 | 174 | 189 | 263 | 189 |
| Welakahao Rd., W. of Piilani (WB) | 139 | 321 | 139 | 321 | 139 | 392 |
| Two-Way | 313 | 510 | 313 | 510 | 402 | 581 |
| Welakahao Rd., E. of S. Kihei (EB) | 96 | 122 | 96 | 122 | 96 | 122 |
| Welakahao Rd., E. of S. Kihei (WB) | 136 | 186 | 136 | 186 | 136 | 186 |
| Two-Way | 232 | 308 | 232 | 308 | 232 | 308 |
| E. Welakahao St., E. of Piilani (EB) | 37 | 8 | 37 | 8 | 165 | 20 |
| E. Welakahao St., E. of Piilani (WB) | 30 | 27 | 30 | 27 | 48 | 98 |
| Two-Way | 67 | 35 | 67 | 35 | 213 | 118 |
| 2-Lane Mauka Collector N. of Project (NB) | N/A | N/A | N/A | N/A | 479 | 731 |
| 2-Lane Mauka Collector N. of Project (SB) | N/A | N/A | N/A | N/A | 889 | 427 |
| Two-Way | N/A | N/A | N/A | N/A | 1,368 | 1,158 |
| 2-Lane Mauka Collector S. of Project (NB) | N/A | N/A | N/A | N/A | 417 | 393 |
| 2-Lane Mauka Collector S. of Project (SB) | N/A | N/A | N/A | N/A | 469 | 446 |
| Two-Way | N/A | N/A | N/A | N/A | 886 | 839 |

APPENDIX L-1
Letter from Acoustic Study Consultant

**Y. Ebisu & Associates**
Acoustical and Electronic Engineers

1126 12th Ave., Room 305
Honolulu, Hawaii 96816
Ph. (808) 735-1634 – Fax (808) 732-0409
e-mail: ebisuyassoc@aol.com

February 22, 2013

Pacific Rim Land, Inc.
P.o. Box 220
1300 North Holopono, Suite 201
Kihei, Hawaii 96753

Attention: Mr. Steve Perkins
Project Coordinator

Subject: Changes to April 2012 Noise Study for Maui Research and Technology Park, Kihei, Maui, Hawaii

Dear Mr. Perkins:

I used the Revised February 2013 Traffic Impact Analysis Report (TIAR) for the Maui Research and Technology Park (MRTP) to develop my revisions to the conclusions of my April 2012 Acoustic Study for the Maui Research and Technology Park. The following conclusions regarding future traffic noise levels in the MRTP environs were based on an examination of the changes in traffic volumes from the February 2012 to the Revised February 2013 TIAR, and the use of logarithmic (or decibel, dB) scaling factors to revise the traffic noise level results contained in my original April 2012 traffic noise study.

The following general conclusions were possible as a result of my examination of the Revised February 2013 TIAR:

1. No changes regarding existing traffic noise levels occurred.

2. Existing traffic noise levels along Piilani Highway from East Waipulani Road to Kaonoulu Street were similar to those previously reported for areas north of East Waipulani Road.

3. Existing traffic noise levels along Kaonoulu and Kulanihakoi Streets west of Piilani Highway are 50 DNL (Day-Night Sound Level) or less at 100 feet setback distance from their centerlines.

4. By 2024, increases in non-project traffic noise levels are anticipated to be between zero and 1.1 DNL greater than those originally reported in my noise study. By 2024, project related traffic noise increases along Piilani Highway are expected to be slightly lower (between zero and 0.5 DNL) than those originally reported in my noise study.

5. By 2034, increases in non-project traffic noise levels are anticipated to be between 0.8 and 1.2 DNL greater than those originally reported in my noise study. By 2024, project related traffic noise increases along Piilani Highway are also expected to be greater (between 0.9 and 1.5 DNL) than those originally reported in my noise study.

6. By 2024, no significant changes in traffic noise levels along Lipoa Parkway or along East Welakahao Street east of Piilani Highway should occur from my prior noise study.

7. By 2034, increases in traffic noise levels along Lipoa Parkway without and with the MRTP and regional roadway improvements were 4.7 and 2.0 DNL (respectively) greater than in my prior noise study.

I have also attached my revisions to Chapter I. Summary of my April 2012 noise study report, which incorporate this current review of the Revised 2013 TIAR. The italicized text in parentheses were deletions from my April 2012 noise study report.

Let me know if you have any questions regarding these findings. If you require copies of my revised report tables, let me know.

Sincerely,

Yoichi Ebisu, P.E.

encl.

## CHAPTER I. SUMMARY

The existing and future traffic noise levels in the vicinity of the planned Maui Research and Technology Park (MRTP) in Kihei, Maui were evaluated for their potential impacts and their relationship to current FHA/HUD noise standards for noise sensitive land uses. The traffic noise level increases along the roadways servicing the project site (see Figure 1) were calculated. Significant increases in traffic noise levels at noise sensitive properties are not expected to occur as a result of project traffic following project build-out by CY 2024 and 2034.

Along Piilani Highway fronting the project site, traffic noise levels of approximately 70 DNL are expected to increase to approximately 71 to 73 *(71)* DNL at 100 foot distance from the centerline by CY 2024 as a result of project and non-project traffic. By CY 2034, traffic noise levels along Piilani Highway are expected to increase by 1 to 3 DNL units along Piilani Highway with or without the MRTP and regional roadway improvements. *(be reduced to existing noise levels following completion of the proposed north-south collector road on the mauka side of the project site).*

The largest increases (1.5 to 10.4 DNL) *(1.4 to 7.7 DNL)* in project related traffic noise are predicted to occur along Lipoa Parkway, East Welakahao Street east of Piilani Highway, along Lipoa Street west of Piilani Highway, and along South Kihei Road south of East Lipoa Street. Adverse traffic noise impacts along Lipoa Parkway and East Welakahao Street are not expected to occur since noise sensitive developments are not planned to be located along those two roadways. The noise sensitive buildings along Lipoa Street west of Piilani Highway have adequate setback distances from Lipoa Street, such that predicted CY 2024 and CY 2034 traffic noise levels should remain in the "Moderate Exposure, Normally Acceptable" category at these buildings. For these reasons, traffic noise mitigation measures should not be required.

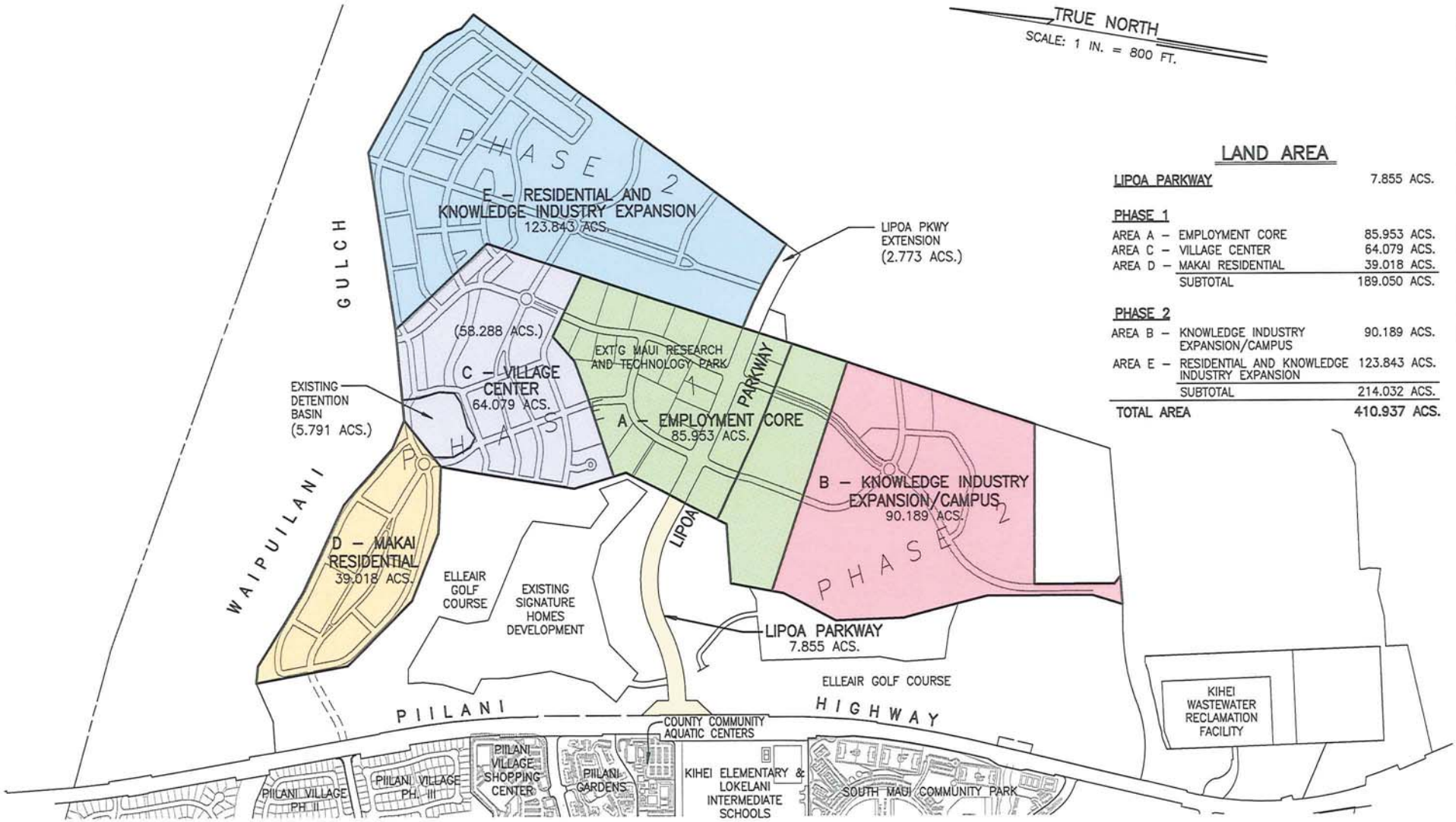
The project site is planned such that noise sensitive residential uses of the project are situated at very large setback distances from Piilani Highway, where existing and future traffic noise levels are predicted to be less than 61 *(60)* DNL. The large buffer distances to the highway will allow for the use of naturally ventilated buildings on the project site.

The dominant traffic noise sources in the project environs will continue to be traffic along Piilani Highway and South Kihei Road. In addition, the addition of the proposed north-south collector road mauka of the project will increase the existing background ambient noise levels at the mauka end of the project site and along the proposed corridors of the collector road and connecting roadways.

Unavoidable, but temporary, noise impacts may occur during construction of the proposed project, particularly during the excavation and earth moving activities on the project site. Because construction activities are predicted to be audible within the

project site and at nearby properties, the quality of the acoustic environment may be degraded to unacceptable levels during periods of construction. Mitigation measures to reduce construction noise to inaudible levels will not be practical in all cases, but the use of quiet equipment and compliance with State Department of Health construction noise regulations are recommended as standard mitigation measures.

APPENDIX M
Historical DBA Incremental Maps




## LAND AREA

| | | |
|---|---|---|
| **LIPOA PARKWAY** | | 7.855 ACS. |
| **PHASE 1** | | |
| AREA A – | EMPLOYMENT CORE | 85.953 ACS. |
| AREA C – | VILLAGE CENTER | 64.079 ACS. |
| AREA D – | MAKAI RESIDENTIAL | 39.018 ACS. |
| | SUBTOTAL | 189.050 ACS. |
| **PHASE 2** | | |
| AREA B – | KNOWLEDGE INDUSTRY EXPANSION/CAMPUS | 90.189 ACS. |
| AREA E – | RESIDENTIAL AND KNOWLEDGE INDUSTRY EXPANSION | 123.843 ACS. |
| | SUBTOTAL | 214.032 ACS. |
| **TOTAL AREA** | | **410.937 ACS.** |

## PHASING PLAN

0 800 1,600 2,400 3,200

SCALE: 1 IN. = 800 FT.

**FIGURE 1- 3**

V:\Projdata\08proj\08028 (Maui R&T Park - Master Plan)\dwg2008\exhibits\Prelim Engineering\Exb-Phasing-00.dwg

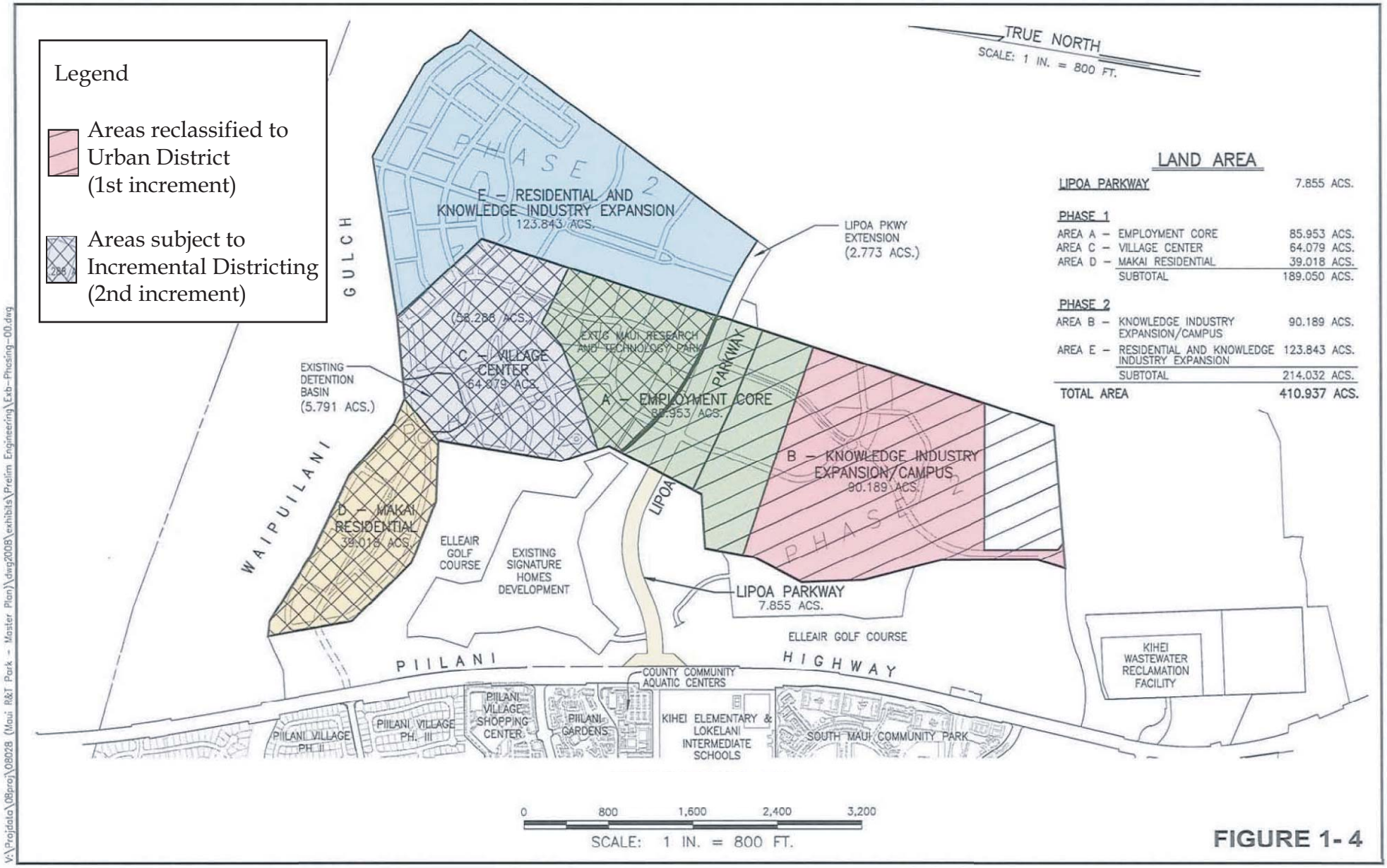
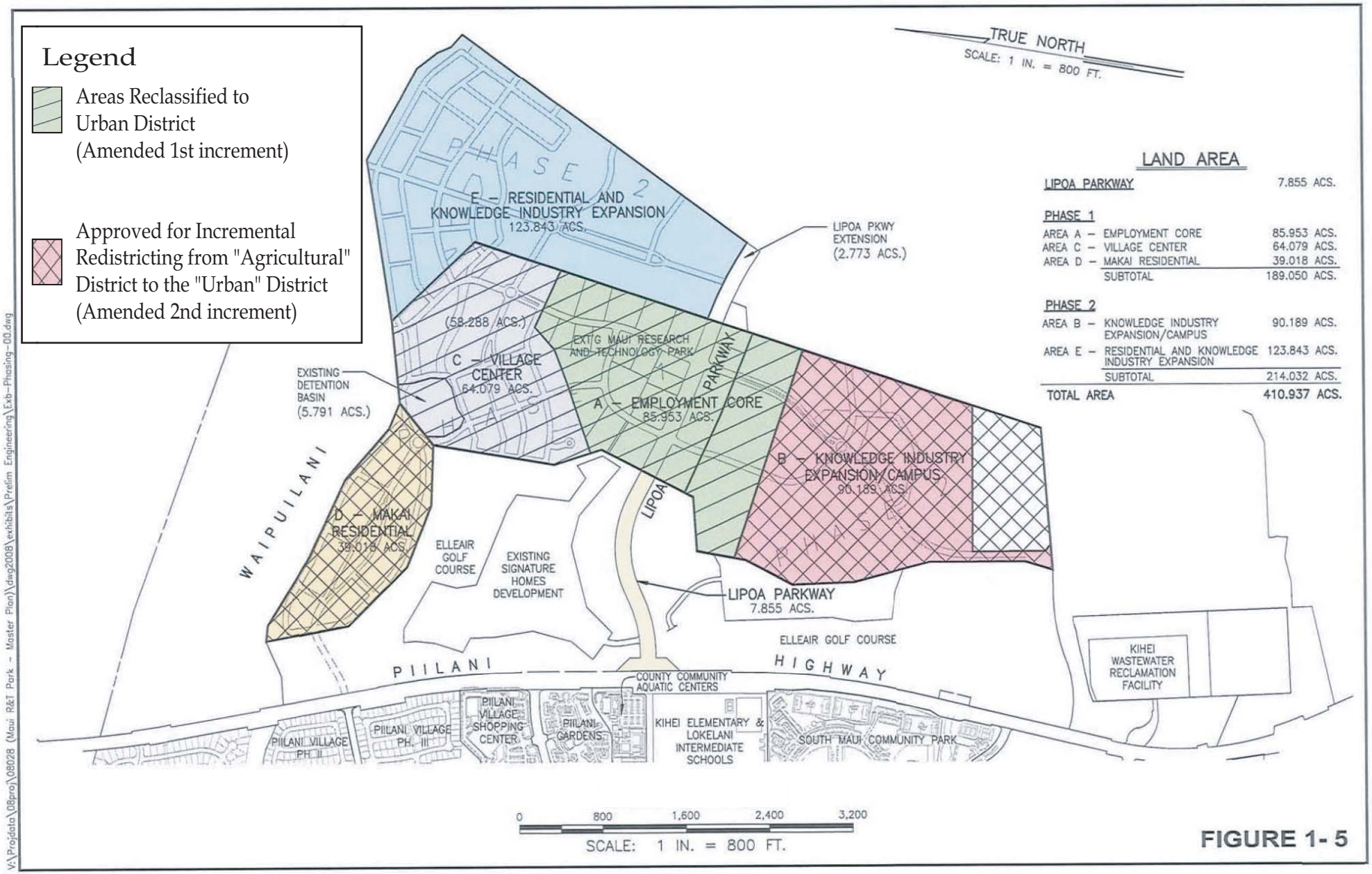



FIGURE 1- 4

1985 State Land Use Decision and Order Designation Area




Areas Affected by State Land Use Commission 1986 Decision and Order

APPENDIX N
Sustainability Study

# MAUI RESEARCH AND TECHNOLOGY PARK

# SUSTAINABILITY PLAN

November 3, 2012

## Maui R&T Partners, LLC

Kihei, Maui, Hawaii

*www.mauitechpark.com*

## Calthorpe Associates

Berkeley, California

*www.calthorpe.com*

## Chris Hart & Partners, Inc.

Wailuku, Maui, Hawaii

*www.chpmaui.com*

*First, urbanism – compact and walkable development – will arise naturally if the built-in bias of our current infrastructure investments, financial structures, zoning norms, and public policies is reformed. Second, such urbanism, when mixed with simple conservation technologies, can have a major impact in reducing carbon emissions and energy demand. Third, urbanism is the most cost-effective solution to climate change, more so than most renewable technologies. And finally, urbanism's many collateral benefits – economic, social, and environmental – enhance its desirability and economics. In short, urbanism is the foundation for a low-carbon future and is our least-cost option.*

*Peter Calthorpe*

The Maui Research & Technology Park is an employment park on the island of Maui. The Park has achieved some of its civic goal of diversifying the economy. However, in order to carry forward this vision, given the current needs of technology businesses, as well as to respond to current environmental and social needs, the Park plans to diversify its land uses, update its infrastructure, and enhance its attractiveness to businesses.

Plans for the Park take a broad view of sustainability, incorporating social, economic and environmental factors. This sense of balance is in fact a fundamental element in long-term sustainability and making Maui even better place than it is now. This Sustainability Plan explains the Park's aspirations. The development of the Park will happen over many years. This plan is intended to guide the development of the Park by showing the reasoning behind the updated Park plan, establishing a base of understanding of sustainability as it relates to the Park, and by discussing a range of options which can be incorporated into future development in the Park.

## The Way to Sustainability

The founding mission of the Maui Research and Technology Park was to help diversify the economy of Maui County. This is an important goal, one which remains as valid now as it was in the earliest years of the Park. The long-term health of Maui's economy will play a vital role in the quality of life here. At the same time, we live in an age where the limits of the environment's ability to absorb the affects of human development are becoming ever more clear. Pursuit of economic development without consideration of our actions' affects on the environment would be unacceptable to the current and future residents of Maui County and the State of Hawai'i. Too many times, environmental principles, and even long-term fiscal health, have been sacrificed in the pursuit of short-term economic gain.

Fortunately, we also live in a time in which companies and the people who run them are concerned with more than the simple equations of profit. More and more companies, and their employees and customers, want to do well and do right at the same time. It is with the goals of sustainability coupled with economic prosperity that the plan for the Technology Park has been created. These goals are not in opposition.

The plan seeks to enable a sustainable future for the Park in large part through the creation of a functional and attractive urban environment. The value of urbanism to the environment can hardly be overstated. Poorly created places, places which make it difficult to travel without an automobile, places which segregate land uses and people, places which spread development out across land without concern for what gets paved over, are the very antithesis of sustainability. The Park, through the current planning process, aims to be a good steward of the environment by creating an efficient place for people to live, work and play.

Especially in the sector of companies which the Park seeks to attract and nurture, high quality urbanism has come to be valued highly. The skilled workers in the technology sector have choices about where to live and start businesses. Maui itself is an attractive place, but technology clusters thrive on the mix of uses and people which an urban environment provides. Such an environment does not guarantee success, but has increasingly become a prerequisite for it. Thus, we aim to create a good urban place in the Park. Its attraction for companies will be matched by its environmental sustainability.

To achieve the highest level of sustainability, it is important to think at the correct scale for every action. The Park's high quality urbanism should be combined with sustainable development practices at the level of building and landscape. The large number of building sites will provide many opportunities to use sustainable practices and the science and understanding of these practices is becoming ever greater.

## Hawai'i Context

Hawai'i is, to state the obvious, a unique and beautiful place. It is this beauty, along with its relative isolation and therefore need for self-sufficiency, which have helped to foster a high level of environmental concern. This concern has motivated the people of the state to put principles of sustainability into the law itself. Hawaii Act 181 defines the Principles of Sustainability:

1. Encouraging balanced economic, social, community, and environmental priorities;
2. Encouraging planning that respects and promotes living within the natural resources and limits of the State;
3. Promoting a diversified and dynamic economy;
4. Encouraging respect for the host culture;
5. Promoting decisions based on meeting the needs of the present without compromising the needs of future generations;
6. Considering the principles of the ahupuaa system; and
7. Emphasizing that everyone, including individuals, families, communities, businesses, and government, has the responsibility for achieving a sustainable Hawaii.

Sustainability is achieving:

1. Respect of the culture, character, beauty, and history of the State's island communities;
2. Striking a balance between economic, social, community, and environmental priorities; and
3. Meeting the needs of the present without compromising the ability of future generations to meet their own needs.

The plan for the Maui Research & Technology Park aspires to move Hawai'i forward toward achieving these principles. The Park will have a more balanced social, economic, and environmental system as a mixed-use community. This balance itself will be a fundamental way to work toward the Principles.

### Ahupua'a

The ahupua'a system provides an example and analogy to guide the actions of the Plan. Each ahupua'a, including a section of land from the mountain to the shore, is in essence a system to itself. Natural processes like the circulation of water extend throughout the ahupua'a, with each part of the system related to the next. The human interaction with this natural system is founded on respect, cooperation, and stewardship, with an understanding of natural limits. Within the system, human activities have appropriate levels and are suitable for certain locations. All activities and processes within the ahupua'a are nested within the overall system, which is itself nested within the island's larger natural and cul-

tural system.

The plan's strength comes from considering these ideas from the start and embedding them into the structure of the community. The plan abandons outdated notions of human communities founded not on natural principles but on machine principles. These ideas held functions like living and working as separate and unrelated, not part of an interrelated system with the possibility of positive feedback between them. Thus, for example, the Park's housing is intended to be affordable to Park workers, strengthening the ability of businesses within the Park to attract talented workers and making the Park more attractive to those businesses. The resulting short commutes can be more frequently made by bicycle and walking, making the Park more sustainable as well. The presence of both homes and employment will make neighborhood-serving retail more viable, again making the Park more attractive to other employers. Without using these ideas of the needs and feedbacks within the system, we could be led to separate employment, retail and residential areas as has been done in most places built in the last fifty years. This separation removes the possibility of these positive feedbacks and makes it necessary to travel everywhere by automobile. This has led to congestion, pollution, lack of physical activity, and higher levels of obesity. None of these promote sustainability over the long term or human quality of life.

## Economic Context

The Maui Research & Technology Park is being developed by a master developer, Maui R&T Partners, LLC. The developer will be in charge of creating a sustainable plan for the Park as well as coordinating infrastructure. Individual parcels may be developed by the developer, or may be developed by others, such as employers seeking a place to start or expand their business.

In both cases, whether development is created by the master developer or by others, the aspiration is that the Park will be a model of sustainability and stewardship. Much of what will make the park sustainable is already contained within the plan, as will be discussed later in this document.

The purpose of the Park, however, is not solely about the environmental aspects of sustainability. As noted in Act 181, it is important to maintain a balance between economic, social, community and environmental priorities. Since the reason for creation of the Park was to enhance the economy of Maui, it will not always be possible to pay for the highest levels of sustainable practices in infrastructure and construction. It is the ambition of the park to keep the Park's level of sustainability very high. But if the Park is not viable financially or cannot attract new business because the standards make it unaffordable for growing businesses, then the goal of economic development will not be achieved.

In addition, because other people and businesses will also develop land within the Park, the master developer will not have full control over all future development activity in the Park. It is hoped that by setting a high example, by educating potential building developers in the Park, and by creating documents such as this which show the ambitions of the Park for sustainability, that the level of sustainability of all aspects of the Park can be kept at a high level.

# Site Description

*Island of Maui*

The Maui Research & Technology Park is located in the South Maui town of Kihei, mauka (east) of the intersection of Pi'ilani Highway and Lipoa Parkway (called Lipoa Street makai of Pi'ilani Highway). Kihei is one of many small towns on Maui, and is developed in a linear form along South Kihei Road, which runs north and south parallel to the ocean shore. The newer Pi'ilani Highway lies mauka of most of the town's development, and is a high speed facility with a limited number of intersections. The island's primary airport is in Kahului, about 30 minutes away by car.

Kihei has a variety of development, including many mid-range hotels and condominium developments, single family homes and some low density multifamily. Much of Kihei's retail is small in scale and lies along South Kihei Road, but several large shopping centers exist as

MRTP lies mauka of Kihei, beyond Pi'ilani Highway

Azeka Shopping Center in Kihei

Maui coastline

well, including Azeka Shopping Center near the intersection of South Kihei Road and Lipoa Street. Pi'ilani Shopping Center is one block north of Lipoa Street and just makai of Pi'ilani Highway, very near the Technology Park, and includes a large Safeway grocery store. A large new shopping center called Downtown Kihei is planned near Pi'ilani Shopping Center, and a large outlet mall and shopping center is planned for an area north of the Park, also mauka of Pi'ilani Highway.

Divided from the rest of Kihei by the high speed four-lane Pi'ilani Highway, the Technology Park is physically and visually isolated. A golf course lies between the Park and the highway, leaving the park with no highway frontage. The one road access, Lipoa Parkway, is currently two lanes with a very wide right of way which will easily accommodate four lanes. There are no through roads in the park, leaving the Park's overall road network to function as a cul de sac. The Park is surrounded by undeveloped land on the north, east and south sides.

A Park tenant

# Local Context

The Park has open setbacks and lush landscaping

Park Plaza building

Existing development in the park is on five parcels. Buildings are one and two stories, and all development (as required by existing design guidelines) sits behind deep setbacks, usually filled with one or more rows of parked cars. Roads and intersections are large, with large turn radii. Most roads have sidewalks, and much of the landscaping is lush and beautiful.

Some Park buildings have little local architectural influence

Hedges screen unattractive parking lots from the street

Parking lots line most streets

*MRTP Context Map*

# SUSTAINABLE DESIGN PRINCIPLES

The following chapter covers the principles which have been followed in this design. As planned, the Maui Research & Technology Park to a great degree has its sustainability "baked in." This is to say, the design of the Park itself has been done in a way intended to create long-term sustainability. The patterns of transportation and land use commonly known as sprawl have devastated the environment with congestion, needless consumption of farmland and natural areas, obesity, inefficiency, and gas consumption, to name a few things.

The understanding of the importance of Urban Design and Planning has changed greatly in the last twenty years. Far from being concerned simply with aesthetic issues, well-designed places function far more efficiently than poorly-designed ones do. They have positive effects on the environment, on individual health and well-being, and on long-term economic viability and adaptability. Well-designed places are also better and more enjoyable places for people to live and work, which has made good design an important element in efforts to create economic development.

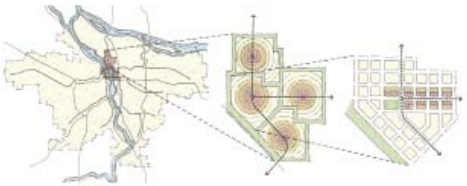
The motivation for the founding of the Maui Research and Technology Park remains as important as ever. Continuing job creation and economic development are essential for the well-being of Maui. This has become even more apparent with the recent economic downturn and the continuing decline of agriculture on the island.

Fortunately, the latest understanding of urban design for quality economic development, especially in fields of high technology, is also urban design which achieves environmental and other goals. Places which attract and create new high technology businesses are those which facilitate the exchange of ideas and make it easier for people to become entrepreneurs, and are able to deliver a high quality of life. By providing a variety of public and private spaces and a quality public environment, these places give people and businesses the flexibility and freedom to experiment, to take chances, and to make connections. These types of places are fertile ground for growth and entrepreneurship.

Conservation and Restoration

Human and Pedestrian Scale

Diversity and Balance



Connections and Interdependence

For these reasons, it is essential to use new models of development for the Park. New development must address many concerns simultaneously, incorporating the latest understanding of multiple issues. While good design involves an infinite number of elements, we have grouped the major concerns of urban design into four categories for purposes of discussion: conservation & restoration of the environment, economic and social diversity & balance, human & pedestrian scale in the public and private realms, and connections & interdependence between the neighborhood, town and region.

Because it is also important that the plan fit the needs and desires of Kihei residents, the details of these principles also incorporate elements of other local guidelines, such as the Kihei Community Association General Open Space and Design Guidelines. The KCA Guidelines are concerned with community quality and livability, with major areas of concern being:

- Open space drainage ways and flood control
- Wetlands and low lying drainage areas
- Neighborhood connectivity and pocket parks
- Shoreline property
- Beach access/impact
- Pedestrian and community safety and de-emphasis of the automobile
- Roundabouts and street design guidelines
- Affordable housing
- Schools, parks and roads
- Commercial and high density developments
- Green Building Guidelines

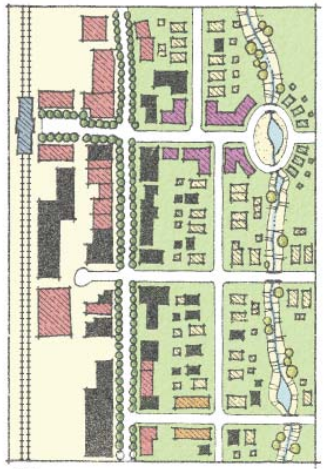
The design principles and plan which follow address nearly all of these concerns and are in near-total agreement with the KCA Guidelines.

*Waipuilani Gulch*

*Park Plaza Building in MRTP*

# Conservation & Restoration

Before



After

Conservation and restoration of the environment does not imply that no land will be developed. On the contrary, this principle recognizes the importance and appropriateness of human activity in the landscape and attempts to do it well and compactly while preserving essential elements and systems in the environment. Cities represent a fragile balance between our human needs and the capacity of our ecosystems. As we continue to gain deeper understanding of the repercussions of our human activity on the world's environment, the city is increasingly understood as an important place to adopt a more sustainable lifestyle.

The design of the Maui Research & Technology Park will have an effect on the environment both locally and globally. Design which respects existing topography and other natural features not only is less damaging to construct, but preserves natural systems and the area's cultural and geographic memory.

On the other hand, design which minimizes unnecessary automobile travel has effects on the environment world-wide. The world is facing an environmental crisis of profound economic and social dimensions. Brought about largely by carbon emissions into the atmosphere, climate change is already affecting the human and natural environment and promises to create immense problems in the coming years and decades. Such problems may be particularly pronounced in island communities like Hawaii.

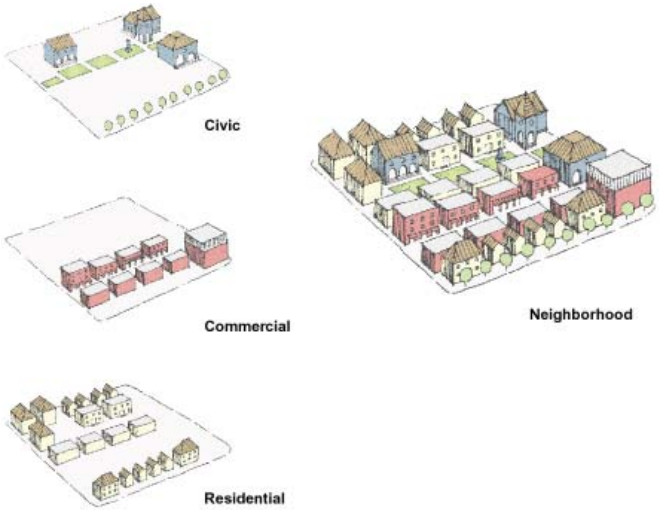
As is now understood, one of the major causes for carbon emissions over the last fifty years has been the way we build our cities. A purposeful emphasis on the creation of cities for automobiles at the expense of pedestrians, bicycles, and transit has increased automobile usage and the associated carbon emissions. At the same time, this style of development has increased land consumption, thereby reducing forest cover and increasing problems with stormwater runoff and pesticide use wherever it has been implemented.

Choices made now will have immense effects on the future of carbon emissions. Creating the Park in an efficient, livable, and environmentally-friendly way will ensure reduced emissions. Using an outmoded, auto-centric development model will do the opposite, and the effects will be solidified in the built environment for years to come.

The Maui Research & Technology Park should add to the sustainability of Maui. It will be environmentally responsible by reducing resource waste, demanding less of the environment, and accommodating growth to support the island economy. It will address an ongoing challenge of economic development by attracting new growth in proximity to housing and regional transit.

By incorporating strategies on the neighborhood and building level, the design of the Maui Research & Technology Park can affect not only its site and surroundings, but the health of the planet as a whole.

# Diversity & Balance




## Mixed Use and Clustering

Mixing of uses and clustering of destinations is a way to reduce distances and make walking and bicycling more convenient. Maui already has development of middle density, but it often lacks clustering with other uses which leaves it seeming unfocused. Bringing the densest development together, ideally around a transit node, shortens trips and makes them more convenient. Having more residents or workers within 1/4 mile of a transit node makes it more likely that those persons will chose to use transit when they go elsewhere in the island, also.

### Mixed Use

Mixed use is the mixing of various activities and land uses within a small area. Vertical mixed use means that a single building has several uses within. Horizontal mixed use means that multiple uses and activities are clustered near each other. Both of these types achieve the goal of making trips shorter and more convenient and raising the possibility that people will choose to use walking, bicycling or transit for their trips.

Mixing of uses at the neighborhood scale, within the 1/4 mile walking radius, allows people to reach daily destinations easily by foot. Large areas with single uses such as housing or employment force everyone to travel long distances to get around. Having retail and civic uses within areas of residential and employment uses makes it easy for people to do quick errands during their daily activities. Having recreational spaces nearby allows people to reach them more easily, creating situations where people can incorporate healthful activity into their daily lives. Having appropriate uses and activities near homes allows children as well as older people who can no longer drive a car to have increased independence.

### Diversity of Housing

There will never be a single perfect housing type. Housing types must be as diverse as the needs of the people who inhabit them and accommodate changing demographic and consumer preferences. Even a single individual's housing needs change over his or her lifetime. A young person living in a small apartment may want a house after marrying, then a larger house after having children. Once these children grow up and leave home, the empty-nester couple may again choose a smaller home or apartment. Neighborhoods with a diversity of housing can accommodate these changes without forcing someone to move a long way or even to another community. A collection of townhomes, single family dwellings, and low apartment buildings can achieve a diversity appropriate for a growing and changing population.

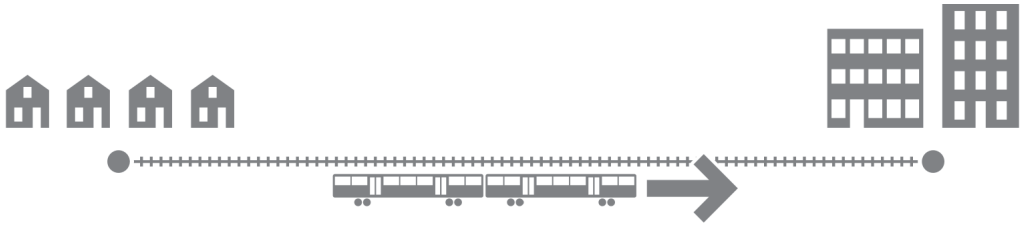
## Jobs Housing Balance

Another important reason for a mix of uses on the district scale is to create jobs housing balance. This means that an area would have a similar amount of jobs within it as it has workers living in it. This not only shortens many commute trips and therefore makes it more likely that people can travel to their jobs by walking or bicycling, but it also makes transit and automobile travel more efficient. By using transportation lines (roads or

bus lines) in both directions in a similar amount, peaking is reduced and a line of the same size can accommodate more travelers. (see diagrams)

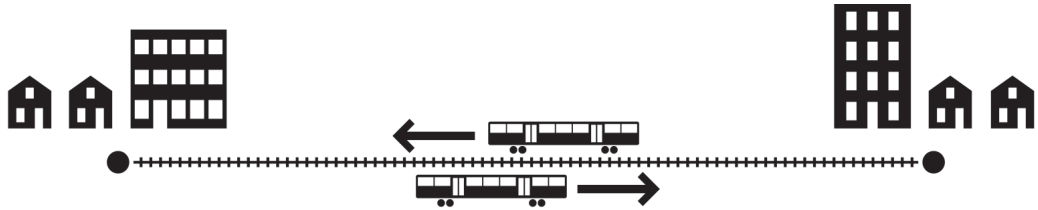
### Balanced Flows

As a jobs center, it is unlikely that the Park would achieve a complete jobs housing balance. However, adding at least some housing will improve the situation, improving transportation efficiency as well as adding 24-hour activity to the Park. Having people in an area during more hours of the day makes an area safer and helps local serving businesses like restaurants survive, since they have customers in both the daytime hours and the evening hours. This will make the Park a more livable and economically viable area.



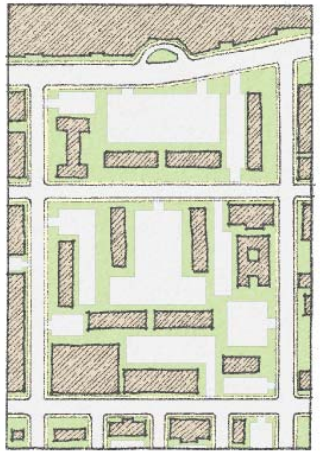
*Unbalanced Morning Commute - going to work*

*Unbalanced Evening Commute - returning home*



*Balanced Commute - moderate flows in both directions*

# Human & Pedestrian Scale



Auto - Scale

Pedestrian - Scale

Places with human scale are in stark contrast to the auto-centric development which has been common over many years and continues all over the world. Human and pedestrian scale recognizes the needs of people for safety, convenience and pleasure in the public realm. By creating places designed for humans, we give people the flexibility to order their lives in ways other than around the automobile.

## Mixed Use and Proximity

Human and pedestrian scale includes many aspects of a place. Among the most important factors is a diversity of land use, as discussed in the preceding pages. A mix of uses in close proximity allows people to satisfy needs within an area which can be easily traveled by walking or bicycling. To achieve this result, the development must also be of sufficient density to contain these uses in a small area. Of course, each person differs in the distance which they are willing or able to walk, and factors such as the current weather affect this as well. However, a good rule of thumb is that destinations should be with about five minutes' walk, which is a distance of about 1/4 mile.

## Walkable Streets

Another critical factor in human and pedestrian scale is walkable streets. An environment that encourages walking is imperative to the creation of a vibrant community. By walking for transportation we receive a variety of benefits – we reduce the need for the automobile, we provide foot traffic to local businesses, we interact with our neighbors, and we improve our physical health. In fact, a Washington State study found that residents of a pedestrian friendly neighborhood weigh, on average, seven pounds less than residents of a sprawling suburb[1]. In addition, walkable neighborhoods need less infrastructure for cars, thus sparing land for more enjoyable spaces such as parks and promenades.

To be walkable, streets must be well designed. Sidewalks are a must, but the design of the road network and of the streets themselves are key.

### Street Networks

Auto-oriented street networks are designed in a very similar way all over the world. Beginning on local streets (often cul de sacs), every journey moves then to collector roads, then arterials, and often then onto a highway. Because of the fear of through traffic and a disregard for pedestrians, road networks are typically designed to force this pattern for every trip, lengthening each trip and congesting all of the arterials. This congestion then creates calls for road widening and the resulting huge roads make walking or bicycling even more difficult and dangerous.

#### *Connector Roads*

Rather than this typical street hierarchy of cul-de-sacs, locals, collectors and arterials, the Plan builds a network of interconnected local streets and connector roads. By ensuring multiple connections and routes, connector roads avoid the difficult problem of unlivable, high traffic collectors which are too busy and too noisy to accommodate residential development. Connector roads

[1] *Smart Growth America, http://blog.smartgrowthamerica.org*

typically occur every quarter mile and serve to disperse traffic widely.

### *Local Roads*

Local roads are intended primarily for local access, but are also a vital part of the road network. They only rarely end in cul-de-sacs in the plan. Speed and through traffic are controlled by narrow road widths and curved alignments, while connections on both ends preserve emergency access and add route choice for daily users. Parking is provided along the road, further slowing traffic and providing for more activity on the street as people access their cars.

## Street Design

### *The Evolution of Street Design*

The weight of years of experience and research is chipping away at the entrenched practice of creating wide, auto-centric roads in disconnected, discontinuous networks. Promoted for years as the safest and most efficient way to build road systems, it has now been proven that this type of system is just the opposite. Wide roads, contrary to providing an added cushion for error by drivers, instead provoke drivers to speeding and carelessness. The result is more crashes and more severe crashes. Pedestrian and bicycle injuries and deaths are multiplied by large, fast, busy roads, and because few people who have other options choose to walk or bicycle, even more traffic is created.

In contrast, the streets in this Plan are designed with a pedestrian-friendly environment as the first priority. Comfortable, walkable and bikeable streets knit neighborhoods and districts together, adding to a sense of community and facilitating transit use. Each sidewalk needs the shelter of trees, the presence of building entries and porches rather than parking lots, and a buffer of parking to protect the pedestrian corridor from moving traffic.

In all cases streets must be designed to slow traffic, as high speeds are entirely unnecessary within the site. High speed traffic creates a much higher level of noise, disturbing workers and residents. Preserving livability on the area's road network will require reasonable speeds to be maintained. More importantly, high automobile speeds create much greater danger for pedestrians as well as automobiles, making accidents more likely and multiplying the force of a crash many times. A pedestrian struck by a car at 20 miles per hour has a less than 10 percent chance of death. At 30 miles per hour, this chance rises to almost 50 percent. And at 40 miles per hour, fatalities are nearly 90 percent [2]. Speed on all roads in the Park should be limited to 25 miles per hour or less. At these speeds, a driver can still easily reach any Park location in minutes or less.

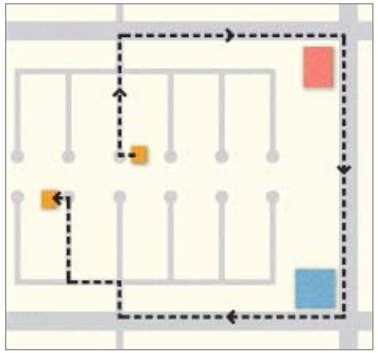
### *Traffic Calming*

Traffic calming is the practice of bringing vehicular speeds and behavior into conformity with the needs of non-drivers. The streets in the Park have been designed to be calmed through their basic design to be more human in scale and character. By sizing the streets correctly and highlighting character elements that emphasize the streets' quality as much as their quantity, the Park's neighborhoods will be naturally safer for all users, including employees, residents, and their children.

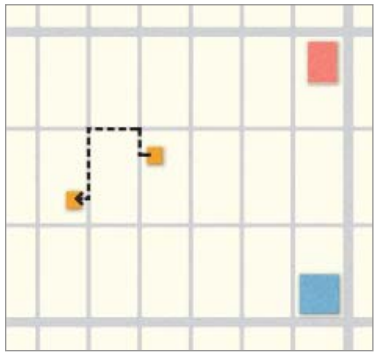
However, where extra care is needed or desired, additional calming methods can be used to ensure a safe and efficient street. Although they vary in application, the basic theory behind these techniques is to present a driver with physical and psychological cues which prompt more careful driving behaviors or choice of travel route. By using signage in concert with uncommon movements, a street's design can encourage safer speeds, reduce volume, or invite more careful navigation. Many times, one or a combination of measures can accomplish all of these goals simultaneously.

There are three major categories whereby a street's design can affect driving behavior, as described below: signage and graphics, deflection (vertical and horizontal), and narrowing.

[2] *http://www.walkinginfo.org/pedsafe/crashstats.cfm*



*Hierarchical road networks require long trips on large roads.*



*Connected road networks allow direct routing and small-scale roadways.*

*Vertical and horizontal deflections slow traffic*

*Simple markings can make streets and pathways safer for all users*

*For further information on traffic calming methods, see "U.S. Traffic Calming Manual", published by APA Planners Press and the American Society of Civil Engineers in 2009, written by Reid Ewing and Steven Brown.*

### *Signage and Graphics*

Signage and graphics are the most common traffic calming measures. Not only are they the least costly and usually the least disruptive to implement, they also benefit from a history of use and are therefore familiar to the public and to regulating municipalities. Common types of signage/graphics include:

- Striping
- Bicycle Lanes
- Crosswalks
- Stop Signs
- Child-Related Signage
- Speed Reduction
- Signal Progression
- Pedestrian and Bicycle Signals

### *Deflection (vertical and horizontal)*

Deflections in the travel path require the driver to slow in order to maintain control or to avoid unpleasant forces on themselves or their automobile. Deflections come in vertical and horizontal varieties, and can be gently, or harshly persuasive in form. Common types of a deflection are:

- Speed Humps/Speed Bumps
- Pedestrian Tables/Speed Tables
- Raised Crosswalks
- Raised Intersections
- Chicanes/Slaloms
- Forced Turns
- Street Closures (full or half)
- Median Islands
- Full Roundabouts (full or mini)
- Traffic Circles

### *Narrowing*

When physical elements of the streetscape are drawn in toward the travel lane, the driver feels that the travel lane narrows as well. This perception, real or imaginary, prompts lower speed and more careful observation of the road ahead. Common types of narrowing include:

- Bumpouts/Curb Extensions
- Bus Bulbs
- Pinch Points/Chokers
- Neckdowns
- Narrow Streets
- Narrow Planting
- Streetside Parking

## Narrow Streets

One of the primary methods of traffic calming, the use of narrow streets has many advantages, not all of which are immediately obvious. As mentioned above, wide roads are not safer roads. Studies have indicated that for local roads, crash frequency and injury rise with street width. The safest local roads are the narrowest. In addition to safety, narrow roads consume less land, produce less stormwater runoff, and are less expensive to construct and maintain.

### *Fire Response*

One major hurdle to implementation of narrow streets is fire access. The International Fire Code sets a standard of 20 feet clear driving space for fire access. This allows two fire trucks to pass each other while getting to a fire, and allows plenty of space for firefighters to set up their equipment at a fire. This 20 foot standard would forbid roads with narrow lanes such as local roads with

12 or 14 feet of driving area (queueing streets) and two-lane roads with medians and less than 20 feet between parked cars and the median. For these narrow roads, approval of fire authorities is necessary.

Fire access is a critical life-safety issue. However, automobile and pedestrian safety is also a life-safety issue, and an increasing number of fire officials are recognizing this in their approval of alternative road configurations. Alternative street sections have already been proposed on Maui Island, including those in the Pulelehua project such as the "Street" and "Avenue" sections.

On roads with less than 20 feet of clear driving space, fire access can be maintained and even improved compared to a standard road network with a number of strategies:

- Alley access – Alleys provide a critical second means of access for fighting fires and are alternate routes for fire trucks.
- Network connectivity – Having room for fire trucks to pass each other becomes less important with good road connectivity. A connected network of streets allows fire trucks to access a fire from multiple directions.
- Center block staging area – Limiting parking in short sections mid-block, within hose distance of buildings in the middle of the block, can create a valuable staging area for fire fighting equipment.
- Entry neck downs – Neck downs limit parking near intersections. In situations where two narrow roads meet, parking too near the corner can reduce turn radii so much that fire trucks cannot enter the street. Neck downs preserve fire access.
- Mountable curbs at corners and roundabouts – Mountable curbs serve to retain access for larger vehicles like fire trucks and freight trucks, while keeping corners tight and thereby limiting vehicular speeds.
- Limited block lengths – Blocks of limited lengths (less

*Store fronts benefit from street parking as it activates the sidewalks*

*Effective streets prioritize spaces for pedestrian*

*Narrow streets slow down traffic enough to create safe environments for pedestrian circulation*

than 300 feet), such as the short ends of typical city blocks, allow fires to be fought from the adjacent intersections even if the street itself is blocked.

- Sprinklers in buildings – Requiring sprinklers in all buildings can reduce fire risk and increase acceptable response time such that a reduction in fire truck speed may be allowed. This strategy was used in Baldwin Park in Orlando, Florida, to achieve local street widths as small as 21 feet across, with street parking.

These strategies, alone and in combination, can keep people and property safe from fires while improving road safety and livability.

*Street parking creates a buffer between moving traffic and sidewalk*

*Parallel parking supplies functional parking for all uses*

## Street Parking

On-street parking acts as a traffic calming device and protects pedestrians from moving vehicles. While this buffer is not typically needed for physical protection, it serves as a valuable psychological division between the automobile realm and the pedestrian realm. In addition to this function, street parking helps to activate the street with people coming and going, and makes street-facing store and business entries work. Parallel parking is preferred to diagonal parking, as it keeps street widths to a minimum and because, diagonal parking can cause serious conflicts with bicycles since it impedes drivers' ability to see bicyclists while backing.

## Intersection Design

Another critical factor for walkable streets is the design of intersections. Intersection design affects the safe and comfortable flow of travel for all modes, including walking and bicycling. Intersections are particularly important to the overall safety of a road network since a high proportion of accidents occur there. A variety of strategies can be used to make intersections safer and more functional for all users while maintaining critical functionality.

### *Actual Curb Radius and Effective Turning Radius*

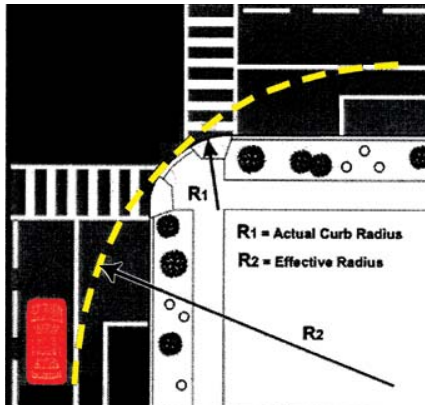
An important factor for intersection safety is the speed of turning vehicles. Smaller curb radii and the associated tighter turns by vehicles at corners can allow normal use by automobiles, while at the same time slowing turning movements and thereby increasing safety.

The effective turning radius (ETR) of a corner refers to the path of travel of the inside wheel of a turning vehicle (see figure at left). This is usually unmarked on the street and is not visible as part of the street assembly. The ETR of an intersection should not be confused with the actual curb radius which is likely to be significantly smaller.

Recognizing the difference between ETR and the actual curb radii is important because overlarge actual curb radii serve to make intersection crossing distances longer without enhancing the intersection's performance for automobiles. In fact, large curb radii can actually encourage drivers to take turns at unsafe speeds, endangering themselves, other drivers, and any pedestrians or bicyclists also using the intersection.

### *Curb extensions*

Narrow widths make intersections safer for pedestrians by limiting crossing distances. Intentionally narrowing roads at intersections with curb extensions achieves shorter distances and helps to slow automobile traffic.




*AASHTO Comparison of Actual Curb Radius (R1) to Effective Turning Radius (R2)*

Curb extensions are allowed and encouraged at all intersections. It is also appropriate to consider curb extension areas as opportunities to achieve other goals of the plan.

In denser and more urban areas, curb extensions are well-suited for bus stops and other pedestrian seating areas. Special care should be taken to understand traffic flow and its implications on safety and signalization when bus stops are located near intersections and within the moving lane.

Curb extensions can also be paired with bicycle storage facilities which provide a safe and visible area for bicycles to be stored on the more active streets. Placing bike facilities in the curb extensions also means that pedestrian walkways and sidewalks in the immediate area are not partially blocked by parked bicycles. Placing bicycles in this prominent area also has the potential to add to the creation of a cycle-minded community where bicycles are not only a priority, but are also aesthetically part of the streetscape.

In lower intensity areas, curb extensions may be well-used as stormwater detention and filtration areas. "Flush" volumes of rainfall can carry unhealthy amounts of surface pollutants when the water runs over the street surface and along the street-side gutter. These pollutants are often carried along hard infrastructure for long distances, and potentially into sensitive water bodies such as streams and ponds, and eventually the ocean. By catching surface contaminants in street-side swales and retention areas, contaminants can be filtered naturally by plants while the clean water is left to infiltrate into the ground. Using curb extensions to build these retention areas means that contaminants are less detrimental to downstream environments, and stormwater infrastructure has less of a chance of being overwhelmed by large volumes of stormwater runoff when large rain events occur.

## Bicycle and Pedestrian Facilities

Walking and bicycling are important transportation modes. They promote health, reduce traffic congestion, reduce the need for large parking lots, and are often enjoyable recreational activities which will serve as amenities for employees, residents, and visitors to the Park.

### Pedestrian Network

The need for pedestrian facilities (sidewalks, safe crossings) is a given. Regardless of whether sidewalks are provided, people will at times walk along roadways, and forcing people to walk in traffic is dangerous and unnecessary. The Plan instead encourages people to walk by providing safe, pleasant sidewalks and pedestrian paths connecting all locations.

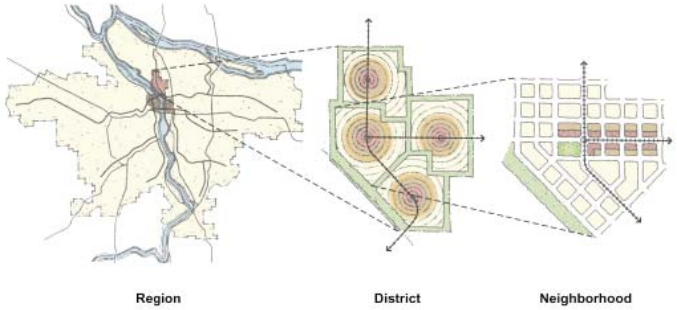
*Traffic circles slow traffic without causing delays and can beautify the streetscape*

### Bicycle System

As for bicycles, they need to travel wherever automobiles travel. Bicycles have many of the health and environmental advantages of walking, and their higher speed allows longer travel distances. This will be especially important in the Park due to its current location outside the main area of development in Kihei.

In contrast to the typical 1/4 mile travel distance limit for pedestrians, their higher speed allows bicyclists to commonly travel much further, between one and 2.5 miles.

# Connections & Interdependence




Thinking of individual elements of the urban environment as distinct and unrelated has been a hallmark of Modernist thought and has led to regions which are socially, economically and environmentally disconnected. Contemporary thought searches for a deeper understanding of the relationships between all elements of the built environment. Elements such as the environmental and economic connections and interrelationship of the park to the rest of the county are important considerations, as discussed above. A more direct and very important connection to consider here is transportation.

## Intermodalism

Much transportation planning as it is currently practiced is in fact only automobile transportation planning. Given the increasingly-apparent health and environmental benefits of non-automotive modes like walking, bicycling and transit, this emphasis on the automobile is unfortunate. A robust, equitable, environmentally sound transportation system accommodates multiple transportation modes. A variety of strategies can be used to achieve this, from provision of adequate pedestrian and bicycling facilities to implementation of transportation demand management strategies such as parking cash-out, where those who do not use “free” parking receive a cash payment instead.

## Connectivity

Connectivity is closely related to intermodalism and is an important tool. Well-connected street networks better accommodate multiple modes. Direct routes are especially important for pedestrians, since the rate of trips made by walking is highly sensitive to distance. Connected streets also affects trip lengths for automobiles, reducing vehicle miles traveled while providing alternate routes in case of road blockages or repairs. And consideration of connectivity between modes, such as good sidewalk connections to transit stations, improves the efficiency and effectiveness of the entire system.

## The Fallacy of Free Parking

The issue of parking is one of the most contentious in planning and urban design. For many years, government authorities have required with minimum parking standards that plentiful parking be made available for every type of land use. The reasoning behind this was that if a business or residence did not provide sufficient parking, people would be forced to park their cars on the street, inconveniencing their neighbors. While generally not requiring that parking be free, regulations have required that parking be provided at such high levels that there

*Multi-Modal street, Ottawa*

has been typically no point in charging for it, and people have become used to the idea of plentiful, free parking wherever they go.

However, free parking is not really free. There are many costs to providing parking, from land costs to construction costs to ongoing maintenance and security. With the current system, however, the costs of parking are bundled into the cost of everything else, and so parking seems free to drivers.

Free, plentiful parking leads to increased driving. When a normal good is underpriced, it will be over consumed. This applies to parking – because a portion of the journey is subsidized, people's decisions are influenced toward driving and away from other modes or carpooling. In addition, the requirement for large amounts of parking means that destinations are spread further apart by large parking lots. Since parking often takes up more than half of a developed parcel, the amount of destinations within reach in the critical pedestrian quarter mile is often cut by more than half. And few people enjoy walking to destinations through the seas of parking in which buildings often float.

### Changing Parking Minimums

For these reasons, this plan proposes reduction of mandated parking provision in the Park. With reduced parking requirements and creative options for meeting those requirements, the Plan will provide one more element of flexibility to businesses seeking to locate in the Park. A business which desires to promote walking, bicycling or transit use, or even to run a commute shuttle service for its employees, may choose to provide less parking.

If street parking becomes scarce, which is to say, if drivers are forced to circle looking for spaces, then metering can be introduced and the price raised to a level where supply equals demand. The resulting income could be devoted to improvements within the park such as sidewalk and street maintenance and improvements, open space maintenance, or transportation demand management measures such as transit passes. Moving automobile parking toward a market-based system will help to incorporate market efficiencies and reduce the overconsumption motivated by underpricing.

*See "The High Cost of Free Parking" by Donald Shoup for an in-depth discussion of the costs and complications of abundant and underpriced parking.*

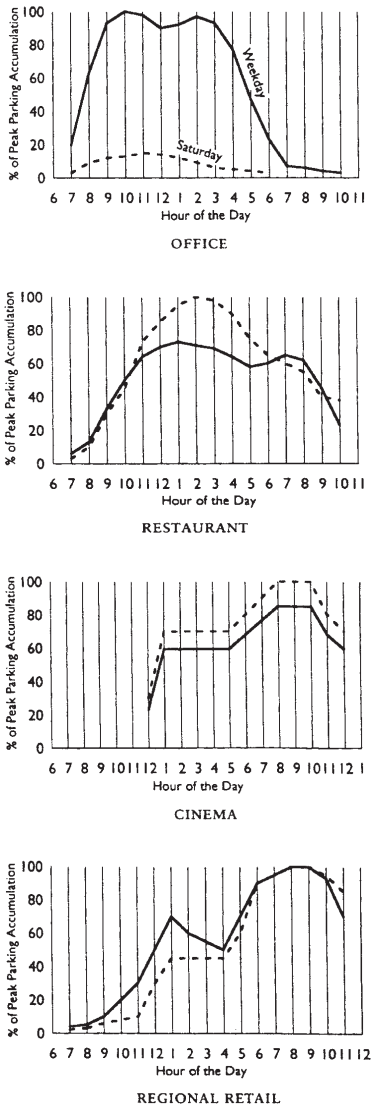
## Shared Parking

While parking lots are necessary parts of the transportation system, they are expensive to build and maintain and they spread development out, making places less walkable. There are many benefits to only building the amount of parking that is needed. While each parking space has a financial and environmental cost, additional usage of that space has little additional cost. Thus, for a given amount of parking needed, it is much better to utilize one space for longer periods than have two spaces each occupied for only a portion of the day.

*For more information about shared parking, see Shared Parking (Urban Land Institute, 2005) and Shared Parking Planning Guidelines (Institute of Transportation Engineers, 1995).*

By recognizing that peak demand occurs at different times for different land uses, shared parking facilities help minimize the need for parking lots and garages. For example, office parking lots are typically full during the day Monday to Friday, but nearly empty at other times. Retail parking has a different pattern, reaching

*Multiple parking facilities can share one parking surface*




*Parking Demand Diagrams*

maximum usage on the weekend. Mixed use, retail, office, civic buildings, and multi-family developments may share off-street parking spaces. This approach works well anywhere, as long as walking distances to the parking area are reasonable.

Commercial users in the Park are encouraged to use shared parking. The Urban Land Institute's (ULI's) Shared Parking Standards, or an equivalent, are good ways to calculate the total number of shared parking spaces. To determine parking demand if spaces are shared, parking demands for the two or more uses are added for each hour of the day - for weekdays, Saturdays and any other days with significant variation in parking patterns - to see which hour produces the highest parking demand.

The following steps can be used to determine the minimum number of spaces needed for mixed-use areas:

1. Start with the maximum parking needed for each user which will be using the shared parking arrangement.
2. Determine the parking demand for each user for key times. The ULI uses weekdays and Saturdays at 10 AM, 1 PM, 5 PM, 8 PM and 10 PM.
3. Determine the total parking demand for these key times by summing the demand of the various land uses for each key time.
4. Determine the minimum shared parking space requirement by noting the largest of the aggregate parking demand figures.

## Example Shared Parking Calculation

The following example illustrates how to determine the parking demand from joint use shared parking for a mixed-use area containing a 10,000 square foot restaurant and 200,000 square feet of office space:

Assume that the restaurant user estimates a maximum need for 10 spaces per 1,000 square feet of restaurant space and the office user estimates a maximum need for 3 spaces per 1,000 square feet of office space. A 10,000 square foot restaurant and a 200,000 square foot office building thus require 100 and 600 spaces, respectively, or 700 total.

| Land Use | Single Use Peak Hour Demand (spaces) | Percentage of Demand for Key Times* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Weekdays | | | | | Saturdays | | | | |
| | | 10 AM | 1 PM | 5 PM | 8 PM | 10 PM | 10 AM | 1 PM | 5 PM | 8 PM | 10 PM |
| Retail | 3/1,000 sf | 50 | 75 | 75 | 65 | 25 | 50 | 100 | 90 | 65 | 35 |
| Office | 3/1,000 sf | 100 | 90 | 50 | 5 | 5 | 15 | 15 | 5 | 0 | 0 |
| Restau-rant | 10/1,000 sf | 20 | 70 | 70 | 100 | 95 | 5 | 45 | 60 | 100 | 95 |
| Cinema | 1/3 seats | 0 | 60 | 60 | 85 | 85 | 0 | 70 | 70 | 100 | 100 |
| Hotel | 1/room | 45 | 30 | 60 | 90 | 100 | 40 | 30 | 60 | 90 | 100 |
| Health Club | 5/1,000 sf | 10 | 80 | 100 | 30 | 10 | 60 | 80 | 60 | 30 | 10 |
| Residen-tial | 1.3 - 2/unit (see req's) | 85 | 80 | 85 | 95 | 100 | 70 | 65 | 75 | 95 | 100 |

** From the Urban Land Institute's Shared Parking Standards, 1983.*

*An example of a shared parking demand spreadsheet*

To determine parking demand if spaces are shared, parking demands for the two uses are added for peak times on weekdays and Saturdays, to see which hour produces the highest parking demand. In this case, the highest total demand is at 10 am on a weekday, when the office parking usage is estimated to be 100%, but the restaurant will be using only 20% of peak usage. The total is parking needed is thus 620 spaces, 80 fewer spaces than would be needed with separate parking lots. Even larger reductions in demand are possible with uses that have greater differences in their demand curves, such as office and cinema.

# The Need for Sustainability

Development-as-usual has proven detrimental to our environment and our health. Maui needs development that is efficient, harmonious with the natural environment, and capable of meeting human needs.

Changing the current standard practice of development will take many years and the efforts of many people. The built environment changes slowly, so for a long time areas with better development patterns will be small pockets in large areas with less to offer. But for places scaled to people, small areas are enough - the walk to the grocery, to work, or to the park will happen at short distances, so even small pockets of quality can function better than they would have as autocentric sprawl.

And it is important to begin now. The Maui Research & Technology Park has the opportunity to showcase an array of cutting edge sustainable design strategies. Workers and residents will enjoy a diversity of housing, transit connectivity, and quality economic development from this community for years to come.

*Wide traveling lanes promote higher vehicular speeds*

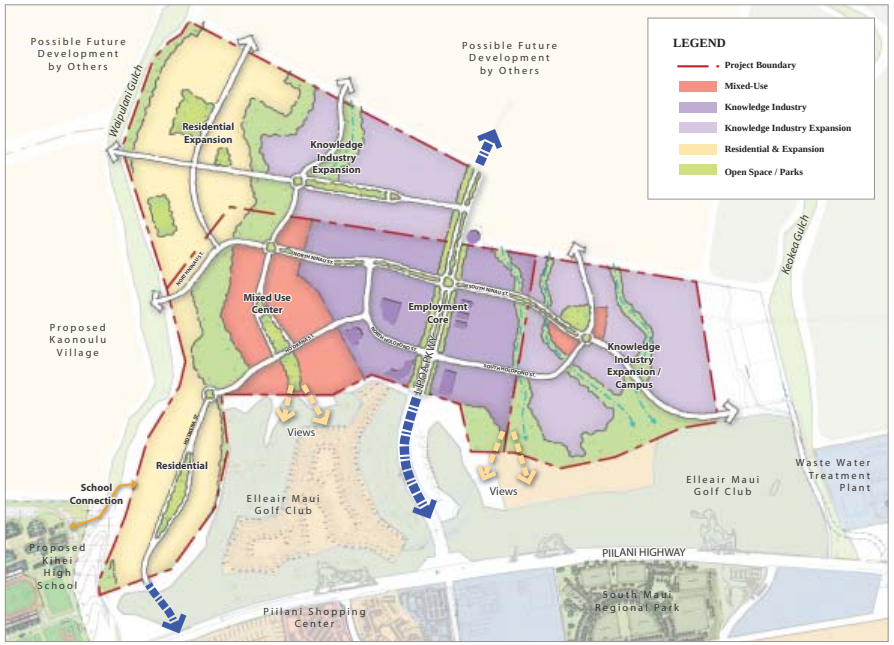
*Car-Centered intersections like this one at Lipoa Parkway and Pi'ilani Highway discourage pedestrian activity, leaving the park somewhat cut off from the rest of Kihei.*

# APPLYING THE PRINCIPLES

The plan for the Maui Research & Technology Park has been prepared using the principles of sustainability which were discussed in the previous chapter. These principles form a holistic system for creating sustainability. When applying the principles to an existing development such as this, some major elements of sustainability are outside the control of the plan. For instance, the Park's location across Pi'ilani Highway from the residential and retail areas of Kihei makes non-motorized transportation to the Park difficult. However, through attention to these principles existing conditions such as this can be mitigated. In this example, adding housing and retail activities to the park serves to add the appropriate mix of activities which will create a more complete community and allow people to meet all of their needs in the area.

The Concept Diagram at right shows the overall vision for the future of the Maui Research and Technology Park. The Park's existing buildings are within the Employment Core area. This area will remain exclusively in employment uses, though incidental supportive retail uses will be allowed. Major new employment zones south of Lipoa Parkway (the Knowledge Industry Expansion/ Campus area) and mauka the employment core (the Knowledge Industry Expansion area) provide large new areas for employment expansion and diversification. The new Mixed Use Center is a flexible area to contain space for incubating new businesses as well as supportive retail, civic uses, open space, and residential uses. New residential zones mauka and makai of the Center provide additional housing in a variety of formats which will appeal to park business owners and employees.

The Park has been envisioned with pedestrian connectivity as a first priority. A green corridor, running north to south along Ninau Street, links the center of the site. This corridor links the Park's two mixed use areas. Ideally, transit stops in these locations will also connect park workers and residents to the larger region. With a majority of businesses and homes within a 5-minute walk of the centers, many daily needs will be within a short and comfortable walk.




*Concept Diagram*

# Conservation & Restoration

Conservation and restoration of the environment is at the heart of the Park's sustainable urban design. Open space, as demonstrated in the Open Space Plan at right, is essential to a healthy community and transcends the aesthetic role of an attractive landscape to accommodate ecological factors, infrastructure systems and social needs. Ecological factors to be addressed include wildlife movement, habitat enhancement, water conservation, storm water capture and treatment, microclimate control to minimize heat island effects, and stream corridor protection. Open space serves as both landscape and infrastructure through the use of constructed facilities to capture, control and clean storm water and the provision of transportation corridors for trails and pathways. Open space also provides for the social needs of the community by providing spaces for recreation, relaxation and social interaction. In the end, multi-layered landscapes become expressions of cultural values and gather meaning and value to the entire community over time and through shared experience.

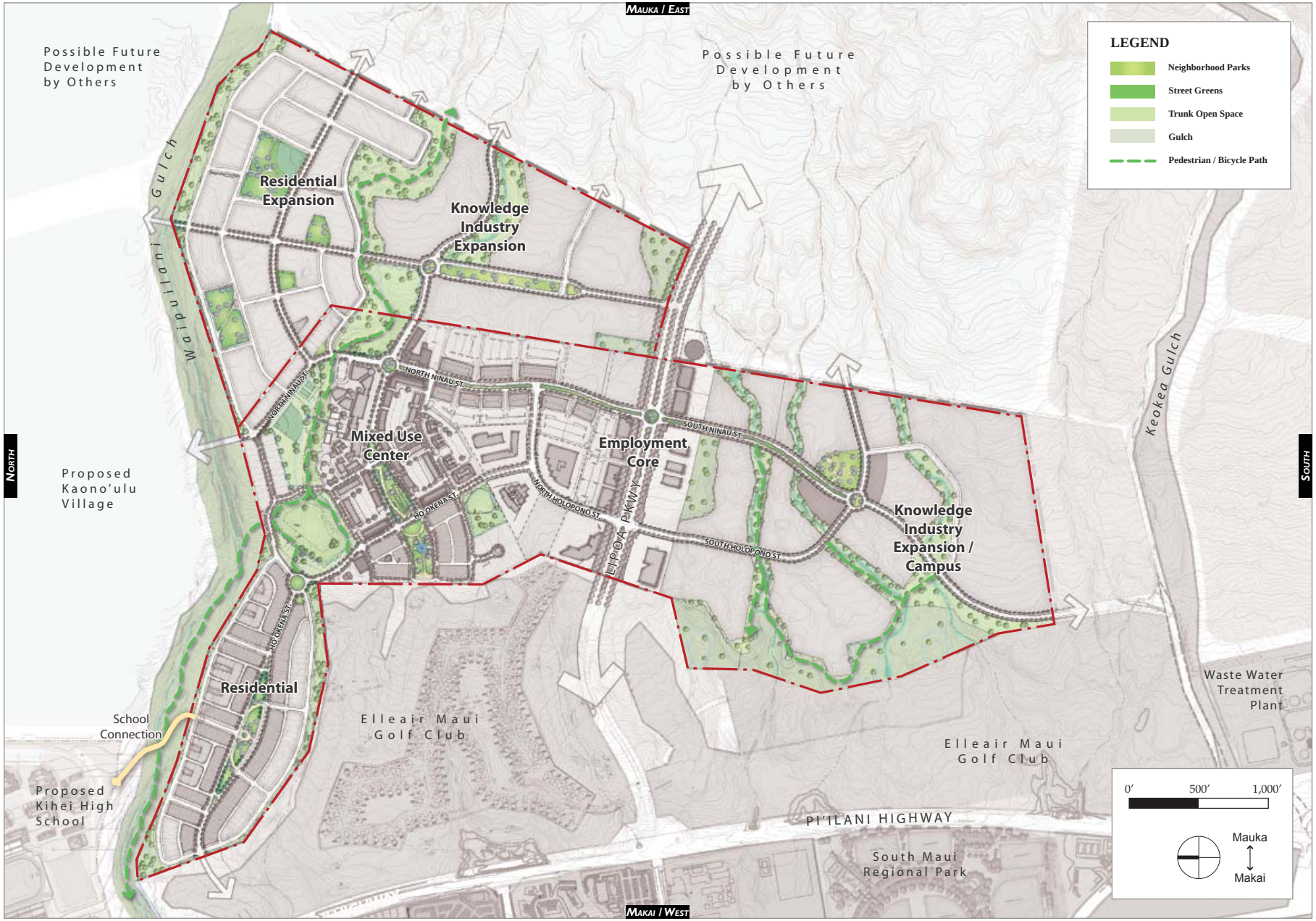
The plan connects to existing gulches (outside the Park boundary) which provide valuable connections mauka/makai and could form the trunk routes of a trail network connecting to the rest of Kihei. Neighborhood parks serve as community focal points and places for exercise, sports, relaxation, activities like community gardening, and celebration. Trunk open spaces contain some of the site's more dramatic terrain, allowing the plan to respect the existing topography while creating another set of linkages throughout the site. The north-south connector greenway (North and South Ninau Street) connects the site laterally, linking the mixed-use center with the employment area center while linking together other open spaces as well. This connection along with the fine grained street system, will serve bicyclists and pedestrians, giving full access to this compact and comprehensive community and reducing automobile use.

The Park will use recycled water from the county wastewater treatment plant everywhere except at single family homes. The master developer will encourage the use of recycled water for fire control, in toilets at commercial facilities, and anywhere else allowed by law. Based on the landscape architect's calculations, this should prevent approximately 170 million gallons of water per year from being sent into injection wells, potentially mitigating damage to ocean reefs and marine life. Water conserving irrigation practices will be implemented and required by design guidelines. As feasible, the park will implement or encourage drainage best practices such as bioswales and pervious surfaces.

Approximately 300 kilowatts of photovoltaic power is currently in use at the park, with another 200+ kilowatts planned. When that power is in place, 4 of the Park's 5 buildings will be offsetting a portion of their electrical use through solar power. The master developer of the park will encourage further use of as much renewable energy and distributed generation as the utility will allow. Design guidelines will encourage renewable energy projects, and energy conservation design features, such as low E glass (while still allowing people outside to see in), and shading of windows through architectural design. Solar hot water systems are required for residential projects in Hawaii.

Landscape CC&R's will allow sub associations to decide to use common areas for community gardens, and "edible landscaping." The use of native, drought tolerant plants will be encouraged. The Park plans to allow for the common areas to be used for a farmer's market.

When parcels are bought from the master developer, buyers will be encouraged to evaluate LEED certification for all commercial buildings. The plan itself has being analyzed for LEED-ND (Neighborhood Development) compatibility. However, certification is not assured as this process takes many years and eligibility is also keyed upon factors outside the control of the current planning process, such as the location of the Park away from other development, which was chosen many years ago by the Park's founders.




*Open Space Plan*

# Diversity & Balance

The plan at right shows an illustrative vision of how the Park might develop, based on the Concept Diagram at the beginning of this chapter. The plan provides a diversity of uses within the Park, far different than typical single-use development.

The housing, employment, retail, educational facilities and recreation areas within the relatively small area of the Park will create a situation with shorter distances for people to travel between their various activities. Many people will be able to forgo the use of a car for many of their trips, reducing pollution and congestion.

There is diversity even within the sub-areas and land use categories in the Park. The Mixed-Use Center contains a diversity of uses and building types, providing the densest housing nearest to the highest concentrations of jobs and retail. In the southern employment area, a small center provides a focus for employment expansion, giving access to retail services to that portion of the Park without having to travel even the short distance to the Mixed-Use Center. These locations, the densest and most varied in land use, will be the most appropriate for service by transit.

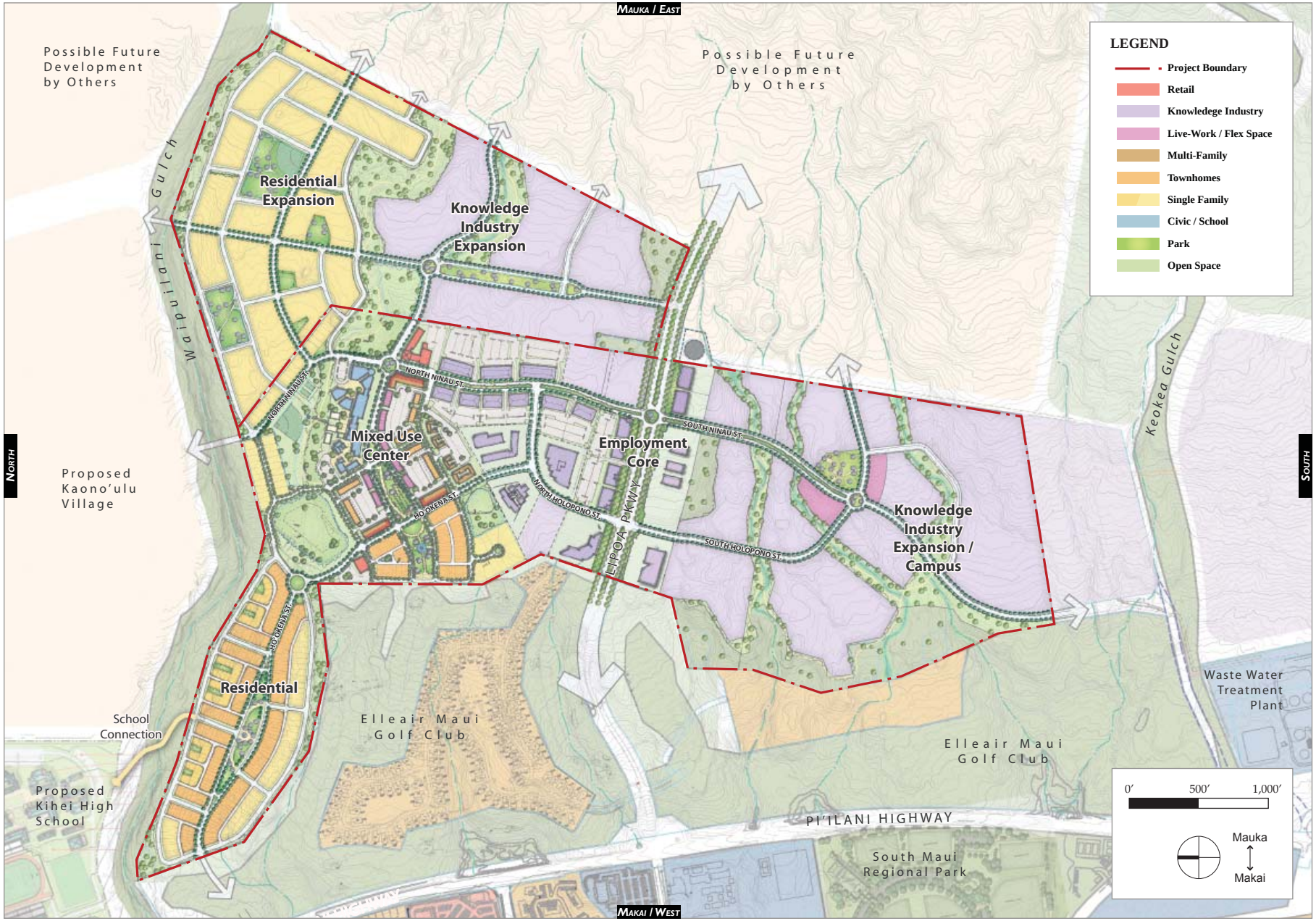
The plan assigns overall densities to the various residential areas in the Park. Within those areas, it is expected that there will be a wide variety of housing types. Housing variety not only allows development to respond to the changing conditions of the market, it will also make the Park a more vibrant area by supplying housing to a wide variety of people. A diverse housing offering will also make the Park more economically vibrant by appealing to a broader portion of the housing market.

Overall densities can be derived with a variety of unit mixes. In the Makai Residential area, for example, an overall density of 14 units per acre for developable land (not including parks, roads, utilities and other non-developable land) could be reached with all fee-simple housing. Most of the homes in this case would be townhomes and small lot detached houses. This mix would serve more young families and first-time home buyers. Other options include both a higher percentage of land with compact development, in multifamily and 3 & 4-plex buildings, and more low density units of various types. This type of mix would create a market for singles and couples to get into the neighborhood, and at the same time provide move-up housing for more established families.

In the same way, the plans for the Park have attempted to create a diversity of opportunity for employers. Current park regulations are highly restrictive, obligating the creation of larger buildings on larger parcels. But businesses go through life cycles just as people do, and one building size would not fit all businesses' needs. Newer businesses need small, inexpensive space. As businesses grow, they need larger spaces and can afford more amenities. Eventually if they continue to grow they will need very large spaces, but as employees move on and start their own businesses, the cycle begins again. Technology business thrives on this kind of change and growth, and the Park should be able to serve many stages of the life of a business. This is part of the economic side of the Park's sustainability mission.

The addition of civic uses and open spaces will create a complete community in the Park. Sprinkling smaller open spaces throughout the residential and business areas provides the opportunity for leisure and for exercise, as well as safe and pleasant routes to get around by foot and bicycle.

The Park's increased balance of employment and residential will help to alleviate problems of commuting. Having employment located nearer to residents shortens trips as well as promotes multi-directional commuting. This helps to avoid the situation where one side of the road is congested and the other is empty.

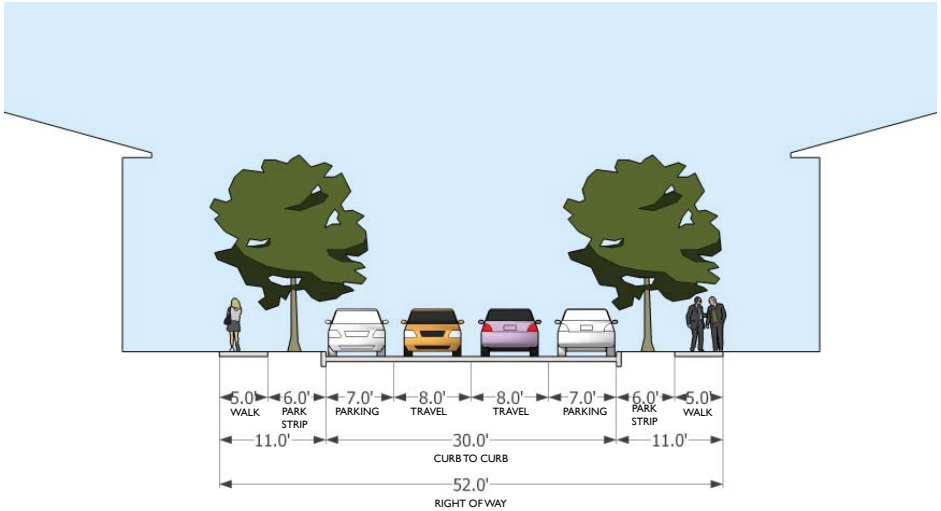



*Illustrative Plan*

# Human & Pedestrian Scale

In large part, the human and pedestrian scale of the Park's design comes from the fine grain of mixed use. Having a variety of activities and land uses available within a reasonable walking and bicycling distance creates an area scaled to people, not automobiles.

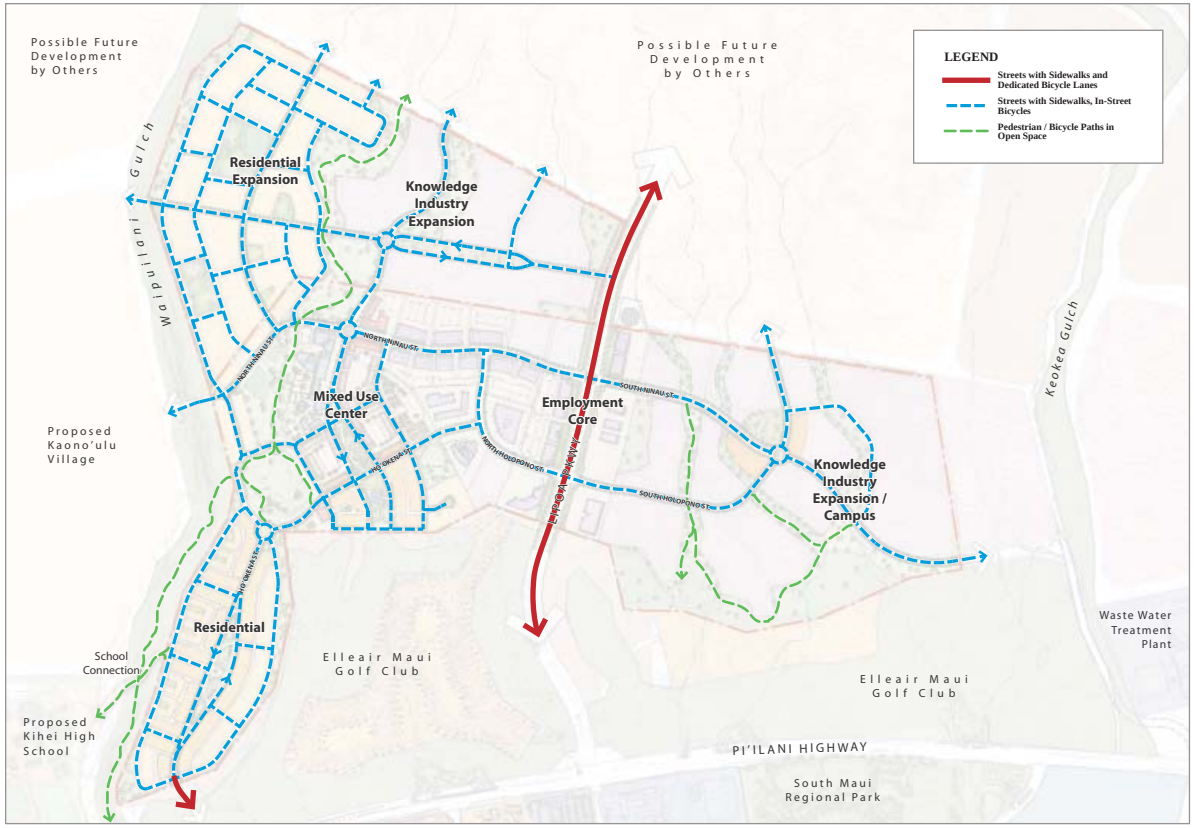
How those various land uses and buildings relate to the streets is also important. One critical but common mistake in urban design is the idea that green space cures every ill. Too much green space, however, particularly in the form of deep, formless setbacks and buffers, saps the vitality from the street, isolates buildings from the public realm, and makes every journey by foot or bicycle significantly longer. In the plan, new employment buildings line the streets and parking is placed at the rear. The scale of development is broken down in many areas to provide a greater variety of buildings and parcels, adding to pedestrian interest and utility. As shown in the proposed street section below, the plan proposes narrow streets for slow automobile traffic and nearby buildings, creating a kind of outdoor room which will be comfortable, safe and inviting for pedestrians.



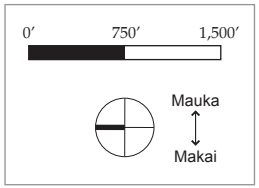

For the overall street network, the plan creates a unified bicycle and pedestrian system within the Park and connections to its existing and future surroundings. The Park's street design includes narrow streets, as previously mentioned, as well as the possibility of other traffic calming measures where needed. Remarkably, in many new developments and road projects one of the most basic elements of pedestrian comfort and safety is missing - sidewalks. The Park's streets will have sidewalks throughout, creating a fine grained network of access as well as the subtle message that walking is respected and valued. The presence of street parking on nearly every street will help to protect pedestrians literally and psychologically from automobile traffic. Intersections are meant to have small corner turn radii, causing cars to slow to reasonable speeds and making crossing distances for pedestrians shorter.

Trails create major connections through many of the greenways within and near the Park, as shown in the Pedestrian and Bicycle Connections Plan at right. Because of the Park's relatively long walking distance from Kihei makai of Pi'ilani Highway, walking will be important inside the park but bicycling will assume additional importance for accessing the Park. The roads into the Park from Pi'ilani Highway will have bicycle paths, making the journey uphill as safe and easy as possible. Connectivity in the Park is mostly provided without separate bicycle lanes; streets within the Park are intended to be small in scale and low in speed, which will make it safe to use bicycles in traffic.

An additional opportunity for access is presented by the Pi'ilani Highway overpass over the Waipuilani Gulch. This wide connection, while also an important stormwater drainageway, could make an excellent connection for pedestrians and bicyclists from the rest of Kihei to the Park and the new high school planned nearby.




*Pedestrian and Bicycle Connections Plan*



*This roadway in Kahului near a major shopping destination has a small sidewalk on one side and only this dangerous shoulder for walking on the other.*

*Pedestrian routes are often unconsidered, discontinuous, and unsafe, like this one at the intersection of Lipoa Parkway and Pi'ilani Highway.*

# Connections & Interdependence

Regardless of the higher level of self-sufficiency created by the mix of uses, the Maui Research & Technology Park will be a part of Maui's economic, social, and environmental landscape. This connection to and interdependence with the island and county as a whole have been considered throughout the plan.

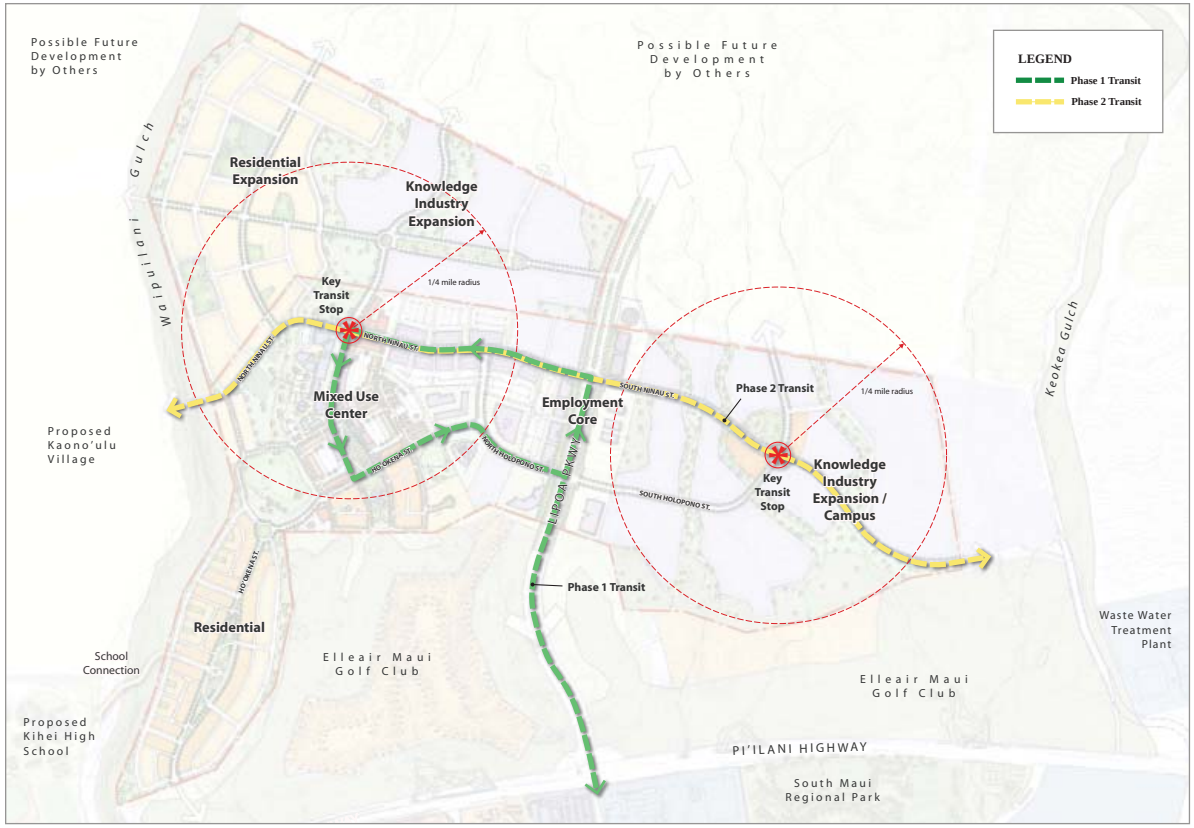
Given the low existing general density of the site and the site's position at the edge of the developed area, high quality transit will be difficult to achieve. However, over time at least a basic level of service should be provided to serve transit dependent persons and those who chose not to drive. As the site gains employment and population, transit service will become more viable as well as more essential. The site has been planned with this in mind, as is shown in the Public Transit Phasing Diagram at right. While many factors are and will remain outside the Park's control, such as the implementation of adjacent development and the level of funding of transit on Maui, it is essential that the plan consider how transit can work in the site.

*The Park in its current context*

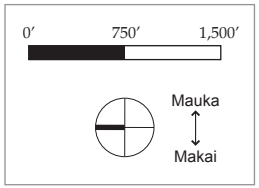
Phase one transit service could run either as an extension of existing transit service from the Pi'ilani Shopping Center area or as a dedicated jitney serving the park. Making a loop within the first phase development area, this line would link central Kihei to the development, providing easy access up the hill across Pi'ilani Highway. Contingent on the form of surrounding development and future road network changes, phase two transit service could run north and south along Ninau Street, connecting the site to nearby development and the island as a whole.

The Park's frequent street connections with proposed nearby development will provide flexibility for future transit routing. These connections will also serve to disperse and calm traffic, making all roads livable instead of creating a few large through roads which then become smothered in traffic. This connectivity will also increase the viability of pedestrian and bicycle access, which thrive in more direct routes and lower levels of traffic.

Many people will of course arrive in the Park by automobile, which will undoubtedly be the primary mode of transportation on Maui for the foreseeable future. However, current parking regulations tend to force businesses and residents to subsidize automobile use via the provision of free and plentiful parking. While parking is necessary, providing too much wastes money and land and causes people to drive more than they would if they had to pay for their own parking. While it does not seem feasible to eliminate parking minimums, the plan proposes reducing minimums, leaving the decision of parking provision more in the hands of the businesses and residents of the Park. The plan also promotes the use of shared parking, so that land uses which need parking spaces at different times can use the same parking lots. These steps will make the park more sustainable not by limiting driving but by causing drivers to pay more of the cost of their driving.




*Public Transit Phasing Diagram*



*Transit networks can be a supportive part of a diverse, multi-modal transportation system on Maui.*

*Phase one jitney services can operate from relatively small and fuel-efficient vehicles, which can be privately owned and easily maintained.*

Natural connections are also maintained in the Park's design. Instead of piping water through the site, the plan preserves many of these natural corridors (see the Open Space Plan shown previously) to provide drainage in a more natural way. This also provides corridors for wildlife, and for recreation and travel through the site by residents and employees.

# Conclusion

Sustainability in new development is not an add-on which can be considered after the structure of the development is conceived. Rather, sustainability relies on the basic structures and relationships of a development as discussed in this plan. Sustainability must be considered from the first stages of planning and design. This is how the design for the Maui Research & Technology Park was created. It is through these principles of Conservation & Restoration, Diversity & Balance, Human & Pedestrian Scale, and Connections & Interdependence that long-lasting, human-centered, and economically successful sustainability will be achieved.

As a further effort to enhance as well as confirm its sustainability, the Park has analyzed the possibility of gaining LEED-ND status. LEED-ND, or LEED-Neighborhood Development, is intended to gauge the overall sustainability of a neighborhood plan. The analysis is contained in this report as an appendix, and concludes that as an existing development, begun over twenty years ago, the Park has certain pre-existing characteristics such as its location which may make it impossible to attain LEED-ND. However, as the analysis also shows, the current plan takes major steps toward sustainability, regardless of whether the project is able to be officially declared LEED-ND.

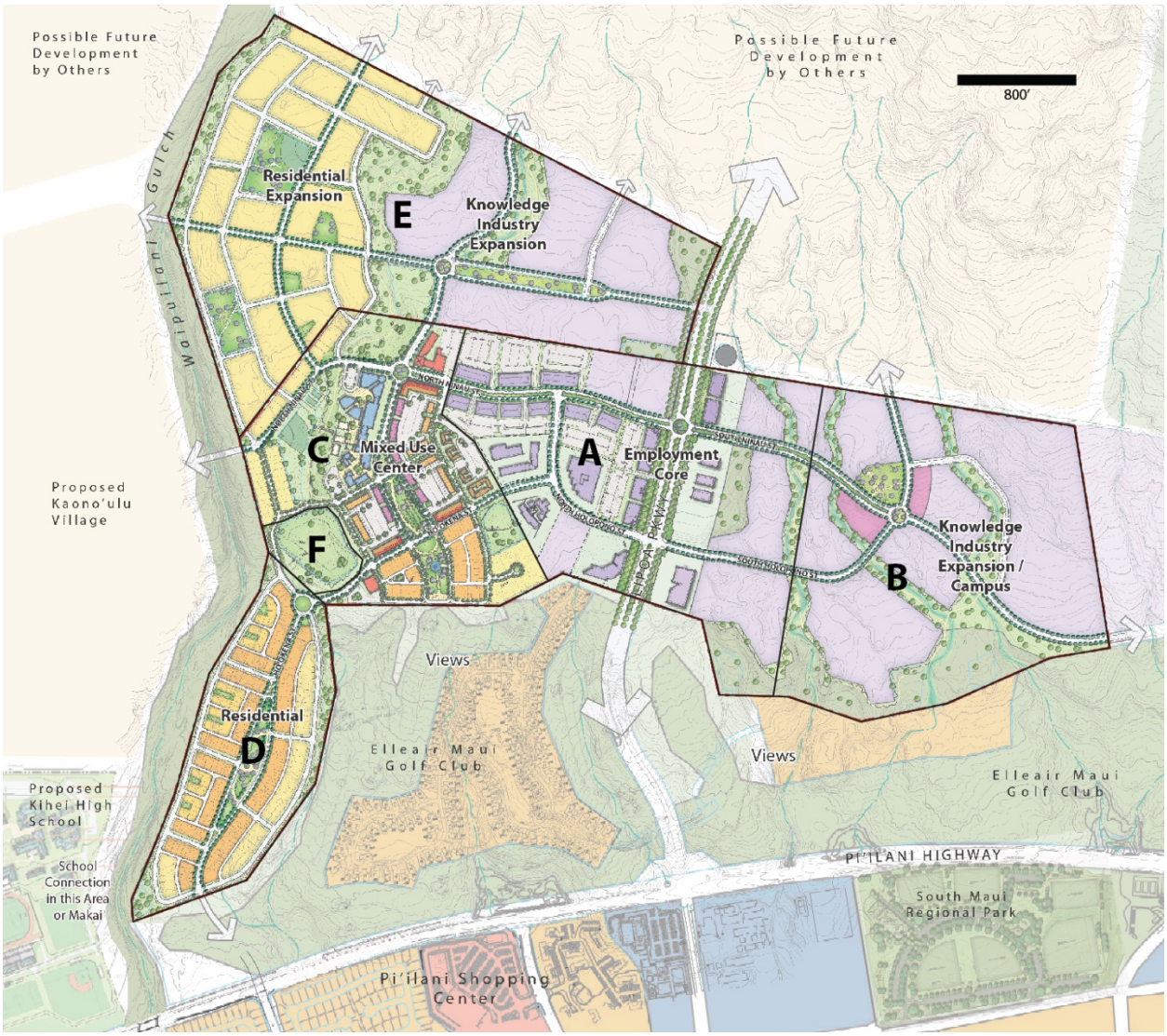
In the end, there is no single action or project that can solve the issues posed by the need for sustainability. Every action is a choice, and some of our choices as a society will require difficult decisions about priorities such as economic development, the environment, costs, and benefits. By incorporating sustainable principles as discussed above into the very structure of the plan for the Maui Research & Technology Park, we hope that the Park can play its part in the long term sustainable future of the island, the State of Hawaii, and the world as a whole.

# LEED for Neighborhood Development
# PRELIMINARY EVALUATION

December 13, 2012

## *The Purpose of This Report*

The goal of this analysis is to demonstrate the commitment of the Maui Research & Technology Park to smart growth and sustainable development standards and the aim to make this project a walkable and healthy community. The certification process is an involved one, and this analysis will also inform the Park management as to whether they should invest the time and resources into trying to make the Park a LEED-ND project. It is possible for a project to be sustainable and of high quality without certification. Many worthy projects do not qualify for one reason or another, or choose not to try for certification for other reasons. But certification provides a verifiable, publicly-acknowledged guarantee of the project's quality and sustainability, and can help a project gain community and government support and acceptance.




*Illustrative plan of the Maui Research & Technology Park with the six major divisions.*

This analysis is based on the current version of the LEED-ND system, LEED 2009 for Neighborhood Development, updated October 2012. All of the analysis in this report is based on an understanding of the LEED rating system. However, actual determinations of prerequisite fulfillment and awards of points are determined during the certification process by the USGBC; thus, it is possible that any prerequisite analysis in this report could need alteration and that the point total shown below could change in either direction. This report does not confer any LEED status, but only discusses what that status might be should the Park management decide to proceed. LEED status can only be conferred by going through the certification process.

## *The LEED-ND System*

The Leadership in Environmental and Energy Design for Neighborhood Development (LEED-ND) system is intended to rate the planning and development of new neighborhoods, whether infill sites or greenfield developments. It certifies exemplary development projects that perform well in terms of smart growth, urbanism, and green building. The program was designed by the US Green Building Council (USGBC), the same organization which created the LEED system for buildings.

LEED-ND certification is based on a set of prerequisites, which the project must meet, and a series of points, awarded based on whether a project meets a list of criteria. Depending on the number of points, the project can attain different levels of certification, as below:

| | |
|---|---|
| 40-49 Points | CERTIFIED |
| 50-59 Points | SILVER |
| 60-79 Points | GOLD |
| 80+ Points | PLATINUM |

Points fall into four general categories. Smart Location and Linkage considers the project's location, context, and links to the surroundings. Neighborhood Pattern & Design considers the design of the project. Green Infrastructure & Buildings considers environmental treatments more specific to individual buildings or to the project's infrastructure. And Innovation considers special factors.

Prerequisites and points are based on both elements of the plan itself and characteristics of the project's existing context. The system considers the context in order to encourage projects to be undertaken in locations which are well suited to development. Because the location of the Maui Research & Technology Park was chosen years ago when the Park was created, the element of context is beyond the control of the current planning and design process. It is the elements based on context and existing conditions which may keep the Maui Research & Technology Park from receiving LEED-ND certification.

## *The LEED Process*

Because of the length of time involved in many development projects, projects may apply in one of three stages of development. At certain times during the development cycle, a project may fall into none of these categories. In such case, the project would need to wait until it moved into the next stage of development before applying for LEED certification.

***Stage 1. Conditional Approval of LEED-ND Plan*** – This is for a project where less than 50% of the project's anticipated building area has land use entitlements ("the existing or granted right to use property for specific types and quantities of residential and nonresidential land uses", i.e. zoning).

Conditional Approval is for a project in the design phase before it has completed entitlements, and provides the Green Building Council's conditional approval of a LEED-ND Plan. The reason to attempt Stage 1 certification would be to help the project get support from the local government and from the community while pursuing entitlements. The Park will surpass this stage immediately when entitlements are approved, as the entire site will be zoned at one time.

***Stage 2. Pre-Certified LEED-ND Plan*** – a project with 100% of the project's building area fully entitled. This is for projects which are fully entitled (zoning, with all land use approvals granted by the locality) or for projects under construction up to completion of 75% of the total building area. Pre-Certification may help a project secure financing, expedited permitting for buildings, or attract tenants.

***Stage 3. LEED-ND Certified Neighborhood Development*** – a project fully built. Because the project is complete, all credits may be verified as achieved. This is the final seal of approval, where a project becomes officially LEED-ND.

The LEED certification process has a variety of steps, as shown below. Note that the process is administered by a third party organization, the non-profit Green Building Certification Institute (GBCI).

**1. PROJECT REGISTRATION**

Registering a project declares the intent to certify a neighborhood development under the LEED Green Building Rating Systems. Registration (for LEED-ND projects) with a fee provides tools and resources necessary to apply for LEED certification and the project is listed on the online LEED project database.

***Introductory Call.*** This call is an opportunity to receive general guidance about the program and review the certification process.

**2. PREPARE APPLICATION**

The project team is assembled to collect the necessary documentation, uploads the materials to LEED online, and starts the application review process.

**3. SUBMIT APPLICATION**

Project teams submit completed documentation requirements for all prerequisites and at least the minimum number of credits required to achieve certification, as well as completed general project information forms.

***Application for Smart Location and Linkage (SLL) Prerequisite Review.*** The SLL Prerequisite Review, for a fee, enables project teams to assess the likelihood of achievement of the SLL prerequisites. The GBCI reviews a project's compliance with the SLL prerequisites and informs the team whether the location qualifies, giving a project team the opportunity to pull out before additional expense is incurred.

***Application for Initial Review (All Stages).***

***Application for Subsequent Review (Stages 2 and 3).***

**4. APPLICATION REVIEW**

All documentation is reviewed with the LEED-ND rating system and each reviewed prerequisite and credit is designated as 'anticipated', 'pending', or 'denied'.

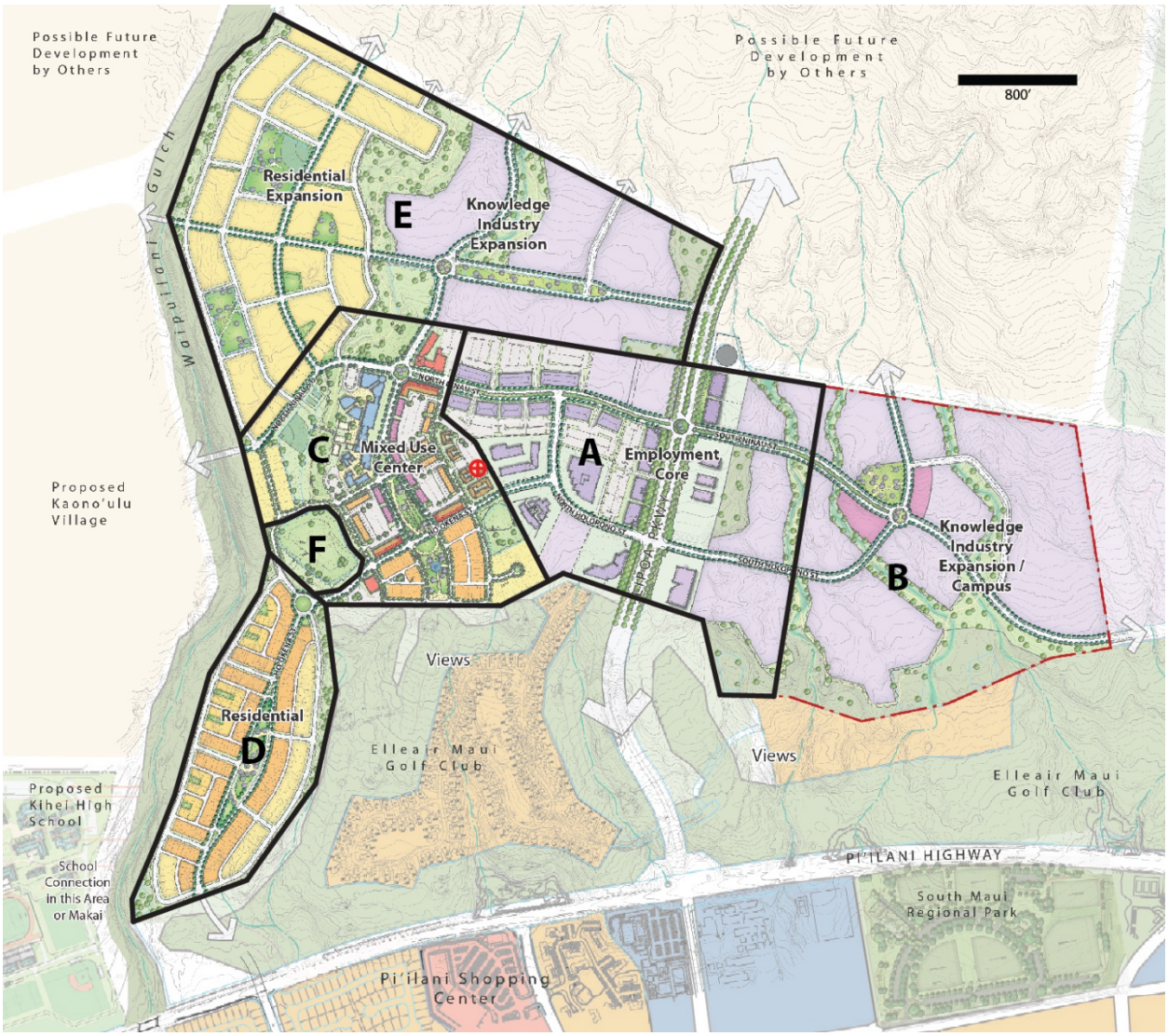
**5. CERTIFICATION**

LEED ND projects are considered certified upon the successful completion of a Stage 3 application. Upon successful completion of any application stage, a LEED-ND project will receive formal recognition and may be included (at the owner's discretion) in online LEED Project Directory of registered and certified projects.

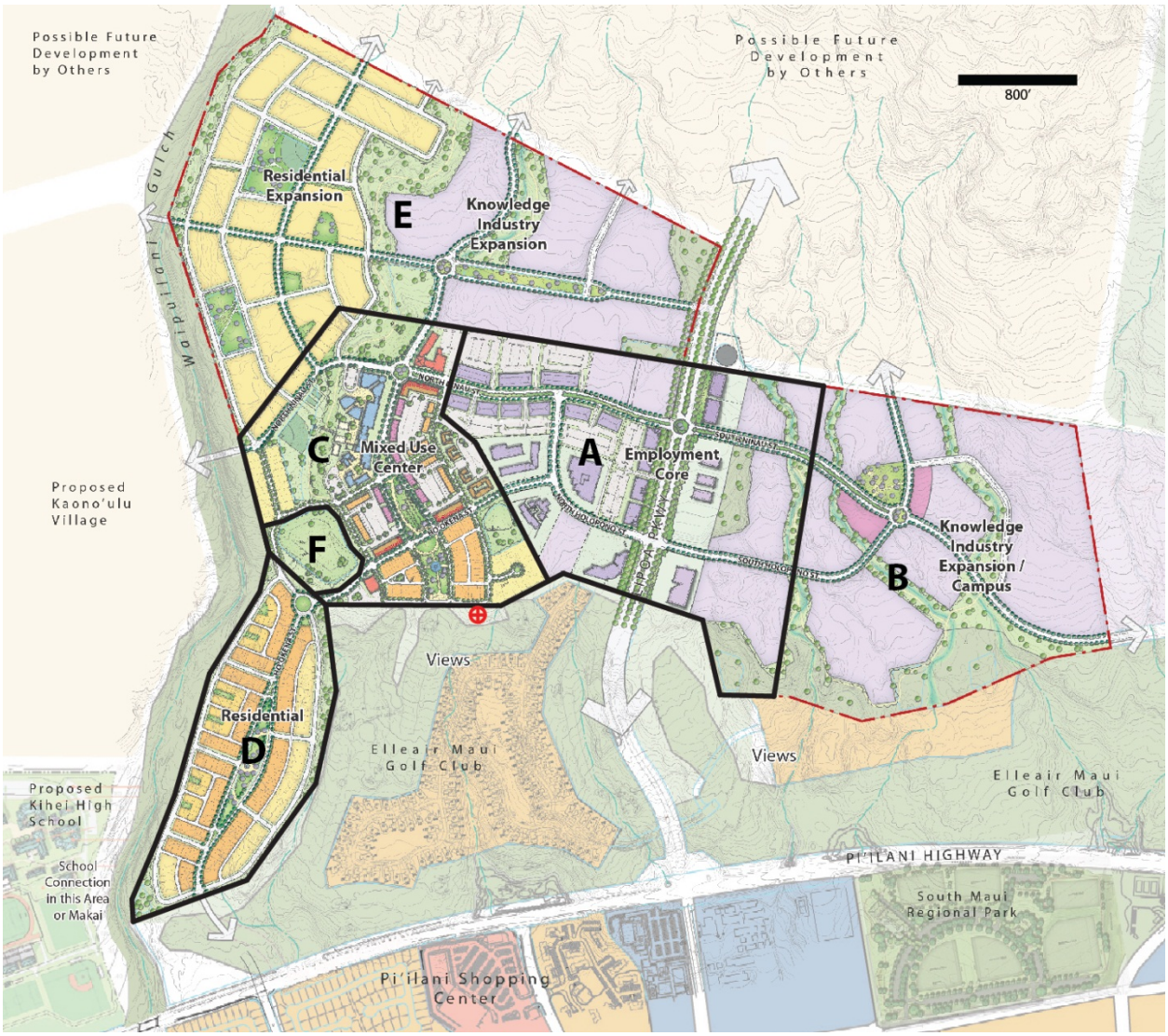
## *Site Selection*

Site selection is an important first step in the LEED-ND program. The location, characteristics, existing uses, adjacencies, and size inform and determine which requirements in the SLL Prerequisites the "project" will pass or fall short of. The maximum size recommended by the USGBC for LEED-ND projects is 320 acres. Beyond that size, a project may run into difficulties meeting certain distance-related requirements such as walking distances to various amenities. The typical project sizes discussed are between 40 and 160 acres, though a project may be as small as two habitable buildings.

It seems likely if the Park was to apply for LEED-ND that it would either need to be split into several "projects," to be dealt with separately, or the Park would only apply for certification for a portion of the total site. The graphics below show several options for projects that encompass various sections of the site. There is no requirement that the project boundary be set based on these large areas, however. On close analysis, it may be found advantageous to divide the site more finely by individual parcels. This report assumes that any meaningful pursuit of LEED-ND certification would include at least the mixed use center and the employment core. Ideally the project area would also include the makai residential area and land in the expansion areas mauka of the mixed use center and employment core.




*A possible LEED-ND "project" area, including Park areas ACDEF. The red circle represent the center of the assembled parcels.*




*A possible LEED-ND "project" area, including Park areas ACDF. The red circle represent the center of the assembled parcels.*

## Analysis One: PREREQUISITES

The prerequisites determine whether a site may even be considered for LEED-ND status. These prerequisites fall into three of the same four categories that points do, as below.

### *Smart Location and Linkage*

- Smart Location
- Imperiled Species and Ecological Communities
- Wetland and Water Body Conservation
- Agricultural Land Conservation
- Floodplain Avoidance

### *Neighborhood Pattern & Design*

- Walkable Streets
- Compact Development
- Connected and Open Community

***Green Infrastructure & Buildings***

- Certified Green Building
- Minimum Building Energy Efficiency
- Minimum Building Water Efficiency
- Construction Activity Pollution Prevention

This section will consider each of the prerequisites. Where a prerequisite could be achieved by a future action of the Park, even where steps have not yet been taken to achieve that prerequisite, this report assumes that the Park would do so in the case that Park management decided to pursue LEED-ND certification.

## *Smart Location and Linkage*

### *SLLP1 SMART LOCATION*

Smart Location is a key element of the LEED-ND program. It focuses on selecting sites that minimize adverse environmental effects of new development and avoiding sprawl; reducing vehicle miles traveled and household transportation costs; and improving the health and livability of a community by offering walkable mixed-use environments. Smart Location is an important first step and for that reason a major hurdle in the LEED-ND program that determines whether a project should register and continue with the certification process.

In some ways, Smart Location is the “gateway” requirement. Projects can change their other characteristics by changing their design and their construction practices, but once the site itself is selected there’s no simple way to qualify for Smart Location if the project is not in the right spot. Since the Maui Research & Technology Park’s site was selected many years ago by the originators of the Park, there is nothing that can currently be done about it.

Within the prerequisite there are two requirements, both of which must be satisfied. One is related to water and one to adjacencies. The Park qualifies for the water requirement because it is served by existing water and wastewater infrastructure.

The adjacencies requirement has four options:

a. an infill site
b. a site adjacent to previously developed land and with a high level of connectivity
c. a site on a transit corridor with a high level of service
d. a site with nearby neighborhood assets

**Infill Site (option a)**

To be an infill site, a project must have one of these characteristics.

a. 75% of the project boundary borders parcels that are previously developed
b. Using selected bordering parcels in addition to the site, 75% of the total boundary borders parcels that are previously developed
c. at least 75% of the land within ½ mile of the project boundary is previously developed
d. land within ½ mile of the project boundary has at least 140 road intersections per square mile

The Park, or any project site within it of reasonable size, does not satisfy any of these requirements and so is not an infill site.

**Adjacent Site (option b)**

To be an adjacent site with connectivity, the project must have at least 25% of the border connected to previously developed land. Per contact with the USGBC, the golf course qualifies as previously developed land. Within the area within ½ mile of the boundary with the golf course, however, there must be at least 90 road intersections per square mile, and the project must be connected to the adjacent land with a roadway at least every 800 feet.

The Park and adjacent site do not meet the required number of existing intersections per square mile, nor does the Park have the required connections to the previously developed land, so it does not qualify as an adjacent site.

**Transit Corridor (option c)**

To qualify as a site on a transit corridor, at least 50% of a project's residences and non-residential development must lie within ¼ mile walking distance of transit stops served by existing or planned transit service with at least 60 weekday trips and 40 weekend trips. To qualify as planned, transit service must have funding agreements or plans in place.

As shown on the plans below, the closest bus stops to the Park for the two nearby routes are in the Pi'ilani Shopping Center, across Pi'ilani Highway from the Park. This is beyond the maximum ¼ mile walking distance requirement. In addition, transit service at the shopping center does not meet the minimum trip requirements in any case. See the Maui Bus website (*http://www.co.maui.hi.us/index.aspx?NID=609*) for detailed schedule information.

*Excerpt of the map for the Kihei Islander, Route 10 (left) and Kihei Villager, Route 15 (right)*

To our knowledge, there is also no planned and funded transit service which would meet the requirement. Therefore, the Park does not have existing or planned transit service at the required level and so does not qualify as a site on a transit corridor.

**Neighborhood Assets (option d)**

To qualify for Smart Location based on neighborhood assets, a site must do both of the following:

a. Have at least 30% of its total building square footage as residential. Depending on the defined project boundary, the Park should easily qualify for this.

b. Locate near existing "diverse uses," so that either:

    a. The project boundary is within ¼ mile walk of at least five diverse uses, or
    b. The project's geographic center is within ½ mile walk of at least seven diverse uses.

The list of diverse uses is as follows:

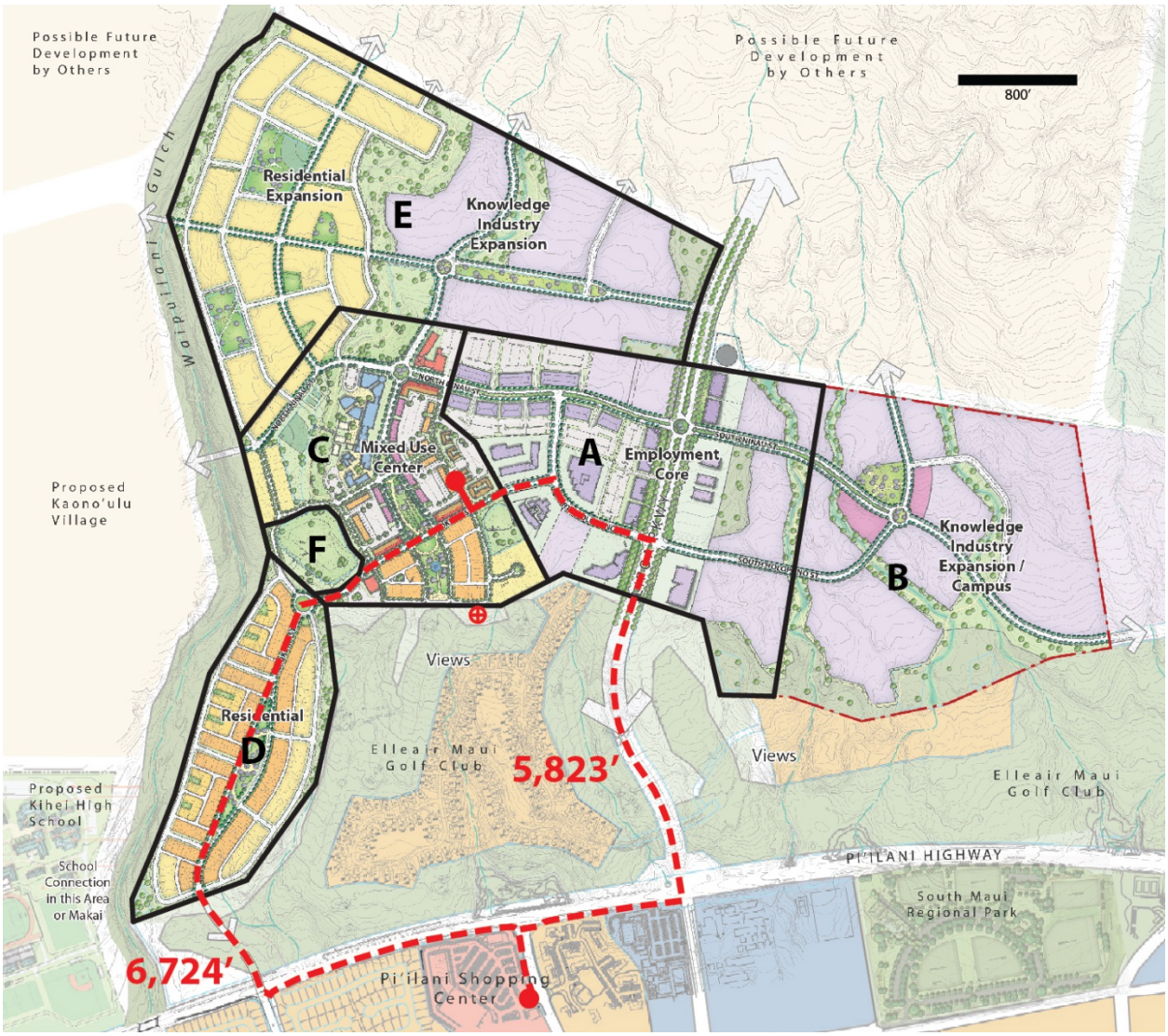
***Food retail***
Supermarket
Other food store with produce

***Community-Serving retail***
Clothing store or department store selling clothes
Convenience store
Farmer's market
Hardware store
Pharmacy
Other retail

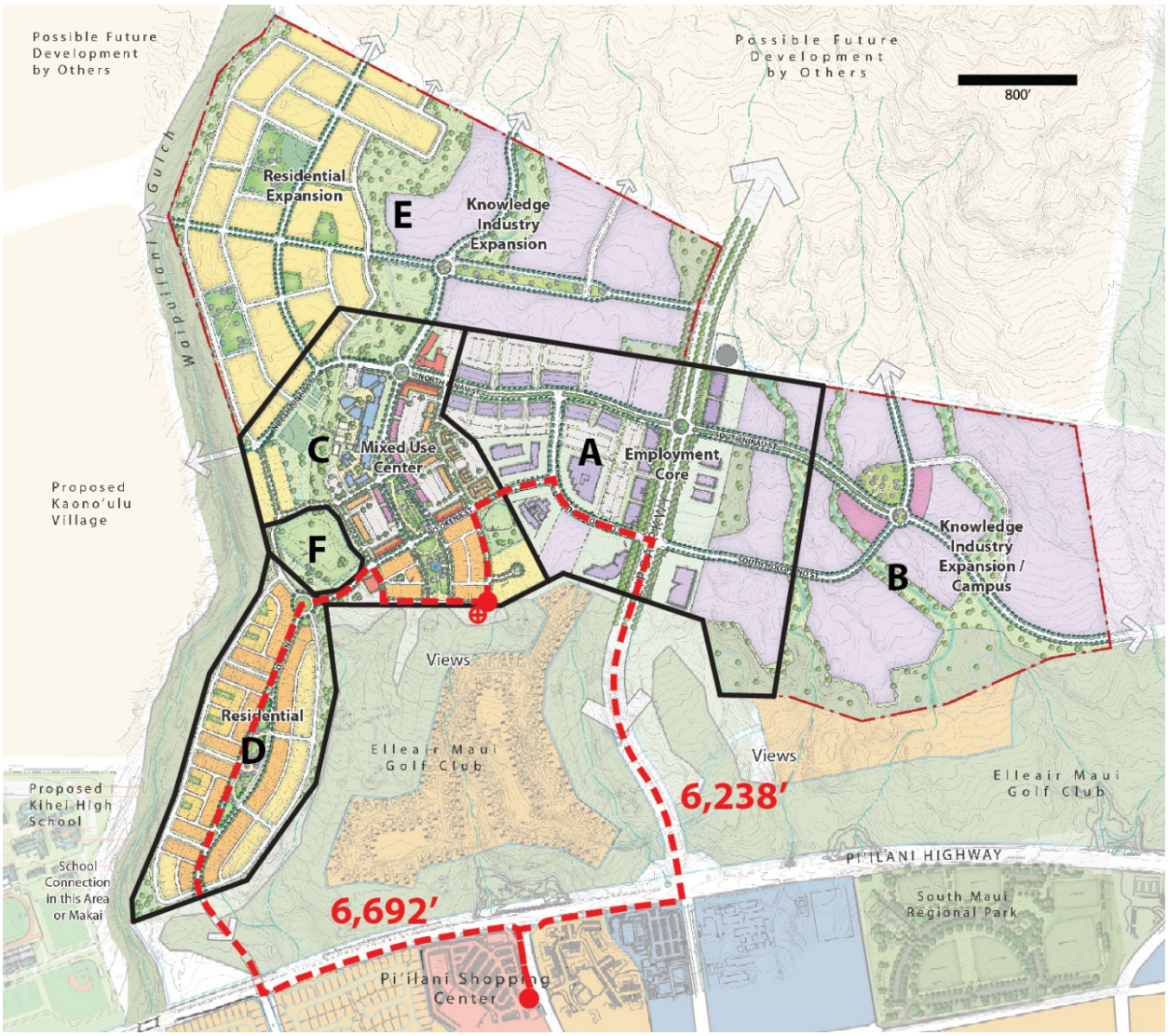
***Services***
Bank
Gym, health club, exercise studio
Hair care
Laundry, dry cleaner
Restaurant, café, diner (excluding establishments with only drive-throughs)

***Civic and Community Facilities***
Adult or senior care (licensed)
Child care (licensed)
Community or recreation center
Cultural arts facility (museum, performing arts)
Educational facility (including K–12 school, university, adult education center, vocational school, community college)
Family entertainment venue (theater, sports)
Government office that serves public on-site
Place of worship
Medical clinic or office that treats patients
Police or fire station
Post office
Public library
Public park
Social services center

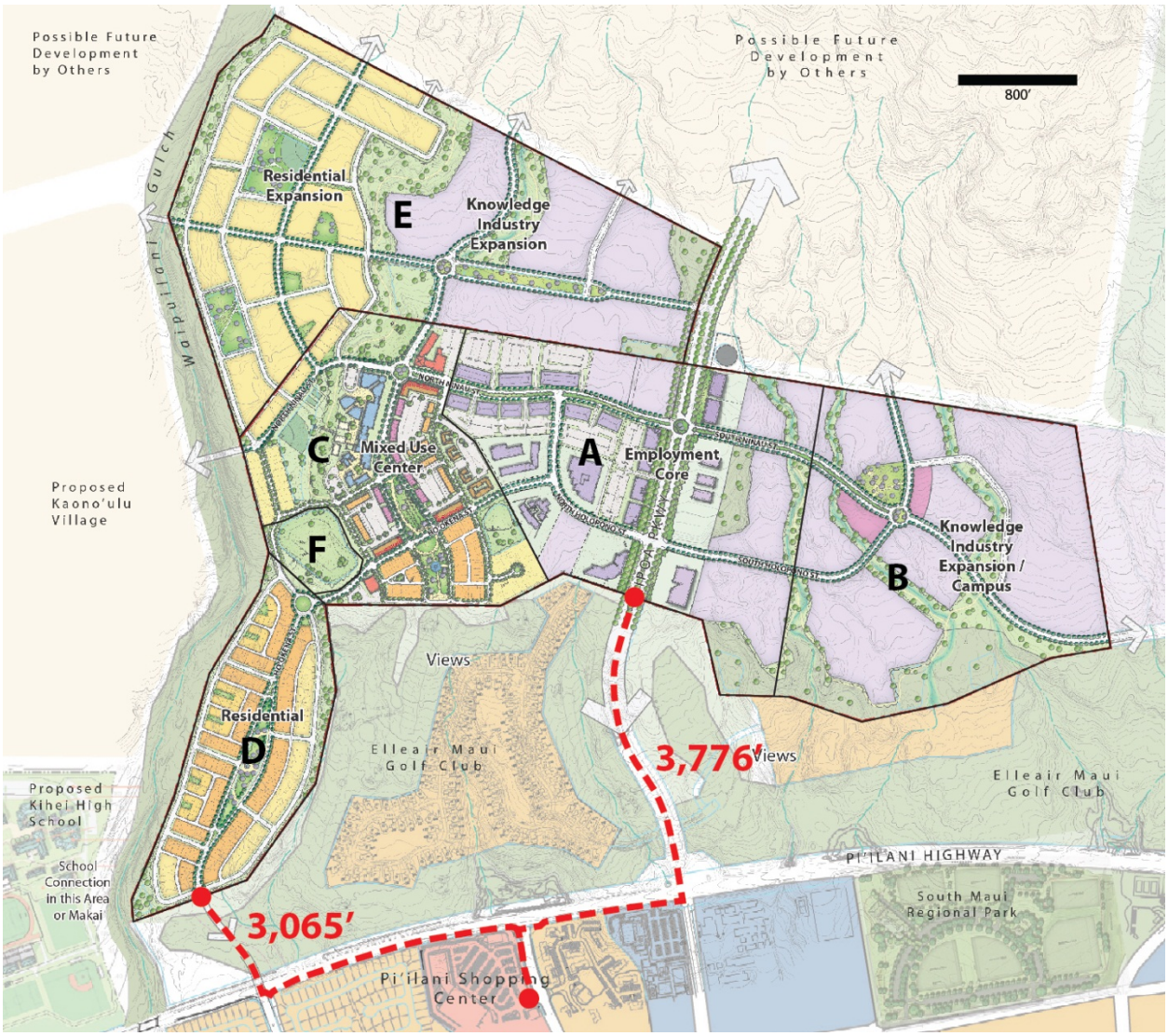
The nearest location which includes these diverse uses possibly in enough quantity to qualify is the Pi'ilani Shopping Center, across Pi'ilani Highway from the Park. The maps which follow investigate two options for reaching this shopping center by foot using two hypothetical project areas. The walking distances are measured using both methods, from the geographic center of the hypothetical project area (one map for each option), and from the project boundary (one map, the same for both).




*Measurement to the entrance of Pi'ilani Shopping Center from the center of a project area including Park areas ACDEF.*




*Measurement to the entrance of Pi'ilani Shopping Center from the center of a project area including Park areas ACDF.*




*Measurement to the entrance of Pi'ilani Shopping Center from the edges of the Park.*

While the Park would most likely qualify based on the percentage of residential area, it would not qualify based on the proximity to diverse uses. Thus, the Park would not qualify under the Neighborhood Assets option.

**Smart Location Prerequisite Conclusion**

As we have seen, the Park would not qualify based on any of the four options, a-d. Therefore, the Park would not meet the SLL prerequisite 1, Smart Location, and would not qualify for LEED-ND status. This disqualification is due to the existing location of the Park.

Based on advice from the USGBC, it might be possible to apply for LEED-ND certification for portion of the Park based on Neighborhood Assets after sufficient "diverse uses" are built within the Park itself. Following creation of those uses, other portions of the Park could count them. However, in the current situation, the Park cannot meet this prerequisite.

### *SLLP2 IMPERILED SPECIES AND ECOLOGICAL COMMUNITIES CONSERVATION*

The project should not be built on a site with imperiled species or ecological communities. Based on extensive flora/fauna surveys conducted for the Park, there are no imperiled species or ecological communities found onsite. The Park should meet this prerequisite.

### *SLLP3 WETLAND AND WATER BODY CONSERVATION*

The project should not include wetlands or water bodies, or be within 50 feet of wetlands or 100 feet of water bodies. While development in the gulches just north and south of the Park is regulated, there are no wetlands or water bodies in or near the site. The Park should meet this prerequisite.

### *SLLP4 AGRICULTURAL LAND CONSERVATION*

The project should not be in a state or locally designated agricultural preservation district, and should not impact important soils. The Park is in the lowest/least valuable classification of land and soil for agriculture. We do not anticipate a problem meeting this prerequisite.

### *SLLP5 FLOODPLAIN AVOIDANCE*

The project should be located in an area without FEMA-designated floodplains, or develop only those portions of the site which are not floodplains. The Park does not contain any floodplains in our knowledge and should meet this prerequisite.

## *Neighborhood Pattern & Design*

### *NPDP1 WALKABLE STREETS*

This prerequisite has four components, all of which must be met.

a. At least 90% of new building frontage must have a principle entry facing a street or public space. Based on the design guidelines, the Park should meet this requirement in most areas. The campus area in the south may create an issue, where buildings are not adjacent to the street but facing private areas and parking lots. This is one reason why the campus area should be excluded from the “project” for the purposes of LEED-ND

b. At least 15% of existing and new street frontage within the project has a building height of at least 1’ for every 3’ of space across the roadway (building façade to building façade). Given the Park’s narrow planned roadways and short allowed setbacks, the Park should be able to meet this requirement. However, final completion of the requirement would depend on the specifics of future development in the Park. Were LEED-ND to be pursued, the Park would need to develop a strategy for meeting this requirement based on the most likely areas for achievement, possibly to include requirements on individual parcels to build buildings which would help to meet this walkable streets component.

c. At least 90% of streets within the project must have sidewalks, at least 8’ wide on mixed use blocks and 4’ elsewhere. The Park should meet this requirement, given that all planned street sections have sidewalks. Proposed sidewalks all meet the 4’ minimum. Sidewalks in mixed use blocks could be built wider, including part or all of the green space shown on the section drawings, to meet the 8’ minimum.

d. No more than 20% of street frontages should be faced directly by garages and service bays. The Park’s design guidelines should allow it to meet this requirement.

It appears that all four requirements of this prerequisite can be met, though with some planning and effort.

### *NPDP2 COMPACT DEVELOPMENT*

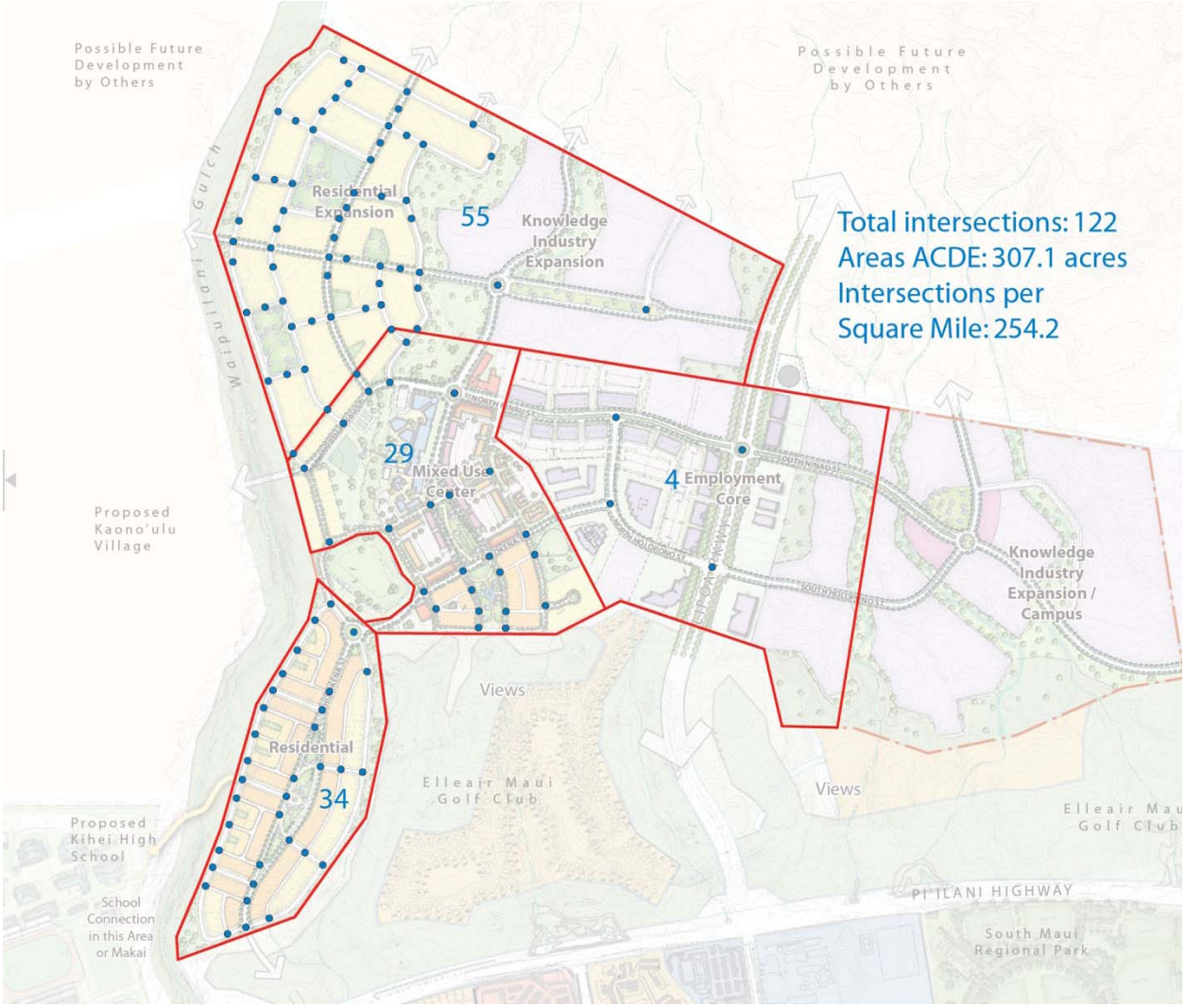
This prerequisite requires that residential components of the plan be built at the minimum average net density of 7 dwelling units per acre, and non-residential components be built at a minimum average floor area ratio (building area divided by land area, also known as FAR) of 0.5. This average FAR will be difficult to achieve, given that the overall non-residential FAR in the Park is to be around 0.3. It is possible, however, that the LEED-ND project area could be targeted for the most dense employment uses, leaving the other employment areas even less dense but the entire Park at the same average density. In any case, there is a possible other way to achieve the density requirement, as noted in the next paragraph.

The Park's planned overall housing density is approximately 15 units per acre, well over the necessary average density. In fact, the LEED-ND system makes an allowance for either residential or non-residential uses to carry the load for the density requirement. The requirement states that if either the constructed housing or non-residential built area on its own, divided by the total (combined) land area for residential and non-residential, equals a density higher than required for that element of the plan (residential or non-residential), then the entire prerequisite is met. Thus, if the housing is built and ends up at a density greater than 7 units per acre over the entire project site's developable land area, the prerequisite is met and the non-residential density is irrelevant.

One complication is that the density must be achieved within five years of the date that the first building of any type is occupied. This seems to bias the choice of project sites to smaller areas which can be built out quickly, in five years or less. Overall, it appears that this prerequisite can be met, with proper planning to achieve the minimum density of development and the right amount of time for development completion.

### *NPDP3 CONNECTED AND OPEN COMMUNITY*

This requires that the project's internal street network have at least 140 intersections per square mile and that the network have one street connecting to the project boundary at least every 800 feet. Intersections which count for this calculation include streets, alleys and non-motorized rights of way. As shown in the graphic below, the Project, if it were to include areas A,C,D and E, has 122 planned and existing intersections in 307 acres, giving an average of 254 intersections per square mile, well over the required amount.




*The intersections within the project are at 254 per square mile.*

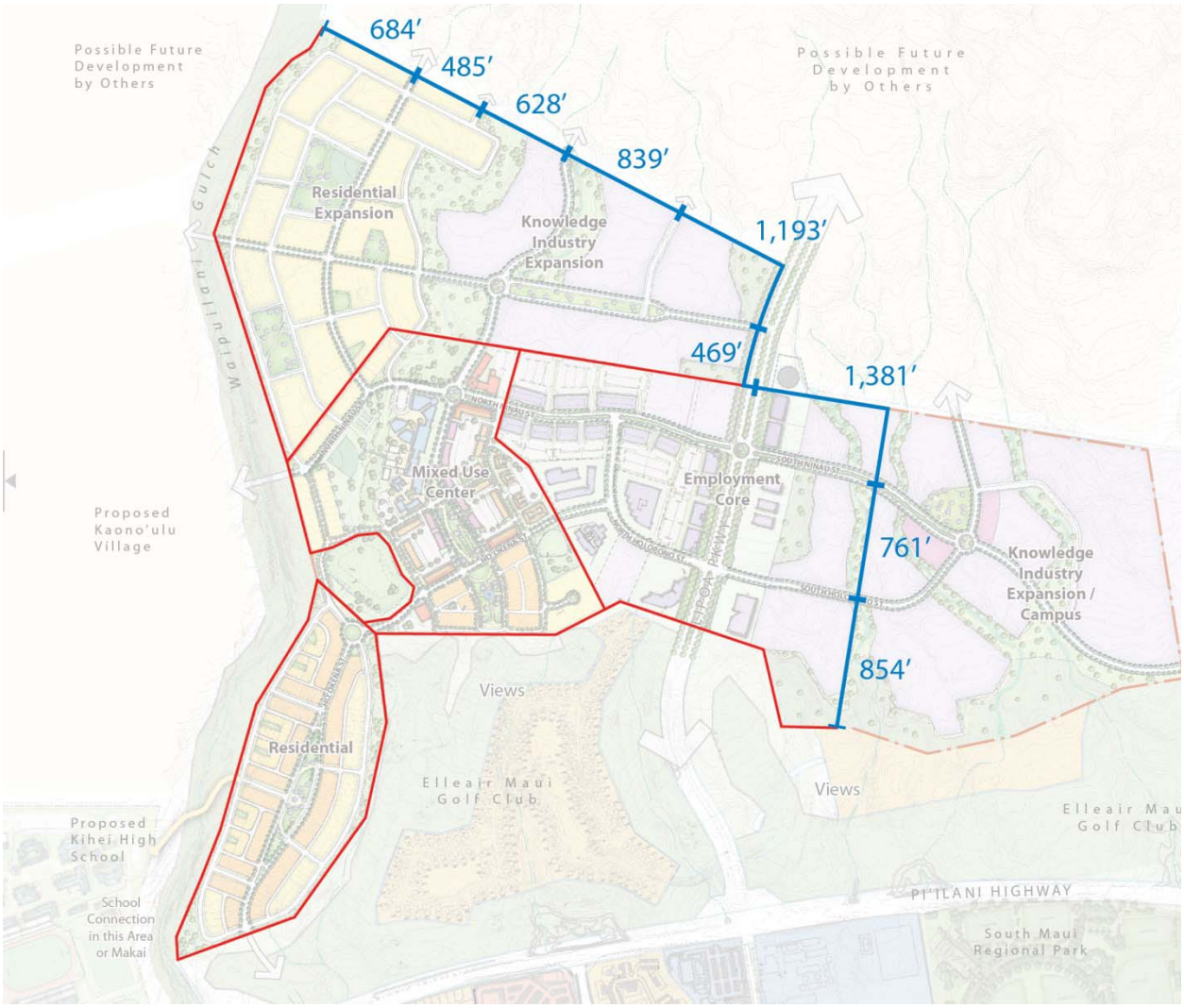
As for street connections, this requirement is a bit more problematic. Note that the connections requirement does not apply to "portions of the boundary where connections cannot be made because of physical obstacles, such as prior platting of property, construction of existing buildings or other barriers, slopes over 15%, *wetlands* and *water bodies*, railroad and utility rights-of-way, existing limited-access motor vehicle rights-of-way, and parks and dedicated open space." We take this to mean that boundaries along the golf course and along Waipuilani Gulch would not need to meet the requirement.

However, given the need for flexibility and the possibility of large employment parcels, the distances between several planned connections to other areas outside the project are over 800 feet, as shown in the graphic below. We believe that each of these could be overcome, however:

- 839' – From the north near Waipuilani Gulch, the first instance of a distance over 800 feet is the distance between the two roads going from the expansion employment land to mauka. Because the distance is not much more than the maximum and there are no existing roadways which these roads are intended to meet, the position of one or both roads could be adjusted to reduce the distance to 800 feet or less.
- 1,193' – Continuing to the south, the next distance between connections is also more than 800'. An exception is granted for areas where a connection is not possible because of slopes over 15%. This area is impacted by slopes, though the precise amount of slope, and whether it creates enough of a barrier to warrant an exception, would have to be investigated. We believe that such an exception will be granted, but a detailed investigation would be required in order to meet LEED-ND reporting

requirements. Alternatively, an alteration could be made to the road network to add another connection in this location should that be necessary, to be added when the associated adjacent property is developed.

- 1,381' – This next location of concern is south of Lipoa Parkway. In this case, there is no problematic area of slope. The reason for the large distance between connections is the desire to preserve large parcels for development. However, should the Park decide to pursue LEED-ND accreditation, an additional road could be added here to connect South Ninau Street to the area mauka of the Park. The road would only be constructed when the parcel through which it ran was developed.
- 854' – This final location of concern borders an area of very steep slope. It seems likely that the exemption for steep slope would be granted in this location.




*Connections outside the project vary from 469 feet apart to 1,381 feet apart. The maximum allowed is 800 feet.*

In the end, there are concerns about connections to the surrounding areas, as discussed. However, we believe that all of these could be overcome if the Park was to pursue LEED-ND.

## *Green Infrastructure & Buildings*

These prerequisites set requirements for buildings and building activities in the project. We list the requirements here in simplified form, but we assume that all of these prerequisites could be met through agreements with and requirements on building in the Park should the Park decide to pursue LEED-ND.

#### *GIBP1 CERTIFIED GREEN BUILDING*

Requires the construction of at least one LEED-certified building within the project.

#### *GIBP2 MINIMUM BUILDING ENERGY EFFICIENCY*

Requires that at least 90% of new building area of nonresidential and mixed use buildings and of multifamily buildings over four stories show an average 10% improvement over ANSI/ASHRAE/IESNA Standard 90.1–2007, and that buildings undergoing major renovation average 5% improvement over ANSI/ASHRAE/IESNA Standard 90.1–2007. Also requires that at least 90% of new single-family residential buildings and new multiunit residential buildings of three stories or fewer meet Energy Star or equivalent.

#### *GIBP3 MINIMUM BUILDING WATER EFFICIENCY*

Requires that nonresidential buildings, mixed-use buildings, and multifamily residential buildings of four stories or more which are new or undergoing major renovations have indoor water usage an average of 20% less than in baseline buildings, based on the Energy Policy Act of 1992, subsequent rulings by the DOE, the requirements of the Energy Policy Act of 2005, and fixture performance standards in the 2006 Uniform Plumbing Code or International Plumbing Code. Also requires that at least 90% of new single-family residential buildings and new multiunit residential buildings three stories or fewer use fixtures that would earn 3 points under LEED for Homes 2008 WE Credit 3, Indoor Water Use.

#### *GIBP4 CONSTRUCTION ACTIVITY POLLUTION PREVENTION*

Requires that all new construction activites create and implement an erosion and sedimentation control plan.

### *Prerequisite Conclusion*

While based on our analysis the Park could meet all other prerequisites, the Park's existing location and context will prevent it from currently meeting the SLLP1 Smart Location prerequisite. Therefore, in our opinion the Park is unfortunately unable to achieve LEED-ND accreditation.

## Analysis Two: POSSIBLE POINTS

Regardless of the conclusion of the prerequisite analysis, in this section we will analyze of the various possible points available in the LEED-ND process. The purpose of this is to determine what level of certification the Park might achieve if it were able to apply. As noted before, this analysis is based on the authors' opinion. Actual awarding of LEED-ND points would be at the discretion of the USGBC in the course of the accreditation process.

### *Smart Location and Linkage*

#### *SLLC1 PREFERRED LOCATIONS – 10 POSSIBLE POINTS*

This credit has a three point-generating options which may be added for a total of 10 points.

**Option 1 – Location Type**

This option has four location types which reward points. However, all of these types require a project to be either an infill site or a previously developed site. The Park would not qualify as either of these.

**Option 2 – Connectivity**

This option is based on existing road intersection density within ½ mile of the project. Because of the project's location, the local intersection density is too low to qualify for points for this option.

**Option 3 – Designated High-Priority Locations**

This option awards points based on whether the project is both in a designated high priority redevelopment area and has long term designated affordable units on-site. The relevant site categories are EPA National Priorities List, Federal Empowerment Zone, Federal Enterprise Community, Federal Renewal Community, Department of Justice Weed and Seed Strategy Community, Department of the Treasury Community Development Financial Institutions Fund Qualified Low-Income Community, and HUD Qualified Census Tract or Difficult Development Area. The project is not located in one of these designated areas, and so would not be eligible for points under this option.

***SLLC2 BROWNFIELDS REDEVELOPMENT – 2 POSSIBLE POINTS***

The project is not a designated brownfield and would not qualify for points.

***SLLC3 LOCATIONS WITH REDUCED AUTOMOBILE DEPENDENCE – 7 POSSIBLE POINTS***

This credit has two point-generating options.

**Option 1 – Transit-Served Location**

This option requires the project to be located near existing high-frequency transit service. The Park would not qualify for points for this option.

**Option 2 – Metropolitan Planning Organization Location with Low VMT**

This option awards points if the project is located in a traffic analysis zone where the annual non-home-based VMT per employee is 90% or less of the average for the metropolitan region. The information must be based on employee transportation surveys conducted by the metropolitan planning organization in the last ten years. The Park does not meet this requirement.

***SLLC4 BICYCLE NETWORK AND STORAGE – 1 POSSIBLE POINT***

To qualify for this point, a project must both lie within ¼ mile of an existing bicycle network of at least 5 miles length and provide a specified amount of bicycle storage within multiunit residential, retail, and other nonresidential buildings. The Park meets the requirement for proximity to a bicycle network due to the bicycle lanes on Pi'ilani Highway. The Park could also meet the bicycle storage requirement by causing builders to provide the bicycle storage. We believe that the Park could earn this credit.

***SLLC5 HOUSING AND JOBS PROXIMITY – 3 POSSIBLE POINTS***

This credit has three options – for projects with affordable residential components (3 points possible), for projects with residential components not including affordable units (2 points possible), and for infill sites (1 point possible). Of these, the Park would fall into the first category. The requirements for this option are that the project include at least 30% residential building square footage and that the geographic center be located within ½ mile walking distance of a number of existing jobs equal to or greater than the number of dwelling units in the project.

The number of jobs within the required distance numbers approximately 400 (existing jobs within the Park). In the case where the project for LEED-ND was to include the entire residential component of the project (1,250), this would not be a sufficient number of jobs. However, it is possible that the project boundary could be set to include a smaller area which would meet this requirement. Since the LEED-ND project boundary is undetermined at this time and could, for this or other reasons, be set to include less than the full Park area, we assume for the purposes of this report that the project could achieve these points during the LEED-ND process.

***SLLC6 STEEP SLOPE PROTECTION – 1 POSSIBLE POINT***

This credit requires that development within a project avoids slopes above 15%. Some development is allowed based on percentages of area developed and the amount of development on steeper versus less steep areas. A detailed analysis of slope amounts has not been completed. However, the project design has been created with extensive consideration of the avoidance of existing slopes. A LEED-ND application would require further study, but we believe that the Park would qualify for this point.

***SLLC7 SITE DESIGN FOR HABITAT OR WETLAND AND WATER BODY CONSERVATION – 1 POSSIBLE POINT***

This requires that the project be located on a site without significant habitat, wetlands, or water bodies, or if it is that the project take steps to protect them. The Park should receive this point.

***SLLC8 RESTORATION OF HABITAT OR WETLANDS AND WATER BODIES – 1 POSSIBLE POINT***

The Park does not have degraded habitat, wetlands, or water bodies and therefore could not qualify for this point.

***SLLC9 LONG-TERM CONSERVATION MANAGEMENT OF HABITAT OR WETLANDS AND WATER BODIES – 1 POSSIBLE POINT***

The Park does not have significant habitat, wetlands or water bodies and could not qualify for this point.

## *Neighborhood Pattern & Design*

***NPDC1 WALKABLE STREETS – 12 POSSIBLE POINTS***

This credit has 12 possible points based on the achievement of up to 16 individual items, with points awarded as below.

| Items Achieved | Points |
|---|---|
| 2-3 | 1 |
| 4-5 | 2 |
| 6-7 | 3 |
| 8-9 | 4 |
| 10 | 7 |
| 11 | 8 |
| 12 | 9 |
| 13 | 10 |
| 14 | 11 |
| 15-16 | 12 |

The items are as below. Many of these items are based on the final built form of the project's buildings and streetscape elements. We have made assumptions about whether the Park would get credit based on current plans and design code elements as well as possible requirements on future building.

a. *At least 80% of the linear feet of street-facing facades are no more than 25 feet from the property line.* The Park should get this.

b. *At least 50% of the linear feet of street-facing facades are no more than 18 feet from the property line.* The Park should get this.

c. *At least 50% of the linear feet of mixed-use and nonresidential street-facing facades are within 1 foot of a sidewalk.* The Park will have many nonresidential buildings which are not retail buildings. These will have setbacks greater than 1 foot, and the Park will not meet this requirement.

d. *Functional entries occur at an average of 75 feet or less along nonresidential or mixed-use buildings or blocks.* Most of the Park's buildings will be larger in footprint for use as offices. While there will be some areas of smaller buildings for flex space and retail uses, it seems unlikely that the average throughout the project for nonresidential and mixed-use buildings will be less than 75 feet, and we do not believe the Park will meet this requirement.

e. *Functional entries occur at an average of 30 feet or less along nonresidential or mixed-use buildings or blocks.* This item is cumulative with item "d". The Park would also not meet this requirement.

f. *All ground-level retail and services that face public space have clear glass on at least 60% of their facades between 3 and 8 feet above ground level.* This requirement could be placed on development within the Park. We assume the Park can meet this requirement.

g. *Building facades along sidewalks have no more than 50 feet and no more than 40% of the facade length without windows or doors.* This requirement could be placed on development within the Park. We assume the Park can meet this requirement.

h. *Project restrictions on buildings must stipulate that ground level retail windows must remain visible (unshuttered) at night.* This requirement could be placed on development within the Park. We assume the Park can meet this requirement.

i. *On street parking are provided on a minimum of 70% of streets.* Park designs include parking along almost all street sections. The Park will meet this requirement.

j. *Continuous sidewalks line both sides of all streets. In retail or mixed-use blocks the walks must be a minimum of 10 feet wide, and 5 feet elsewhere.* The Park's streets will meet this requirement. The widths of sidewalks are not 10 feet in the street sections as shown, but it is anticipated that in retail and mixed-use blocks the sidewalk would be expanded to include the Park Strip. In all cases this would provide over 10 feet of sidewalk width.

k. *The principal floor of at least 50% of ground floor dwelling units must be at least 24 inches above the sidewalk grade.* The achievement of this requirement would depend on final building designs. We assume here that this requirement could be achieved.

l. *Among other elements, this requirement requires that at least 50% of office buildings include ground floor retail along at least 60% of the street facade.* Due to the high level of employment in the Park compared to the low amount of retail, there will not be enough retail within the Park to meet this requirement.

m. *At least 40% of all street frontage within the project has a minimum building height to street width ratio of 1:3, measured between building facades.* Due to the relatively low heights of buildings anticipated in the Park, even with the generally narrow streets we do not anticipate that the Park will meet this requirement.

n. *At least 75% of residential-only streets within the project are designed for speeds of 20 miles per hour or less.* The Park has been designed with a dense network of narrow streets, suitable for low speed travel. Should the Park pursue LEED-ND accreditation, the streets could be designed to this requirement.

o. *At least 70% of non-residential or mixed-use streets within the project are designed for speeds of 25 miles per hour or less.* The Park has been designed with a dense network of narrow streets,

suitable for low speed travel. Should the Park pursue LEED-ND accreditation, the streets could be designed to this requirement.

p. *Driveway crossings should occupy no more than 10% of the sidewalk length in the project.* Due to the use of alleys and rear-accessed parking lots, the Park should meet this requirement.

In sum, we anticipate that the Park could achieve 13 of the 16 items in this credit, giving it 10 points.

***NPDC2 COMPACT DEVELOPMENT – 6 POSSIBLE POINTS***

This credit encourages dense development. Points are awarded based on the level of density achieved on buildable land. Non-residential density required for points begins at 0.75 FAR. Development at this density would exceeds the Park's maximum allowable development. The residential density required is also relatively high, beginning at 10 units per acre. The Park's overall residential density on residential and mixed use buildable land is slightly lower than this. However, depending on the final LEED-ND project boundary chosen, some of the lower density residential areas may not be included. In that case, the residential density should rise above the minimum. Given this uncertainty, we estimate that the Park could achieve 1 point based on its residential density.

***NPDC3 MIXED-USE NEIGHBORHOOD CENTERS – 4 POSSIBLE POINTS***

This credit requires that 50% of a project's dwelling units be within a ¼ mile walking distance of a specified number of "diverse uses". Unlike the SLL prerequisite, uses may be planned and not currently existing. These must include at least one use in each of these four categories, with higher numbers of uses granting higher numbers of points – food retail, community-serving retail, services, and civic and community facilities.

Given the Park's size, not all residential development is within ¼ mile of the mixed use center. This credit like others may point to the need to use a smaller portion of the Park for the LEED-ND project area. However, the densest residential development will occur in the mixed use center, so the likelihood of being able to reach the 50% requirement is very high.

As for the diverse uses, the precise uses which locate in the Park will be determined by market forces. Space has been created in the design to accommodate these uses, however, and we assume with the success of the Park that a reasonable number will occupy the space. Points are awarded based on the numbers as shown in the table below:

| Diverse Uses | Points |
|---|---|
| 4-6 | 1 |
| 7-10 | 2 |
| 11-18 | 3 |
| 19+ | 4 |

We assume, based on the size of the mixed use center, that 7-10 qualifying uses will be there, which would give the Park 2 points.

***NPDC4 MIXED-INCOME DIVERSE COMMUNITIES – 7 POSSIBLE POINTS***

There are three sections of this credit – housing diversity, housing affordability, and the combination of diversity and affordability. To achieve points for housing diversity, the precise unit mix must be known. Based on that, a formula is used to derive the point total, from 1 to 3 points. Given the high level of diversity in the Park's housing, we believe that it could obtain 3 points for housing diversity. Note that this is an estimate and is not based on a calculation.

Housing affordability points are based on the percentage of designated affordable units in the project. Based on the applicable workforce housing ordinance, the Park will be required to provide at least 25% of sold or rented units to “income-qualified groups”. These groups include households with from 50% to 160% of the area median income. LEED-ND points are awarded based on specified percentages of units affordable to various income groups. Points are awarded for amounts starting at 5% of affordable units in rental and for sale housing. While the precise combination of affordable units in the Park is not yet known, because of the much-higher (25%) requirement for the Park, we believe that the full 3 points would be awarded for this requirement.

The combined diversity and affordability point is awarded for projects that earn at least two points in both. Since we believe the Park will earn 3 points for both diversity and affordability, it will also receive this point.

***NPDC5 REDUCED PARKING FOOTPRINT – 1 POSSIBLE POINT***

This credit has four parts, all of which must be satisfied:

1. New non-residential development must either not construct new off-street parking facilities, or those facilities must be beside or behind the building, leaving the building lining the street. The Park will satisfy this requirement.

2. Off-street parking facilities must not cover more than 20% of the project’s “development footprint,” as defined here:

   > ***development footprint*** *- the total land area of a project site covered by buildings, streets, parking areas, and other typically impermeable surfaces constructed as part of the project.*

   Unfortunately, the Park would most likely not meet this requirement. Employment and mixed use land occupies over half the developable land, and these development types will most likely require parking lots which cover significantly over 20% of the “development footprint.” Even with the lower percentage of parking facility coverage for residential land, it seems unlikely that the percentage will be below 20% overall.

3. Provide bicycle parking to specified levels for multifamily, retail, and other non-residential development. The Park could achieve this if it was to place requirements on new development.

4. Provide carpool and shared-use vehicle parking equal to 10% of the total spaces for non-residential uses. This is a high requirement, and could possibly be achieved. Given that part 2 above will not be satisfied, however, it would not make a difference for this credit.

The Park will not achieve this point.

***NPDC6 STREET NETWORK – 2 POSSIBLE POINTS***

This credit has two requirements, as below:

1. The project must have a street intersecting the project boundary at least every 400 feet.

2. The project must have at least 300 intersections per square mile, with the second point awarded to projects with more than 400 intersections per square mile.

These are very high levels of connectivity and not suited to the large parcels required in the Park for employment uses. Based on the calculations done for the Connected and Open Community prerequisite, the Park will satisfy neither of these requirements and will not receive points for this credit.

### *NPDC7 TRANSIT FACILITIES – 1 POSSIBLE POINT*

This credit requires the project sponsors to work with the local transit agency to appropriately locate and fund high quality transit facilities within and bordering the site. The project would also be required to plan for informational kiosks and signage informing possible riders about transit stops and schedules. We assume that the Park would be able to achieve this point were it to pursue LEED-ND accreditation.

### *NPDC8 TRANSPORTATION DEMAND MANAGEMENT – 2 POSSIBLE POINTS*

This credit has five options. For each two options achieved, the project would receive one point.

**Option 1 – TDM Program -** Create and fund a transportation demand management program that reduces vehicle use by at least 20%.

**Option 2 – Transit Passes -** Provide subsidized transit passes to occupants for at least three years following occupancy.

**Option 3 – Developer-Sponsored Transit -** Provide year-round developer sponsored transit of at least 45 trips per weekday following 20% occupancy of the site until at least 3 years following buildout.

**Option 4 – Vehicle Sharing -** Ensure at least 50% of residents and non-residential building entrances are within ¼ mile walking distance of a shared vehicle following 20% project occupancy. Additional shared vehicles are required depending on project density.

**Option 5 – Unbundling of Parking -** At least 90% of the parking spaces for multifamily and nonresidential development must be sold or rented separately from the developed space.

Given the expense and effort required for some of these options, it seems likely that the Park would choose to complete only some of them. We assume that at least two of the five would be implemented, earning one point.

### *NPDC9 ACCESS TO CIVIC AND PUBLIC SPACE – 1 POSSIBLE POINT*

This credit has two parts, both required:

1. At least 90% of residential units and non-residential building entrances are within ¼ mile walking distance of a park, square or plaza of at least 1/6 acre.

2. Design or locate the project so that the median size of public open spaces is at least ½ acre.

The design of the Park includes a great variety of open spaces accessible to the public. The Park will achieve this point.

### *NPDC10 ACCESS TO RECREATION FACILITIES – 1 POSSIBLE POINT*

This credit is earned if at least 90% of residential units and non-residential building entries are within ½ mile walking distance of a recreational facility of at least 1 acre, to include physical improvements such as sports fields and tot lots. As currently planned, the shared-use recreational facility in the proposed mixed-use center should satisfy this requirement, earning the project one point.

### *NPDC11 VISITABILITY AND UNIVERSAL DESIGN – 1 POSSIBLE POINT*

This credit requires that a certain percentage of residential units in the project be built with a high level of accessibility and accessible features. This detail of design would be determined at the architectural level, but we assume that this could be achieved through agreements with residential builders.

### *NPDC12 COMMUNITY OUTREACH AND INVOLVEMENT – 2 POSSIBLE POINTS*

This credit has three options, two of which build upon the first.

**Option 1 – Community Outreach** – this requires that the project sponsor conduct a series of meetings and workshops to solicit community input. This option would earn a project one point, and we believe that the Park would qualify.

**Option 2 – Charrette** – this option requires that a project satisfy Option 1 and also hold a public design charrette of at least two days duration. The Park would not qualify for this option.

**Option 3 – Local Endorsement Pursuant to Evaluation Program** – this option is achieved if the project satisfies option 1 and also earns an endorsement from a local or regional non-governmental organization which rates smart growth projects based on a point rating system. The Park would not to our knowledge qualify for this option.

### *NPDC13 LOCAL FOOD PRODUCTION – 1 POSSIBLE POINT*

This credit requires that the project ensure in its covenants and restrictions that food production is allowed on all portions of a lot and on balconies and rooftops. In addition, the project must meet at least one of the following:

**Option 1 – Neighborhood Farms and Gardens –** At the Park's residential density, this would require 200 square feet per residential unit of dedicated neighborhood garden space. With 1,250 units, this would require 5.7 acres of garden space. Given the amount of space required, as well as the poor growing conditions in the Park, we do not think this is a reasonable option.

**Option 2 – Community Supported Agriculture –** This option would require that the Park purchase shares in a community supported agriculture program for at least 80% of the project's dwelling units, to continue for at least two years.

**Option 3 – Proximity to Farmers Market –** This option requires that the project's geographic center be located less than ½ mile walk from a farmers market, either existing or planned.

In pursuit of this credit, the Park could either use option 2 or, ideally, provide space for a farmers market as in option 3. We believe that the Park could reasonably achieve this point.

### *NPDC14 TREE-LINED AND SHADED STREETS – 2 POSSIBLE POINTS*

In this credit, one point is given for planting of trees along at least 60% of streets in the project at intervals no greater than 40 feet. Another point is given for provision of shade along at least 40% of all sidewalks. We believe the project could earn these points.

### *NPDC15 NEIGHBORHOOD SCHOOLS – 1 POSSIBLE POINT*

This credit requires that at least 50% of dwelling units be within ½ mile walking distance of an existing or planned middle or elementary school building entrance, or 1 mile walking distance of an existing or planned high school building entrance. In addition, the school size must not exceed 15 acres for a high school, 10 acres for a middle school, or 5 acres for an elementary school.

Unfortunately, the size of the planned high school as well as the probable indirectness and therefore long distance of the walking connection to the building entrance will make the high school ineligible for this credit. However, the location of the planned school in the mixed use center should fall within the distance requirement. In addition, while the site as shown may exceed the size limit (if the school is an elementary only), areas such as playfields which are under shared-use agreements with the community (which is envisioned for this school) do not count as part of the site. This should make the site area small enough to qualify, earning the Park one point.

## *Green Infrastructure & Buildings and Innovation Categories*

Points in the final two categories (Green Infrastructure and Buildings; and Innovation) will be earned based primarily on future actions taken by the Park in the construction of specific buildings and infrastructure. Thus, it is not possible to determine at this time how many points the Park will earn. Considering the Park's high commitment to sustainability combined with the need to maintain flexibility in order to attract employers, we estimate that the Park would earn a little over half of the points. The precise total of points will depend on a variety of factors and many credits would require significant expenditure of time, effort and money. The Park would have to make many choices about what to prioritize in order to maximize earned points while staying within budget and on schedule.

The total possible points in these categories are 35. We estimate that the Park would earn 60%, or 21 points. Obviously, this is a very rough approximation.

### *Green Infrastructure & Buildings*

*GIBC1 Certified Green Buildings – 5 Possible Points*
*GIBC2 Building Energy Efficiency – 2 Possible Points*
*GIBC3 Building Water Efficiency – 1 Possible Point*
*GIBC4 Water Efficient Landscaping – 1 Possible Point*
*GIBC5 Existing Building Reuse – 1 Possible Point*
*GIBC6 Historic Resource Preservation and Adaptive Use – 1 Possible Point*
*GIBC7 Minimized Site Disturbance in Design and Construction – 1 Possible Point*
*GIBC8 Rainwater Management – 4 Possible Points*
*GIBC9 Heat Island Reduction – 1 Possible Point*
*GIBC10 Solar Orientation – 1 Possible Point*
*GIBC11 On-Site Renewable Energy Sources – 3 Possible Points*
*GIBC12 District Heating and Cooling – 2 Possible Points*
*GIBC13 Infrastructure Energy Efficiency– 1 Possible Point*
*GIBC14 Wastewater Management – 2 Possible Points*
*GIBC15 Recycled Content in Infrastructure – 1 Possible Point*
*GIBC16 Solid Waste Management Infrastructure – 1 Possible Point*
*GIBC17 Light Pollution Reduction – 1 Possible Point*

### *Innovation*

*IDC1 Innovation and Exemplary Performance – 5 Possible Points*
*IDC2 LEED Accredited Professional – 1 Possible Point*

## *Point Total*

The following table shows all of the point estimates as detailed above. The column "Based on Existing Location" is an attempt to understand which points are denied to the Park based on its location, regardless of the current design. At bottom is the total and the expected LEED-ND rating, were the Park eligible to apply for accreditation.

| | Based on Existing Location | Point Estimate |
|---|---|---|
| **SMART LOCATION AND LINKAGE - POSSIBLE: 27** | | **6** |
| SLLc1 Preferred locations – possible 10 | yes | 0 |
| SLLc2 Brownfields redevelopment – possible 2 | yes | 0 |
| SLLc3 Locations with reduced automobile dependence – possible 7 | yes | 0 |
| SLLc4 Bicycle network and storage – possible 1 | yes | 1 |
| SLLc5 Housing and jobs proximity – possible 3 | yes | 3 |
| SLLc6 Steep slope protection – possible 1 | no | 1 |

| | | |
|---|---|---|
| SLLc7 Site design for habitat or wetland and water body conservation – possible 1 | yes | 1 |
| SLLc8 Restoration of habitat or wetlands and water bodies – possible 1 | yes | 0 |
| SLLc9 Long-term conservation Management of habitat or wetlands and water bodies – possible 1 | yes | 0 |
| | | |
| **NEIGHBORHOOD PATTERN & DESIGN - POSSIBLE: 44** | | **30** |
| NPDc1 Walkable streets – possible 12 | no | 10 |
| NPDc2 Compact development – possible 6 | no | 1 |
| NPDc3 Mixed-use neighborhood centers – possible 4 | no | 2 |
| NPDc4 Mixed-income diverse communities – possible 7 | no | 7 |
| NPDc5 Reduced parking footprint – possible 1 | no | 0 |
| NPDc6 Street network – possible 2 | no | 0 |
| NPDc7 Transit facilities – possible 1 | no | 1 |
| NPDc8 Transportation demand Management – possible 2 | no | 1 |
| NPDc9 Access to civic and public space – possible 1 | no | 1 |
| NPDc10 Access to recreation facilities – possible 1 | no | 1 |
| NPDc11 Visitability and universal design – possible 1 | no | 1 |
| NPDc12 Community outreach and involvement – possible 2 | no | 1 |
| NPDc13 Local food production – possible 1 | no | 1 |
| NPDc14 Tree-lined and shaded streets – possible 2 | no | 2 |
| NPDc15 Neighborhood schools – possible 1 | no | 1 |
| | | |
| **GREEN INFRASTRUCTURE & BUILDINGS - POSSIBLE: 29** | | **60% est.** |
| GIBc1 Certified green buildings – possible 5 | | |
| GIBc2 Building energy efficiency – possible 2 | | |
| GIBc3 Building water efficiency – possible 1 | | |
| GIBc4 Water efficient landscaping – possible 1 | | |
| GIBc5 Existing building reuse – possible 1 | | |
| GIBc6 Historic resource preservation and adaptive use – possible 1 | | |
| GIBc7 Minimized site disturbance in design and construction – possible 1 | | |
| GIBc8 Rainwater Management – possible 4 | | |
| GIBc9 Heat island reduction – possible 1 | | |
| GIBc10 Solar orientation – possible 1 | | |
| GIBc11 On-site renewable energy sources – possible 3 | | |
| GIBc12 District heating and cooling – possible 2 | | |
| GIBc13 Infrastructure energy efficiency – possible 1 | | |
| GIBc14 Wastewater Management – possible 2 | | |
| GIBc15 Recycled content in infrastructure – possible 1 | | |
| GIBc16 Solid waste Management infrastructure – possible 1 | | |
| GIBc17 Light pollution reduction – possible 1 | | |
| | | |
| **INNOVATION - POSSIBLE: 6** | | **60% est.** |
| IDc1 Innovation and exemplary performance – possible 5 | | |
| IDc2 LEED Accredited Professional – possible 1 | | |
| | | |
| **TOTAL - POSSIBLE: 106** | | **57** |
| Expected Rating, had Prerequisites been met | | Silver |

## Overall Conclusion

In the end, the Maui Research & Technology Park is not eligible to pursue LEED-ND certification. This is unfortunate, and is due to decisions made many years before the current planning process began, and many years before the current understanding of sustainability was derived. The issue is that the Park was originally located without concern for the priorities that LEED-ND is meant to address. LEED-ND tries to prevent development in locations which are far from existing development, on the edge of the community. The Park can and should be designed and built to the highest standards from this point forward. However, the Park will not attain LEED-ND status due to decisions made many years ago which cannot now be changed.

APPENDIX O
Draft Ordinance Chapter 19.33A, MCC

**FORM BASED CODE HYBRID DRAFT 1**

ORDINANCE NO. _____

BILL No. _____ (2013)

A BILL FOR AN ORDINANCE AMENDING TITLE 19.33, MAUI COUNTY CODE, TO ESTABLISH PERMISSABLE LAND USES, STANDARDS OF DEVELOPMENT, AND ALLOCATIONS OF LAND FOR THE "MAUI RESEARCH & TECHNOLOGY PARK" SITUATED IN KIHEI, MAUI, HAWAII

BE IT ORDAINED BY THE PEOPLE OF MAUI:

SECTION 1. Title 19.33, Maui County Code, is amended to read as follows:

"Chapter 19.33A
Maui Research & Technology Park"

Sections:


| | |
|---|---|
| 19.33A.010 | Purpose and intent. |
| 19.33A.020 | Definitions. |
| 19.33A.030 | Land use categories and acreage. |
| 19.33A.040 | Controlling plan. |
| 19.33A.050 | Lot types by district. |
| 19.33A.060 | Districts. |
| 19.33A.070 | Development standards. |
| 19.33A.080 | Additional standards for all districts. |
| 19.33A.090 | Environmental controls. |
| 19.33A.100 | Maui research and technology park coordinator. |
| 19.33A.110 | Technical review committee. |
| 19.33A.120 | Design review board |
| 19.33A.130 | Procedure for subdivision. |
| 19.33A.140 | Procedure for securing building and site improvement permits. |
| 19.33A.150 | Improvement district program for the construction of off-site improvements. |
| 19.33A.160 | Procedure for securing approval of additional permitted uses in the Maui Research & Technology Park |

**19.33A.010 Purpose and intent.** The purpose and intent of these standards is to create opportunities for a broader range of desirable knowledge based and emerging industries, which will provide high-skilled and well-paying jobs for Maui residents. As the Maui Research and Technology Park (MRTP) develops it should utilize the principles of new urbanism and smart growth to create a community of innovation. This includes providing diverse housing options within close proximity of the MRTP employment and integrating neighborhood serving retail, civic and commercial uses in a manner that will encourage bicycling, walking and public transportation.

**19.33A.020 Definitions.** The following definitions shall apply to this chapter. Terms not defined below shall have the meanings set forth in section 19.04.040, Maui County Code, unless the context clearly indicates a different meaning:

"Application" means a formal request filed by an owner or lessee pursuant to the provisions of this chapter.

"Association" means a group of owners of lots in the MRTP District (other than the association itself in its capacity as owner of the common area) formed for the purposes set forth in this chapter.

"Committee" means the MRTP District technical review committee hereinafter established.

"Design Guidelines" means those detailed architectural, engineering, landscape architectural and or other design related standards to be applied in the development of the MRTP which shall be consistent with the performance standards specified herein.

"Design Review Board" means a group of professionals in fields such as architecture, planning, landscape architecture, engineering and sustainability, formed for the purpose of assisting in the design review of projects within the MRTP. Design Review Board members are appointed by the Association.

"Dormitory" means a building or group of buildings with group living quarters for a student body or other group associated with educational institution use.

"Dwelling, Four-Plex" means an apartment house consisting of only four dwelling units designed exclusively for occupancy by four families living independently of each other.

"Dwelling, Tri-Plex" means an apartment house consisting of only three dwelling units designed exclusively for occupancy by three families living independently of each other.

"Dwelling, Townhome" means a dwelling sharing a common sidewall with another single family dwelling of similar building type, typically arranged in a row.

"Economic Development Director" means the director of the county's office of economic development.

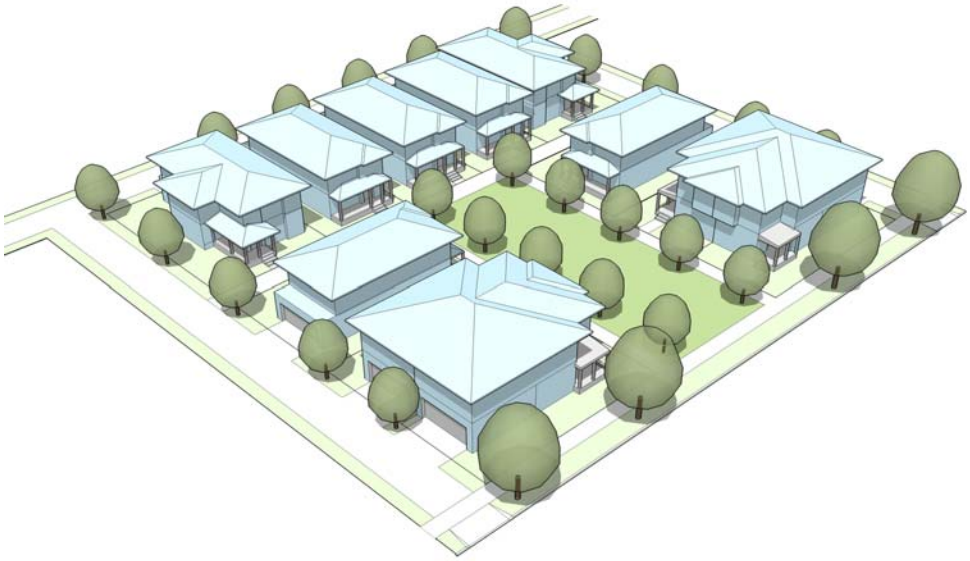
"Enforcement Agency" means the fire chief of the department of fire and public safety of the County of Maui or such other person or agency designated by the Mayor of the County of Maui.

"Flex Space" means unfinished flexible building space suitable for combined residential, commercial and light industrial uses.

"Green Court" means an arrangement of dwellings around a central green space. The green space is bounded on at least two sides by dwellings and opens onto a street. Individual home lots are relatively compact, with most open area in the shared green

space. House lots may include a mix of single family detached dwellings, single family attached dwellings, and multi-family dwellings.

Example of Green Court configuration:



"Home Occupation" means an enterprise or activity conducted by the occupant of the dwelling unit wherein the enterprise or activity takes place and which involves either the growing, processing, or manufacturing of product or the provision of services for consideration and profit, provided;

1. That no more than two employees, other than residents of the dwelling unit, shall be employed by the home occupation;
2. That no more than 40% of the floor area of the dwelling unit shall be used by the home occupation;
3. That group instruction classes or group sales meetings shall not include more than four persons, excluding employees of the home occupation;
4. That signs to advertise the home occupation shall be no larger than four square feet and shall be attached to the dwelling unit;
5. That no goods, chattel, materials, supplies, or items of any kind shall be delivered either to or from the premises of the dwelling unit used for a home occupation other than by a vehicle owned by the residents of the dwelling unit and limited to cars, jeeps, vans with a maximum capacity of nine passengers, and four-wheel drives and trucks with a maximum load capacity of three-quart tons, except for the delivery of furniture or large equipment;
6. That any storage of goods samples, materials, or objects used in connection with the home occupation shall be stored within the dwelling unit and shall receive the approval of all appropriate governmental agencies; and
7. That the following occupations shall not be constructed to be a home occupation and therefore shall not be permitted;

a. Harboring, training, or raising dogs, cats, birds, horses, or other animals, and

b. Automobile and/or body fender repairing.

"Knowledge Industry" means industries characterized by highly-skilled workers in professional, scientific, and technical services establishments that specialize in performing professional, scientific, and technical activities. Knowledge industries are supported by employees who work primarily with information or who develop and use knowledge in the workplace. Knowledge Industry includes, but is not limited to, the following uses:

1. Accounting, bookkeeping and payroll services;
2. Advertising services;
3. Architectural, engineering and specialized design services;
4. Biotechnology;
5. Computer sciences;
6. Consulting services;
7. Disaster mitigation
8. Education
9. Electro-optic research;
10. Electronics;
11. Energy research and development, prototyping, testing, and demonstration projects;
12. Environmental assessment and university sponsored or related research programs;
13. Information technology data center;
14. Manufacturing, assembly, testing and repair of electrical, electromechanical and optical components, devices, equipment and systems;
15. Multimedia and art production;
16. Legal advise and representation;
17. Pharmaceutical, biological, medical and agricultural research and production facilities;
18. Photographic services;
19. Research services, laboratories and facilities, developmental laboratories and facilities, testing laboratories and facilities, and demonstration laboratories and facilities;
20. Technological Product Marketing Center;
21. Telecommunication and information services centers; and
22. Veterinary services.

"Lessee" means a person holding land situated in the County of Maui pursuant to a recorded lease under which the unexpired remaining term is not less than five years at the time of filing of an application hereunder.

"Light Industrial and Manufacturing" means enclosed facilities for the production or assembly of products involving limited or minor emissions of odor, fumes, noise, vibrations, heat, glare, or electrical interference to the exterior. Light industrial and manufacturing uses are technology or innovation oriented, such as, but not limited to, laboratories, machine shops, and craft industries.

"Live/work" means a combined residential and commercial use of a dwelling unit where the commercial activity takes place within the ground floor of the dwelling or on a lot whose principal use is a dwelling.

"Lot line, front" or "Front Lot Line" means a line separating the lot from the primary street as identified by the design guidelines.

"Maui Research and Technology Park District" or "MRTP" means land specifically designated and zoned for the permitted uses set forth hereinafter in Section 19.33A.060 of this chapter.

"Occupant" means a person holding record fee simple or leasehold title to land situated in the County of Maui and who has legal occupancy in the property in the Maui Research and Technology Park District.

"Office over Retail" means a combined use building with office above and ground floor retail use.

"Office/Research and Development" means an office building used for knowledge and research-based commercial employment or business offices for other allowed uses.

"Owner" means a person holding record fee simple or leasehold title to land situated in the County of Maui.

"Planning Commission" means the Planning Commission of Maui.

"Planning Director" means the director of the Department of Planning of the County of Maui; also referred to as the "coordinator" pursuant to the provisions of this chapter.

"Public Works Director" means the Director of the Department of Public Works of the County of Maui.

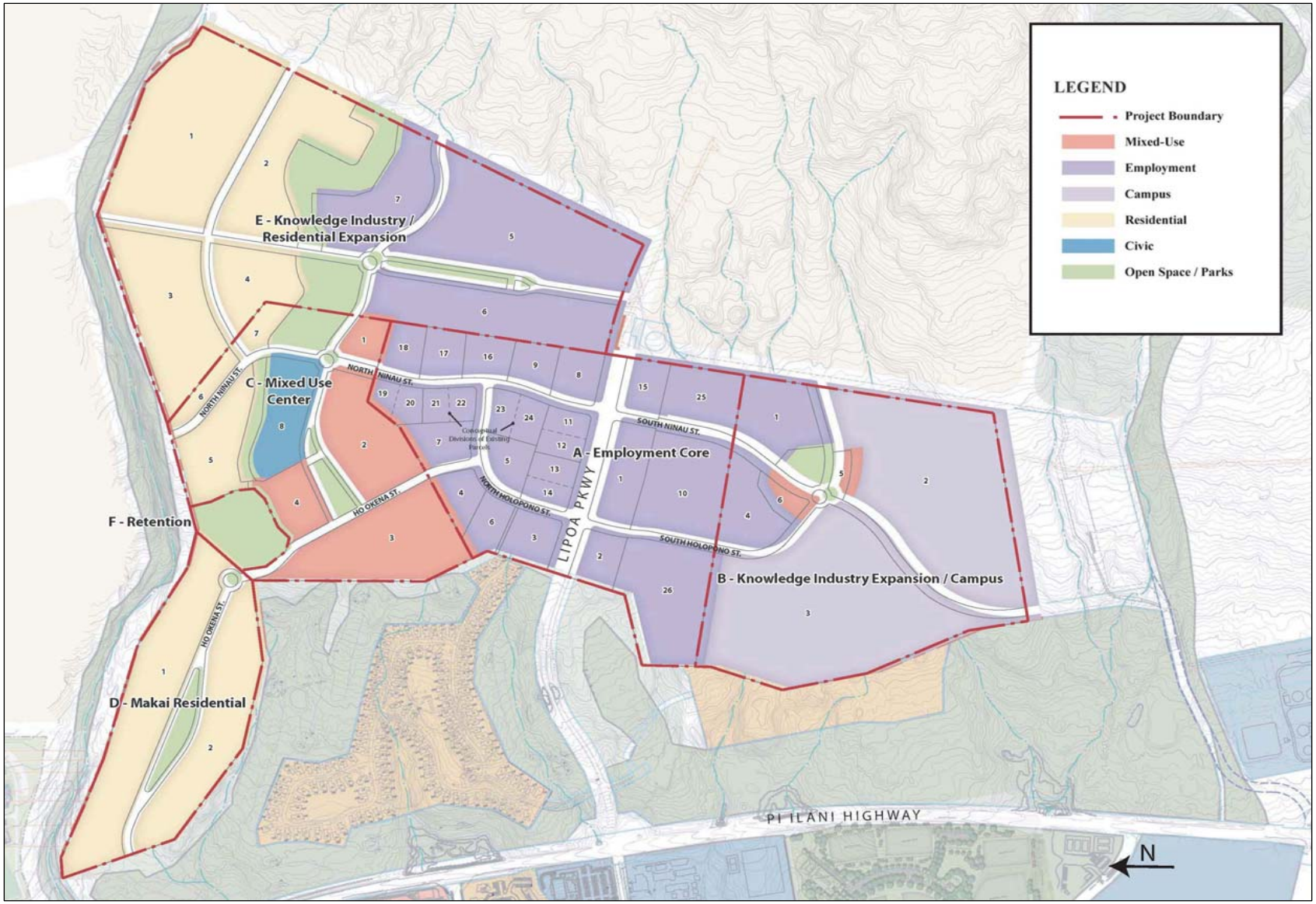
"Residential over Retail Use" means a combined residential and retail use of a single-family, two-family or multi-family dwelling, with a ground floor retail use.

"Retail" means a building or portion there of used for businesses engaged in the retail sales of goods and services.

**19.33A.030 Land use categories and acreage.** The following are established as the acreage for the various land use categories within the Maui Research & Technology Park:

| | | |
|---|---|---|
| Employment district: | 142.77 | acres |
| Campus district: | 73.20 | acres |
| Mixed-use district: | 37.50 | acres |
| Residential district: | 115.40 | acres |
| Civic district: | 6.20 | acres |
| Open space / park district: | 28.60 | acres |
| | | |
| Total acreage: | 403.67 | acres |

**19.33A.040 Controlling Plan.** The controlling plan establishes the layout of districts within the MRTP.



**19.33A.050 Lot Types by District.** The following matrix establishes allowed lot types by districts.

| | Lot Types | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Districts** | Office / Research & Development | Office Over Retail | Retail | Flex Space | Residential Over Retail | Multi-Family | Four-Plex | Tri-Plex | Townhome | Single Family Green Court | Single Family Small Lot | Single Family Large Lot | Civic / Public |
| Employment | • | • | • | • | | •* | •* | •* | •* | •* | •* | •* | • |
| Campus | • | • | • | • | | •* | •* | •* | •* | •* | •* | •* | • |
| Mixed Use | • | • | • | • | • | • | • | • | • | | • | • | • |
| Residential | | | • | • | • | • | • | • | • | • | • | • | • |
| Civic | | | | | | | | | | | | | • |

*Residential lot types, except flex space, in the employment and campus districts must be associated with a permitted educational institution at the MRTP and used to house staff, faculty, students and campus visitors of such educational institution.

**19.33A.060 Districts.**

A. Employment district:

1. Purpose: The purpose of the employment district is to allow for a broad mix of knowledge industry employment uses and incidental supportive uses and provide for a range of lot and building sizes. The district is characterized by small blocks, buildings built on front property lines, and ample pedestrian amenities. Uses in the employment district are predominantly knowledge industry employment uses including, but not limited to, research and development, education, office, light industrial, hospital, and medical facilities. Incidental supportive retail, service, and civic uses, such as recreational facilities, day care centers, and police and fire stations are allowed. Live/work businesses on flex space lots and housing associated with educational institutions constitute the only residential uses within the employment district. Interpretation of permitted uses shall be liberally construed.

2. Permitted uses:

a. Administrative offices;

b. Assembly area;

c. Business, financial, marketing or professional offices and services, including banks and corporate headquarters;

d. Customer contact center;

e. Day care facility;

f. Dormitory, provided that such building(s) are associated with a permitted educational institution at the MRTP and used to house staff, faculty, students and campus visitors of such educational institution;

g. Dwelling, single family, provided that such dwellings are associated with a permitted educational institution at the MRTP and used to house staff, faculty, students and campus visitors of such educational institution;

h. Dwelling, two-family or duplex, provided that such dwellings are associated with a permitted educational institution at the MRTP and used to house staff, faculty, students and campus visitors of such educational institution;

i. Dwelling, multi-family, provided that such dwellings are associated with a permitted educational institution at the MRTP and used to house staff, faculty, students and campus visitors of such educational institution;

j. Eating and drinking establishments, including the brewing of beer, fermentation of wine and distillation of spirits;

k. Education general;

l. Education specialized;

m. Educational institutions;

n. Energy systems, small and large scale;

o. Fire and police stations;

p. General merchandizing (maximum store size 10,000 square feet);

q. General office;

r. Government offices;

s. Hotel;

t. Knowledge industry;

u. Light industrial and manufacturing; provided that such activity is enclosed within a building and does not pose a nuisance to persons or property on adjoining lots;

v. Live/work, including light industrial and manufacturing uses on flex space lots only; provided that such activity is enclosed within a building and does not pose a nuisance to persons or property on adjoining lots;

w. Medical center, minor and major;

x. Medical or dental offices or clinics;

y. Office buildings;

z. Parks and playgrounds;

aa. Personal and business services;

bb. Private or public parking lots or structures;

cc. Public utility substation, which will not be hazardous or a nuisance to the surrounding uses;

dd. Recreation, indoor and open land;

ee. Storage, distribution and warehouse facilities;

ff. Technical conferencing; and

gg. Utility facilities, minor.

3. Accessory uses:

a. Fences;

b. Garage; and

c. Walls.

4. Permitted lot types:

a. Office/research and development;

b. Office over retail;
c. Retail;
d. Flex space; and
e. Civic/public.

B. Campus district:

1. Purpose: The purpose of the campus district is to accommodate users requiring large contiguous parcels of developable land. The campus district allows for the same uses and lot types as allowed in the employment district. Interpretation of permitted uses shall be liberally construed.

2. Permitted uses:

a. All uses permitted in the employment district.

3. Accessory uses:

a. All uses permitted in the employment district.

4. Permitted lot types:

a. All lot types permitted in the employment district.

C. Mixed-use district:

1. Purpose: The mixed-use district is a flexible area containing space for incubating new businesses as well as supportive retail, civic uses, schools, open space, and residential uses. Neighborhood-serving retail uses, flex space, live/work, multi-family buildings with ground floor retail, and a range of multi-family and single family residences provide for a mix of activity and 24-hour usage of the MRTP. The mixed-use district is characterized by small blocks, buildings built on front property lines, and ample pedestrian amenities and open space, and the district is within walking distance of the surrounding residential and employment districts. Interpretation of permitted uses shall be liberally construed.

2. Permitted uses:

a. Administrative offices;
b. Assembly area;
c. Business, financial, marketing or professional offices and services, including banks and corporate headquarters;
d. Community gardens;
e. Customer contact center;
f. Day care facility;
g. Dwelling, single family;
h. Dwelling, two-family or duplex;
i. Dwelling, multi-family;
j. Eating and drinking establishments, including the brewing of beer, fermentation of wine, or distillation of spirits;
k. Education general;
l. Education, specialized;
m. Educational institutions, including dormitories, housing and apartments for staff, faculty, students and campus visitors;
n. Fire and police stations;
o. Gasoline retailing, provided that it is owned and operated as an adjunct neighborhood store; and provided further, that no servicing,

repairing, storing, or maintenance of vehicles will be permitted on the premises;

p. General merchandizing (maximum store size 20,000 square feet)

q. General office;

r. Government office;

s. Home occupation;

t. Hotel;

u. Housing for low and moderate income families, operated by governmental or nonprofit organizations;

v. Housing for the aged, operated by governmental and nonprofit organizations;

w. Knowledge industry;

x. Light industrial and manufacturing; provided that such activity is enclosed within a building and does not pose a nuisance to persons or property on adjoining lots;

y. Live/work, including light industrial and manufacturing uses on flex space lots only; provided that such activity is enclosed within a building and does not pose a nuisance to persons or property on adjoining lots;

z. Medical center, minor and major;;

aa. Medical or dental offices or clinics;

bb. Office buildings;

cc. Parks and playgrounds;

dd. Personal and business services;

ee. Private or public parking lots or structures;

ff. Public utility substation, which will not be hazardous or a nuisance to the surrounding uses;

gg. Recreation, indoor and open land;

hh. Storage, distribution and warehouse facilities;

ii. Technical conferencing; and

jj. Utility facilities, minor.

3. Accessory uses:

a. Accessory dwelling;

b. Energy systems, small scale;

c. Fences;

d. Garage; and

e. Walls.

4. Permitted lot types:

a. Office/research and development;

b. Office over retail;

c. Retail;

d. Flex space.

e. Residential over retail;

f. Multi-family;

g. Four-plex;

h. Tri-plex;
i. Townhome;
j. Single family small lot;
k. Single family large lot; and
l. Civic/public.

D. Residential district:

1. Purpose: The residential district accommodates the largest concentration of residential uses in the MRTP. A mix of housing types are permitted and encouraged in the residential district including, but not limited to, single family detached, green court, townhome, tri-plex, four-plex, and apartment complexes. While the residential district is primarily residential in character, a mix of small neighborhood-serving retail uses, live/work, and institutional/civic uses, such as churches, libraries, recreational facilities, and day care centers, are permitted. Residential districts are located within walking distance of the mixed-use district.

2. Permitted uses:

a. Churches;
b. Day care facility (limited to six or fewer persons cared for);
c. Dwelling, single family;
d. Dwelling, two-family or duplex;
e. Dwelling unit, multi-family;
f. Eating and drinking establishments, including the brewing of beer, fermentation of wine, and distillation of spirits, but excluding fast food restaurants and nightclubs;
g. Education general;
h. Education specialized;
i. Educational institutions, including dormitories, housing and apartments for staff, faculty, students and campus visitors;
j. General merchandizing (maximum store size 5,000 square feet)
k. Greenhouses, flower and truck gardens, nurseries, and community gardens;
l. Home occupation;
m. Housing for low and moderate income families, operated by governmental or nonprofit organizations;
n. Housing for the aged, operated by governmental and nonprofit organizations;
o. Libraries;
p. Live/work, excluding light industrial and manufacturing uses;
q. Other similar retail businesses or service establishments that supply commodities or perform services primarily for residents of the surrounding neighborhood;
r. Parks and playgrounds;
s. Public utility substation, which will not be hazardous or a nuisance to the surrounding uses;
t. Recreation, indoor and open land;

u. Utility facilities, minor.

3. Accessory uses:

a. Accessory dwelling;

b. Energy systems, small scale;

c. Fences;

d. Garage;

e. Parking area, public; and

f. Walls.

4. Permitted lot types:

a. Retail;

b. Flex space.

c. Residential over retail;

d. Multi-family;

e. Four-plex;

f. Tri-plex;

g. Townhome;

h. Single family green court;

i. Single family small lot;

j. Single family large lot; and

k. Civic/public.

E. Civic district:

1. Purpose: The civic district is intended to allow for a concentration of institutional and civic uses within the MRTP. Interpretation of permitted uses shall be liberally construed.

2. Permitted uses:

a. Assembly area;

b. Community garden;

c. Day care facility;

d. Education, general;

e. Education, specialized;

f. Educational institutions, including dormitories, housing and apartments for staff, faculty, students and campus visitors;

g. Fire and police stations;

h. Government buildings and facilities;

i. Medical center, minor and major;

j. Nursery schools and day care centers;

k. Offices for non-profit charitable organizations;

l. Private or public parking lots or structures;

m. Public utility substation, which will not be hazardous or a nuisance to the surrounding uses;

n. Recreation, indoor and open land;

o. Storage, distribution and warehouse facilities; and

p. Utility facilities, minor.

3. Accessory uses:

a. Energy systems, small scale;

b. Fences;

c. Garage; and

d. Walls.

4. Permitted lot types:

a. Civic/public

F. Open space / park district:

1. Purpose: The open space / park district is intended to provide areas for active and passive recreation, site drainage and water retention, and natural vegetation.

2. Permitted uses:

a. Accessory buildings and structures, including but not limited to pavilions, restrooms, play and outdoor exercise equipment, and utility buildings;

b. Agriculture, including but not limited to community gardens, orchards, and nurseries. Not including agricultural products processing or animal and livestock raising;

c. Drainage ways, retention basins, reservoirs, dry wells, and other drainage or water storage facilities;

d. Energy systems, small scale;

e. Natural vegetation areas, including areas planted in native Hawaiian plant species;

f. Public parking lot;

g. Recreation, open land;

h. Public utility substation, which will not be hazardous or a nuisance to the surrounding uses; and

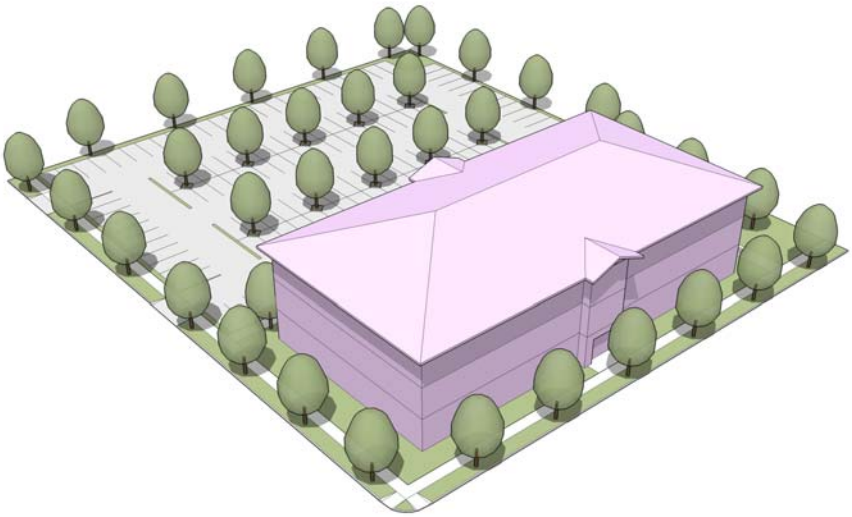
i. Utility facilities, minor.

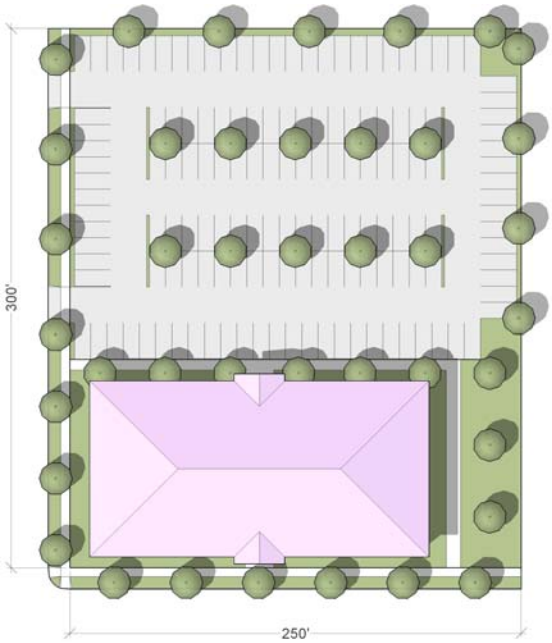
3. Permitted lot types: No lot types are permitted in the open space district.

**19.33A.070 Development standards.** The following are established as the development standards for each lot type in the MRTP. Lot type diagrams are provided for each lot type for illustrative purposes only. The diagrams are examples and shall not restrict building form.

A. Office/research and development.

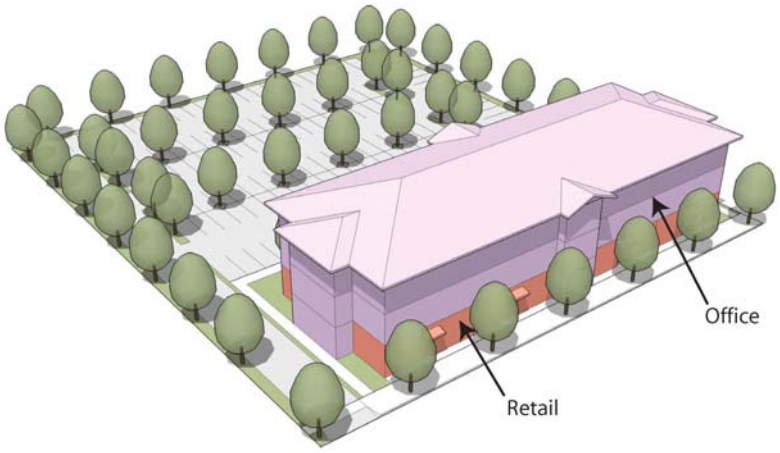
| Lot Area (min) | FAR (net) (min/ max) | Unit Size (min/ max) | Stories / Building Height (max) | Density (net units/ ac) (min/ max) | Parking Access | Front Setback (min/ max) | Rear Setback (min) | Side Setback (min) | Length of Primary Frontage Occupied (min) |
|---|---|---|---|---|---|---|---|---|---|
| 6,000 sf | .3 - 0.65 | N/A | 4<br>50 ft | N/A | Alley or side drive or secondary street | 0 ft – 15 ft | 5 ft | 0 ft | 60% |

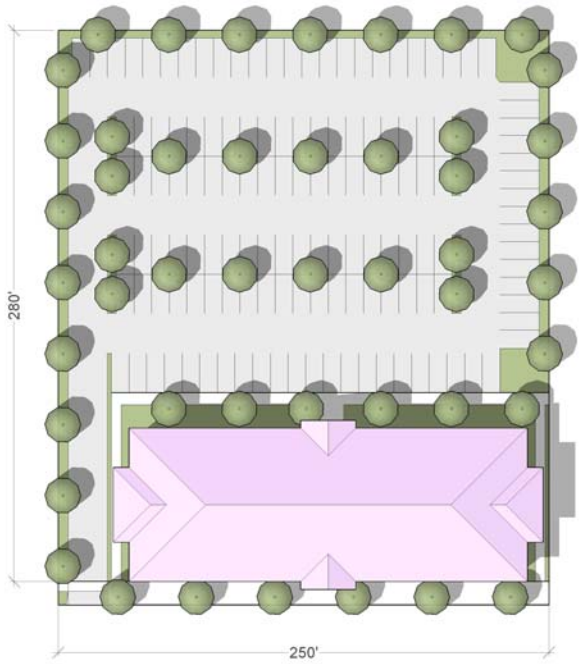




B. Office over retail.

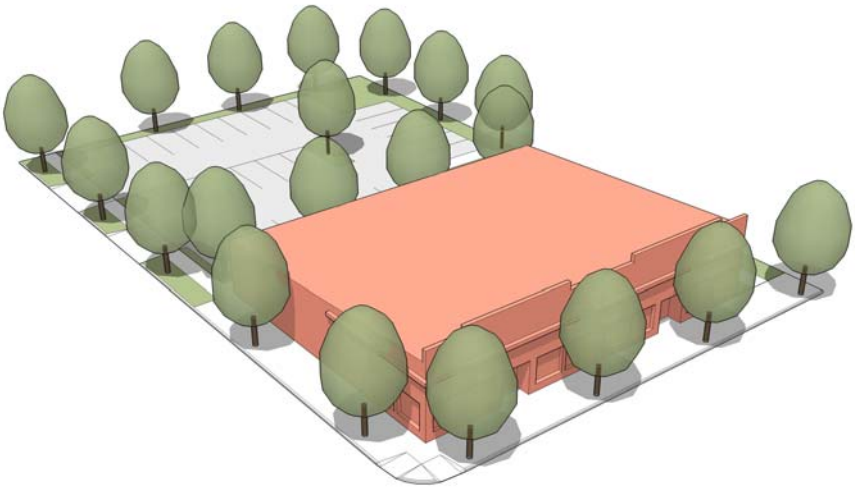
| Lot Area (min) | FAR (net) (min/ max) | Unit Size (min/ max) | Stories / Building Height (max) | Density (net units/ ac) (min/ max) | Parking Access | Front Setback (min/ max) | Rear Setback (min) | Side Setback (min) | Length of Primary Frontage Occupied (min) |
|---|---|---|---|---|---|---|---|---|---|
| 6,000 sf | 0.5 – 0.65 | N/A | 4<br>50 ft | N/A | Alley or side drive or secondary street | 0 ft – 15 ft | 5 ft | 0 ft | 60% |

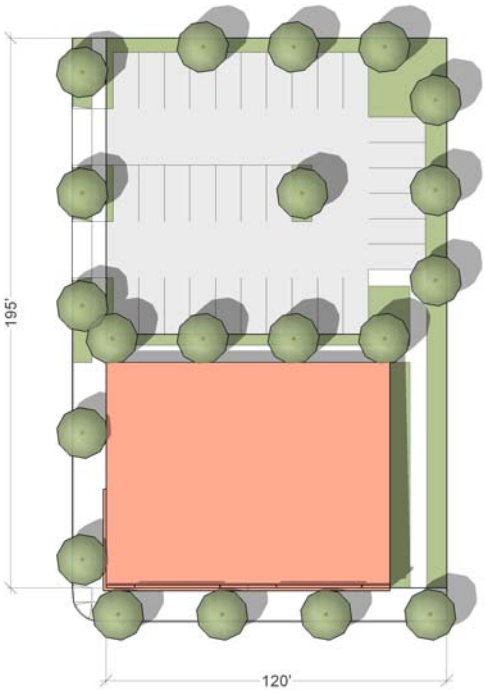


C. Retail.

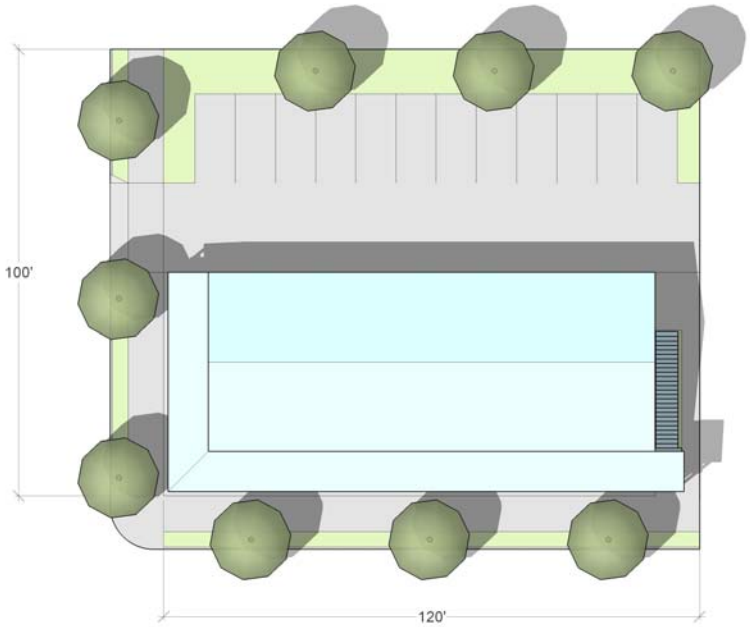
| Lot Area (min) | FAR (net) (min/ max) | Unit Size (min/ max) | Stories / Building Height (max) | Density (net units/ ac) (min/ max) | Parking Access | Front Setback (min/ max) | Rear Setback (min) | Side Setback (min) | Length of Primary Frontage Occupied (min) |
|---|---|---|---|---|---|---|---|---|---|
| 2,400 sf | 0.3 – 0.4 | N/A | 2<br>40 ft | N/A | Alley or side drive or secondary street | 0 ft – 10 ft | 5 ft | 0 ft | 70% |





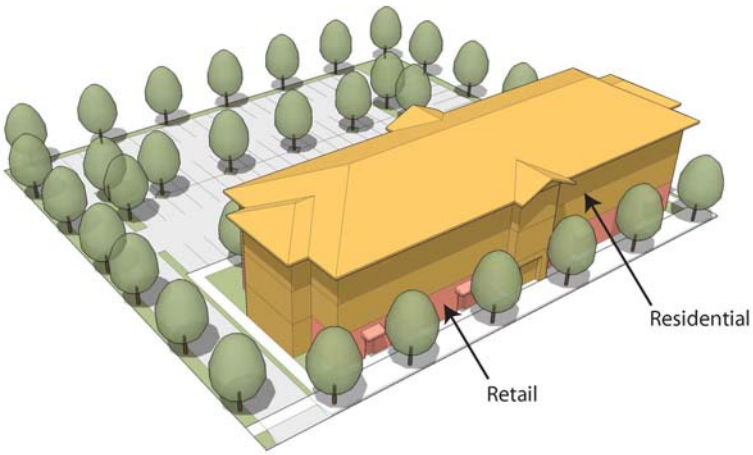
D. Flex space.

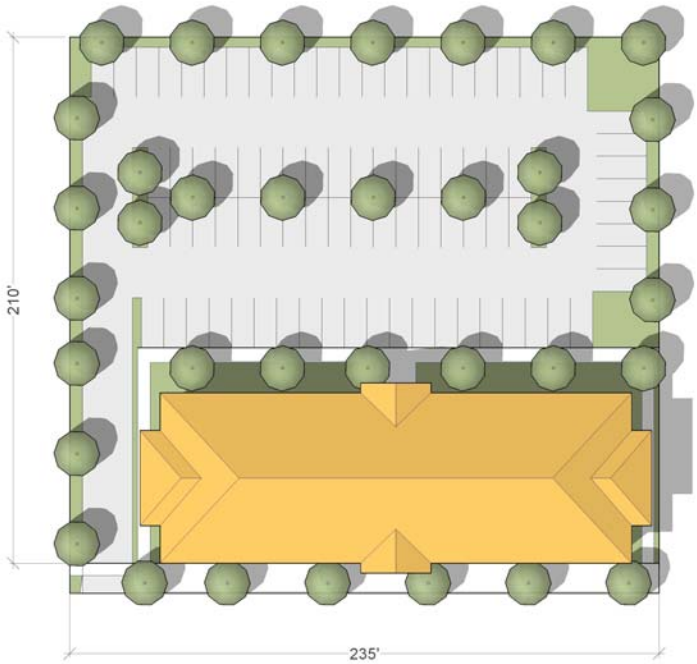
| Lot Area (min) | FAR (net) (min/ max) | Unit Size (min/ max) | Stories / Building Height (max) | Density (net units/ ac) (min/ max) | Parking Access | Front Setback (min/ max) | Rear Setback (min) | Side Setback (min) | Length of Primary Frontage Occupied (min) |
|---|---|---|---|---|---|---|---|---|---|
| 1,800 sf | 0.5 – 0.8 | 1,000 sf -2,000 sf | 2 40 ft | 15 – 20 | Alley or secondary street | 0 ft – 10 ft | 5 ft | 0 ft | 80% |



E. Residential over retail.

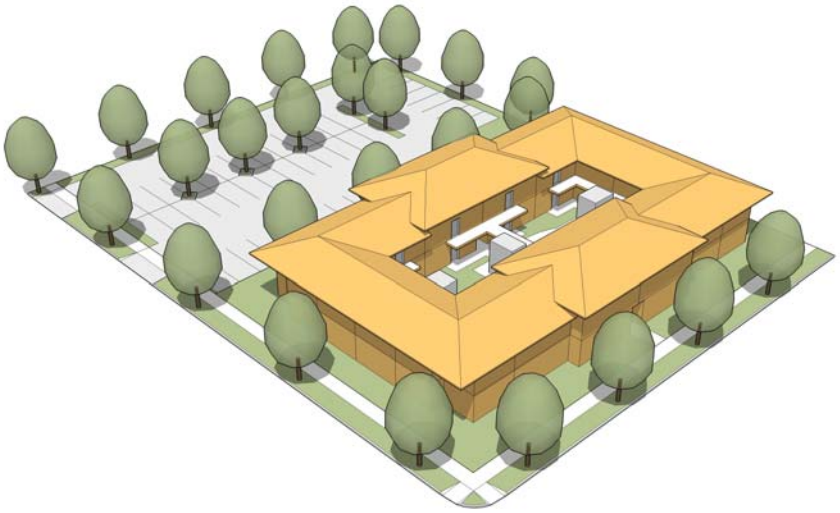
| Lot Area (min) | FAR (net) (min/ max) | Unit Size (min/ max) | Stories / Building Height (max) | Density (net units/ ac) (min/ max) | Parking Access | Front Setback (min/ max) | Rear Setback (min) | Side Setback (min) | Length of Primary Frontage Occupied (min) |
|---|---|---|---|---|---|---|---|---|---|
| 6,000 sf | N/A | 400 sf - 1,000 sf | 4<br>50 ft | 18 – 30 | Alley or side drive or secondary street | 0 ft – 10 ft | 5 ft | 0 ft | 70% |

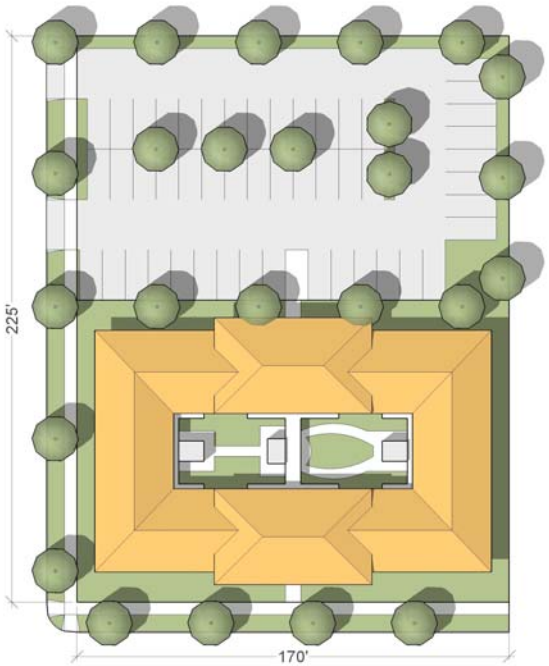


F. Multi-family.

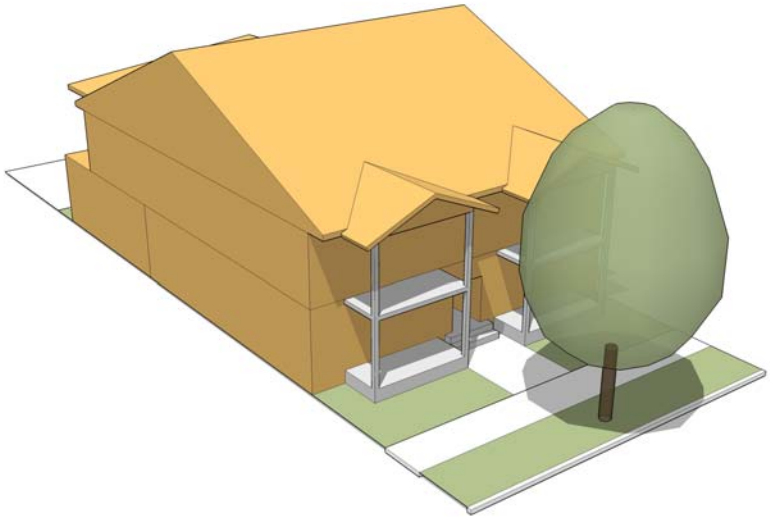
| Lot Area (min) | FAR (net) (min/ max) | Unit Size (min/ max) | Stories / Building Height (max) | Density (net units/ ac) (min/ max) | Parking Access | Front Setback (min/ max) | Rear Setback (min) | Side Setback (min) | Length of Primary Frontage Occupied (min) |
|---|---|---|---|---|---|---|---|---|---|
| 4,500 sf | N/A | 400 sf - 1,000 sf | 3<br>40 ft | 28 – 40 | Alley or side drive or secondary street | 5 ft – 15 ft | 5 ft | 5 ft | 70% |

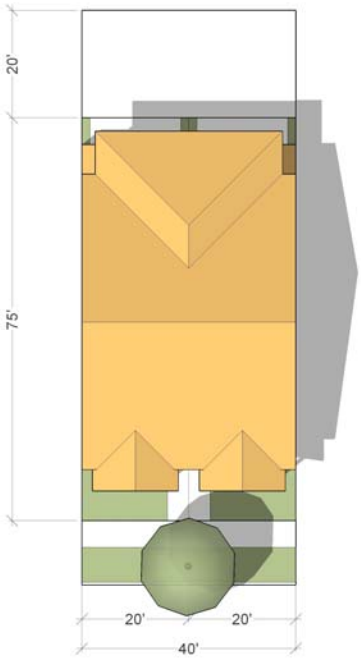




G. Four-plex.

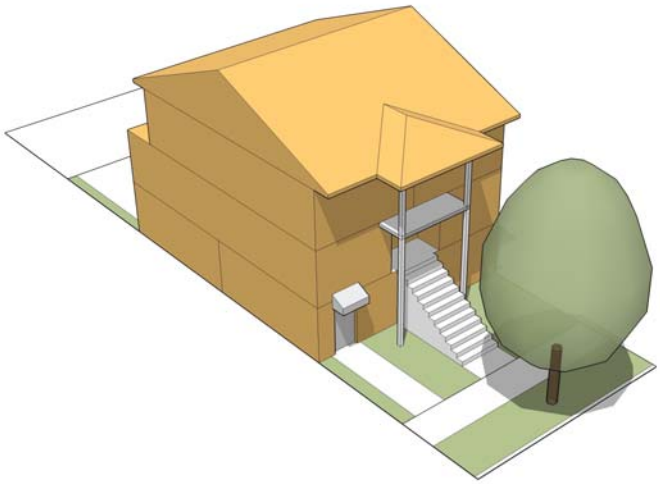
| Lot Area (min) | FAR (net) (min/ max) | Unit Size (min/ max) | Stories / Building Height (max) | Density (net units/ ac) (min/ max) | Parking Access | Front Setback (min/ max) | Rear Setback (min) | Side Setback (min) | Length of Primary Frontage Occupied (min) |
|---|---|---|---|---|---|---|---|---|---|
| 3,000 sf | N/A | 500 sf - 1,100 sf | 3<br>40 ft | 40 – 60 | Alley or secondary street (side of unit) | 5 ft – 12 ft | 5 ft | 5 ft | 70% |

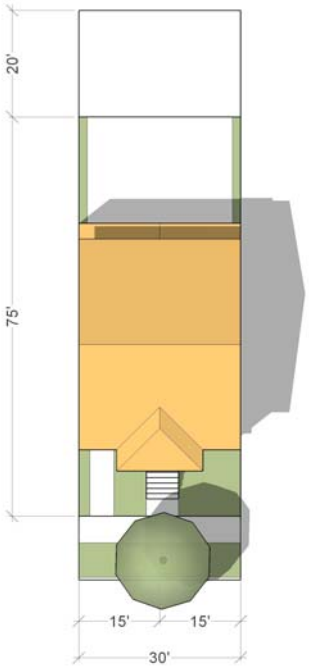




H. Tri-plex.

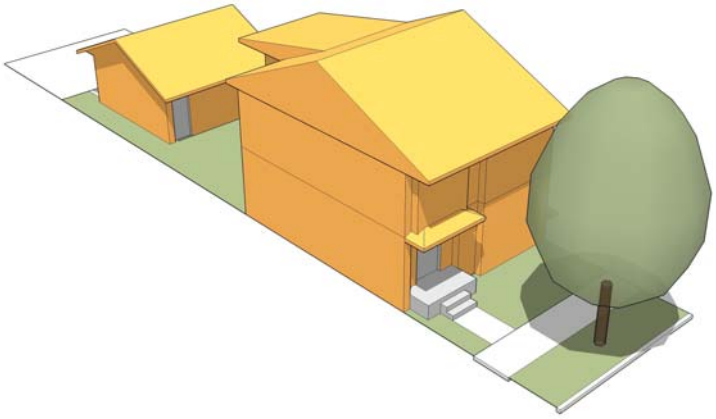
| Lot Area (min) | FAR (net) (min/ max) | Unit Size (min/ max) | Stories / Building Height (max) | Density (net units/ ac) (min/ max) | Parking Access | Front Setback (min/ max) | Rear Setback (min) | Side Setback (min) | Length of Primary Frontage Occupied (min) |
|---|---|---|---|---|---|---|---|---|---|
| 2,200 sf | N/A | 500 sf - 1,100 sf | 3<br>40 ft | 40 – 60 | Alley or secondary street (side of unit) | 5 ft – 12 ft | 5 ft | 5 ft | 70% |

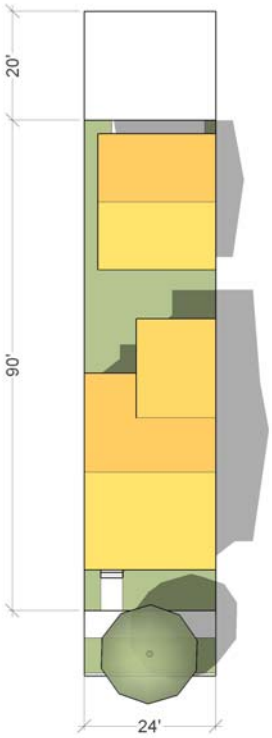




I. Townhome.

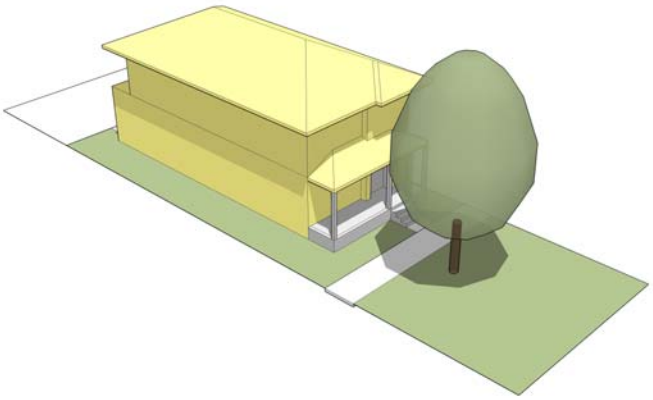
| Lot Area (min) | FAR (net) (min/ max) | Unit Size (min/ max) | Stories / Building Height (max) | Density (net units/ ac) (min/ max) | Parking Access | Front Setback (min/ max) | Rear Setback (min) | Side Setback (min) | Length of Primary Frontage Occupied (min) |
|---|---|---|---|---|---|---|---|---|---|
| 1,100 sf | N/A | 900 sf - 1,400 sf | 3<br>40 ft | 18 – 40 | Alley or secondary street (side of unit) | 5 ft – 11 ft | 5 ft | 0 ft | 70% |

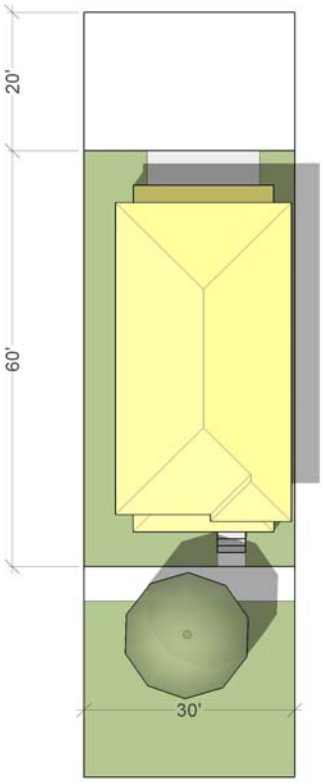




J. Single family green court.

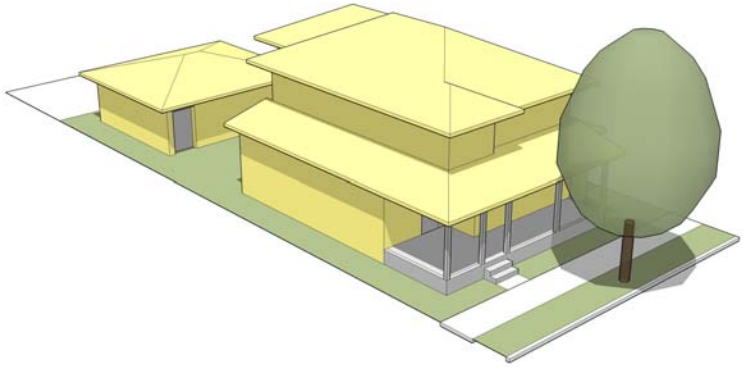
| Lot Area (min) | FAR (net) (min/ max) | Unit Size (min/ max) | Stories / Building Height (max) | Density (net units/ ac) (min/ max) | Parking Access | Front Setback (min/ max) | Rear Setback (min) | Side Setback (min) | Length of Primary Frontage Occupied (min) |
|---|---|---|---|---|---|---|---|---|---|
| 1,650 sf | N/A | 800 sf - 1,400 sf | 2<br>30 ft | n/a | Alley | 5 ft – 10 ft | 5 ft | 5 ft | 60% |

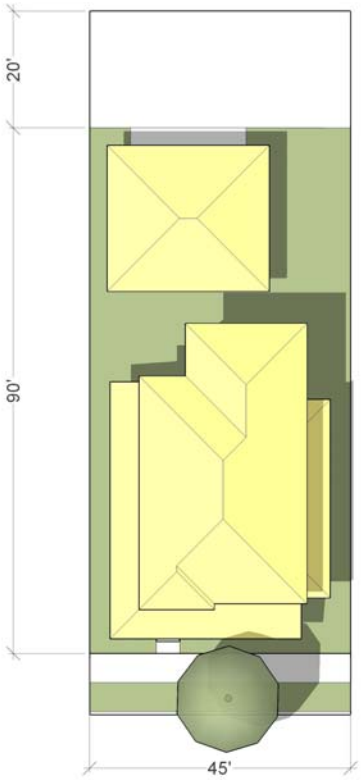




K. Single family small lot.

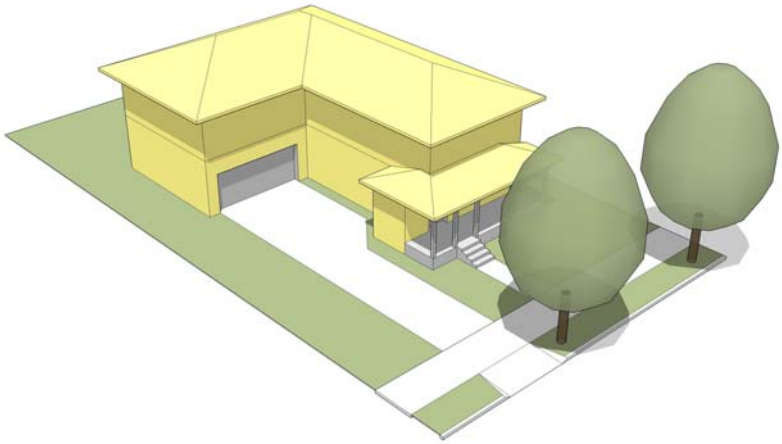
| Lot Area (min/ max) | FAR (net) (min/ max) | Unit Size (min/ max) | Stories / Building Height (max) | Density (net units/ ac) (min/ max) | Parking Access | Front Setback (min/ max) | Rear Setback (min) | Side Setback (min) | Length of Primary Frontage Occupied (min) |
|---|---|---|---|---|---|---|---|---|---|
| 3,600 sf -4,800 sf | N/A | 1,200 sf -1,800 sf | 2 30 ft | n/a | Alley or secondary street (side of unit) | 5 ft – 10 ft | 5 ft | 0 ft | 60% |

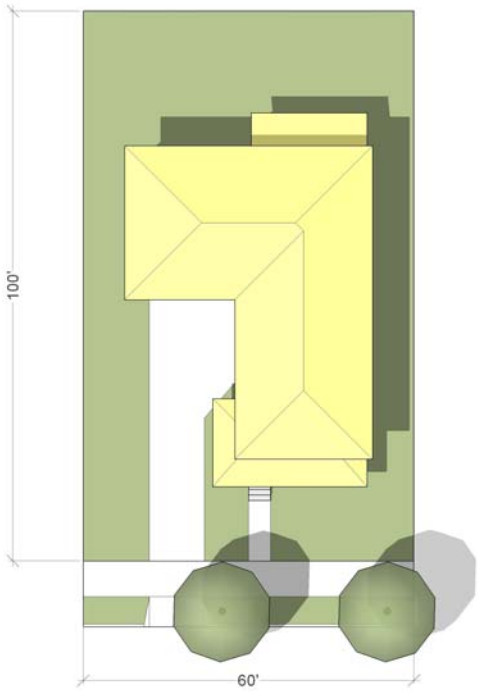




L. Single family large lot.

| Lot Area (min/ max) | FAR (net) (min/ max) | Unit Size (min/ max) | Stories / Building Height (max) | Density (net units/ ac) (min/ max) | Parking Access | Front Setback (min/ max) | Rear Setback (min) | Side Setback (min) | Length of Primary Frontage Occupied (min) |
|---|---|---|---|---|---|---|---|---|---|
| 4,801 sf -7,250 sf | N/A | 1,400 sf -2,000 sf | 2 30ft | n/a | Alley or side drive or secondary street (side of unit) | 5 ft – 15 ft | 6 ft | 6 ft | 40% |





M. Civic/public.

| Lot Area (min/ max) | FAR (net) (min/ max) | Unit Size (min/ max) | Stories / Building Height (max) | Density (net units/ ac) (min/ max) | Parking Access | Front Setback (min/ max) | Rear Setback (min) | Side Setback (min) | Length of Primary Frontage Occupied (min) |
|---|---|---|---|---|---|---|---|---|---|
| 5,000 sf | N/A | N/A | 4<br>50 ft | N/A | Alley or side drive or secondary street | 5 ft – 15 ft | 5 ft | 0 ft | 50% |

**19.33A.080 Additional standards for all districts.**

A. Density. No more than 1,250 dwellings or dwelling units shall be developed at the MRTP. Additional units may be permitted through a transfer of development rights program or to provide affordable housing in excess of what is required by law.

B. Accessory Dwellings. An accessory dwelling may be part of the main dwelling, attached to or above a garage, or a separate building on single family lots. The maximum gross floor area of an accessory dwelling shall be 600 square feet. An accessory dwelling shall have at least one separate entrance and shall not have an interior connection to the main dwelling. No more than one accessory dwelling shall be permitted on a single lot regardless of the size of the lot.

C. Design. All building construction, alterations and site improvements within the MRTP shall be prepared, reviewed and approve in accordance with the MRTP design guidelines which shall be approved by the association.

D. Landscape Planting. Landscape planting and irrigation plans shall be prepared for all development at the MRTP except single family development. Landscape planting plans shall be prepared to specify species, sizes, quantities and locations. Landscape irrigation plans shall be prepared to specify irrigation equipment appurtenances and locations. Irrigation plans shall specify anticipated average daily irrigation water demand. The use of drought-tolerant plant species and in-line drip irrigation, as well as other relevant measures, are encouraged for water conservation purposes. Landscape planting and irrigation plans shall be prepared by a registered landscape architect, licensed in the state of Hawaii. Landscape planting and irrigation plans shall be subject to the approval of the design review board. For single family development, a landscape planting plan shall be required for front yards only. All single family landscape planting shall be in accordance with relevant owner's associations' controlling documents and subject to stated design review conditions therein. Landscape planting and irrigation plans shall be in accordance with section 19.36, Maui County Code.

E. Signs. Signage for the park and the individual businesses therein shall conform to the requirements of Chapter 16.12, Outdoor Signs, except for the following provisions:

1. General MRTP identification signs at the entry location shall be coordinated with the master landscape planting plan and appropriately sized and illuminated to clearly denote the project name for the passing motorists entering the project.

2. The name of each business in the MRTP shall be clearly displayed and individually associated with its facilities when viewed from the street. The business's sign shall display the name and/or symbol of the business only.

3. There may be one freestanding sign for each individual parcel's public street frontage. If the property frontage exceeds three hundred feet, an additional sign shall be allowed.

4. Detached business identification signs shall not exceed thirty-two square feet, and no freestanding sign shall exceed four feet in height unless approved by the design review board.

5. Building identification signs shall be limited to displaying the building name or the name of the business occupying the site. Building signs may be mounted to any vertical surface of a building or building-related wall providing such signs appear as an integral part of the architectural concept.

6. A comprehensive signage plan in conformance with the design guidelines shall be submitted to the design review board for review and who shall approve, approve with conditions or disapprove the comprehensive signage plan.

F. On-site Storage and Loading.

1. Unless otherwise approved by the association, no materials, supplies or equipment shall be stored upon a site except inside a closed building or in an enclosed area.

2. Provisions shall be made for on-street vehicle loading and unloading zones every four hundred feet within the employment, campus and mixed-use districts.

3. Service and storage areas, including loading docks, trash compactors and storage yards, shall be located away from pedestrian areas and out of sight of the public right-of-way and where possible, open space areas. Where visible from the street, these areas shall be screened from streets and open space by walls matching the adjacent buildings in materials, detailing and color.

G. Screening fences and walls may be permitted by the design review board, in accordance with the approved design guidelines.

H. Access and Driveway

1. The location and design of access point(s) from public roadways and streets and internal driveways shall conform with the requirements of the approved design guidelines.

2. No direct access onto a state highway shall be permitted from individual lots of the MRTP.

3. Landscaping shall be required at all entrances to the MRTP.

I. Solid Waste Disposal. No refuse collection areas shall be permitted between a street and the front of the building.

J. Roof Equipment. Equipment pipes and ducts on roof tops shall be screened from view along adjacent public roadways or streets.

K. Utilities and Communication Devices.

1. All on-site utilities including, but not limited to, drainage systems, sewers, gas lines, waterlines and wires and conduits associated with street lighting, electrical power, telephone, and communication equipment shall be installed underground.

L. Grading.

1. All building pad elevations shall conform to the overall drainage program for the MRTP.

2. Grading and drainage improvements shall be designed and constructed to minimize adverse dust and runoff impacts on adjacent and down slope properties.

M. Exterior Mechanical Equipment. All exterior components of electrical, plumbing, heating, cooling and ventilating systems should not be visible from adjoining streets, lots or buildings.

N. Special building elements. Special building elements, such as awnings/marquees, balconies, colonnades/arcades, porches, and outside open air dining, may project within the right-of-way, subject to chapter 16.26, Maui County Code, as amended.

O. A dwelling or dwelling unit shall not be used for fractional ownership, as short-term rental home, time-share unit, or bed and breakfast home.

P. Parking requirements. The intent of these parking regulations is to encourage a balance between compact pedestrian oriented development and necessary car storage. Notwithstanding any provision in Chapter 19.36 of this Code to the contrary, the off-street parking requirements shall be as follows:

1. The compact mixed-use land use pattern within the MRTP fosters more pedestrian and bicycle trips and less automobile trips than other more automobile dependent commercial districts in Maui County. Therefore, a forty percent reduction in the required number of parking spaces stated below shall be applied to all non-residential uses.

2. When the computation of required parking spaces results in a fractional number of spaces, the number of spaces required shall be rounded up to the nearest whole number when a fraction of a space is greater than or equal to .5 and rounded down when a fraction of a space is less than .5.

**Required Parking Spaces by Use**

| | |
|---|---|
| Assembly area | Church: 1 space per 100 sq ft of floor area.<br>Library, community center, museum, art gallery: 1 space per 300 sq ft of floor area.<br>All other types of assembly: 1 space per 75 sq ft of floor area or 1 space per 5 fixed seats, whichever is greater. |
| Business building | 1 space for every 500 sq ft of floor area of building; provided that the minimum shall be three parking spaces. |
| Day care facility | 1 space per 10 care recipients; plus 4 pick-up/drop-off spaces for facilities with more than 25 care recipients. |
| Dormitory | 1 space per every 2 lodging rooms. |
| Dwelling, accessory | 1 on-site space per dwelling unit. |
| Dwelling, single family | 2 on-site spaces per unit for detached single family dwellings and duplexes. |
| Dwelling, multi-family | Studio and one bedroom: 1 on-site space per unit.<br>Two or more bedrooms: 2 on-site spaces per unit. |

| | |
|---|---|
| Eating and drinking establishment | 1 space per 100 sq ft of serving and dining areas. |
| Education, specialized | 1 space per each 10 students, plus 1 space per 400 sq ft of office floor space. |
| Food and beverage retail | 1 space per 500 sq ft. |
| Food processing | 1 space per 600 sq ft or 25% of the lot area, whichever is greater. |
| General merchandise | 1 space per 500 sq ft; 1 space per 600 sq ft for appliance, furniture, plumbing supply, automobile, marine supply and machinery stores requiring large floor spaces for product display. |
| General office | 1 space per 500 sq ft of floor area of building. |
| Hotel | 1 space per 2 hotel units, plus parking for eating establishments and assembly areas on the same lot. |
| Light manufacturing and processing | 1 space per 1,500 sq ft of floor area of building for warehouses and storage facilities. 1 space per 600 sq ft of floor area for all other uses. |
| Live/work business | 1 space per 750 sq ft of area used for live/work business; commercial uses and residential uses within a live/work configuration may share parking spaces. The spaces required for the residential unit on a live/work building lot may be applied toward the number of spaces required for the business use. |
| Medical center, major | 1 space per 3 beds; 0.5 spaces per bed for skilled nursing facilities. |
| Medical center, minor | Same as personal and business services. |
| Outside open air dining | 1 space per 500 sq ft. |
| Outside open air markets | None if within 400 ft of a public parking lot with more than 50 stalls. Otherwise, 1 space per 500 sq ft of floor area; none required during County sponsored special events. |
| Personal and business services | 1 space per 300 sq ft of floor area of building for medical and dental clinics, barber shops and beauty shops, financial institutions, health spas. 1 space per 500 sq ft of floor area of building for other personal and business services. |
| Quasi-public use | As specified in this section; otherwise 1 space per 500 sq ft of floor area of building. |
| Recreation | 1 space per 600 sq ft for swimming pool, gymnasium, or wellness center. |
| School | Students under fifteen years of age: 1 space per classroom.<br>Students fifteen years of age or older: 8 spaces per classroom. |
| Storage, wholesale and distribution | 1 space per 1,500 sq ft for storage facilities; 1 space per 600 sq ft all other uses. |
| Workshop/loft | 1 space per 1,500 sq ft for warehousing; |

3. On-site parking shall be located in the rear, accessed by an alley or side street. If a lot is not accessible by an alley or side street, the parking location must be 20 feet minimum beyond the front façade of the principal building.

4. Off-site parking: Parking spaces located on-street and in commonly-owned lots may be used to meet parking requirements as approved by the association. The association shall be responsible for tracking off-site parking agreements.

5. Joint-use parking: The association may permit joint-use of required parking spaces where two or more of the required parking spaces on the same lot are able to jointly use the same parking spaces because their demands occur at different times. The applicant shall submit an analysis showing the peak parking times of the uses occur at different times and that the parking area will be large enough for the anticipated demands of both uses. The association will be responsible for tracking joint-use parking agreements.

6. Parking abatement: The association, in consultation with the design advisory board, may approve a partial or total abatement of parking spaces required pursuant to Section 19.33A.050.O.2, provided that criteria A and a majority of criteria B to F are met. The criteria are as follows:

a. The abatement will forward the vision and objectives of the MRTP;

b. The majority of trips generated can be expected to be pedestrian or bicycle oriented because the project's principal market area is the MRTP;

c. The floor area of the proposed use is less than 1,000 square feet;

d. The applicant, for economic reasons, is not capable of providing cash in-lieu-of parking or participating in other parking programs set forth herein;

e. It is impractical to provide parking at the proposed site;

f. The project will have little or no effect on the parking supply.

Q. Parking lots and structures. Parking lots and parking structures shall be designed and constructed in accordance with the MRTP design guidelines.

R. Carport solar facilities. Upon review and approval by the design review board, landscaped parking stall requirements do not apply to carports.

**19.33A.090 Environmental Controls.**

A. Notwithstanding any other provisions contained in this chapter, no use or activity shall be permitted on any lot or portion of a lot within the Maui research and technology park district, unless conducted in such a manner as not to constitute a nuisance to persons or property situate upon any adjoining lots whether the lots are located within the MRTP or outside of the MRTP. Such prohibited uses shall include, but not be limited to, the following:

1. Any use, excluding reasonable construction activity, of a lot or building which emits dust, sweepings, dirt or cinders into the atmosphere, or discharges liquid or solid wastes or other matter into any stream, river, waterway, leaching pond, cesspool, injection well or drainage system which may adversely

affect the health, safety, comfort of, or intended use of their property by persons within the area;

2. The discharge of waste or any substance or materials of any kind shall be in compliance with all applicable laws;

3. The escape or discharge of any fumes, odors, spray, mists, gases, vapors, steam, acids or other substance, toxic and nontoxic, into the atmosphere which discharge may be offensive, detrimental to the health, safety or welfare of any person or may interfere with the comfort of persons within the area or which may be harmful to property or vegetation;

4. The radiation or discharge of intense glare or heat, or electromagnetic, microwave, ultrasonic, laser or other radiation. Any operation producing intense glare or heat or such other radiation shall be performed only within an enclosed or screened area and then only in such manner that the glare, heat or radiation emitted will not be discernible from any point exterior to the site or lot upon which the operation is conducted;

5. The presence at any point outside of any lot plane of a sound pressure level of any machine, device or any combination of same, from any individual plant or operation or property, which exceeds a decibel level which causes discomfort or annoyance to adjoining properties or lots;

6. The vibration of ground which is perceptible without instruments at a point exterior to the lot which is the source of such vibration;

7. Excessive emissions of smoke, steam or particulate matter (other than emissions caused by compliance with environmental requirements or due to waste control equipment), and visible (outside any building) emissions of smoke or steam which exceed Ringleman No. 1 on the Ringleman Chart of the United States Bureau of Mines (including those arising from disposal of trash and waste materials);

8. Interference with radio, television or other telecommunication signals.

B. Enforcement, Control and Monitoring Requirements.

1. The enforcing agency with technical assistance from the public works director or representative(s) and the committee shall establish such conditions and procedures to control, enforce, limit and monitor any use or activity defined and identified in subsection A of this section and is empowered to promulgate such rules and regulations as shall be necessary to implement the provisions of this chapter. Further, the enforcing agency shall also seek other technical assistance, if appropriate, from federal, state and county agencies as it relates to its duties provided hereinabove.

**19.33A.100 Maui research and technology park coordinator.** The planning director shall coordinate the submittal and review of all applications relative to development of lands within the MRTP district, including, but not limited to, zoning, subdivision, construction of improvements and building and site development. The planning director shall be responsible to facilitate the review process, and may establish time limitations and procedures for review not inconsistent with the provisions of this chapter.

**19.33A.110 Technical review committee.** The committee shall consist of the managing director, director of planning, director of public works, director of water supply, fire

chief, and any other representatives of county, state or federal agencies as designated from time to time by the coordinator. The committee shall be responsible for carrying out the duties enumerated in this chapter, as well as other duties which may be assigned by the coordinator. The purpose of the committee shall be to facilitate and expedite the permit approval process.

**19.33A.120 Design review board.** The design review board shall be appointed by the association and consist of professionals in fields such as architecture, planning, landscape architecture, engineering and sustainability. The design review board shall be responsible for assisting in the design review of projects within the MRTP prior to filing an application with the coordinator.

**19.33A.130 Procedures for subdivision.** The owner or duly authorized agent of a parcel of land within the MRTP desiring to subdivide the parcel shall file an application in accordance with the following procedures:

A. Preliminary Subdivision Approval.

1. Application for preliminary subdivision approval shall be filed with the coordinator, and include the following information:

2. The planning director shall review the application and determine whether it is complete. Within seven calendar days from the date of receipt of the application, the planning director shall refer the application to the committee and other appropriate government agencies for review and comment; or if the application is incomplete, shall return it to the applicant and specify the additional information required.

3. Within twenty calendar days from the receipt of a complete application, the coordinator shall forward the application, together with the recommendation of the committee for approval, approval with conditions, or disapproval, to the director of public works.

4. Within fifteen calendar days from the receipt of the application, the director of public works shall approve, approve with conditions, or disapprove the application for preliminary subdivision approval.

5. Unless otherwise specifically provided for by law, the general provisions of Title 18 of this code relating to subdivisions, shall apply, consistent with the time requirements provided herein.

B. Construction Plan Approval. Any application for approval of construction plans in conjunction with a subdivision having received preliminary approval as provided for in subsection A of this section, shall be submitted to the coordinator in accordance with Section 19.33.130 and shall be subject to the same expedited review process.

C. Final Subdivision Approval. All applications for final subdivision approval shall be submitted to the coordinator for review and processing. Within fifteen calendar days, the coordinator shall forward the application to the public works director, together with a recommendation for approval or disapproval. The public works director shall approve or disapprove the request for final subdivision approval within ten calendar days from the receipt of the application. If the public works director fails to approve or disapprove a request within the allotted time period, final subdivision approval shall be granted, provided that the application has been approved by the design review board and the association, and the plans have been stamped by a Hawaii licensed engineer.

**19.33A.140 Procedure for securing building and site improvement permits.** The owner or lessee of a lot within the MRTP desiring to construct any improvements, or to build, replace, enlarge or modify new or existing structures, where such construction, building, replacement, enlargement or modification requires a building, plumbing, electrical or any other type of permit or approval, shall file an application for such permit or approval with the coordinator following review by the design review board.

A. Application Requirements. The application shall contain the following information:

1. A final subdivision plat map, if applicable;

2. A specific development plan, which incorporates the approved design guidelines and also includes, where applicable and required by the coordinator, the following information:

a. A detailed drainage, grading and soil erosion report and plans,

b. Landscape planting plan,

c. Signage plan,

d. Building plans and specifications,

e. Solid and liquid waste disposal plan,

f. Parking and circulation plans,

g. Other pertinent information necessary for permit approval;

3. If required, permit fees, in accordance with this code.

B. Procedure.

1. The coordinator shall review the application and determine whether it is complete. Within seven calendar days from the date of receipt of the application, the coordinator shall refer the application to the committee and, if appropriate, other government agencies for review and comment; or if the application is incomplete, shall return it to the applicant and specify the additional information required.

2. Within twenty calendar days from the receipt of a complete application, the coordinator shall forward the application, together with the recommendation of the committee and other appropriate government agencies to the director of public works.

3. Within fifteen calendar days from the receipt of the application, the director of public works shall approve, approve with conditions, or disapprove the application for building or site improvement permit.

**19.33A.150 Improvement district program for the construction of off-site improvements.** The construction of off-site and on-site improvements for a research and technology park may be financed by improvement district bonds, based on a tax increment funding program or other instrument, in accordance with Title 14 Article 3, Improvement Districts, of this code.

**19.33A.160 Procedure for securing approval of additional permitted uses.** Developments in research, technology, and knowledge industry will occur at a faster pace than changes can be promulgated to ordinances and controlling documents. Potential users for the

MRTP, in fields that are not now contemplated, will emerge after the adoption of this ordinance. To allow future flexibility and prompt decision making, the follow measures are implemented:

A. Existing permitted uses in the various districts shall be liberally construed.

B. Where no clearly comparable use exists, a group consisting of the planning director, managing director, and economic development director will be convened within seven working days of an application being deemed complete to determine suitability. The president of the Maui Economic Development Board or designee, and the president of the association shall serve as ex-officio members of such group, and use the following criteria to guide decision making on the use;

1. Will the use further economic diversification and local job creation?

2. Is the use culturally and environmentally appropriate for Maui and otherwise compliant with the regulations governing MRTP?

3. Will the use compliment existing users within the development?

C. The decision to permit or deny the use shall be made and conveyed to the applicant no more than seven calendar days after the committee makes a decision.

The preceding standards of this chapter achieve the purpose and intent identified in Section 19.33A.010 which is to create opportunities for a broader range of desirable knowledge based and emerging industries which will provide high-skilled and well-paying jobs for Maui residents; utilize the principles of new urbanism and smart growth to create a community of innovation; and providing diverse housing options within close proximity of the MRTP employment and integrating neighborhood serving retail, civic and commercial uses in a manner that will encourage bicycling, walking and public transportation.

APPENDIX P
Incremental Development Plan

# *Maui Research & Technology Park*
# *Incremental Development Plan*

Maui R&T Partners LLC is seeking Urban District reclassification of a 253 acre Petition Area to facilitate the development of the 411 acre Maui Research & Technology Park located in Kihei, Maui. The project will take more than 10 years to develop, so this Plan has been prepared to describe the incremental districting of the project in compliance with Sections 15-15-50(c)(19) and 15-15-78 of the Hawaii Administrative Rules.

The Maui Research & Technology Park will be developed in two successive 10-year increments between years 2014 and 2034. Figure 1 is a 20-year project development timeline; Figure 2 identifies the lands included within each increment.

*INCREMENT 1*

Development of the first increment of the Maui Research & Technology Park is expected to begin in 2014 and continue through 2024. It will include the construction of approximately 750 new residential units and 700,000 square feet of new commercial and industrial floor space over 10 years.

The major infrastructure elements constructed with Increment 1 will include:

a) Sanitary Sewer System improvements consisting of a new sewer lift station, force main, and a gravity sewer collection system (see Figure 3a);
b) Potable Water System improvements consisting of a new well source, a water treatment plant, a 1.0 MG capacity water storage tank, transmission mains and distribution piping (see Figure 4a);
c) Non-Potable Water System improvements consisting of a 0.4 MG capacity water storage tank, transmission main, booster pump station, a connection to the County of Maui's R-1 reclaimed water system and distribution piping (see Figure 5a);
d) Storm Drainage improvements consisting of stormwater detention basins, confinement levees along natural drainage channels, installation of large underground trunk drainlines and smaller storm drainage collection piping (see Figure 6a); and
e) Roadway Improvements consisting of additional turning lanes at the Lipoa Parkway / Piilani Highway intersection, extension of Ninau Street to the northern project boundary, paving the northern side of Lipoa Parkway, extension of Ho'okena Street to Piilani Highway, and expansion of the internal roadway network. (See Figures 7a and 8)

***Maui R&T Park Incremental Development Plan***

*INCREMENT 2*

Development of the second increment of the Maui Research & Technology Park is expected to commence in 2025 and continue through 2034. It will include the construction of approximately 500 new residential units and 1,300,000 square feet of new commercial and industrial floor space over 10 years.

The major infrastructure elements constructed with Increment 2 will include:

a) Sanitary Sewer System improvements consisting of a new gravity sewer connection near the Kihei Wastewater Treatment Plant and further expansion of the gravity sewer collection system (see Figure 3b);

b) Potable Water System improvements consisting of additional wells to increase water source capacity, a 0.5 MG capacity water storage tank and expansion of the distribution piping network (see Figure 4b);

c) Non-Potable Water System improvements consisting of expansion of the distribution piping network (see Figure 5b);

d) Storm Drainage improvements consisting of additional stormwater detention basins, runoff diversions along the mauka project boundary, additional confinement levees along natural drainage channels, roadway culvert crossings, and expansion of the underground storm drain network (see Figure 6b); and

e) Roadway Improvements, including the extension of Ninau Street to the southern project boundary and further expansion of the internal roadway network (see Figure 7).

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Figure 5a - Non-Potable Water System Improvements for Increment 1
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Figure 6b - Storm Drainage Improvements for Increment 2
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Figure 7a - Roadway System Improvements for Increment 2
Figure 8 - Piilani Highway Improvements

**Maui Research & Technolgy Park**
**Incremental Development Plan**
**version 2, 5 November 2012**

# Maui Research and Technology Park Development Timeline

| | Totals | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **INCREMENT 1** | | | | | | | | | | | | | | | | | | | | | | | |
| **INFRASTRUCTURE** | | | | | | | | | | | | | | | | | | | | | | | |
| **Sanitary Sewer System** | | | | | | | | | | | | | | | | | | | | | | | |
| Sewer Lift Station and Force Main | | | | | | | | | | | | | | | | | | | | | | | |
| Deploy Gravity Sewer Collection System | | | | | | | | | | | | | | | | | | | | | | | |
| **Potable Water System** | | | | | | | | | | | | | | | | | | | | | | | |
| Construct Well Source | | | | | | | | | | | | | | | | | | | | | | | |
| Construct Water Treatment Plant | | | | | | | | | | | | | | | | | | | | | | | |
| Construct 1.0 MG Storage Tank | | | | | | | | | | | | | | | | | | | | | | | |
| Construct Transmission Lines | | | | | | | | | | | | | | | | | | | | | | | |
| Deploy Distribution Main Network | | | | | | | | | | | | | | | | | | | | | | | |
| **Non-Potable Water System** | | | | | | | | | | | | | | | | | | | | | | | |
| Construct Well Source | | | | | | | | | | | | | | | | | | | | | | | |
| Construct 0.4 MG Storage Tank and Transmission Main | | | | | | | | | | | | | | | | | | | | | | | |
| Construct Booster Pump Station and Connect to County R-1 System | | | | | | | | | | | | | | | | | | | | | | | |
| Deploy Distribution Main Network | | | | | | | | | | | | | | | | | | | | | | | |
| **Drainage System** | | | | | | | | | | | | | | | | | | | | | | | |
| Construct Drainage Basins | | | | | | | | | | | | | | | | | | | | | | | |
| Improve Primary Drainageways | | | | | | | | | | | | | | | | | | | | | | | |
| Install Primary Underground Drainlines | | | | | | | | | | | | | | | | | | | | | | | |
| Deploy Underground Storm Drain Network | | | | | | | | | | | | | | | | | | | | | | | |
| **Roadway Improvements** | | | | | | | | | | | | | | | | | | | | | | | |
| Improve Lipoa Pkwy / Piilani Highway Intersection | | | | | | | | | | | | | | | | | | | | | | | |
| Extend Ninau Street Northward | | | | | | | | | | | | | | | | | | | | | | | |
| Construct Lanes on Northern Side of Lipoa Parkway | | | | | | | | | | | | | | | | | | | | | | | |
| Connect Ho'okena Street to Piilani Highway | | | | | | | | | | | | | | | | | | | | | | | |
| Deploy Internal Roadway Network | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| **RESIDENTIAL** | **Units** | | | | | | | | | | | | | | | | | | | | | | |
| SF | 450 | - | - | - | - | 75 | 57 | 57 | 57 | 57 | 57 | 52 | 38 | | | | | | | | | | |
| MF | 300 | - | - | - | - | 50 | 40 | 40 | 40 | 40 | 40 | 40 | 10 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| **NON-RESIDENTIAL** | **Sq. Ft.** | | | | | | | | | | | | | | | | | | | | | | |
| Commercial / Other | 259,860 | - | - | - | - | 15,542 | 15,542 | 15,542 | 105,542 | 18,423 | 52,423 | 18,423 | 18,423 | | | | | | | | | | |
| Industrial / Business | 420,464 | 50,000 | 10,000 | 15,000 | 20,000 | 30,770 | 30,770 | 30,770 | 30,770 | 50,596 | 50,596 | 50,596 | 50,596 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| **INCREMENT 2** | | | | | | | | | | | | | | | | | | | | | | | |
| **INFRASTRUCTURE** | | | | | | | | | | | | | | | | | | | | | | | |
| **Sanitary Sewer System** | | | | | | | | | | | | | | | | | | | | | | | |
| Extend Gravity Sewer Collection System | | | | | | | | | | | | | | | | | | | | | | | |
| **Potable Water System** | | | | | | | | | | | | | | | | | | | | | | | |
| Expand Well Source (Offsite Improvement) | | | | | | | | | | | | | | | | | | | | | | | |
| Construct 0.5 MG Storage Tank (Offsite Improvement) | | | | | | | | | | | | | | | | | | | | | | | |
| Extend Distribution Main Network | | | | | | | | | | | | | | | | | | | | | | | |
| **Non-Potable Water System** | | | | | | | | | | | | | | | | | | | | | | | |
| Expand Well Source (Offsite Improvement) | | | | | | | | | | | | | | | | | | | | | | | |
| Extend Distribution Main Network | | | | | | | | | | | | | | | | | | | | | | | |
| **Drainage System** | | | | | | | | | | | | | | | | | | | | | | | |
| Construct Drainage Basins | | | | | | | | | | | | | | | | | | | | | | | |
| Improve Primary Drainageways | | | | | | | | | | | | | | | | | | | | | | | |
| Install Primary Underground Drainlines | | | | | | | | | | | | | | | | | | | | | | | |
| Expand Underground Storm Drain Network | | | | | | | | | | | | | | | | | | | | | | | |
| **Roadway Improvements** | | | | | | | | | | | | | | | | | | | | | | | |
| Extend Ninau Street Southward | | | | | | | | | | | | | | | | | | | | | | | |
| Expand Internal Roadway Network | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| **RESIDENTIAL** | **Units** | | | | | | | | | | | | | | | | | | | | | | |
| SF | 300 | | | | | | | | | | | | | 57 | 57 | 57 | 57 | 57 | 15 | - | - | - | - |
| MF | 200 | | | | | | | | | | | | | 40 | 40 | 40 | 40 | 40 | - | - | - | - | - |
| | | | | | | | | | | | | | | | | | | | | | | | |
| **NON-RESIDENTIAL** | **Sq. Ft.** | | | | | | | | | | | | | | | | | | | | | | |
| Commercial / Other | 261,478 | | | | | | | | | | | | | 68,440 | 21,118 | 21,118 | 21,118 | 21,118 | 21,118 | 24,362 | 24,362 | 24,362 | 14,362 |
| Industrial / Business | 1,058,198 | | | | | | | | | | | | | 50,596 | 75,725 | 75,725 | 75,725 | 75,725 | 75,725 | 89,736 | 89,736 | 49,505 | 400,000 |

*V:\Projdata\08proj\08028 (Maui R&T Park - Master Plan)\Reports\Incremental Development Plan\Timeline_rev03.xlsx*

**FIGURE 1**

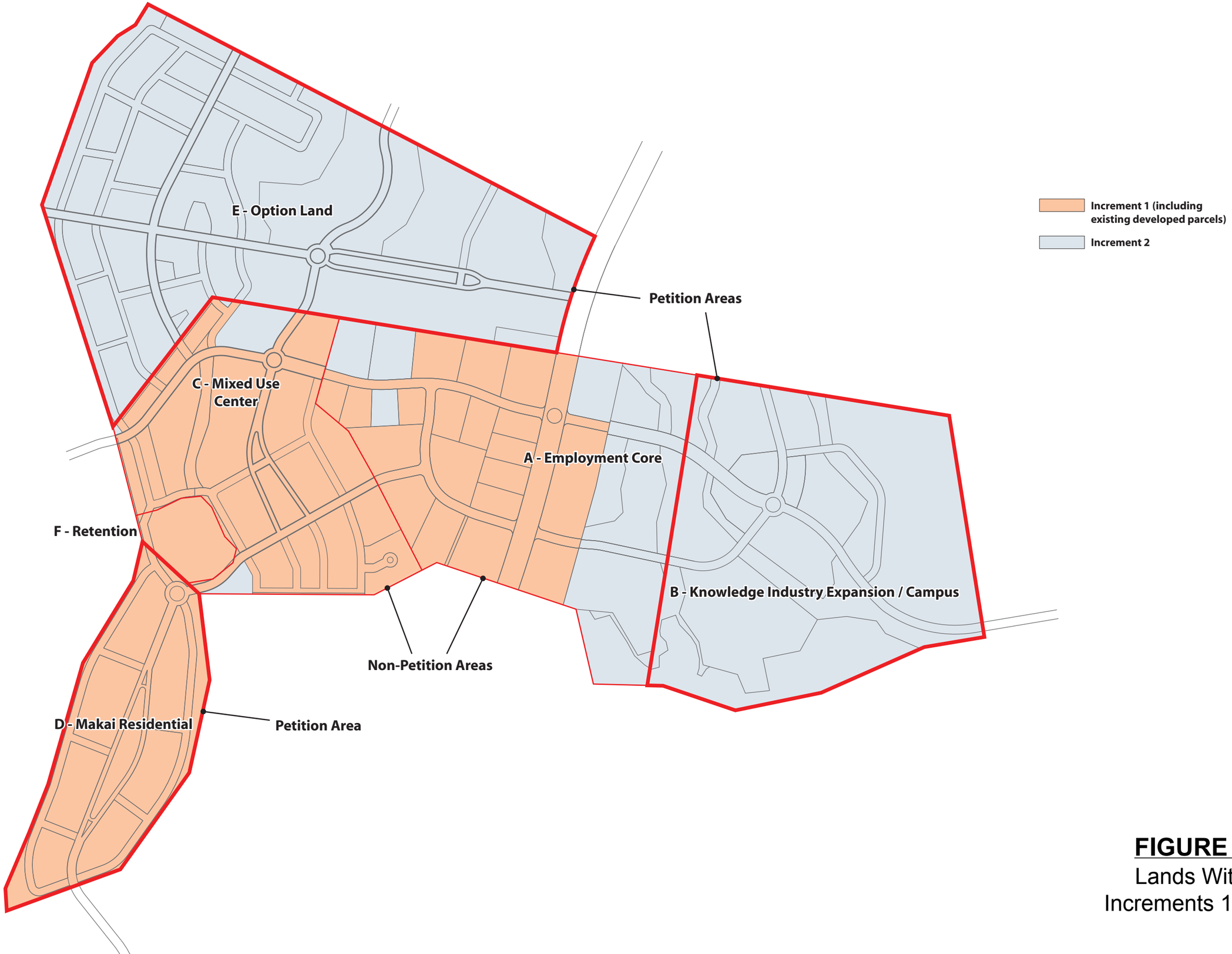



**FIGURE 2a**
Lands Within
Increments 1 and 2

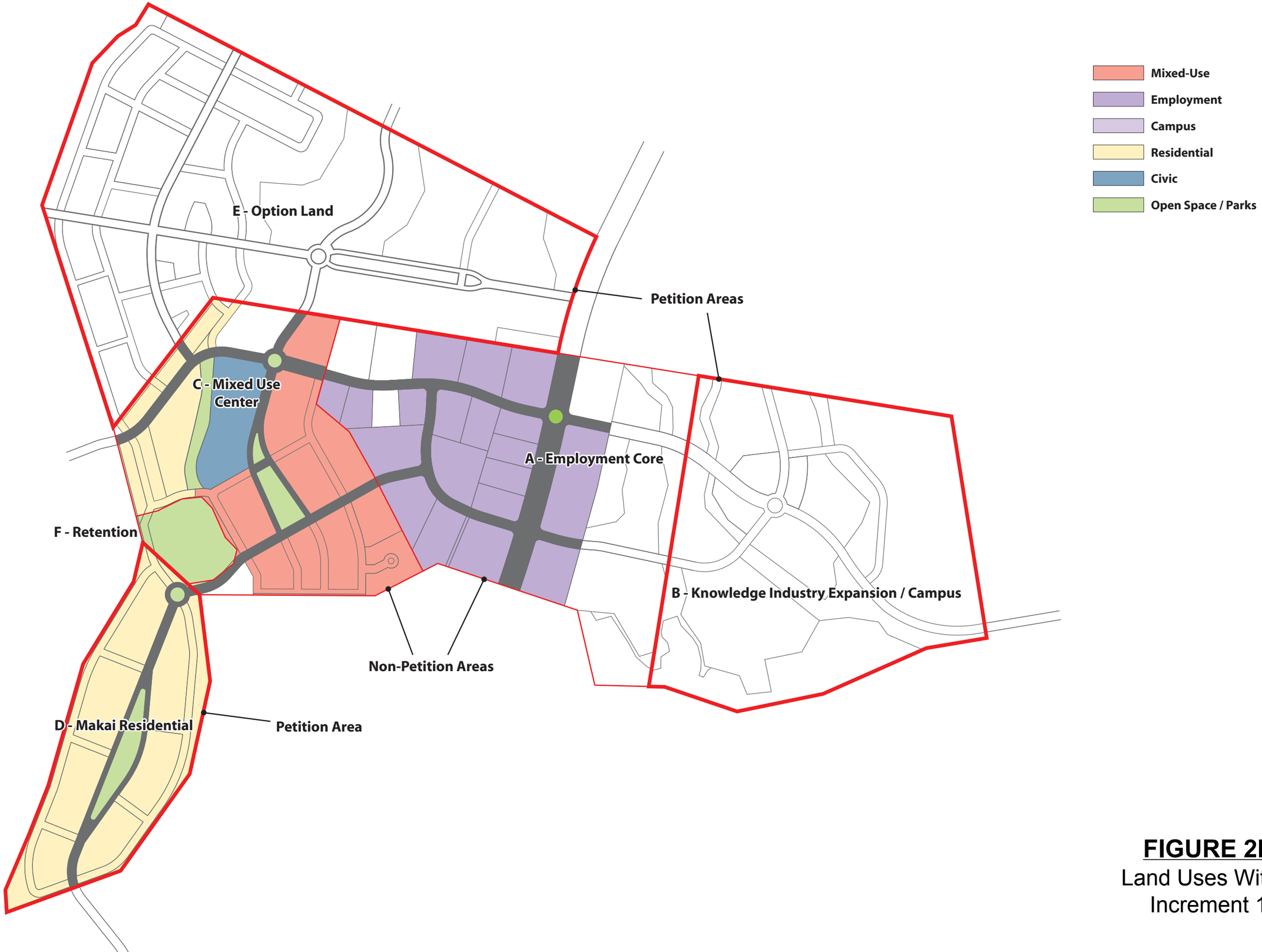



**FIGURE 2b**
Land Uses Within Increment 1

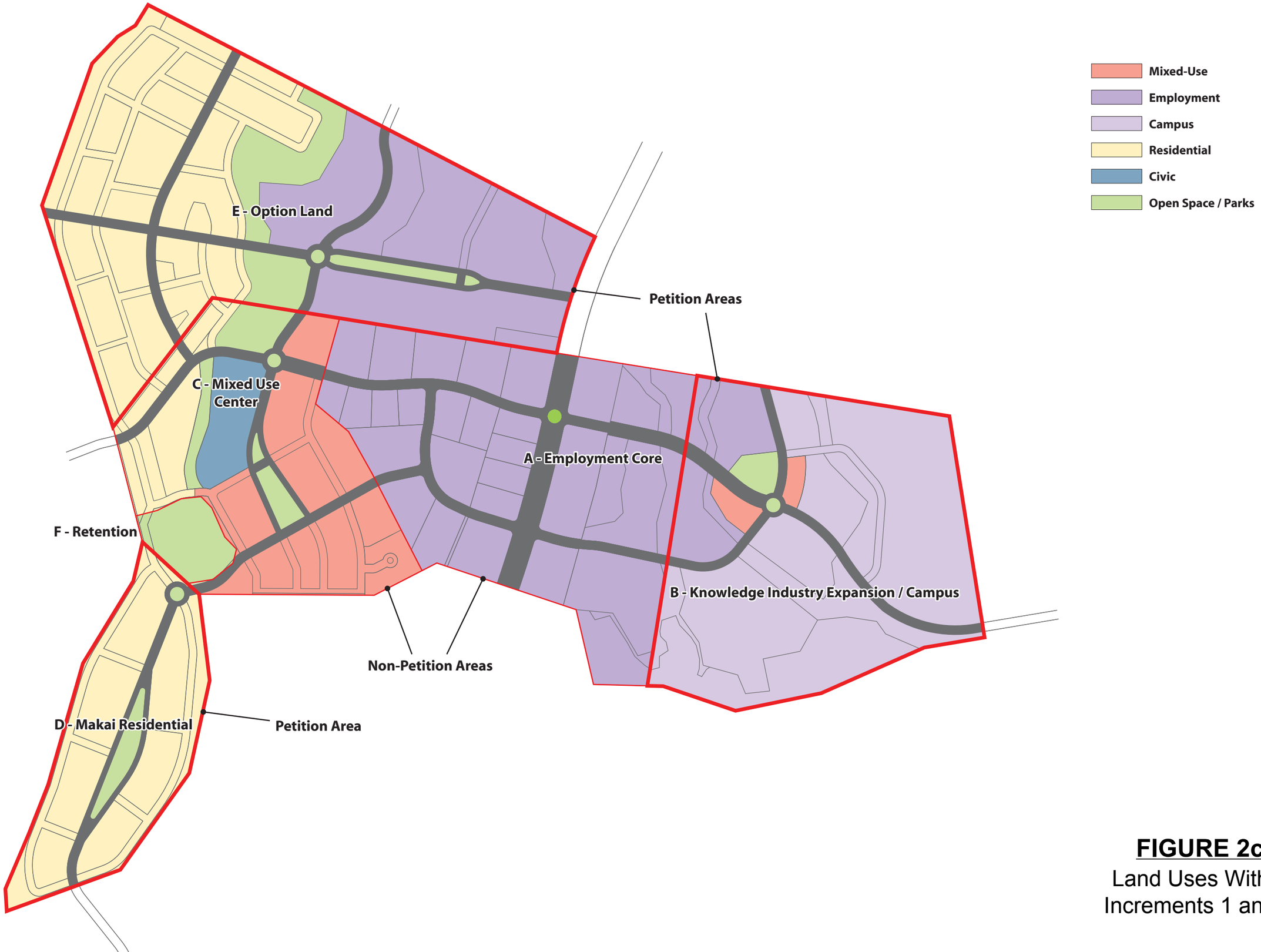



**FIGURE 2c**
Land Uses Within Increments 1 and 2

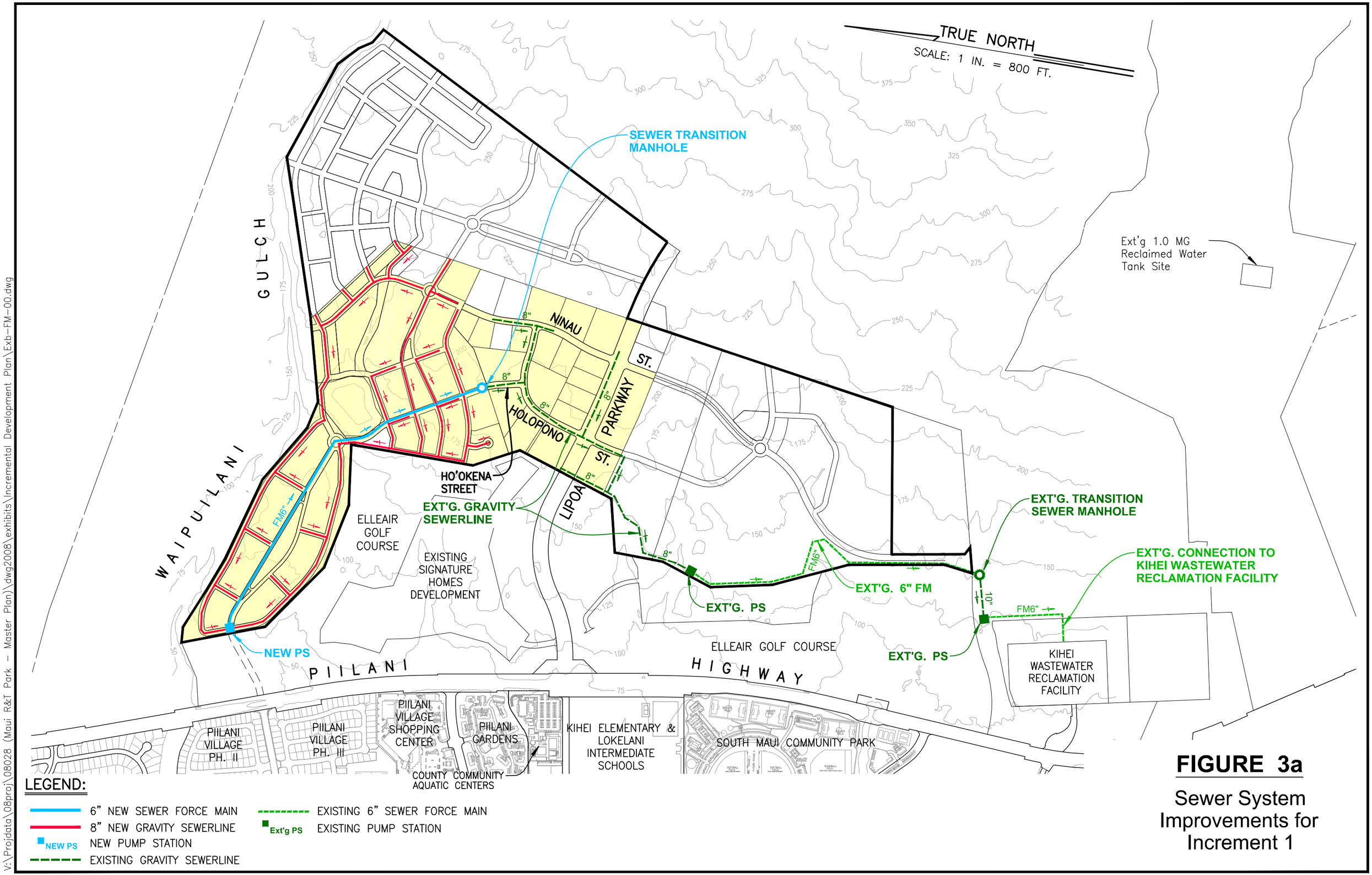



**FIGURE 3a**

Sewer System Improvements for Increment 1

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Incremental Development Plan\Exb-FM-00.dwg

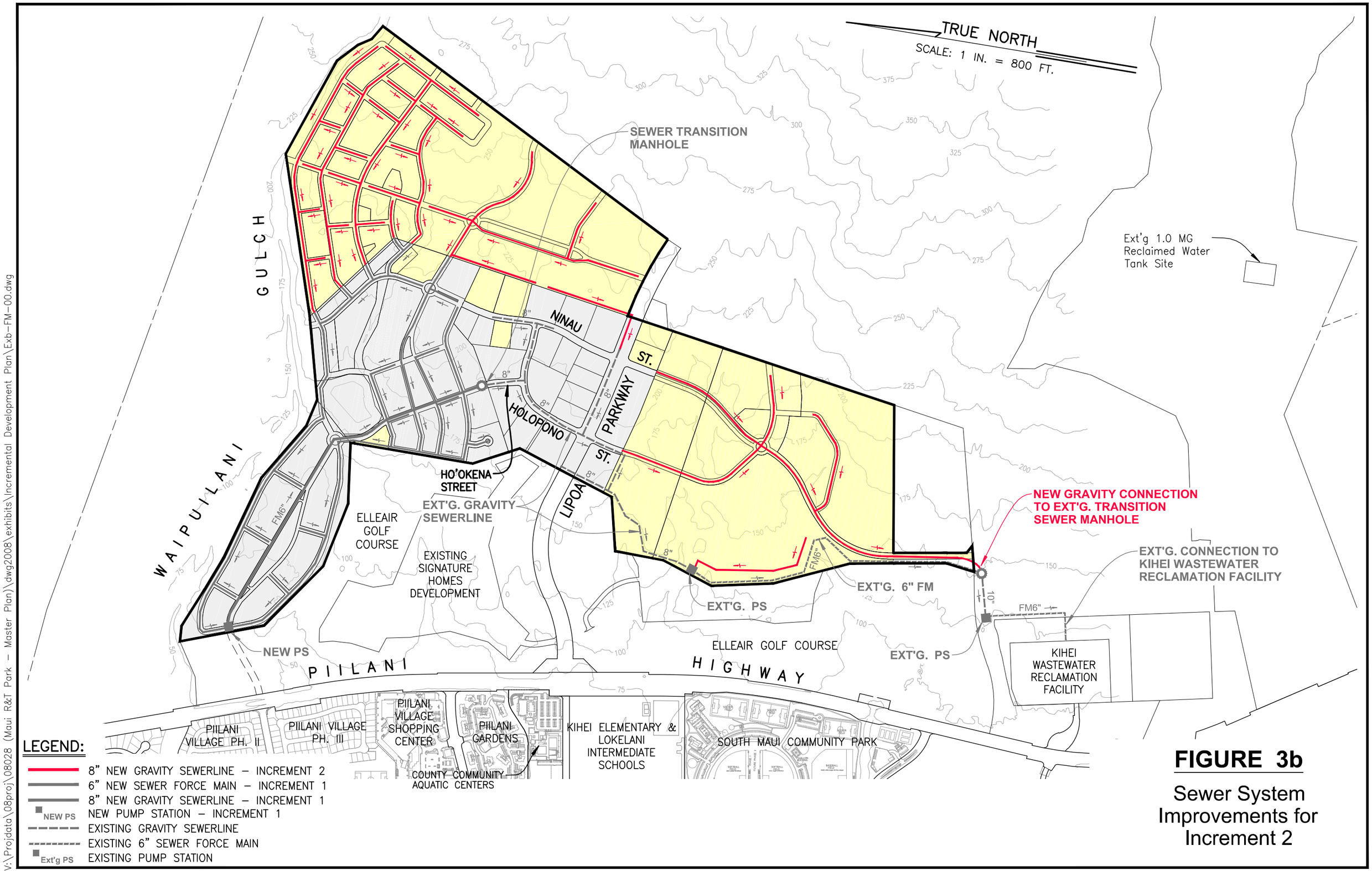



**FIGURE 3b**

Sewer System Improvements for Increment 2

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Incremental Development Plan\Exb-FM-00.dwg

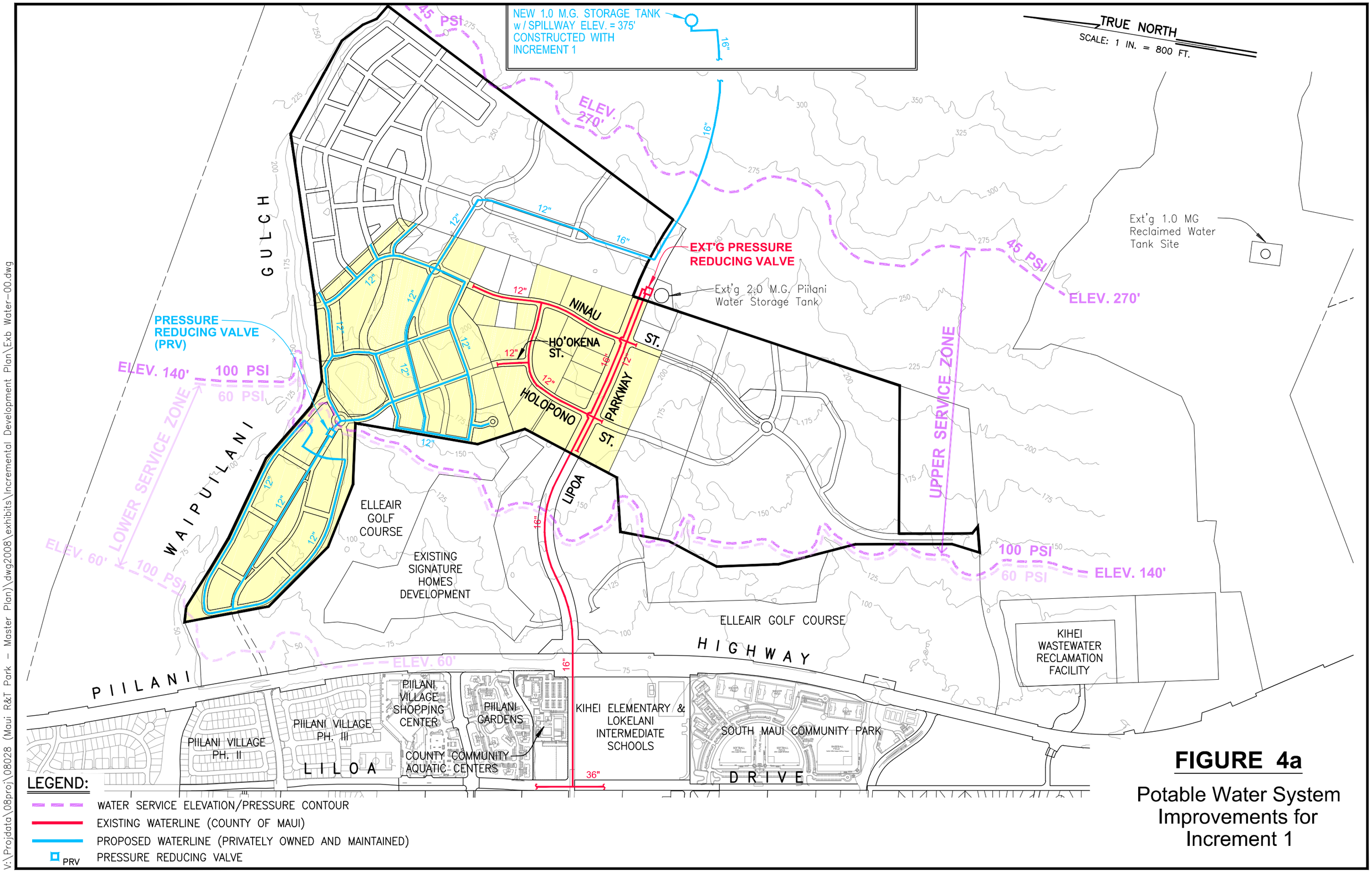



**FIGURE 4a**

Potable Water System Improvements for Increment 1

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Incremental Development Plan\Exb Water-00.dwg

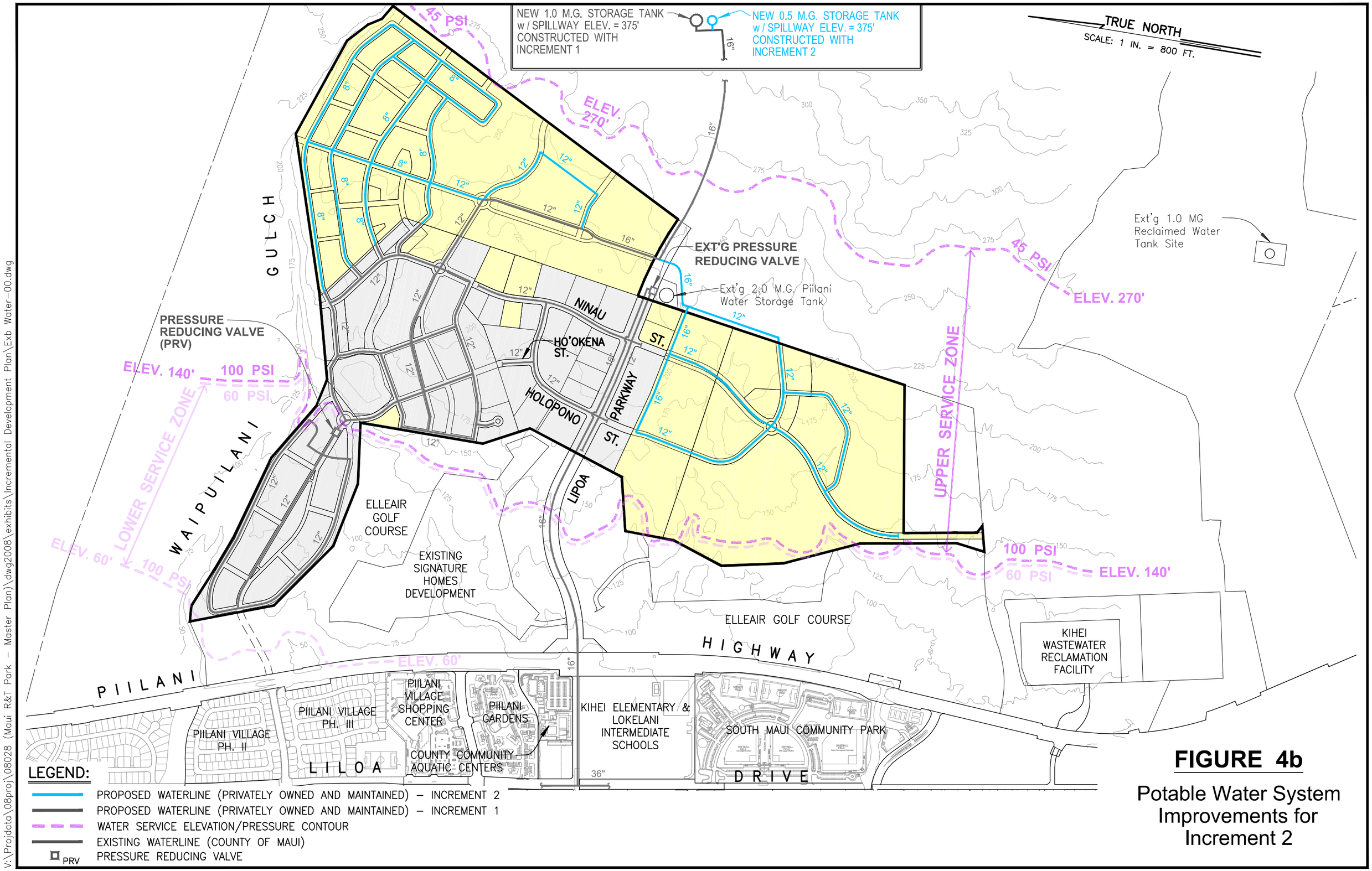



**FIGURE 4b**

Potable Water System Improvements for Increment 2

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Incremental Development Plan\Exb Water-00.dwg

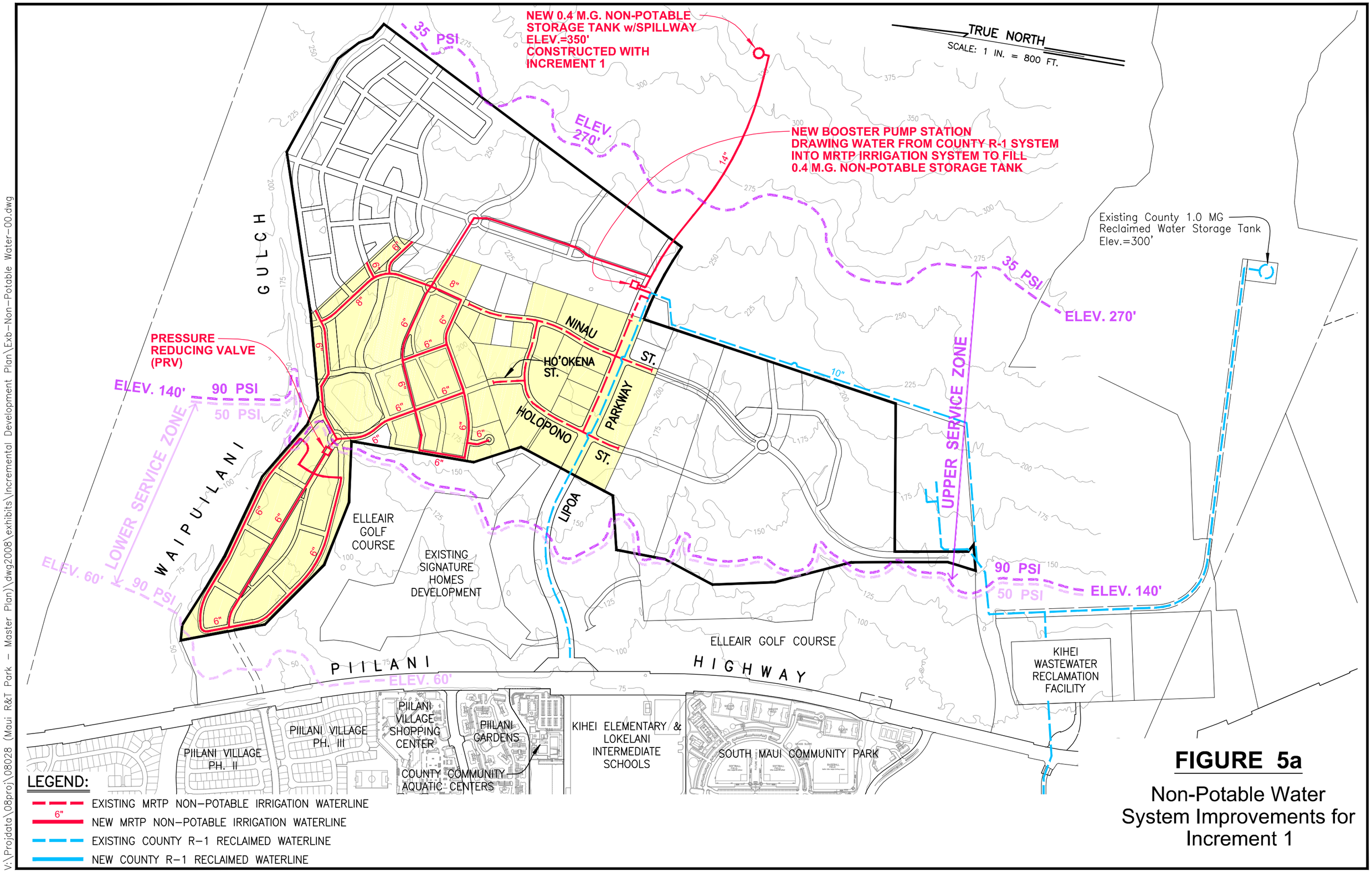



**FIGURE 5a**

Non-Potable Water System Improvements for Increment 1

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Incremental Development Plan\Exb-Non-Potable Water-00.dwg

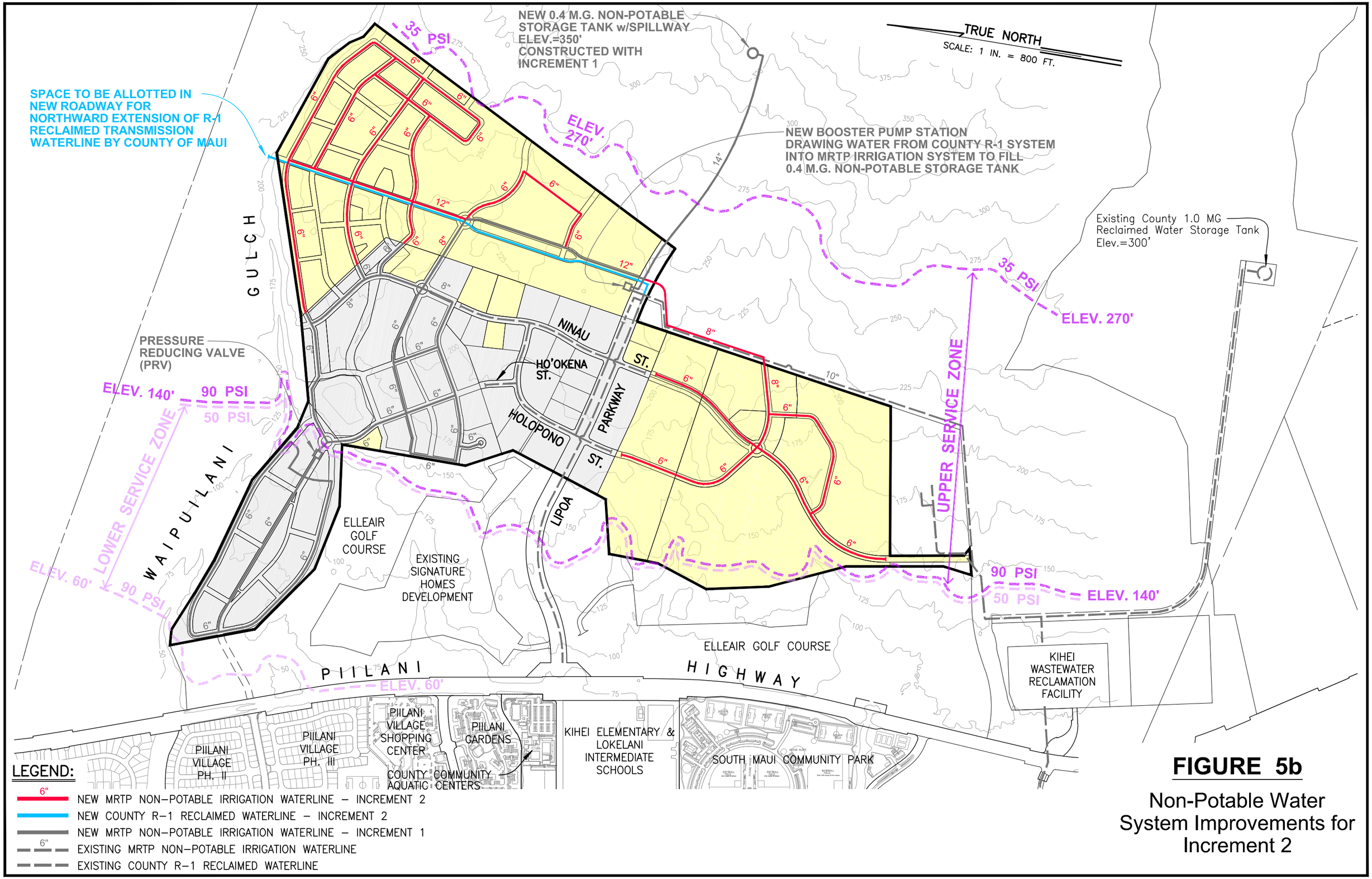
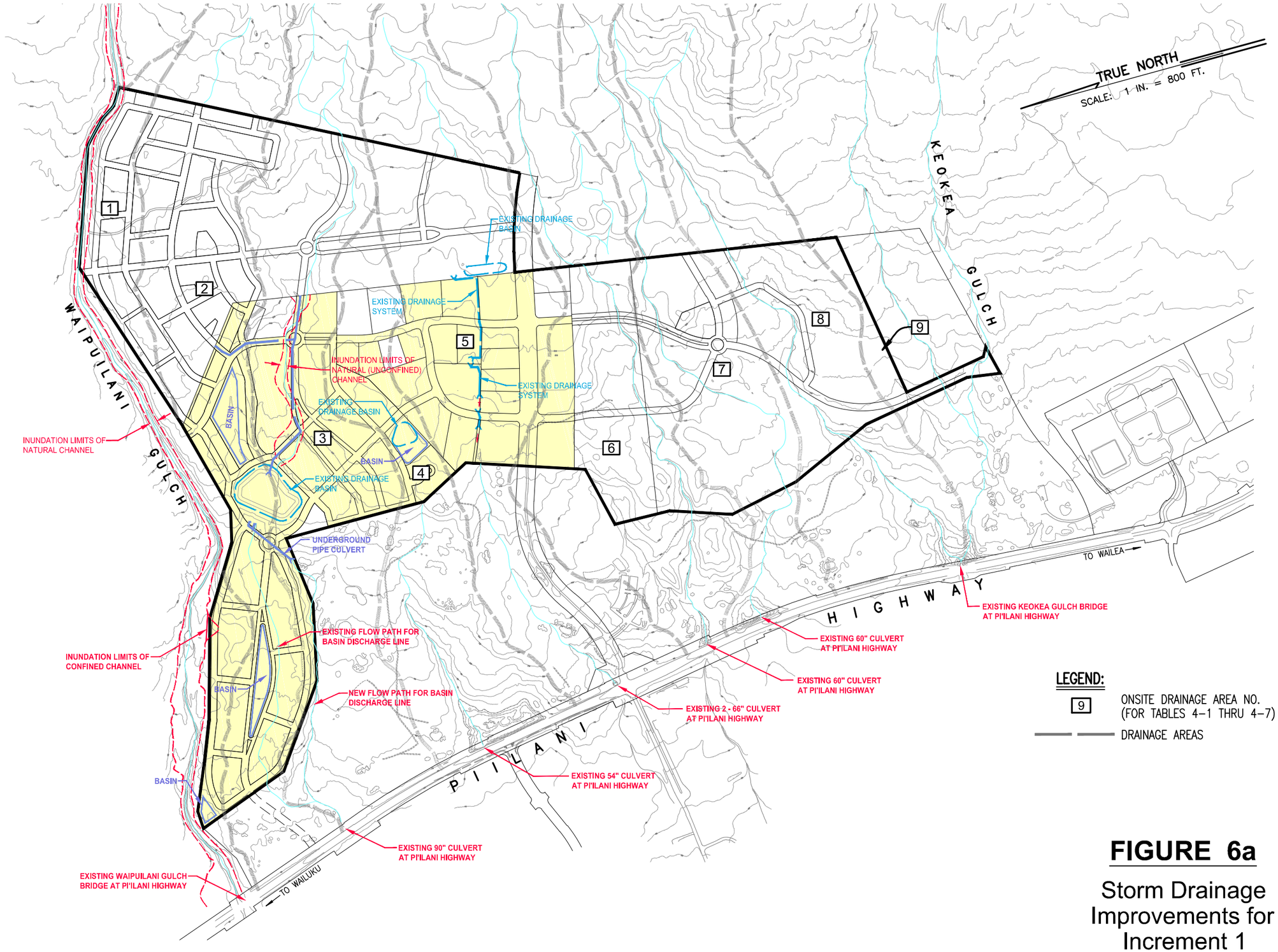



**FIGURE 5b**

Non-Potable Water System Improvements for Increment 2

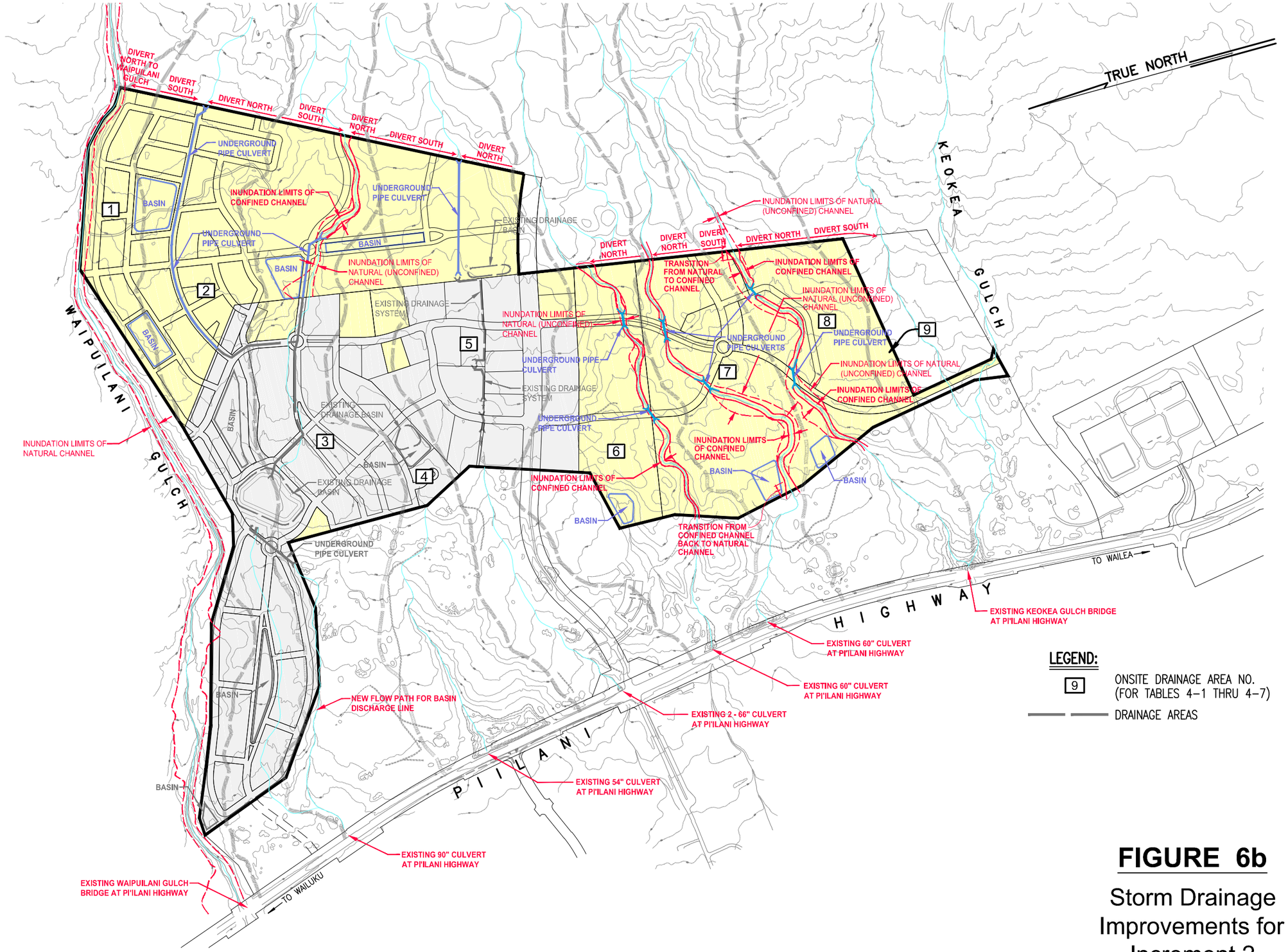
V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Incremental Development Plan\Exb-Non-Potable Water-00.dwg




# FIGURE 6a

Storm Drainage Improvements for Increment 1

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Incremental Development Plan\Exb-Drainage Plan-00.dwg




# FIGURE 6b

Storm Drainage Improvements for Increment 2

V:\Projdata\08proj\08028 (Maui R&T Park - Master Plan)\dwg2008\exhibits\Incremental Development Plan\Exb-Drainage Plan-00.dwg

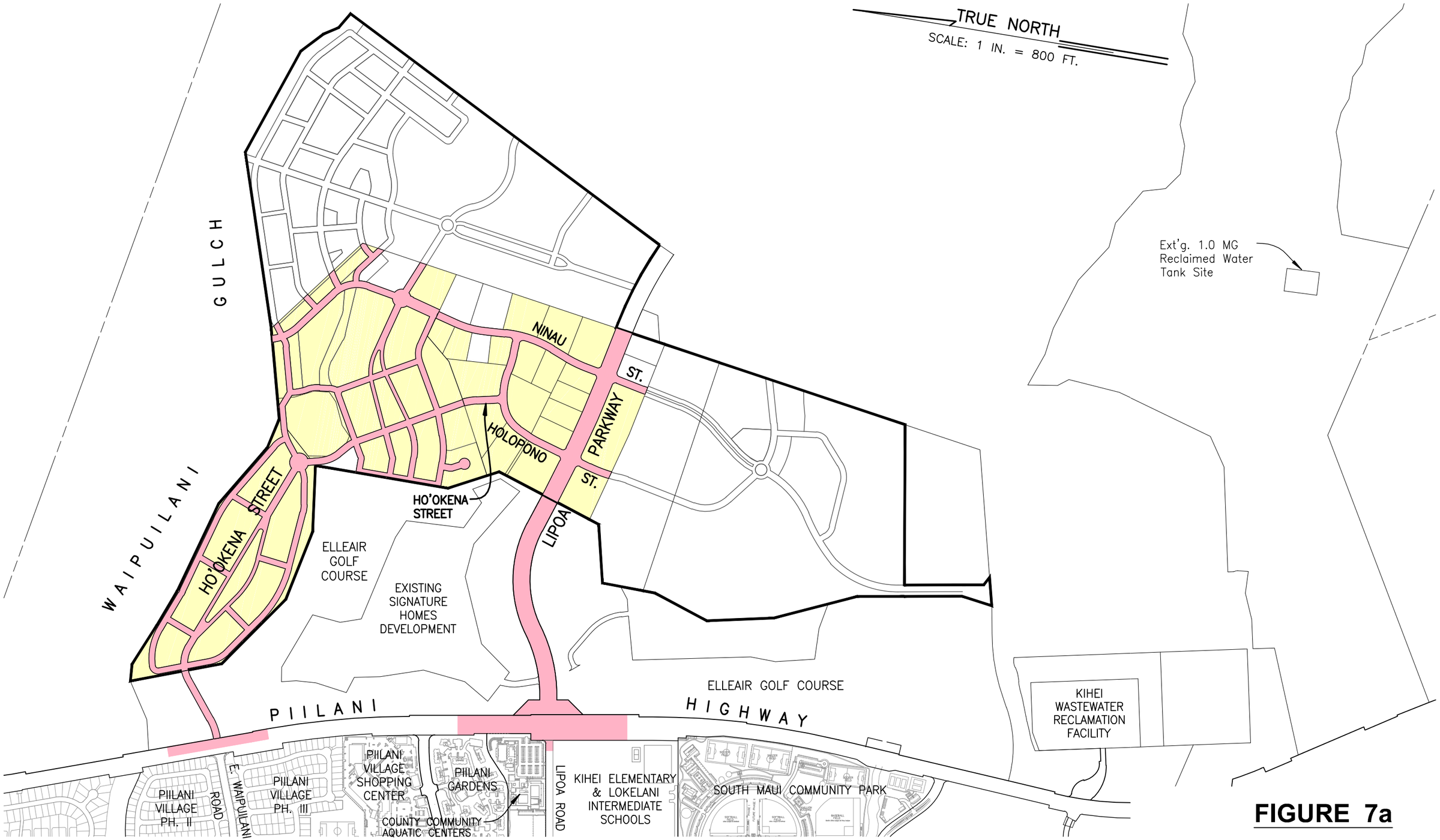



**FIGURE 7a**

Roadway System Improvements for Increment 1

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Incremental Development Plan\Exb-Roadway-00.dwg

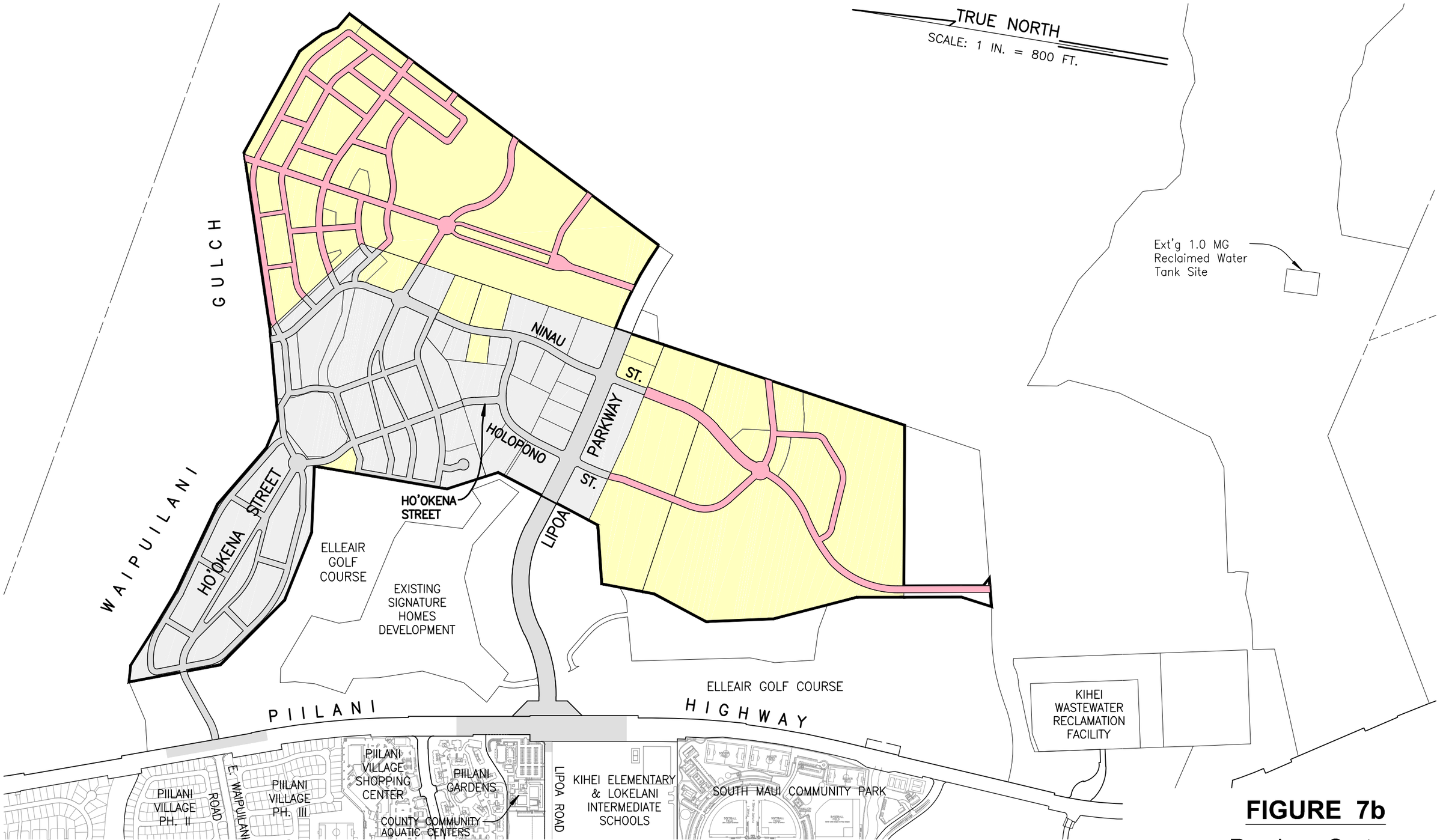
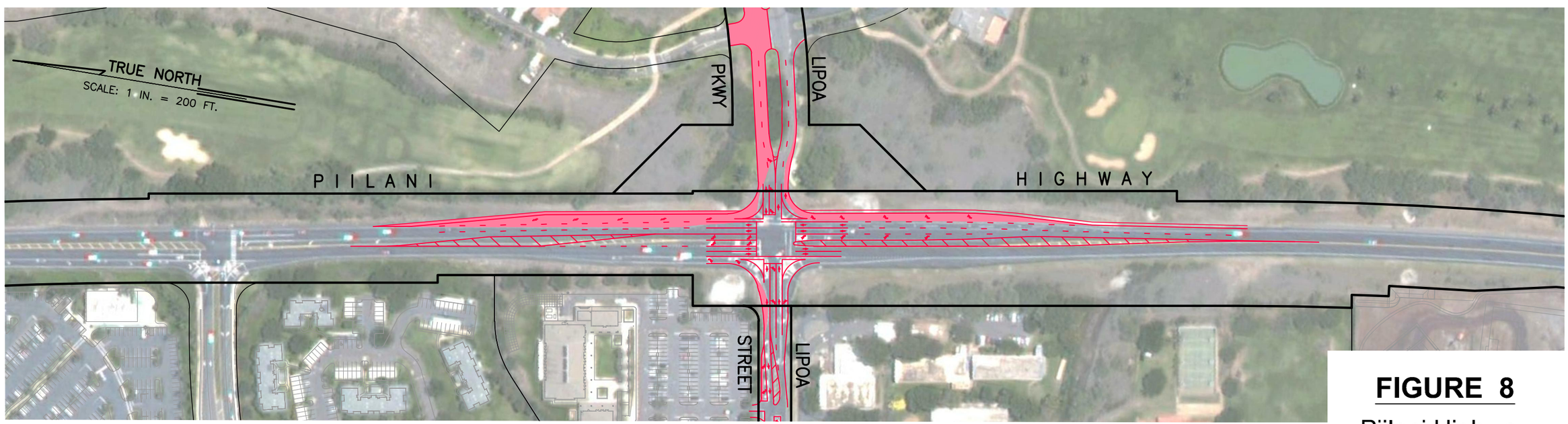



**FIGURE 7b**

Roadway System Improvements for Increment 2

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Incremental Development Plan\Exb-Roadway-00.dwg

**Ho'okena Street Extension at Piilani Highway**




**Piilani Highway at Lipoa Parkway**

**FIGURE 8**

Piilani Highway Improvements

V:\Projdata\08proj\08028 (Maui R&T Park – Master Plan)\dwg2008\exhibits\Incremental Development Plan\EXB-INTERSECTION-00.dwg

MAUI RESEARCH & TECHNOLOGY PARK
Order-Of-Magnitude Construction Cost Summary

November 21, 2011

| Description | | Total |
|---|---|---|
| INCREMENT 1 | | |
| Petition Area | | |
| Sewer System | $ | 1,316,000 |
| Potable Water System | $ | 2,509,000 |
| Non-Potable Water System | $ | 514,000 |
| Roadway Improvements | $ | 10,991,000 |
| Drainage System | $ | 5,512,500 |
| Building Site Mass Earthwork | $ | 590,000 |
| Subtotal - Petition Area: | $ | 21,432,500 |
| Non-Petition Area | | |
| Sewer System | $ | 1,732,000 |
| Potable Water System | $ | 3,373,000 |
| Non-Potable Water System | $ | 1,027,500 |
| Roadway Improvements | $ | 21,215,300 |
| Drainage System | $ | 7,154,000 |
| Building Site Mass Earthwork | $ | 3,160,000 |
| Subtotal - Non-Petition Area: | $ | 37,661,800 |
| Offsite Improvements | | |
| Potable Water System | $ | 12,490,000 |
| Non-Potable Water System | $ | 2,880,000 |
| Roadway Improvements | $ | 3,045,000 |
| Subtotal - Offsite Imrovements: | $ | 18,415,000 |
| Subtotal - Increment 1: | $ | 77,509,300.00 |

Note: See Schedule A for Detailed Breakdown

| Description | | Total |
|---|---|---|
| INCREMENT 2 | | |
| Petition Area | | |
| Sewer System | $ | 3,795,000 |
| Potable Water System | $ | 4,515,000 |
| Non-Potable Water System | $ | 1,575,500 |
| Roadway Improvements | $ | 32,320,600 |
| Drainage System | $ | 20,796,000 |
| Building Site Mass Earthwork | $ | 10,370,000 |
| Subtotal - Petition Area: | $ | 73,372,100 |
| Non-Petition Area | | |
| Sewer System | $ | 165,000 |
| Potable Water System | $ | 858,500 |
| Non-Potable Water System | $ | 71,500 |
| Roadway Improvements | $ | 1,615,700 |
| Drainage System | $ | 1,887,000 |
| Building Site Mass Earthwork | $ | 1,185,000 |
| Subtotal - Non-Petition Area: | $ | 5,782,700 |
| Offsite Improvements | | |
| Potable Water System | $ | 6,170,000 |
| Subtotal - Offsite Improvements: | $ | 6,170,000 |
| Subtotal - Increment 2: | $ | 85,324,800 |
| TOTAL - INCREMENTS 1 AND 2: | $ | 162,834,100 |
| 20% Contingency: | $ | 32,566,820 |
| TOTAL CONSTRUCTION COST: | $ | 195,400,920 |

# SCHEDULE A

## MAUI RESEARCH & TECHNOLOGY PARK
## Construction Cost Breakdown

November 21, 2012

| Description | Approx. Quan. | Unit | Unit Price | Total |
|---|---|---|---|---|
| INCREMENT 1 | | | | |
| Petition Area | | | | |
| Sewer System | | | | |
| 6" Sewer Force Main | 2,200 | L.F. | $ 80 | $ 176,000 |
| 8" Gravity Sewerline with Manholes | 6,600 | L.F. | $ 150 | $ 990,000 |
| Sewer Lift Station | 1 | EA. | $ 150,000 | $ 150,000 |
| | | | Subtotal - Sewer System: | $ 1,316,000 |
| Potable Water System | | | | |
| 12" Waterline & Fittings | 7,600 | L.F. | $ 130 | $ 988,000 |
| Pressure Reducing Valve Assembly | 1 | EA. | $ 40,000 | $ 40,000 |
| Residential (SF) Service Lateral | 350 | EA. | $ 4,000 | $ 1,400,000 |
| Fire Hydrant | 30 | EA. | $ 2,700 | $ 81,000 |
| | | | Subtotal - Potable Water System: | $ 2,509,000 |
| Non-Potable Water System | | | | |
| 6" Irrigation Waterline & Fittings | 7,600 | L.F. | $ 65 | $ 494,000 |
| Pressure Reducing Valve Assembly | 1 | EA. | $ 20,000 | $ 20,000 |
| | | | Subtotal - Non-Potable Water System: | $ 514,000 |
| Roadway Improvements | | | | |
| Roundabout | 2 | EA. | $ 600,000 | $ 1,200,000 |
| Local Street (Type E)[1] | 6,900 | L.F. | $ 890 | $ 6,141,000 |
| Split Connector (Type D)[1] | 2,400 | L.F. | $ 712 | $ 1,708,800 |
| Connector Street (Type C)[1] | 1,100 | L.F. | $ 1,242 | $ 1,366,200 |
| Roads - Embankment | 55,000 | C.Y. | $ 5 | $ 275,000 |
| Roads - Excavation | 25,000 | C.Y. | $ 12 | $ 300,000 |
| | | | Subtotal - Roadway Improvements: | $ 10,991,000 |

[1] See Schedule B for Detailed Breakdown

| Description | Approx. Quan. | Unit | Unit Price | Total |
|---|---|---|---|---|
| INCREMENT 1 | | | | |
| Petition Area | | | | |
| Drainage System | | | | |
| Trunk Drainline | 500 | L.F. | $ 825 | $ 412,500 |
| Drainline with Manholes and Catch Basins | 10,000 | L.F. | $ 420 | $ 4,200,000 |
| Drainage Detention Basin | 2 | EA. | $ 300,000 | $ 600,000 |
| Waipuilani Levee | 300 | L.F. | $ 1,000 | $ 300,000 |
| | | | Subtotal - Drainage System: | $ 5,512,500 |
| Building Site Mass Earthwork | | | | |
| Lots - Embankment | 10,000 | C.Y. | $ 5 | $ 50,000 |
| Lots - Excavation | 45,000 | C.Y. | $ 12 | $ 540,000 |
| | | | Subtotal - Building Site Mass Earthwork: | $ 590,000 |
| Non-Petition Area | | | | |
| Sewer System | | | | |
| 6" Sewer Force Main | 1,400 | L.F. | $ 80 | $ 112,000 |
| 8" Gravity Sewerline with Manholes | 10,700 | L.F. | $ 150 | $ 1,605,000 |
| Sewer Transition Manhole | 1 | EA. | $ 15,000 | $ 15,000 |
| | | | Subtotal - Sewer System: | $ 1,732,000 |
| Potable Water System | | | | |
| 12" Waterline & Fittings | 13,900 | L.F. | $ 130 | $ 1,807,000 |
| 16" Waterline & Fittings | 600 | L.F. | $ 160 | $ 96,000 |
| Residential (SF) Service Lateral | 100 | EA. | $ 4,000 | $ 400,000 |
| Residential (MF) Service Lateral | 40 | EA. | $ 8,500 | $ 340,000 |
| Commercial Service Lateral | 70 | EA. | $ 8,500 | $ 595,000 |
| Fire Hydrant | 50 | EA. | $ 2,700 | $ 135,000 |
| | | | Subtotal - Potable Water System: | $ 3,373,000 |

| Description | Approx. Quan. | Unit | Unit Price | Total |
|---|---|---|---|---|
| INCREMENT 1 | | | | |
| Non-Petition Area | | | | |
| Non-Potable Water System | | | | |
| 6" Irrigation Waterline & Fittings | 6,900 | L.F. | $ 65 | $ 448,500 |
| 8" Irrigation Waterline & Fittings | 1,600 | L.F. | $ 90 | $ 144,000 |
| 14" Irrigation Waterline & Fittings | 3,000 | L.F. | $ 145 | $ 435,000 |
| | Subtotal - Non-Potable Water System: | | | $ 1,027,500 |
| Roadway Improvements | | | | |
| Roundabout | 2 | EA. | $ 600,000 | $ 1,200,000 |
| Local Street (Type E)[1] | 6,800 | L.F. | $ 890 | $ 6,052,000 |
| Split Connector (Type D)[1] | 1,400 | L.F. | $ 712 | $ 996,800 |
| Connector Street (Type C)[1] | 4,900 | L.F. | $ 1,242 | $ 6,085,800 |
| Greenway (Type B)[1] | 2,300 | L.F. | $ 1,521 | $ 3,498,300 |
| Lipoa Parkway Widening (Type A3)[1] | 2,900 | L.F. | $ 956 | $ 2,772,400 |
| Roads - Embankment | 50,000 | C.Y. | $ 5 | $ 250,000 |
| Roads - Excavation | 30,000 | C.Y. | $ 12 | $ 360,000 |
| | Subtotal - Roadway Improvements: | | | $ 21,215,300 |
| Drainage System | | | | |
| Trunk Drainline | 2,400 | L.F. | $ 825 | $ 1,980,000 |
| Drainline with Manholes and Catch Basins | 11,200 | L.F. | $ 420 | $ 4,704,000 |
| Drainage Detention Basin | 1 | EA. | $ 370,000 | $ 370,000 |
| Expansion of Existing Basin | 1 | EA. | $ 100,000 | $ 100,000 |
| | Subtotal - Drainage System: | | | $ 7,154,000 |
| Building Site Mass Earthwork | | | | |
| Lots - Embankment | 200,000 | C.Y. | $ 5 | $ 1,000,000 |
| Lots - Excavation | 180,000 | C.Y. | $ 12 | $ 2,160,000 |
| | Subtotal - Building Site Mass Earthwork: | | | $ 3,160,000 |

| Description | Approx. Quan. | Unit | Unit Price | Total |
|---|---|---|---|---|
| INCREMENT 1 | | | | |
| Offsite Improvements | | | | |
| Potable Water System | | | | |
| Potable Well | | L.S. | | $ 3,650,000 |
| Water Treatment Plant | | L.S. | | $ 3,080,000 |
| 1.0 MG Water Tank | | L.S. | | $ 2,100,000 |
| Transmission Lines, Control Tank and Access Roads | | L.S. | | $ 3,660,000 |
| | | Subtotal - Potable Water System: | | $ 12,490,000 |
| Non-Potable Water System | | | | |
| 0.4 MG Water Tank | | L.S. | | $ 1,640,000 |
| Booster Pump Station | | L.S. | | $ 640,000 |
| 14" Transmission Line | | L.S. | | $ 600,000 |
| | | Subtotal - Non-Potable Water System: | | $ 2,880,000 |
| Roadway Improvements | | | | |
| Lipoa Pkwy / Piilani Hwy Intersection[2] | | L.S. | | $ 1,387,000 |
| Ho'okena St./ Piilani Highway Intersection[2] | | L.S. | | $ 1,658,000 |
| | | Subtotal - Roadway Improvements: | | $ 3,045,000 |
| | | TOTAL - INCREMENT 1: | | $ 77,509,300 |

[2] See Schedule C for Detailed Breakdown

| Description | Approx. Quan. | Unit | Unit Price | Total |
|---|---|---|---|---|
| INCREMENT 2 | | | | |
| Petition Area | | | | |
| Sewer System | | | | |
| 8" Gravity Sewerline with Manholes | 25,300 | L.F. | $ 150 | $ 3,795,000 |
| | | | Subtotal - Sewer System: | $ 3,795,000 |
| Potable Water System | | | | |
| 8" Waterline & Fittings | 12,500 | L.F. | $ 90 | $ 1,125,000 |
| 12" Waterline & Fittings | 4,400 | L.F. | $ 130 | $ 572,000 |
| 16" Waterline & Fittings | 1,700 | L.F. | $ 160 | $ 272,000 |
| Residential (SF) Service Lateral | 300 | | $ 4,000 | $ 1,200,000 |
| Residential (MF) Service Lateral | 25 | | $ 8,500 | $ 212,500 |
| Commercial Service Lateral | 100 | | $ 8,500 | $ 850,000 |
| Fire Hydrant | 105 | | $ 2,700 | $ 283,500 |
| | | | Subtotal - Potable Water System: | $ 4,515,000 |
| Non-Potable Water System | | | | |
| 6" Irrigation Waterline & Fittings | 16,900 | L.F. | $ 65 | $ 1,098,500 |
| 8" Irrigation Waterline & Fittings | 2,100 | L.F. | $ 90 | $ 189,000 |
| 12" Irrigation Waterline & Fittings | 1,800 | L.F. | $ 160 | $ 288,000 |
| | | | Subtotal - Non-Potable Water System: | $ 1,575,500 |
| Roadway Improvements | | | | |
| Roundabout | 2 | | $ 600,000 | $ 1,200,000 |
| Local Street (Type E)[1] | 14,900 | L.F. | $ 890 | $ 13,261,000 |
| Split Connector (Type D)[1] | 2,400 | L.F. | $ 712 | $ 1,708,800 |
| Connector Street (Type C)[1] | 9,500 | L.F. | $ 1,245 | $ 11,827,500 |
| Greenway (Type B)[1] | 700 | L.F. | $ 1,521 | $ 1,064,700 |
| Ninau Street Extension (Type C)[1] | 800 | L.F. | $ 1,242 | $ 993,600 |
| Roads - Embankment | 105,000 | C.Y. | $ 5 | $ 525,000 |
| Roads - Excavation | 145,000 | C.Y. | $ 12 | $ 1,740,000 |
| | | | Subtotal - Roadway Improvements: | $ 32,320,600 |

| Description | Approx. Quan. | Unit | Unit Price | Total |
|---|---|---|---|---|
| INCREMENT 2 | | | | |
| Petition Area | | | | |
| Drainage System | | | | |
| Trunk Drainline | 3,600 | L.F. | $ 825 | $ 2,970,000 |
| Drainline with Manholes and Catch Basins | 26,700 | L.F. | $ 420 | $ 11,214,000 |
| Roadway Culvert | 4 | EA. | $ 453,000 | $ 1,812,000 |
| Drainage Detention Basin | 6 | EA. | $ 200,000 | $ 1,200,000 |
| Channel Confinement | 3,600 | L.F. | $ 1,000 | $ 3,600,000 |
| | | | Subtotal - Drainage System: | $ 20,796,000 |
| Building Site Mass Earthwork | | | | |
| Lots - Embankment | 550,000 | C.Y. | $ 5 | $ 2,750,000 |
| Lots - Excavation | 635,000 | C.Y. | $ 12 | $ 7,620,000 |
| | | | Subtotal - Building Site Mass Earthwork: | $ 10,370,000 |
| Non-Petition Area | | | | |
| Sewer System | | | | |
| 8" Gravity Sewerline with Manholes | 1,100 | L.F. | $ 150 | $ 165,000 |
| | | | Subtotal - Sewer System: | $ 165,000 |
| Potable Water System | | | | |
| 12" Waterline & Fittings | 1,100 | L.F. | $ 130 | $ 143,000 |
| 16" Waterline & Fittings | 1,200 | L.F. | $ 160 | $ 192,000 |
| Commercial Service Lateral | 60 | | $ 8,500 | $ 510,000 |
| Fire Hydrant | 5 | | $ 2,700 | $ 13,500 |
| | | | Subtotal - Potable Water System: | $ 858,500 |
| Non-Potable Water System | | | | |
| 6" Irrigation Waterline & Fittings | 1,100 | L.F. | $ 65 | $ 71,500 |
| | | | Subtotal - Non-Potable Water System: | $ 71,500 |

| Description | Approx. Quan. | Unit | Unit Price | Total |
|---|---|---|---|---|
| INCREMENT 2 | | | | |
| Non-Petition Area | | | | |
| Roadway Improvements | | | | |
| Connector Street (Type C) | 600 | L.F. | $ 1,242 | $ 745,200 |
| Greenway (Type B) | 500 | L.F. | $ 1,521 | $ 760,500 |
| Roads - Embankment | 10,000 | C.Y. | $ 5 | $ 50,000 |
| Roads - Excavation | 5,000 | C.Y. | $ 12 | $ 60,000 |
| | | | Subtotal - Roadway Improvements: | $ 1,615,700 |
| Drainage System | | | | |
| Drainline with Manholes and Catch Basins | 1,100 | L.F. | $ 420 | $ 462,000 |
| Roadway Culvert | 1 | EA. | $ 425,000 | $ 425,000 |
| Drainage Detention Basin | 1 | EA. | $ 100,000 | $ 100,000 |
| Channel Confinement | 400 | L.F. | $ 1,000 | $ 400,000 |
| Bridge | 1 | EA. | $ 500,000 | $ 500,000 |
| | | | Subtotal - Drainage System: | $ 1,887,000 |
| Building Site Mass Earthwork | | | | |
| Lots - Embankment | 165,000 | C.Y. | $ 5 | $ 825,000 |
| Lots - Excavation | 30,000 | C.Y. | $ 12 | $ 360,000 |
| | | | Subtotal - Building Site Mass Earthwork: | $ 1,185,000 |
| Offsite Improvements | | | | |
| Potable Water System | | | | |
| Well 4 and 5 | | L.S. | | $ 3,230,000 |
| Water Treatment Plant Extention | | L.S. | | $ 1,205,000 |
| 0.5 MG Water Tank | | L.S. | | $ 1,735,000 |
| | | | Subtotal - Potable Water System: | $ 6,170,000 |
| | | | TOTAL - INCREMENT 2: | $ 85,324,800 |

# SCHEDULE B

## MAUI RESEARCH & TECHNOLOGY PARK
## Roadway Unit Cost Breakdown

November 21, 2012

| Description | Unit | Unit Price |
|---|---|---|
| **Lipoa Parkway Widening (Type A3)** | | |
| Pavement, 16' wide (DPW Class A) | L.F. | $ 400 |
| Concrete Curbing, 2x | L.F. | $ 100 |
| Sidewalk, 6'-0" Wide | L.F. | $ 36 |
| Striping and Signage | L.F. | $ 20 |
| Street Lighting and Underground Electrical Utilities | L.F. | $ 200 |
| Street Landscaping and Irrigation | L.F. | $ 200 |
| Cost Per Lineal Foot: | | $ 956 |
| **Greenway (Type B)** | | |
| Pavement, 38' wide (DPW Class B) | L.F. | $ 500 |
| Concrete Curbing, 4x | L.F. | $ 200 |
| Sidewalks, 2 x 8'-0" Wide | L.F. | $ 96 |
| Striping and Signage | L.F. | $ 25 |
| Street Lighting and Underground Electrical Utilities | L.F. | $ 400 |
| Street Landscaping and Irrigation | L.F. | $ 300 |
| Cost Per Lineal Foot: | | $ 1,521 |
| **Connector Street (Type C)** | | |
| Pavement, 38' wide (DPW Class B) | L.F. | $ 500 |
| Concrete Curbing, 2x | L.F. | $ 100 |
| Sidewalks, 2 x 6'-0" Wide | L.F. | $ 72 |
| Striping and Signage | L.F. | $ 20 |
| Street Lighting and Underground Electrical Utilities | L.F. | $ 350 |
| Street Landscaping and Irrigation | L.F. | $ 200 |
| Cost Per Lineal Foot: | | $ 1,242 |

| Description | Unit | | Unit Price |
|---|---|---|---|
| Split Connector (Type D) | | | |
| Pavement, 19' wide (DPW Class B) | L.F. | $ | 250 |
| Concrete Curbing, 2x | L.F. | $ | 100 |
| Sidewalk, 6'-0" Wide | L.F. | $ | 72 |
| Striping and Signage | L.F. | $ | 15 |
| Street Lighting and Underground Electrical Utilities | L.F. | $ | 175 |
| Street Landscaping and Irrigation | L.F. | $ | 100 |
| Cost Per Lineal Foot: | | $ | 712 |
| Local Street (Type E) | | | |
| Pavement, 30' wide (DPW Class C) | L.F. | $ | 215 |
| Concrete Curbing, 2x | L.F. | $ | 100 |
| Sidewalk, 2 x 5'-0" Wide | L.F. | $ | 60 |
| Striping and Signage | L.F. | $ | 15 |
| Street Lighting and Underground Electrical Utilities | L.F. | $ | 300 |
| Street Landscaping and Irrigation | L.F. | $ | 200 |
| Cost Per Lineal Foot: | | $ | 890 |

# SCHEDULE C

## MAUI RESEARCH & TECHNOLOGY PARK
## Piilani Highway Intersection Improvements - Cost Breakdown

November 21, 2012

| Description | Approx. Quan. | Unit | Unit Price | Total |
|---|---|---|---|---|
| **Lipoa Parkway / Piilani Highway Intersection Improvements** | | | | |
| Pavement, State Highway | 22,500 | S.F. | $ 20 | $ 450,000 |
| Concrete Drainage Swale | 1,700 | L.F. | $ 60 | $ 102,000 |
| Excavation | 10,000 | C.Y. | $ 30 | $ 300,000 |
| Embankment | 1,000 | C.Y. | $ 15 | $ 15,000 |
| Striping and Signage | | L.S. | | $ 70,000 |
| Traffic Signal Equipment Relocation / Upgrade | | L.S. | | $ 400,000 |
| Street Lighting Relocation / Upgrade | | L.S. | | $ 50,000 |
| | | | Subtotal: | $ 1,387,000 |
| **Ho'okena Street / Piilani Highway Intersection Improvements** | | | | |
| Pavement, DPW Class B | 15,000 | S.F. | $ 13 | $ 195,000 |
| Pavement, State Highway | 30,000 | S.F. | $ 20 | $ 600,000 |
| Concrete Drainage Swale | 1,300 | L.F. | $ 60 | $ 78,000 |
| Excavation | 4,000 | C.Y. | $ 20 | $ 80,000 |
| Embankment | 15,000 | C.Y. | $ 7 | $ 105,000 |
| Striping & Signage | | L.S. | | $ 50,000 |
| Golf Cart Underpass | | L.S. | | $ 400,000 |
| Street Lighting | | L.S. | | $ 150,000 |
| | | | Subtotal: | $ 1,658,000 |

APPENDIX Q
MRTP Development Code

# MAUI RESEARCH AND TECHNOLOGY PARK

# DEVELOPMENT CODE

November 20, 2012

# INTRODUCTION

The idea for the Maui Research and Technology Park originated in the 1980's with local private and public sector leaders intent on diversifying Maui's economy through investment in high technology. The economy was too heavily dependent on tourism and agriculture, and a Research & Technology Park was envisioned as a tool to help create the "third leg of the stool", adding different kinds of jobs and making the overall economy less vulnerable and more robust through diversity. Since that time, the Island's agricultural sector has been contracting, and the tourist economy has shown its volatility with changes in the broader economy. The goal of economic diversification remains more important now than ever.

The Park's first building opened in the early 1990's, and to date approximately 180,000 square feet of Class A office, laboratory, and data center space has been developed. An estimated $100-$150 million a year in revenue flows through the Park's businesses and projects. The Park and all its current buildings and associated infrastructure represent an estimated $60 Million investment. Approximately 400 people work in the Maui Research & Technology Park at over 20 companies in a variety of sectors, including optics, directed energy, data fusion, space surveillance/situational awareness, software development, and professional services.

However, even with these achievements, the breadth and depth of employment opportunities is significantly less than what more modern and progressively planned parks are capable of delivering. At their best, technology parks act not only as a magnet for already established businesses, but also embrace and accelerate businesses start-ups by nurturing local talent and ideas.

The current Maui Research & Technology Park is too inflexible to fully respond to the needs of an increasingly diverse high technology industry. The Park's current 2-acre minimum lot size makes it cost prohibitive for many small businesses to enter the Park. And, at the other end of the spectrum, fully entitled lots of sufficient size are not readily available for large campus type users. If such a user was to desire a lot in the Park, years of costly entitlement processing would be required before the campus could be developed.

Exacerbating the current condition is the Park's zoning ordinance which prohibits mixed use development. This prohibition has made the Park isolated from the types of goods, services and amenities that a high technology workforce desires. Current employees of the Park are required to drive to and from work and since few daytime amenities exist, the Park is entirely automobile dependent.

In the time since the creation of the Maui Research and Technology Park, the understanding of innovation clusters and the needs of knowledge workers and businesses has increased. Technology businesses thrive in areas of diversity and activity. A diversity of businesses and workers and availability of many startup spaces enhance the chance for success of individual businesses as well as the cluster as a whole.

This Plan utilizes the principles of New Urbanism and Smart Growth to transform the current, single-use large lot research and technology campus into an integrated and vibrant mixed-use community focused around a regional knowledge industry employment base. This transformation will have positive effects on the environment, on individual health and well being, and on the long-term economic viability and adaptability of the Park.

## Maui R&T Partners, LLC

Kihei, Maui, Hawaii

*www.mauitechpark.com*

## Calthorpe Associates

Berkeley, California

*www.calthorpe.com*

## Chris Hart & Partners, Inc.

Wailuku, Maui, Hawaii

*www.chpmaui.com*

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# 1 - BACKGROUND


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# Organization of this Book

This document sets forth the details and implementation strategy of an updated vision for the Maui Research & Technology Park. This chapter discusses the Park's background and context. Chapter 2 explains the genesis of the Park's challenges in achieving its economic development goals and overarching strategies to help the park achieve those goals. Chapter 3 discusses a broad set of design principles which encompass the current state of the art in urban design and planning.

Based on the approach and principles from chapters 2 & 3, Chapter 4 shows the proposed updated master plan for the park. The plan is a vision for one possible way for the Park to develop. Finally, chapters 5, 6 and 7 create a set of regulations to guide the Park's development based on the preceding chapters' principles and vision. These chapters comprise the project's form-based code.

**Controlling Plan**

*The major layout for the plan, including the location of various land use zones*

**Land Use Matrix**

*The land uses assigned to each land use zone*

**Building Types**

*The specific rules for building types*

**General Rules at the Neighborhood and Building Scales**

*The overall set of rules which give the plan a uniform quality of development*

## Form-Based Codes

Form-based codes regulate the built environment in order to create better places. The standard zoning and its concentration on land use has proven unable to create high quality places. By creating large areas of uniform land use, leaving the urban structure and public realm unregulated, zoning has allowed the growth of formless, dysfunctional places that often fail to achieve even the goals for which the zoning was created.

Form-based codes are an attempt to remedy this problem. By concentrating on the elements of physical form while allowing more flexibility in land use, they work to weave buildings, streets, and neighborhoods together into beautiful, functional, and adaptable places.

*See "Form-Based Codes: A Guide for Planners, Urban Designers, Municipalities, and Developers" by Parolek, Parolek, and Crawford for an in-depth discussion of form-based codes.*

Form-based codes can be organized in a variety of ways. This code regulates multiple elements, from the design and location of public spaces to the creation of a set of building typologies. Because of the necessity of keeping a high degree of flexibility for the employment uses, the

portion of the code which deals with the larger employment areas regulates by concentration on the public street frontages.

## Form-Based Code Elements

Form-based codes have a variety of elements. There is no fixed list, but the most common elements are the regulating plan, standards for public space and infrastructure, standards for private development, and administration procedures.

A regulating plan shows how elements fit together on the site, including streets, parks and other public spaces, and private properties. The regulating plan may be more or less detailed, in some cases showing every street or in others showing larger blocks of development. The regulating plan is the element of the code which is most specific to an individual site, since it shows the overall vision for the project. The regulating plan for the Maui Research & Technology Park is in Chapter 5 of this document.

The standards for public space and infrastructure and the standards for private development set basic requirements for how the public and private realm are constructed. These code elements should work together to create a public and private sphere that achieves the overall goals of the project, including economic development, aesthetic goals, and quality of life goals. Subjects which may be included in these sections are block and subdivision rules, building types, architecture, green building, and landscape. Public space and infrastructure regulations are included in chapter 5 of this document, “Neighborhood Scale.” Private development standards are included in chapter 6, “Building Scale.”

Administration procedures are included in form-based codes to ensure that the elements of the code are implemented as envisioned. The administration for this code is shown in chapter 7, “Implementation.”

# Site Description

*Island of Maui*

The Maui Research and Technology Park (MRTP) is located in the South Maui town of Kihei, mauka (east) of the intersection of Pi'ilani Highway and Lipoa Parkway (called Lipoa Street makai of Pi'ilani Highway). Kihei is one of many small towns on Maui, and is developed in a linear form along South Kihei Road, which runs north and south parallel to the ocean shore. The newer Pi'ilani Highway lies mauka of most of the town's development, and is a high speed facility with a limited number of intersections. The island's primary airport is in Kahului, about 30 minutes away by car.

Kihei has a variety of development, including many mid-range hotels and condominium developments, single family homes and some low density multifamily. Much of Kihei's retail is small in scale and lies along South Kihei Road, but several large shopping centers exist as

MRTP lies mauka of Kihei, beyond Pi'ilani Highway

Azeka Shopping Center in Kehei

Maui coastline

well, including Azeka Shopping Center near the intersection of South Kihei Road and Lipoa Street. Pi'ilani Shopping Center is one block north of Lipoa Street and just makai of Pi'ilani Highway, very near the Technology Park, and includes a large Safeway grocery store. A large new shopping center called Downtown Kihei is planned near Pi'ilani Shopping Center, and a large outlet mall and shopping center is planned for an area north of the Park, also Mauka of Pi'ilani Highway.

Divided from the rest of Kihei by the high speed four-lane Pi'ilani Highway, the Technology Park is physically and visually isolated. A golf course lies between the Park and the highway, leaving the park with no highway frontage. The one road access, Lipoa Parkway, is currently two lanes with a very wide right of way which will easily accommodate four lanes. There are no through roads in the park, leaving the Park's overall road network to function as a cul de sac. The Park is surrounded by undevel-

A Park tenant

# Local Context

The Park has open setbacks and lush landscaping

Park Plaza building

oped land on the north, east and south sides.

Existing development in the park is on five parcels. Buildings are one and two stories, and all development (as required by existing design guidelines) sits behind deep setbacks, usually filled with one or more rows of parked cars. Roads and intersections are large, with large turn radii. Most roads have sidewalks, and much of the landscaping is lush and beautiful.

Some Park buildings have little local architectural influence

Hedges screen unattractive parking lots from the street

Parking lots line most streets

*MRTP Context Map*

# Opportunities & Constraints

*Maui's Valley Landscape*

*Retention Basin and Spillway*

*Views to West Maui*

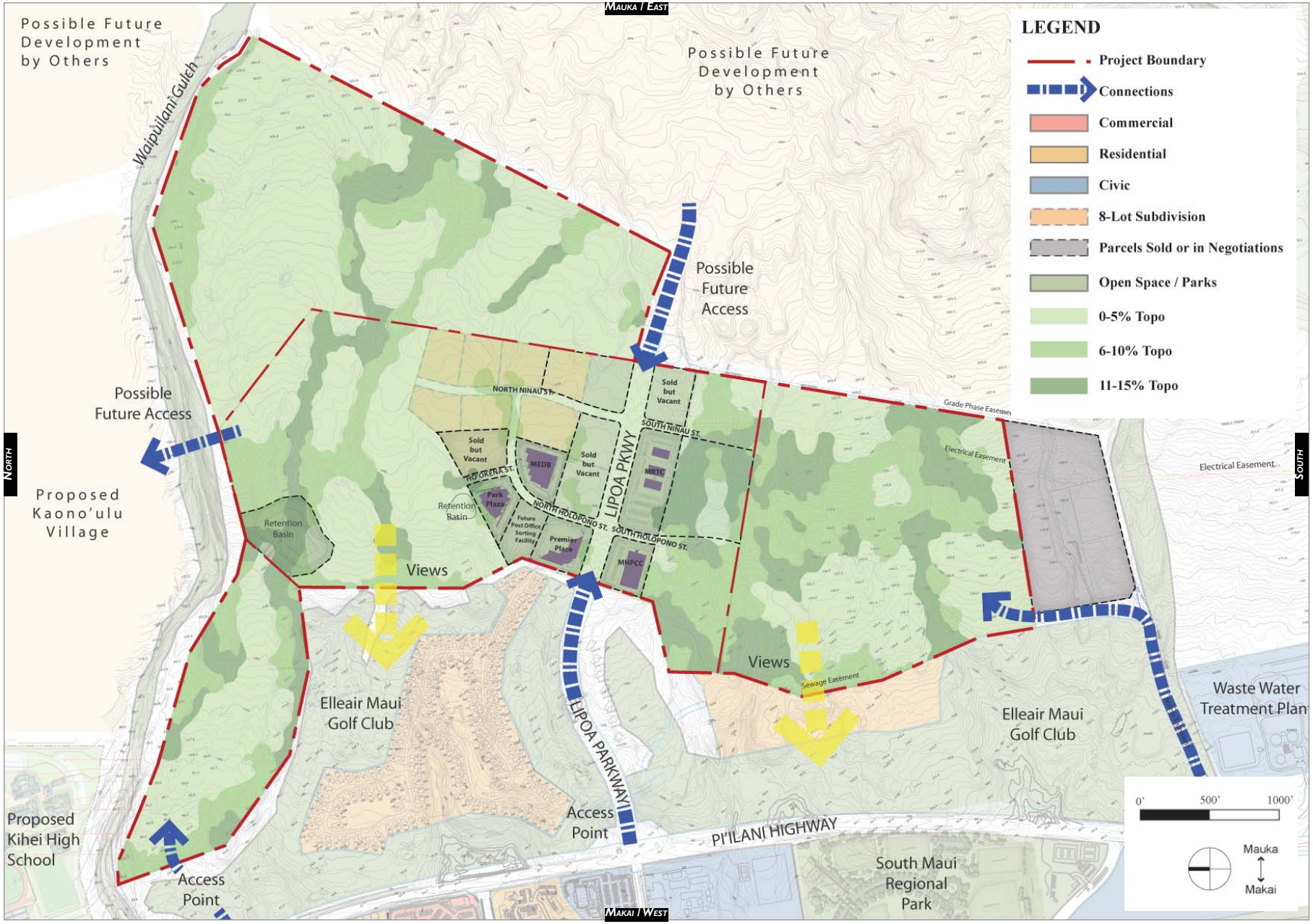
The most interesting opportunity on this site is the presence of an existing employment base. The creation of mixed use and walkable areas is of the highest importance, as will be discussed in chapters 2 and 3. Unlike most greenfield sites, however, the Park already contains the most difficult element to obtain for creation of walkable mixed use - employment. This site presents a unique opportunity on Maui for the creation of a true mixed use center.

As for topography, the site generally falls to the west toward the ocean. The slope is typically gradual, with some areas of steeper terrain including several small gulley systems. A large gulley lies just outside the site's northern boundary. Just under the shallow soils of the site is a very hard rock called blue rock, which makes excavation expensive.

The most spectacular views from the site are makai. They encompass the ocean, west Maui, and neighboring islands. Many parts of the site also overlook the adjacent golf course. Views mauka are also good, toward Haleakala.

Access and visibility for the site are extremely limited. Hidden by topography and the golf course, the site is most visible on Pi'ilani Highway by its entry sign at Lipoa Parkway. Possible future access points from Pi'ilani Highway at Waipuilani Road in the north and Welakahao Road in the south will help this situation some. However, the lack of visibility and through traffic, as well as the presence of large amounts of nearby retail, would make it unlikely that significant retail development in the Park would be successful.

A development of executive golf course homes is currently under way in the golf course makai of the Park. The housing north of Lipoa Parkway is partially complete, and another area south of the Parkway and adjacent to the Park is also planned. Haleakala Ranch has proposed




*Opportunities and Constraints Map*

development on Ranch property on the north and mauka sides of the Park. The timeline for this development is unknown, but would likely happen over many years. This adjacent development will help to make the Park less isolated, would help to support employment and retail uses in the Park, and would necessitate the creation of connections to the Park.

*Retention basin and mountain view*

*Waipuilani Gulch*

*Elleair Maui Gulf Course*

# 2 - CHALLENGE & APPROACH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# Challenge

The Maui Research and Technology Park's mission of job creation and diversification of the island's economy remains one of vital importance. In light of the current worldwide economy's condition and its effect on tourism, as well as the reduction in agriculture on Maui, having a viable economic "third leg of the stool" is more important than ever. For this reason, the Park's slow development calls for a change in tactics.

The Park retains many advantages, not the least of which is the high amenity value of life on Maui. But a variety of factors have impeded hoped-for growth. Among these factors are the physical and visual isolation of the park, offshore perception of Maui as destination for leisure - not business, a lack of flexibility created by restrictive zoning and design guidelines, a lack of some of the public amenities valued by knowledge workers, and the lack of flexible, cheap space for use by entrepreneurs for growing businesses.

*Aerial of Maui Research and Technology Park*

# Approach

While there are limits to what urban design can do, such as changing the offshore perception of Maui, this plan aims to create a Park that is fertile ground for the growth of new jobs on Maui. This plan addresses the challenges posed by the park with a variety of strategies. These can be broadly grouped into two categories – creating a place and diversifying the offering.

## Creating a Place

Recent years have been productive ones in the understanding of businesses, cities, and economic development. In the early part of the 20th century, Modernist thinking sought to isolate people and businesses, creating strictly separated zones of employment, work, shopping and recreation. This may have had some validity in the days of belching steel mills and other heavy industry, but even when these ideas originated their power to divide and destroy healthy communities was clear.

These patterns of separation of uses continue largely today. They have lead to single use subdivisions, big box retail strung along highways and part of no neighborhood, and isolated business parks. It was from this branch of thinking that the Maui Research and Technology Park grew. Now, however, most places of employment do not create the noise, smell, or pollution which would require them to be isolated from housing and other uses. Instead, the separation of land uses by long distances has forced people to drive for the vast majority of trips. Ironically, the thing most people now dislike about commercial development is the very traffic that this separation of uses has created.

On the other hand, years of research into the growth of businesses in Silicon Valley and other tech centers have shown the value of a mixture of uses and activities. For businesses and cities alike, the healthiest situations arise where there is a mixture of elements. In cities, this allows easy interactions and transportation between home, work, play and education, with a corresponding rise in the option of getting around by foot or bicycle

*Lahaina streetscape*

*Maui single family housing*

Office and retail mixed-use building, Stapleton, Denver, Colorado

and a reduction in carbon emissions and in consumption of natural areas and agricultural land for sprawling development. Not surprisingly, businesses also thrive in these mixed environments, especially young businesses which depend on the business connections made available by diverse environments and the labor pool which comes with these areas. The younger, highly-educated, highly-motivated knowledge workers which make up this labor pool are drawn to these diverse and interesting environments on their own, and become a kind of natural resource that in turn attracts and creates business. Publications like the Wall Street Journal have written on this trend, noting that in Silicon Valley, "demand for downtown office space is being driven by start-ups wanting better access to public transportation and to be in walking distance to restaurants."[1]

This understanding has also been recognized in prominent economic development publications like the 2008 report by the Association of University Research Parks, "The Power of Place." Among that reports recommendations was to:

> *Build Sustainable Communities of Innovation: Incentives for sustainable 'smart growth' development should be central to establishing American Innovation Zones. The U.S. Department of Housing should explore best practices nationally to encourage density and mixed-use development in American Innovation Zones in urban areas, which will encourage researchers and entrepreneurs to live where they work, and reduce sprawl.* [2]

Creating a "place", a location which people are drawn to, involves a combination of factors. Among others, these factors include diversification of land uses and creation of an attractive and welcoming public realm. A satisfying and interesting place contains a variety of users and activities, and is friendly to people on foot. In order to create a place, this plan proposes the diversification of land uses within the park. The addition of housing, retail, civic, and open spaces to the Park will add amenity for business attraction and retention. While the plan does not contemplate addition of a large amount of retail, local serving retail such as coffee shops, restaurants, dry cleaners, and business services will be amenities for employees of the park. Civic uses such as a school or a library, if they can be attracted to the park, also serve as amenities. Residential development, especially development with a wide variety of unit types targeted toward

Urban format office, Daybreak, UT

[1] *Wall Street Journal, "Start-Ups Are Drawn to Pulse of Downtown," November 4, 2010.*

[2] *The report "The Power of Place: A National Strategy for Building America's Communities of Innovation," October 2008, by the Association of University Research Parks, can be found online at http://data.memberclicks.com/site/aurp/The_Power_of_Place.pdf*

workers in the park, would also be an amenity, helping businesses in the park attract and retain qualified workers and reducing the barrier of the high cost of housing on the island.

Put together, the combination of existing businesses and employees in the Park, new businesses which will be created and attracted, housing, retail, open space, and civic elements will create a true neighborhood in place of the isolated, single use Park that exists today. The combination of elements will create synergies beyond what all of these land uses would add up to as separated pods, and this added energy will drive development of employment at the Park.

## Diversifying the Offering

The current condition of the Park is one of quiet and uniformity. Buildings of similar scale and massing sit quietly behind beautiful landscaping in rigid isolation. Some businesses see this type of environment as ideal, regardless of the environmental or social consequences. This current strategy is most suited to attracting mid-size businesses which have been in existence for some time. However, the Park's existing one-size-fits-all strategy is destined to miss out on many opportunities to achieve the ultimate goal of the Park, which is diversification of Maui's economy with high skilled, high paying jobs.

Jane Jacobs, one of the most influential urban theorists of the 20th century, understood the power of diversity for both the health of a place and for its power to generate new economic development. In her seminal book, "The Death and Life of Great American Cities," she noted that in order to create opportunities for innovation, cities must provide a variety of spaces. She said, "Old ideas can sometimes use new buildings. New ideas must use old buildings." [3] This was an argument against the blank and lifeless uniformity of single use zoning and urban monocultures.

Of course, the Park is new and lacks old buildings. The

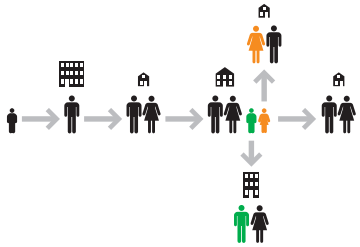
*Inspiration for flex typology from local built form*

*Wailuku commercial building*

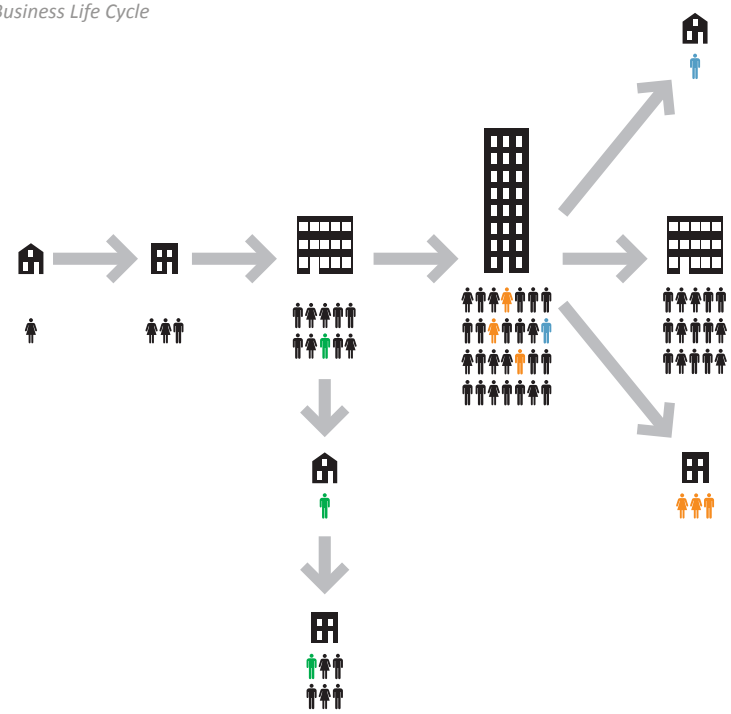
*Informal space as incubator - the birth places of Hewlett-Packard, Apple and Google.*

[3] *"The Death and Life of Great American Cities," 1961, by Jane Jacobs.*

Family Life Cycle



Business Life Cycle



*Businesses move through stages of life, just as families do. At top, a person goes from childhood to young adulthood to marriage to children, and finally to an empty nest. At each stage of life, the individual's desired housing type changes, from apartment to small house to larger house and then again to a small house. Similar stages apply to businesses, from inception to growth in various stages. As time goes by, people leave even successful businesses to found new businesses, starting the process again. Unfortunately, with its uniform buildings, the Park at present can only accommodate mid-size and large businesses and does not help to incubate new businesses for Maui.*

same result can be achieved, however, by creating a wide variety of spaces, especially small, inexpensive, flexible spaces which will allow entrepreneurs to begin and grow businesses. The plan proposes a great diversification in the Park's offering of spaces for business. One strategy to achieve this will be the revision of the Park's guidelines. The revised guidelines protect essential aspects of the park but loosen many of the onerous restrictions on business development in the park. For example, large minimum lot sizes and deep setback requirements promote a certain aesthetic vision that unfortunately serves to exclude many possible park tenants, such as those who do not need or want a large building or parcel of land. A more open set of regulations can still serve to create an attractive setting, while allowing businesses to create facilities that respond more closely to their own needs.

Another diversification strategy is the master plan's variety in parcel sizes. This element of the physical plan will allow the Park to maximize job creation by being opportunistic, seizing every chance at business attraction. While still providing parcels at current sizes of approxi-

*Single use development*

*Auto-centric development*

mately two acres, the plan subdivides some into smaller parcels for smaller users. At the same time, the plan maintains space for a large, "campus"-scale user should the opportunity arise to accommodate one in the Park.

Unlike some other places which serve as fertile ground for innovation, the Park does not possess a varied stock of old and new buildings of varied conditions and sizes. The key idea in this is that new businesses often do not need or want large, new spaces, and in an area with a variety of spaces, entrepreneurs can occupy space of the size and quality that suit their business's life stage. To accommodate this need, the plan proposes the use of innovative flex space. Used before in other places as a seed space, notably in the Second Street Studios in Santa Fe, New Mexico, flex space provides cheap, flexible space for entrepreneurial efforts. Even while keeping such space affordable, quality architecture can make flex buildings attractive parts of an area.

And finally, the plan proposes casting a wider net to attract the high skill, high paying jobs so vital to Maui's economy. While the goal of attracting "high technology" workers is a good one, other quality jobs broadly falling in the category of "knowledge industries." The Park's mission of economic development will be facilitated by the flexibility to attract many different knowledge businesses. The addition of new employees will aid in creation of a critical mass in the park, benefitting the effort to make the Maui Research and Technology Park into a place, moving beyond its current state as an isolated, single use zone.

*Staffordshire Technology Park, Staffordshire, United Kingdom*

*Urban format office, Daybreak, Salt Lake City, Utah*

# Supportive Efforts

While physical design of the built environment is vital, other supportive efforts will be essential to the health of the Park. These include continued efforts to attract businesses and coordinate between existing businesses in the park. Collaboration with the Maui Economic Development Board, County of Maui, and the State and Federal Government on efforts to attract, retain and expand businesses in the park will be of key importance - a concerted and joint approach is a must. These entities are very supportive of economic diversification, and the Park has always been recognized as an appropriate location for jobs developed as result of joint economic development efforts.

Locating civic facilities and amenities in the Park will accelerate and enhance efforts to grow into the hoped for regional employment center for knowledge and technology workers. Examples of value added projects that would enhance the Park would include additional public or private university projects, or establishments of new university campuses, public or private K-12 schools - including charter schools, community-based organizations such as a YMCA or youth center, and the re-emergence of business incubation efforts.

*Google Campus, Mountain View, California*

# 3 - DESIGN PRINCIPLES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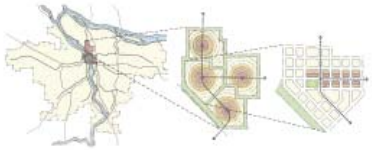
Conservation and Restoration

Diversity and Balance

Human and Pedestrian Scale



Connections and Interdependence

*Principles of Urban Design*

The understanding of the importance of Urban Design and Planning has changed greatly in the last twenty years. Far from being concerned simply with aesthetic issues, well-designed places function far more efficiently than poorly-designed ones do. They have positive effects on the environment, on individual health and well-being, and on long-term economic viability and adaptability. Well-designed places are also better and more enjoyable places for people to live and work, which has made good design an important element in efforts to create economic development.

The motivation for the founding of the Maui Research and Technology Park remains as important as ever. Continuing job creation and economic development are essential for the well-being of Maui. This has become even more apparent with the recent economic downturn and the continuing decline of agriculture on the island.

Fortunately, the latest understanding of urban design for quality economic development, especially in fields of high technology, is also urban design which achieves environmental and other goals. Places which attract and create new high technology businesses are those which facilitate the exchange of ideas and make it easier for people to become entrepreneurs, and are able to deliver a high quality of life. By providing a variety of public and private spaces and a quality public environment, these places give people and businesses the flexibility and freedom to experiment, to take chances, and to make connections. These types of places are fertile ground for growth and entrepreneurship.

For these reasons, it is essential to use new models of development for the Park. New development must address many concerns simultaneously, incorporating the latest understanding of multiple issues. While good design involves an infinite number of elements, we have grouped the major concerns of urban design into four categories for purposes of discussion: conservation & restoration of the environment, economic and social diversity & balance, human & pedestrian scale in the public and private realms, and connections & interdependence between the neighborhood, town and region.

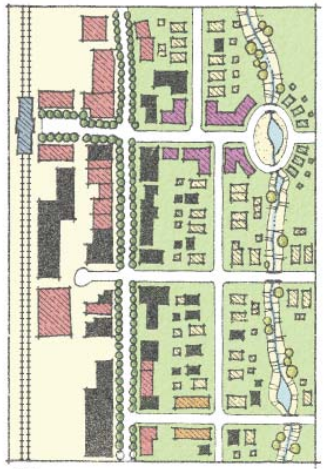
Because it is also important that the plan fit the needs and desires of Kihei residents, the details of these principles also incorporate elements of other local guidelines, such as the Kihei Community Association General Open Space and Design Guidelines. The KCA Guidelines are concerned with community quality and livability, with major areas of concern being:

- Open space drainage ways and flood control
- Wetlands and low lying drainage areas
- Neighborhood connectivity and pocket parks
- Shoreline property
- Beach access/impact
- Pedestrian and community safety and de-emphasis of the automobile
- Roundabouts and street design guidelines
- Affordable housing
- Schools, parks and roads
- Commercial and high density developments
- Green Building Guidelines

The design principles and plan which follow address nearly all of these concerns and are in near-total agreement with the KCA Guidelines.

# Conservation & Restoration

Before



After

Cities represent a fragile balance between our human needs and the capacity of our ecosystems. As we continue to gain deeper understanding of the repercussions of our human activity on the world's environment, the city is increasingly understood as an important place to adopt to a more sustainable lifestyle.

The design of the Maui Research & Technology Park will have an effect on the environment both locally and globally. Design which respects existing topography and other natural features not only is less damaging to construct, but preserves natural systems and the area's cultural and geographic memory.

On the other hand, design which minimizes unnecessary automobile travel has effects on the environment world-wide. The world is facing an environmental crisis of profound economic and social dimensions. Brought about largely by carbon emissions into the atmosphere, climate change is already affecting the human and natural environment and promises to create immense problems in the coming years and decades. Such problems may be particularly pronounced in island communities like Hawaii.

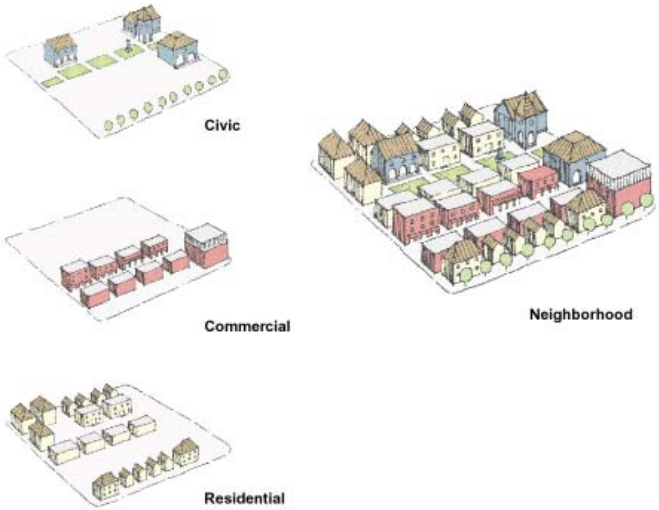
As is now understood, one of the major causes for carbon emissions over the last fifty years has been the way we build our cities. A purposeful emphasis on the creation of cities for automobiles at the expense of pedestrians, bicycles, and transit has increased automobile usage and the associated carbon emissions. At the same time, this style of development has increased land consumption, thereby reducing forest cover and increasing problems with stormwater runoff and pesticide use wherever it has been implemented.

Choices made now will have immense effects on the future of carbon emissions. Creating the Park in an efficient, livable, and environmentally-friendly way will ensure reduced emissions. Using an outmoded, auto-centric development model will do the opposite, and the effects will be solidified in the built environment for years to come.

The Maui Research & Technology Park should add to the sustainability of Maui. It will be environmentally responsible by reducing resource waste, demanding less of the environment, and accommodating growth to support the island economy. It will address an ongoing challenge of economic development by attracting new growth in proximity to housing and regional transit.

By incorporating strategies on the neighborhood and building level, the design of the Maui Research & Technology Park can affect not only its site and surroundings, but the health of the planet as a whole.

# Diversity & Balance




## Mixed Use and Clustering

Mixing of uses and clustering of destinations is a way to reduce distances and make walking and bicycling more convenient. Maui already has development of middle density, but it often lacks clustering with other uses which leaves it seeming unfocused. Bringing the densest development together, ideally around a transit node, shortens trips and makes them more convenient. Having more residents or workers within 1/4 mile of a transit node makes it more likely that those persons will chose to use transit when they go elsewhere in the island, also.

### Mixed Use

Mixed use is the mixing of various activities and land uses within a small area. Vertical mixed use means that a single building has several uses within. Horizontal mixed use means that multiple uses and activities are clustered near each other. Both of these types achieve the goal of making trips shorter and more convenient and raising the possibility that people will choose to use walking, bicycling or transit for their trips.

Mixing of uses at the neighborhood scale, within the 1/4 mile walking radius, allows people to reach daily destinations easily by foot. Large areas with single uses such as housing or employment force everyone to travel long distances to get around. Having retail and civic uses within areas of residential and employment uses makes it easy for people to do quick errands during their daily activities. Having recreational spaces nearby allows people to reach them more easily, creating situations where people can incorporate healthful activity into their daily lives. Having appropriate uses and activities near homes allows children as well as older people who can no longer drive a car to have increased independence.

### Diversity of Housing

There will never be a single perfect housing type. Housing types must be as diverse as the needs of the people who inhabit them and accommodate changing demographic and consumer preferences. Even a single individual's housing needs change over his or her lifetime. A young person living in a small apartment may want a house after marrying, then a larger house after having children. Once these children grow up and leave home, the empty-nester couple may again choose a smaller home or apartment. Neighborhoods with a diversity of housing can accommodate these changes without forcing someone to move a long way or even to another community. A collection of townhomes, single family dwellings, and low apartment buildings can achieve a diversity appropriate for a growing and changing population.

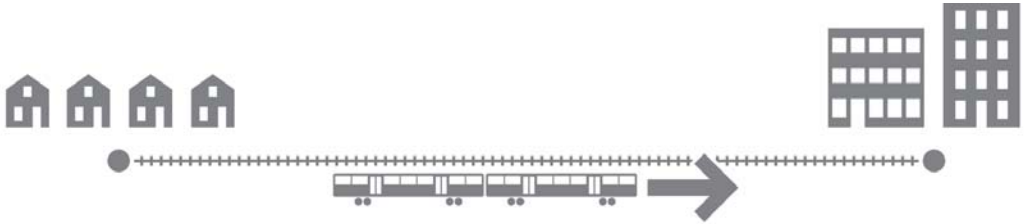
## Jobs Housing Balance

Another important reason for a mix of uses on the district scale is to create jobs housing balance. This means that an area would have a similar amount of jobs within it as it has workers living in it. This not only shortens many commute trips and therefore makes it more likely that people can travel to their jobs by walking or bicycling, but it also makes transit and automobile travel more efficient. By using transportation lines (roads or

bus lines) in both directions in a similar amount, peaking is reduced and a line of the same size can accommodate more travelers. (see diagrams)

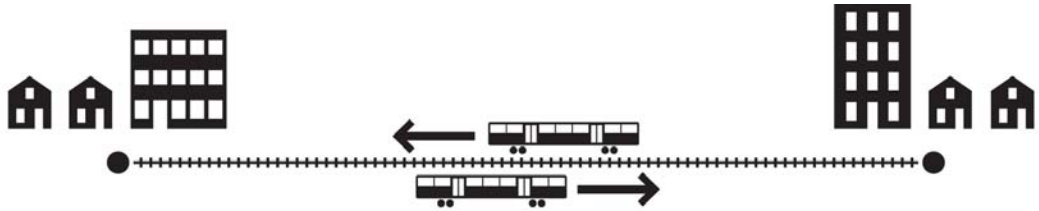
### Balanced Flows

As a jobs center, it is unlikely that the Park would achieve a complete jobs housing balance. However, adding at least some housing will improve the situation, improving transportation efficiency as well as adding 24-hour activity to the Park. Having people in an area during more hours of the day makes an area safer and helps local serving businesses like restaurants survive, since they have customers in both the daytime hours and the evening hours. This will make the Park a more livable and economically viable area.



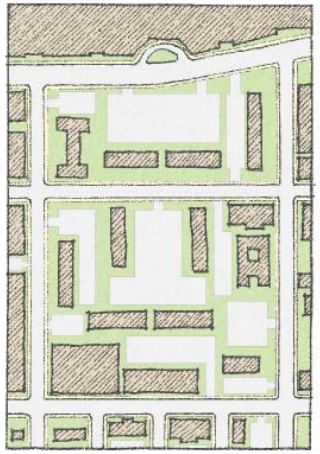
*Unbalanced Morning Commute - going to work*

*Unbalanced Evening Commute - returning home*



*Balanced Commute - moderate flows in both directions*

# Human & Pedestrian Scale



Auto - Scale

Pedestrian - Scale

Creating a place of human scale would leave it in stark contrast to the auto-centric development which has been common over many years and continues all over the world. Human and pedestrian scale recognizes the needs of people for safety, convenience and pleasure in the public realm. By creating places designed for humans, we give people the flexibility to order their lives in ways other than around the automobile.

## Mixed Use and Proximity

Human and pedestrian scale includes many aspects of a place. Among the most important factors is a diversity of land use, as discussed in the preceding pages. A mix of uses in close proximity allows people to satisfy needs within an area which can be easily traveled by walking or bicycling. To achieve this result, the development must also be of sufficient density to contain these uses in a small area. Of course, each person differs in the distance which they are willing or able to walk, and factors such as the current weather affect this as well. However, a good rule of thumb is that destinations should be with about five minutes' walk, which is a distance of about 1/4 mile.

## Walkable Streets

Another critical factor in human and pedestrian scale is walkable streets. An environment that encourages walking is imperative to the creation of a vibrant community. By walking for transportation we receive a variety of benefits – we reduce the need for the automobile, we provide foot traffic to local businesses, we interact with our neighbors, and we improve our physical health. In fact, a Washington State study found that residents of a pedestrian friendly neighborhood weigh, on average, seven pounds less than residents of a sprawling suburb[1]. In addition, walkable neighborhoods need less infrastructure for cars, thus sparing land for more enjoyable spaces such as parks and promenades.

To be walkable, streets must be well designed. Sidewalks are a must, but the design of the road network and of the streets themselves are key.

### Street Networks

Auto-oriented street networks are designed in a very similar way all over the world. Beginning on local streets (often cul de sacs), every journey moves then to collector roads, then arterials, and often then onto a highway. Because of the fear of through traffic and a disregard for pedestrians, road networks are typically designed to force this pattern for every trip, lengthening each trip and congesting all of the arterials. This congestion then creates calls for road widening and the resulting huge roads make walking or bicycling even more difficult and dangerous.

#### *Connector Roads*

Rather than this typical street hierarchy of cul-de-sacs, locals, collectors and arterials, the Plan builds a network of interconnected local streets and connector roads. By ensuring multiple connections and routes, connector roads avoid the difficult problem of unlivable, high traffic collectors which are too busy and too noisy to accommodate residential development. Connector roads

[1] *Smart Growth America, http://blog.smartgrowthameri-*

typically occur every quarter mile and serve to disperse traffic widely.

### *Local Roads*

Local roads are intended primarily for local access, but are also a vital part of the road network. They only rarely end in cul-de-sacs in the plan. Speed and through traffic are controlled by narrow road widths and curved alignments, while connections on both ends preserve emergency access and add route choice for daily users. Parking is provided along the road, further slowing traffic and providing for more activity on the street as people access their cars.

## Street Design

### *The Evolution of Street Design*

The weight of years of experience and research is chipping away at the entrenched practice of creating wide, autocentric roads in disconnected, discontinuous networks. Promoted for years as the safest and most efficient way to build road systems, it has now been proven that this type of system is just the opposite. Wide roads, contrary to providing an added cushion for error by drivers, instead provoke drivers to speeding and carelessness. The result is more crashes and more severe crashes. Pedestrian and bicycle injuries and deaths are multiplied by large, fast, busy roads, and because few people who have other options choose to walk or bicycle, even more traffic is created.

In contrast, the streets in this Plan are designed with a pedestrian-friendly environment as the first priority. Comfortable, walkable and bikeable streets knit neighborhoods and districts together, adding to a sense of community and facilitating transit use. Each sidewalk needs the shelter of trees, the presence of building entries and porches rather than parking lots, and a buffer of parking to protect the pedestrian corridor from moving traffic.

In all cases streets must be designed to slow traffic, as high speeds are entirely unnecessary within the site. High speed traffic creates a much higher level of noise, disturbing workers and residents. Preserving livability on the area's road network will require reasonable speeds to be maintained. More importantly, high automobile speeds create much greater danger for pedestrians as well as automobiles, making accidents more likely and multiplying the force of a crash many times. A pedestrian struck by a car at 20 miles per hour has a less than 10 percent chance of death. At 30 miles per hour, this chance rises to almost 50 percent. And at 40 miles per hour, fatalities are nearly 90 percent [2]. Speed on all roads in the Park should be limited to 25 miles per hour or less. At these speeds, a driver can still easily reach any Park location in minutes or less.

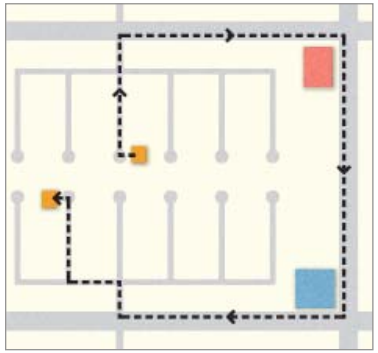
### *Traffic Calming*

Traffic calming is the practice of bringing vehicular speeds and behavior into conformity with the needs of non-drivers. The streets in the Park have been designed to be calmed through their basic design to be more human in scale and character. By sizing the streets correctly and highlighting character elements that emphasize the streets' quality as much as their quantity, the Park's neighborhoods will be naturally safer for all users, including employees, residents, and their children.

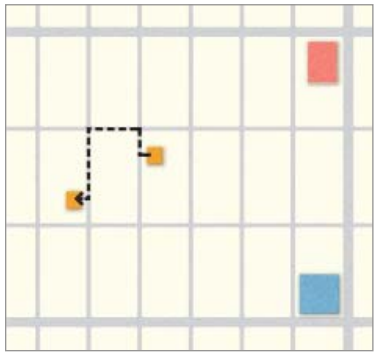
However, where extra care is needed or desired, additional calming methods can be used to ensure a safe and efficient street. Although they vary in application, the basic theory behind these techniques is to present a driver with physical and psychological cues which prompt more careful driving behaviors or choice of travel route. By using signage in concert with uncommon movements, a street's design can encourage safer speeds, reduce volume, or invite more careful navigation. Many times, one or a combination of measures can accomplish all of these goals simultaneously.

There are three major categories whereby a street's design can affect driving behavior, as described below: signage and graphics, deflection (vertical and horizontal), and narrowing.

[2] *http://www.walkinginfo.org/pedsafe/crashstats.cfm*



*Heirarchical road networks require long trips on large roads.*



*Connected road networks allow direct routing and small-scale roadways.*

*Vertical and horizontal deflections slow traffic*

*Simple markings can make streets and pathways safer for all users*

*For further information on traffic calming methods, see "U.S. Traffic Calming Manual", published by APA Planners Press and the American Society of Civil Engineers in 2009, written by Reid Ewing and Steven Brown.*

### *Signage and Graphics*

Signage and graphics are the most common traffic calming measures. Not only are they the least costly and usually the least disruptive to implement, they also benefit from a history of use and are therefore familiar to the public and to regulating municipalities. Common types of signage/graphics include:

- Striping
- Bicycle Lanes
- Crosswalks
- Stop Signs
- Child-Related Signage
- Speed Reduction
- Signal Progression
- Pedestrian and Bicycle Signals

### *Deflection (vertical and horizontal)*

Deflections in the travel path require the driver to slow in order to maintain control or to avoid unpleasant forces on themselves or their automobile. Deflections come in vertical and horizontal varieties, and can be gently, or harshly persuasive in form. Common types of a deflection are:

- Speed Humps/Speed Bumps
- Pedestrian Tables/Speed Tables
- Raised Crosswalks
- Raised Intersections
- Chicanes/Slaloms
- Forced Turns
- Street Closures (full or half)
- Median Islands
- Full Roundabouts (full or mini)
- Traffic Circles

### *Narrowing*

When physical elements of the streetscape are drawn in toward the travel lane, the driver feels that the travel lane narrows as well. This perception, real or imaginary, prompts lower speed and more careful observation of the road ahead. Common types of narrowing include:

- Bumpouts/Curb Extensions
- Bus Bulbs
- Pinch Points/Chokers
- Neckdowns
- Narrow Streets
- Narrow Planting
- Streetside Parking

## Narrow Streets

One of the primary methods of traffic calming, the use of narrow streets has many advantages, not all of which are immediately obvious. As mentioned above, wide roads are not safer roads. Studies have indicated that for local roads, crash frequency and injury rise with street width. The safest local roads are the narrowest. In addition to safety, narrow roads consume less land, produce less stormwater runoff, and are less expensive to construct and maintain.

### *Fire Response*

One major hurdle to implementation of narrow streets is fire access. The International Fire Code sets a standard of 20 feet clear driving space for fire access. This allows two fire trucks to pass each other while getting to a fire, and allows plenty of space for firefighters to set up their equipment at a fire. This 20 foot standard would forbid roads with narrow lanes such as local roads with

12 or 14 feet of driving area (queueing streets) and two-lane roads with medians and less than 20 feet between parked cars and the median. For these narrow roads, approval of fire authorities is necessary.

Fire access is a critical life-safety issue. However, automobile and pedestrian safety is also a life-safety issue, and an increasing number of fire officials are recognizing this in their approval of alternative road configurations. Alternative street sections have already been proposed on Maui Island, including those in the Pulelehua project such as the "Street" and "Avenue" sections.

On roads with less than 20 feet of clear driving space, fire access can be maintained and even improved compared to a standard road network with a number of strategies:

- Alley access – Alleys provide a critical second means of access for fighting fires and are alternate routes for fire trucks.
- Network connectivity – Having room for fire trucks to pass each other becomes less important with good road connectivity. A connected network of streets allows fire trucks to access a fire from multiple directions.
- Center block staging area – Limiting parking in short sections mid-block, within hose distance of buildings in the middle of the block, can create a valuable staging area for firefighting equipment.
- Entry neck downs – Neck downs limit parking near intersections. In situations where two narrow roads meet, parking too near the corner can reduce turn radii so much that fire trucks cannot enter the street. Neck downs preserve fire access.
- Mountable curbs at corners and roundabouts – Mountable curbs serve to retain access for larger vehicles like fire trucks and freight trucks, while keeping corners tight and thereby limiting vehicular speeds.
- Limited block lengths – Blocks of limited lengths (less

*Store fronts benefit from street parking as it activates the sidewalks*

*Effective streets prioritize spaces for pedestrian*

*Narrow streets slow down traffic enough to create safe environments for pedestrian circulation*

than 300 feet), such as the short ends of typical city blocks, allow fires to be fought from the adjacent intersections even if the street itself is blocked.

- Sprinklers in buildings – Requiring sprinklers in all buildings can reduce fire risk and increase acceptable response time such that a reduction in fire truck speed may be allowed. This strategy was used in Baldwin Park in Orlando, Florida, to achieve local street widths as small as 21 feet across, with street parking.

These strategies, alone and in combination, can keep people and property safe from fires while improving road safety and livability.

*Street parking creates a buffer between moving traffic and sidewalk*

*Parallel parking supplies functional parking for all uses*

## Street Parking

On-street parking acts as a traffic calming device and protects pedestrians from moving vehicles. While this buffer is not typically needed for physical protection, it serves as a valuable psychological division between the automobile realm and the pedestrian realm. In addition to this function, street parking helps to activate the street with people coming and going, and makes street-facing store and business entries work. Parallel parking is preferred to diagonal parking, as it keeps street widths to a minimum and because, diagonal parking can cause serious conflicts with bicycles since it impedes drivers' ability to see bicyclists while backing.

## Intersection Design

Another critical factor for walkable streets is the design of intersections. Intersection design affects the safe and comfortable flow of travel for all modes, including walking and bicycling. Intersections are particularly important to the overall safety of a road network since a high proportion of accidents occur there. A variety of strategies can be used to make intersections safer and more functional for all users while maintaining critical functionality.

### *Actual Curb Radius and Effective Turning Radius*

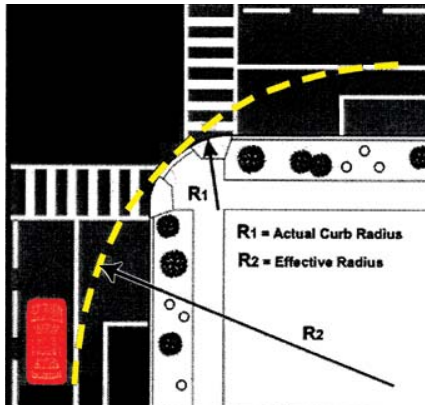
An important factor for intersection safety is the speed of turning vehicles. Smaller curb radii and the associated tighter turns by vehicles at corners can allow normal use by automobiles, while at the same time slowing turning movements and thereby increasing safety.

The effective turning radius (ETR) of a corner refers to the path of travel of the inside wheel of a turning vehicle (see figure at left). This is usually unmarked on the street and is not visible as part of the street assembly. The ETR of an intersection should not be confused with the actual curb radius which is likely to be significantly smaller.

Recognizing the difference between ETR and the actual curb radii is important because overlarge actual curb radiuses serve to make intersection crossing distances longer without enhancing the intersection's performance for automobiles. In fact, large curb radii can actually encourage drivers to take turns at unsafe speeds, endangering themselves, other drivers, and any pedestrians or bicyclists also using the intersection.

### *Curb extensions*

Narrow widths make intersections safer for pedestrians by limiting crossing distances. Intentionally narrowing roads at intersections with curb extensions achieves




*AASHTO Comparison of Actual Curb Radius (R1) to Effective Turning Radius (R2)*

shorter distances and helps to slow automobile traffic. Curb extensions are allowed and encouraged at all intersections. It is also appropriate to consider curb extension areas as opportunities to achieve other goals of the plan.

In denser and more urban areas, curb extensions are well-suited for bus stops and other pedestrian seating areas. Special care should be taken to understand traffic flow and its implications on safety and signalization when bus stops are located near intersections and within the moving lane.

Curb extensions can also be paired with bicycle storage facilities which provide a safe and visible area for bicycles to be stored on the more active streets. Placing bike facilities in the curb extensions also means that pedestrian walkways and sidewalks in the immediate area are not partially blocked by parked bicycles. Placing bicycles in this prominent area also has the potential to add to the creation of a cycle-minded community where bicycles are not only a priority, but are also aesthetically part of the streetscape.

In lower intensity areas, curb extensions may be well-used as stormwater detention and filtration areas. “Flush” volumes of rainfall can carry unhealthy amounts of surface pollutants when the water runs over the street surface and along the street-side gutter. These pollutants are often carried along hard infrastructure for long distances, and potentially into sensitive waterbodies such as streams and ponds, and eventually the ocean. By catching surface contaminants in street-side swales and retention areas, contaminants can be filtered naturally by plants while the clean water is left to infiltrate into the ground. Using curb extensions to build these retention areas means that contaminants are less detrimental to downstream environments, and stormwater infrastructure has less of a chance of being overwhelmed by large volumes of stormwater runoff when large rain events occur.

## Bicycle and Pedestrian Facilities

Walking and bicycling are important transportation modes. They promote health, reduce traffic congestion, reduce the need for large parking lots, and are often enjoyable recreational activities which will serve as amenities for employees, residents, and visitors to the Park.

### Pedestrian Network

The need for pedestrian facilities (sidewalks, safe crossings) is a given. Regardless of whether sidewalks are provided, people will at times walk along roadways, and forcing people to walk in traffic is dangerous and unnecessary. The Plan instead encourages people to walk by providing safe, pleasant sidewalks and pedestrian paths connecting all locations.

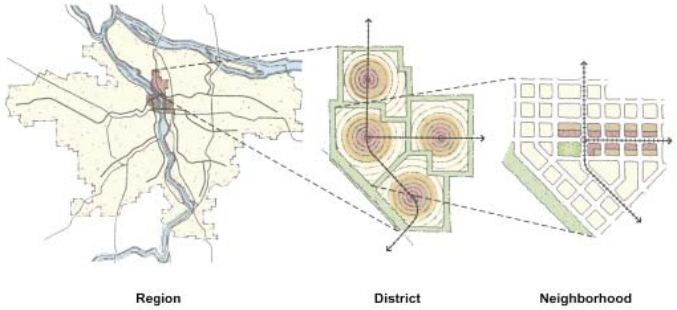
### Bicycle System

As for bicycles, they need to travel wherever automobiles travel. Bicycles have many of the health and environmental advantages of walking, and their higher speed allows longer travel distances. This will be especially important in the Park due to its current location outside the main area of development in Kihei.

In contrast to the typical 1/4 mile travel distance limit for pedestrians, their higher speed allows bicyclists to commonly travel much further, between one and 2.5 miles.

*Traffic circles slow traffic without causing delays and can beautify the streetscape*

# Connections & Interdependence




Thinking of individual elements of the urban environment as distinct and unrelated has been a hallmark of Modernist thought and has led to regions which are socially, economically and environmentally disconnected. Contemporary thought searches for a deeper understanding of the relationships between all elements of the built environment. Elements such as the environmental and economic connections and interrelationship of the park to the rest of the county are important considerations, as discussed above. A more direct and very important connection to consider here is transportation.

## Intermodalism

Much transportation planning as it is currently practiced is in fact only automobile transportation planning. Given the increasingly-apparent health and environmental benefits of non-automotive modes like walking, bicycling and transit, this emphasis on the automobile is unfortunate. A robust, equitable, environmentally sound transportation system accommodates multiple transportation modes. A variety of strategies can be used to achieve this, from provision of adequate pedestrian and bicycling facilities to implementation of transportation demand management strategies such as parking cash-out, where those who do not use “free” parking receive a cash payment instead.

## Connectivity

Connectivity is closely related to intermodalism and is an important tool. Well-connected street networks better accommodate multiple modes. Direct routes are especially important for pedestrians, since the rate of trips made by walking is highly sensitive to distance. Connected streets also affects trip lengths for automobiles, reducing vehicle miles traveled while providing alternate routes in case of road blockages or repairs. And consideration of connectivity between modes, such as good sidewalk connections to transit stations, improves the efficiency and effectiveness of the entire system.

## The Fallacy of Free Parking

The issue of parking is one of the most contentious in planning and urban design. For many years, government authorities have required with minimum parking standards that plentiful parking be made available for every type of land use. The reasoning behind this was that if a business or residence did not provide sufficient parking, people would be forced to park their cars on the street, inconveniencing their neighbors. While generally not requiring that parking be free, regulations have required that parking be provided at such high levels that there

*Multi-Modal street, Ottawa*

has been typically no point in charging for it, and people have become used to the idea of plentiful, free parking wherever they go.

However, free parking is not really free. There are many costs to providing parking, from land costs to construction costs to ongoing maintenance and security. With the current system, however, the costs of parking are bundled into the cost of everything else, and so parking seems free to drivers.

Free, plentiful parking leads to increased driving. When a normal good is underpriced, it will be overconsumed. This applies to parking – because a portion of the journey is subsidized, people's decisions are influenced toward driving and away from other modes or carpooling. In addition, the requirement for large amounts of parking means that destinations are spread further apart by large parking lots. Since parking often takes up more than half of a developed parcel, the amount of destinations within reach in the critical pedestrian quarter mile is often cut by more than half. And few people enjoy walking to destinations through the seas of parking in which buildings often float.

### Reduced Parking Minimums

For these reasons, this plan proposes reductions of mandated parking provision in the Park. Businesses will undoubtedly choose to provide parking, but making their own decisions about the amount of parking will provide one more element of flexibility to businesses seeking to locate in the Park. A business which desires to promote walking, bicycling or transit use, or even to run a commute shuttle service for its employees, may choose to provide less parking.

If street parking becomes scarce, which is to say, if drivers are forced to circle looking for spaces, then metering can be introduced and the price raised to a level where supply equals demand. The resulting income could be devoted to improvements within the park such as sidewalk and street maintenance and improvements, open space maintenance, or transportation demand management measures such as transit passes. Moving automobile parking toward a market-based system will help to incorporate market efficiencies and reduce the overconsumption motivated by underpricing.

*See "The High Cost of Free Parking" by Donald Shoup for an in-depth discussion of the costs and complications of abundant and underpriced parking.*

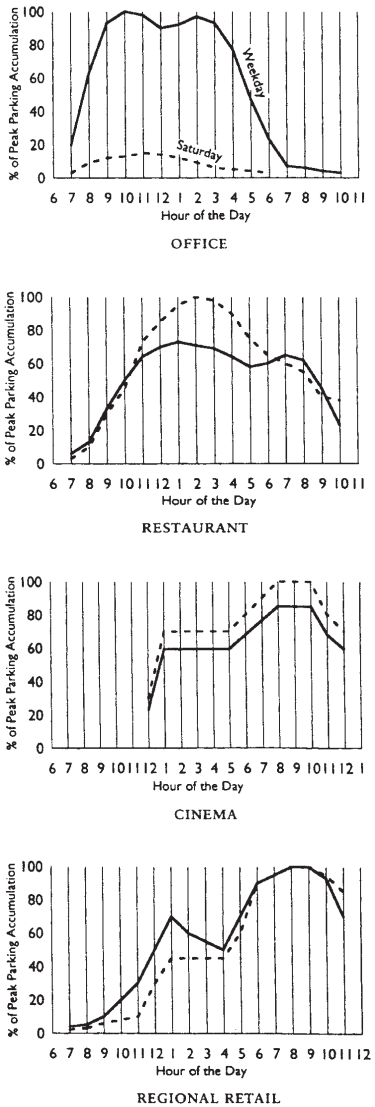
## Shared Parking

While parking lots are necessary parts of the transportation system, they are expensive to build and maintain and they spread development out, making places less walkable. There are many benefits to only building the amount of parking that is needed. While each parking space has a financial and environmental cost, additional usage of that space has little additional cost. Thus, for a given amount of parking needed, it is much better to utilize one space for longer periods than have two spaces each occupied for only a portion of the day.

*For more information about shared parking, see Shared Parking (Urban Land Institute, 2005) and Shared Parking Planning Guidelines (Institute of Transportation Engineers, 1995).*

By recognizing that peak demand occurs at different times for different land uses, shared parking facilities help minimize the need for parking lots and garages. For example, office parking lots are typically full during the day Monday to Friday, but nearly empty at other

*Multiple parking facilities can share one parking surface*




*Parking Demand Diagrams*

times. Retail parking has a different pattern, reaching maximum usage on the weekend. Mixed use, retail, office, civic buildings, and multi-family developments may share off-street parking spaces. This approach works well anywhere, as long as walking distances to the parking area are reasonable.

Commercial users in the Park are encouraged to use shared parking. The Urban Land Institute's (ULI's) Shared Parking Standards, or an equivalent, are good ways to calculate the total number of shared parking spaces. To determine parking demand if spaces are shared, parking demands for the two or more uses are added for each hour of the day - for weekdays, Saturdays and any other days with significant variation in parking patterns - to see which hour produces the highest parking demand.

The following steps can be used to determine the minimum number of spaces needed for mixed-use areas:

1. Start with the maximum parking needed for each user which will be using the shared parking arrangement.
2. Determine the parking demand for each user for key times. The ULI uses weekdays and Saturdays at 10 AM, 1 PM, 5 PM, 8 PM and 10 PM.
3. Determine the total parking demand for these key times by summing the demand of the various land uses for each key time.
4. Determine the minimum shared parking space requirement by noting the largest of the aggregate parking demand figures.

## Example Shared Parking Calculation

The following example illustrates how to determine the parking demand from joint use shared parking for a mixed-use area containing a 10,000 square foot restaurant and 200,000 square feet of office space:

Assume that the restaurant user estimates a maximum need for 10 spaces per 1,000 square feet of restaurant space and the office user estimates a maximum need for 3 spaces per 1,000 square feet of office space. A 10,000 square foot restaurant and a 200,000 square foot office building thus require 100 and 600 spaces, respectively, or 700 total.

| Land Use | Single Use Peak Hour Demand (spaces) | Percentage of Demand for Key Times* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Weekdays | | | | | Saturdays | | | | |
| | | 10 AM | 1 PM | 5 PM | 8 PM | 10 PM | 10 AM | 1 PM | 5 PM | 8 PM | 10 PM |
| Retail | 3/1,000 sf | 50 | 75 | 75 | 65 | 25 | 50 | 100 | 90 | 65 | 35 |
| Office | 3/1,000 sf | 100 | 90 | 50 | 5 | 5 | 15 | 15 | 5 | 0 | 0 |
| Restaurant | 10/1,000 sf | 20 | 70 | 70 | 100 | 95 | 5 | 45 | 60 | 100 | 95 |
| Cinema | 1/3 seats | 0 | 60 | 60 | 85 | 85 | 0 | 70 | 70 | 100 | 100 |
| Hotel | 1/room | 45 | 30 | 60 | 90 | 100 | 40 | 30 | 60 | 90 | 100 |
| Health Club | 5/1,000 sf | 10 | 80 | 100 | 30 | 10 | 60 | 80 | 60 | 30 | 10 |
| Residential | 1.3 - 2/unit (see req's) | 85 | 80 | 85 | 95 | 100 | 70 | 65 | 75 | 95 | 100 |

** From the Urban Land Institute's* Shared Parking Standards, *1983.*

*An example of a shared parking demand spreadsheet*

To determine parking demand if spaces are shared, parking demands for the two uses are added for peak times on weekdays and Saturdays, to see which hour produces the highest parking demand. In this case, the highest total demand is at 10 am on a weekday, when the the office parking usage is estimated to be 100%, but the restaurant will be using only 20% of peak usage. The total is parking needed is thus 620 spaces, 80 fewer spaces than would be needed with separate parking lots. Even larger reductions in demand are possible with uses that have greater differences in their demand curves, such as office and cinema.

# Conclusion

Development-as-usual has proven detrimental to our environment and our health. Maui needs development that is efficient, harmonious with the natural environment, and capable of meeting human needs.

Changing the current standard practice of development will take many years and the efforts of many people. The built environment changes slowly, so for a long time areas with better development patterns will be small pockets in large areas with less to offer. But for places scaled to people, small areas are enough - the walk to the grocery, to work, or to the park will happen at short distances, so even small pockets of quality can function better than they would have as autocentric sprawl.

And it is important to begin now. The Maui Research & Technology Park has the opportunity to showcase an array of cutting edge sustainable design strategies. Workers and residents will enjoy a diversity of housing, transit connectivity, and quality economic development from this community for years to come.

*Wide traveling lanes promote higher vehicular speeds*

*Car-Centered intersections like this one at Lipoa Parkway and Pi'ilani Highway discourage pedestrian activity, leaving the park somewhat cut off from the rest of Kihei.*

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# Concept Diagram

*Maui shoreline*

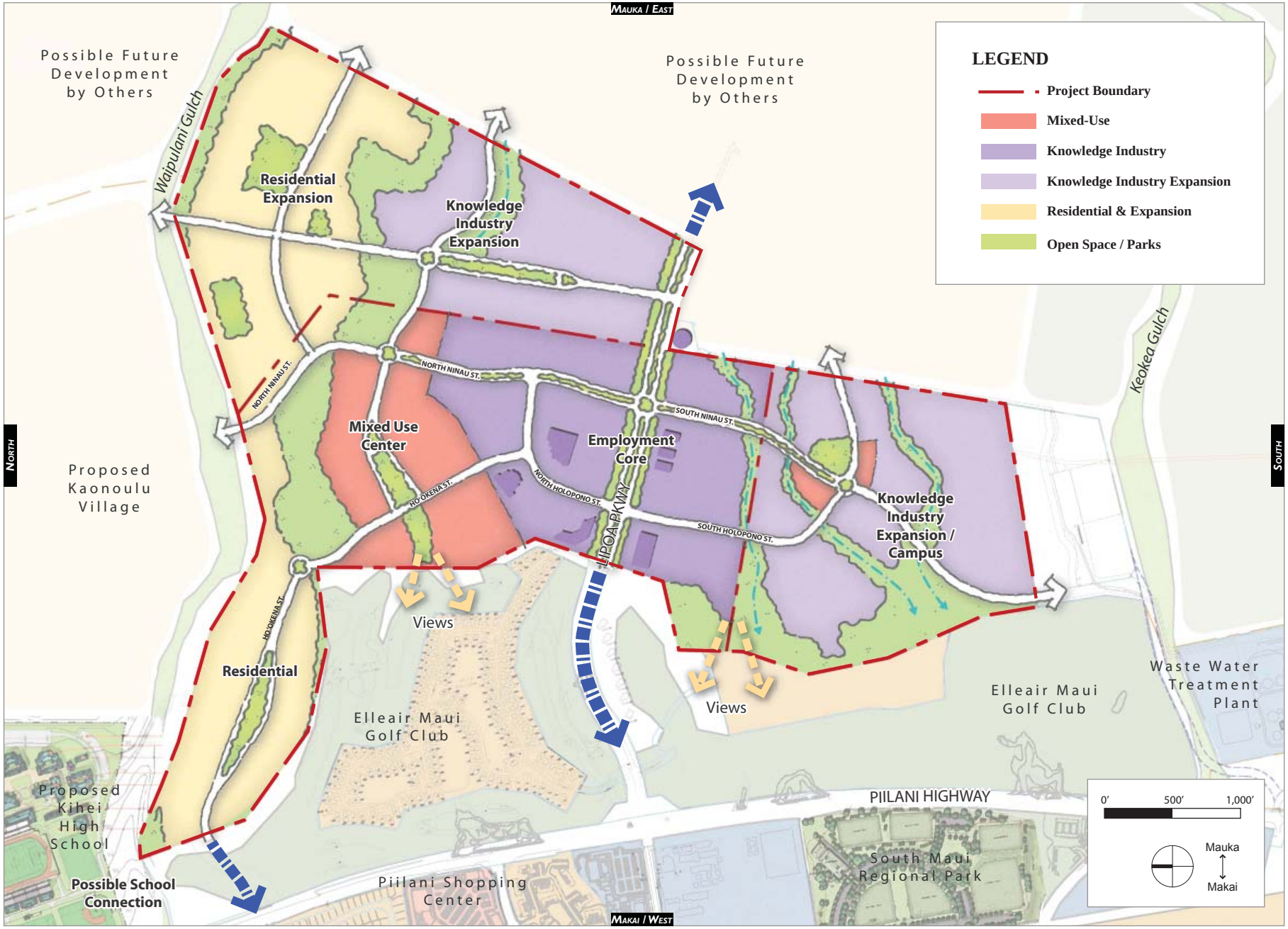
The Concept Diagram shows the overall vision for the future of the Maui Research and Technology Park. The Park's existing buildings are within the Employment Core area. This area will remain exclusively in employment uses, though incidental supportive retail uses will be allowed. Major new employment zones south of Lipoa Parkway (the Knowledge Industry Expansion/ Campus area) and mauka the employment core (the Knowledge Industry Expansion area) provide large new areas for employment expansion and diversification. The new Mixed Use Center is a flexible area to contain space for incubating new businesses as well as supportive retail, civic uses, open space, and residential uses. New residential zones mauka and makai of the Center provide additional housing in a variety of formats which will appeal to park business owners and employees.

The Park has been envisioned with pedestrian connectivity as a first priority. A green corridor, running north to south along Ninau Street, links the center of the site. This corridor links the Park's two mixed use areas. Ideally, transit stops in these locations will also connect park workers and residents to the larger region. With a majority of businesses and homes within a 5-minute walk of the centers, many daily needs will be within a short and comfortable walk.

*Park Plaza Building in MRTP*

*Wailuku commercial building*

*Maui single family housing*




*Concept Diagram*

# Conceptual Development Program and Illustrative Plan

The plan at right shows an illustrative vision of how the Park might develop, based on the Concept Diagram on the preceding page. The numbers below show the development resulting from the Illustrative Plan.

In the Plan, new employment buildings line the streets and parking is placed at the rear. The scale of development is broken down in many areas to provide a greater variety of buildings and parcels.

The Village Center contains a diversity of uses and building types. In the southern employment area, a small center provides a focus for employment expansion. Parks and an open space system unify the Park and provide an important focus of leisure and activity. Throughout the mixed use and residential areas, a robust local road network provides flexibility in routing and raises walkability with greater route directness.

*Note 1. The total Maui Research & Technology Park land area is 410.937 acres. The 401 acre total on this page does not include land areas for Lipoa Parkway makai of the Park and the portion of Ninau Street south of the Park boundary (which is shown in the plan on the opposite page). Both of these areas are roadways and do not contain development.*

*Note 2: Net Developable Land is land in excess of roads, utilities, open space requirements, etc.*

**A Employment Core**

| | Acres | |
|---|---|---|
| Net Developable Land | 63.7 | 74.1% |
| Parks & Open Space | 9.3 | 10.8% |
| Road Rights-of-Way | 13.0 | 15.2% |
| Total Land Area | 86.0 | 100.0% |
| Employment BUA (New) | 716,000 Square Feet | |
| Employment BUA (Total) | 896,000 Square Feet | |
| Dwelling Units | 0 | |

**B Knowledge Industry Expansion / Campus**

| | Acres | | Park Acres Required |
|---|---|---|---|
| Net Developable Land | 54.6 | 62.0% | |
| Parks & Open Space | 25.9 | 29.4% | 0.24 |
| Road Rights-of-Way | 7.6 | 8.6% | |
| Total Land Area | 88.2 | 100.0% | |
| Non-Residential BUA (New) | 611,082 Square Feet | | |
| Dwelling Units | 21 | | |

**C Village Center**

| | Acres | | Park Acres Required |
|---|---|---|---|
| Net Developable Land | 34.1 | 58.5% | |
| Parks & Open Space | 10.4 | 17.9% | 4.59 |
| Road Rights-of-Way | 13.8 | 23.7% | |
| Total Land Area | 58.3 | 100.0% | |
| Non-Residential BUA (New) | 269,200 Square Feet | | |
| Dwelling Units | 400 | | |

**D Makai Residential**

| | Acres | | Park Acres Required |
|---|---|---|---|
| Net Developable Land | 21.0 | 53.9% | |
| Parks & Open Space | 7.0 | 17.8% | 4.02 |
| Road Rights-of-Way | 11.0 | 28.2% | |
| Total Land Area | 39.0 | 100.0% | |
| Non-Residential BUA (New) | 0 Square Feet | | |
| Dwelling Units | 350 | | |

**E Option Land**

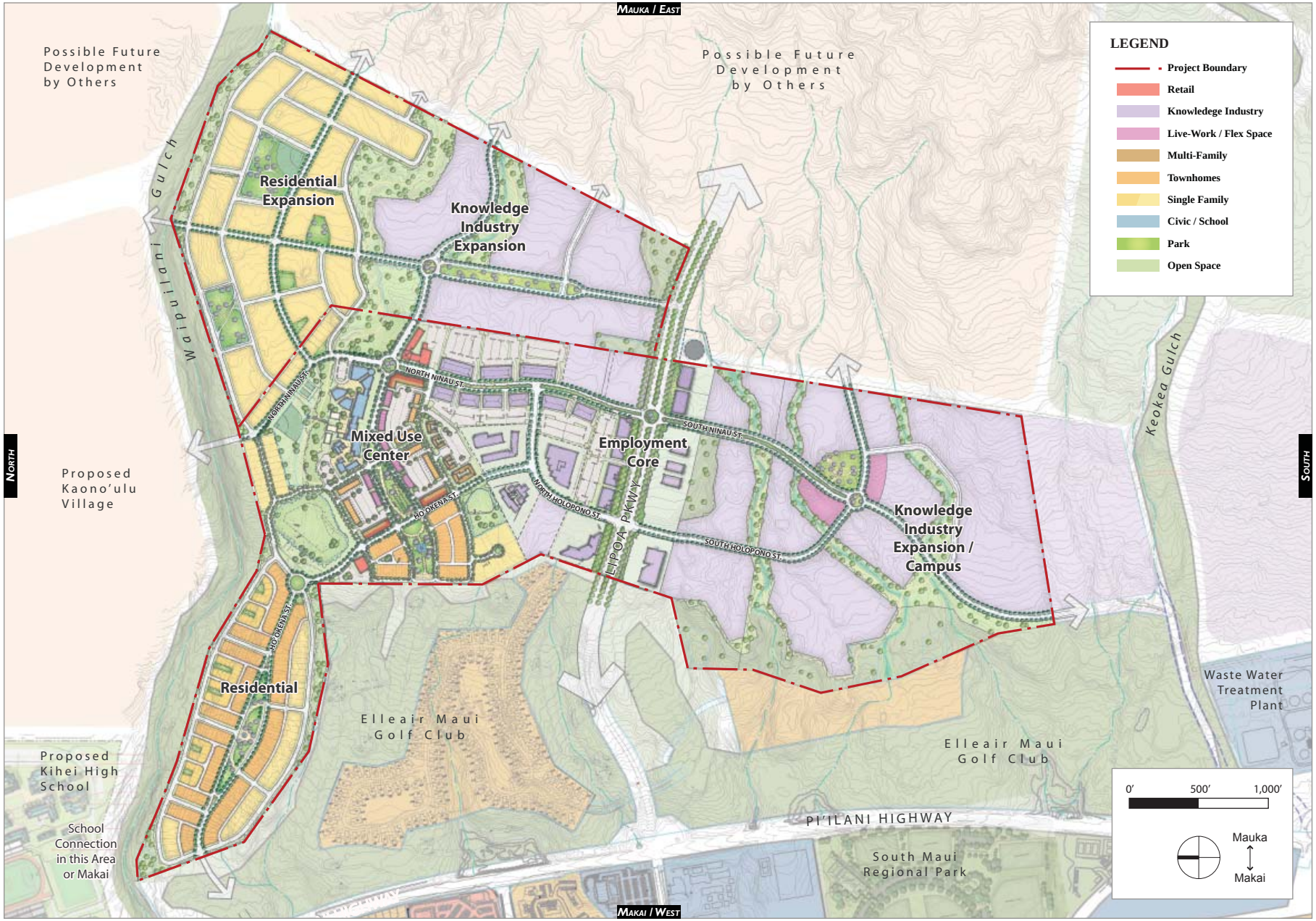
| | Acres | | Park Acres Required |
|---|---|---|---|
| Net Developable Land - Employment | 34.6 | 27.9% | |
| Net Developable Land - Residential | 34.5 | 27.8% | |
| *Net Developable Land - Total* | *69.1* | *55.8%* | |
| Residential Parks & Open Space | 6.3 | 5.1% | 5.50 |
| Other Parks & Open Space | 24.4 | 19.7% | |
| Road Rights-of-Way | 24.0 | 19.4% | |
| Total Land Area | 123.8 | 100.0% | |
| Non-Residential BUA (New) | 403,718 Square Feet | | |
| Dwelling Units | 479 | | |

**F Retention Pond**

| | Acres |
|---|---|
| Open Space | 5.5 |
| Road Rights-of-Way | 0.3 |
| Total Land Area | 5.8 |

**SITE TOTALS**

| | Acres | |
|---|---|---|
| Net Developable Land | 242.5 | 60.5% |
| Parks & Open Space | 88.7 | 22.1% |
| Road Rights-of-Way | 69.8 | 17.4% |
| **Total Land Area** | **401.0** | **100.0%** |
| Non-Residential BUA (New) | 2,000,000 Square Feet | |
| Non-Residential BUA (Total) | 2,180,000 Square Feet | |
| **Dwelling Units** | **1,250** | |




*Illustrative Plan*

# Open Space Network & Parks

*Open space trails*

*Armory Park in Lahaina*

*Community gardens could be welcome elements of the Park's open spaces*

*Waipuilani Gulch*

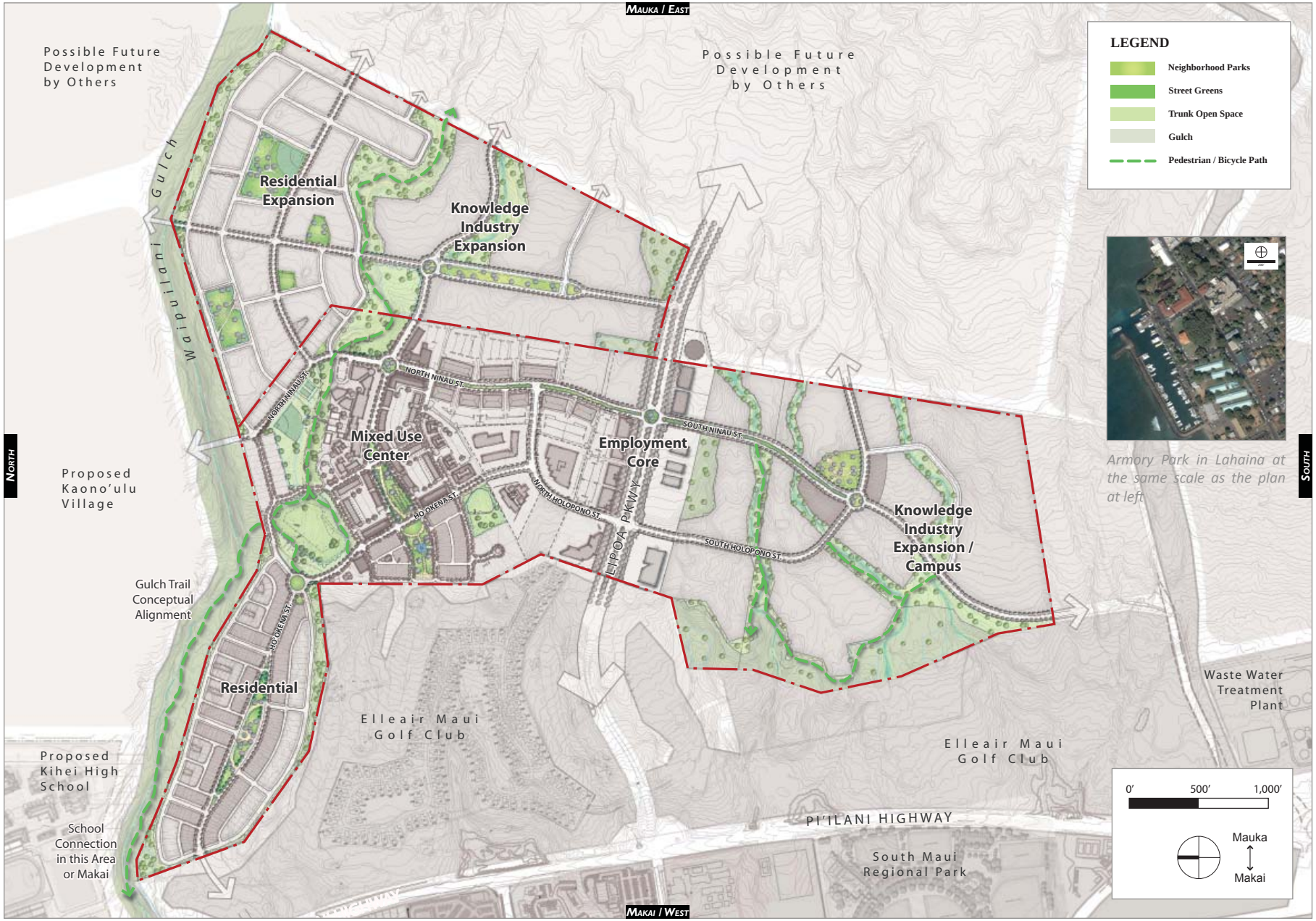
Open space is essential to a healthy community. Successfully designed, it transcends the traditional aesthetic role of an attractive landscape to accommodate ecological factors, infrastructure systems and many social needs. Ecological factors to be addressed include wildlife movement, habitat enhancement, water conservation, storm water capture and treatment, microclimate control to minimize heat island effects, and stream corridor protection. Open space serves as both landscape and infrastructure through the use of constructed facilities to capture, control and clean storm water and the provision of transportation corridors for trails and pathways. Open space also provides for the social needs of the community by providing spaces for recreation, relaxation and social interaction. In the end, multi-layered landscapes become expressions of cultural values and gather meaning and value to the entire community over time and through shared experience.

The Park will provide multiple types of open spaces and parks. The spaces take inspiration from some of the Park and Island's existing landscape and parks.

*Linear open space along Lipoa Parkway*

Existing gulches (outside the Park boundary) provide valuable connections mauka/makai, and could form the trunk routes of a trail network connecting to the rest of Kihei. Neighborhood parks serve as community focal points and places for exercise, sports, relaxation, activities like community gardening, and celebration. Trunk open spaces contain some of the site's more dramatic terrain, allowing the plan to respect the existing topography while creating another set of linkages throughout the site.

Finally, street greens continue the Park's beautiful landscape treatments and serve to link the park together. On Lipoa Parkway, continuation of the existing 60 foot setback rule creates a wide greensward lined with lush landscaping. This treatment is a reference to the Park's existing aim for park-like atmosphere and a way to take full advantage of the beautiful mature trees along the Parkway. The north-south connector greenway (North and South Ninau Street) connects the site laterally, linking the mixed-use center with the employment area center while linking together other open spaces as well.




*Open Space Plan*

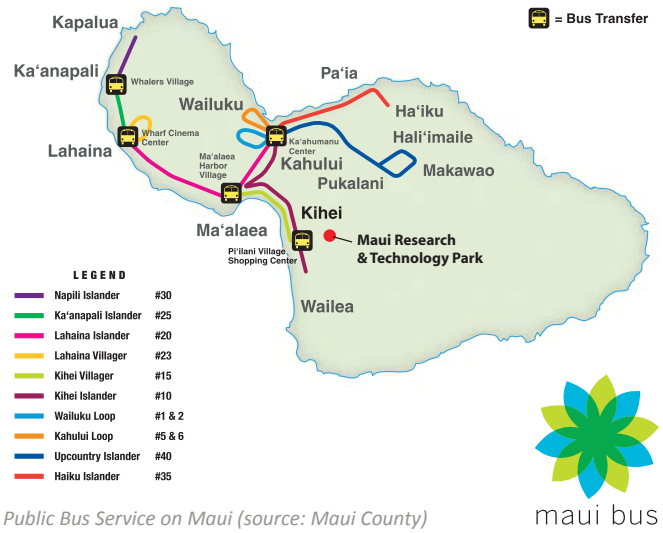
# Transit Plan

Given the low general density of the site and its position at the edge of the developed area, high quality transit will be difficult to achieve. However, at least a basic level of service should be provided to serve transit dependent persons and those who chose not to drive. As the site gains employment and population, transit service will become more viable as well as more essential.

Phase one transit service could run either as an extension of existing transit service from the Pi'ilani Shopping Center area or as a dedicated jitney serving the park. Making a loop within the first phase development area, this line would link central Kihei to the development, providing easy access up the hill across Pi'ilani Highway. The major transit stop would be the intersection of north Ninau and the mauka extension of the village green, though other stops could be provided along the route depending on development patterns.

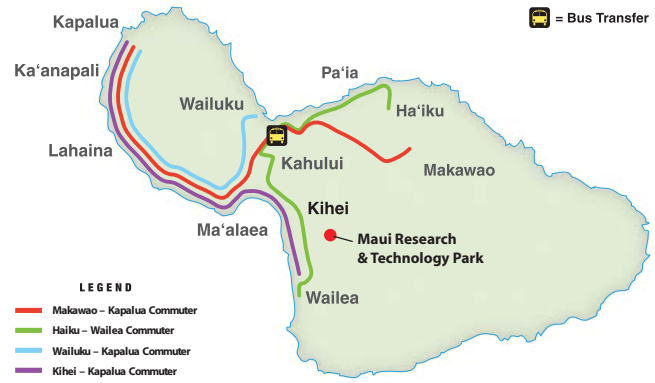
Contingent on the form of surrounding development and future road network changes, phase two transit service could run north and south along Ninau Street, connecting the site to nearby development and the island as a whole. The Park's frequent street connections with proposed nearby development will provide flexibility for future transit routing. The primary southern transit stop is located at the mixed use district and the park, a point which puts the entire southern portion of the site within an easy walking distance.

*Maui Bus vehicle (source: Wikipedia)*

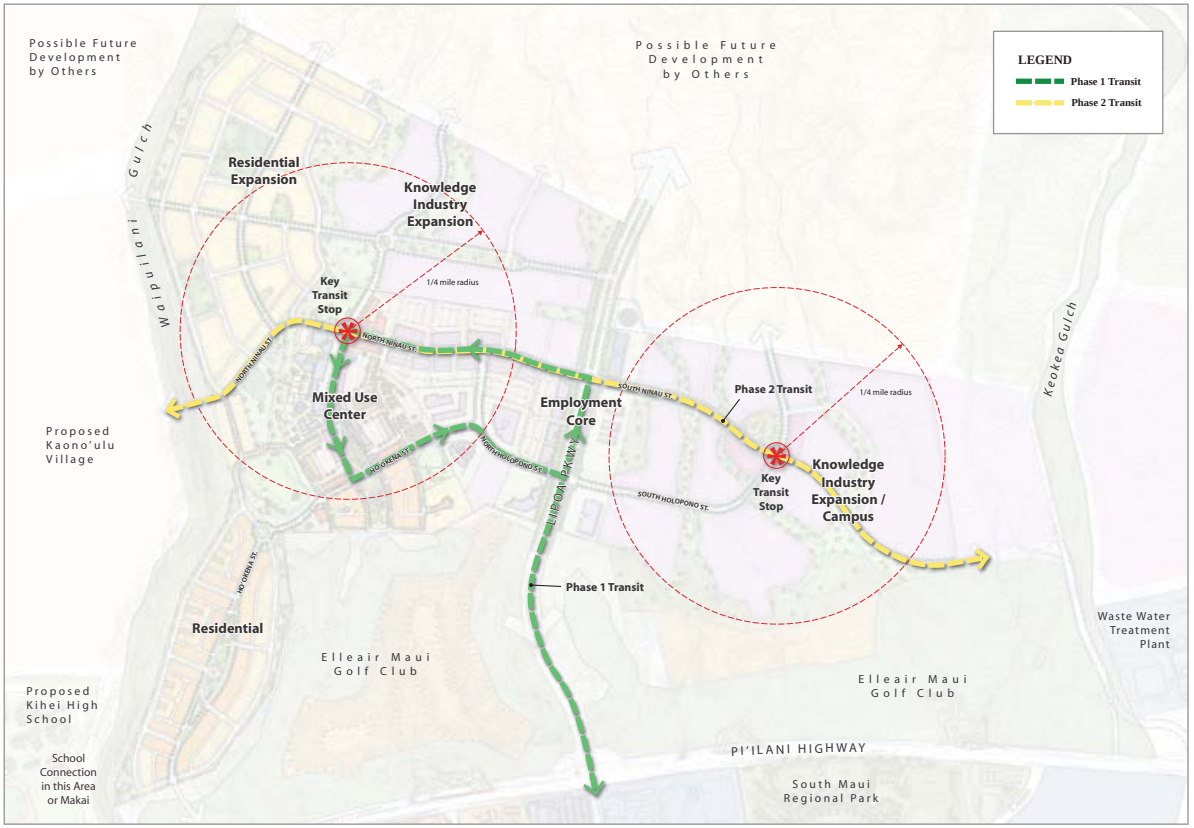



*Public Bus Service on Maui (source: Maui County)*

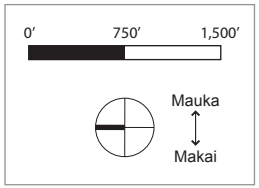
maui bus




*Commuter Bus Service on Maui (source: Maui County)*




*Public Transit Phasing Diagram*



*Transit networks can be a supportive part of a diverse, multi-modal transportation system on Maui.*

*Phase one jitney services can operate from relatively small and fuel-efficient vehicles, which can be privately owned and easily maintained.*

# Bicycle & Pedestrian Connections

*This roadway in Kahului near a major shopping destination has a small sidewalk on one side and only this dangerous shoulder for walking on the other.*

*Pedestrian routes are often unconsidered, discontinuous, and unsafe, like this one at the intersection of Lipoa Parkway and Pi'ilani Highway.*

*This fire lane could be a valuable pedestrian path to the Park.*

The plan creates a unified bicycle and pedestrian system within the Park and connections to its existing and future surroundings. Unfortunately, bicycle and pedestrian connectivity is often ignored in the current auto-centric transportation engineering system. This has the effect of creating discontinuous networks, unsafe conditions, and unpleasant environments for users. These factors naturally reduce the number of people bicycling and walking, further marginalizing these beneficial transportation modes.

Because of the Park's relatively long walking distance from Kihei makai, walking will be important inside the park but bicycling will assume additional importance for accessing the Park. The roads into the Park from Pi'ilani Highway will have bicycle paths, making the journey uphill as safe and easy as possible. Connectivity in the Park is provided both with bicycle lanes and with mixed flow riding. Streets within the Park are intended to be small in scale and low in speed, which will make it safe to use bicycles in traffic.

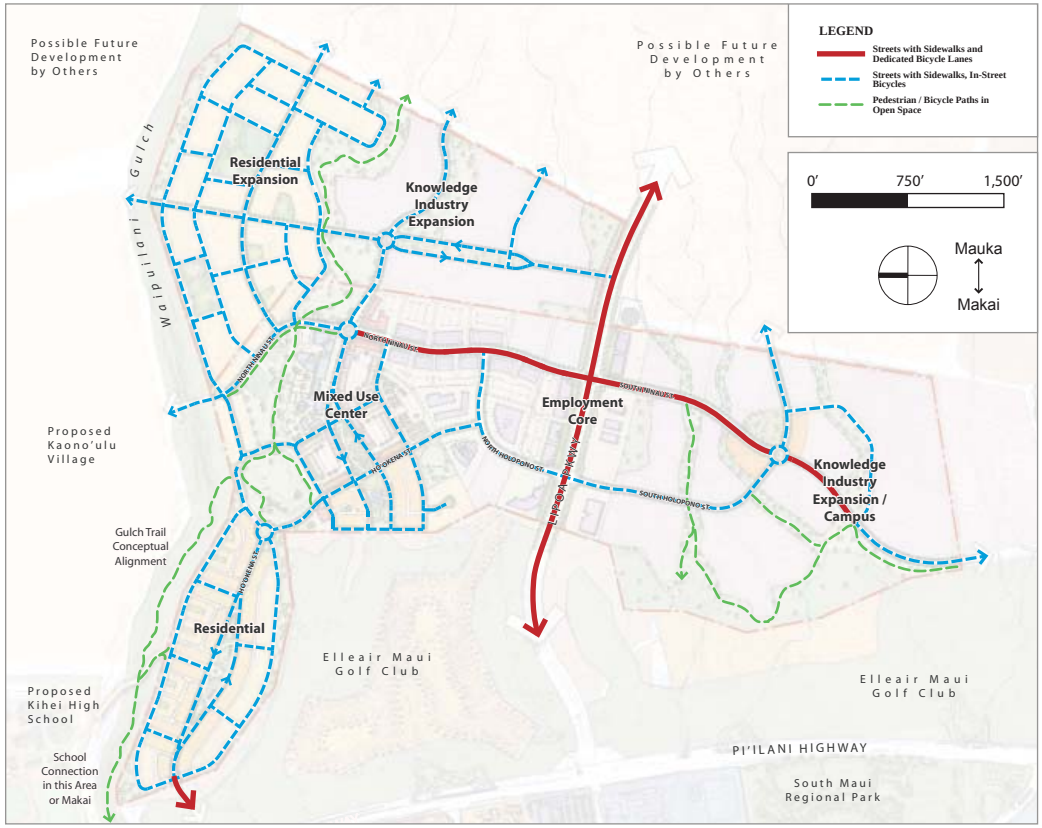
An additional opportunity for access is presented by the Pi'ilani Highway overpass over the Waipuilani Gulch. This wide connection (see photo at top right), while also an important stormwater drainageway, could make an excellent connection for pedestrians and bicyclists from the rest of Kihei to the Park and the new high school planned nearby. Concerns over safety from storm events and the consequent water in the gulch can be overcome, as seen in other similar cases throughout the world. This connection would connect the Park to the North/South Greenway along Liloa Drive as well as possibly to other bicycle facilities like the bicycle lanes on South Kihei Road.

Other pedestrian and bicycle connections can be made opportunistically, where feasible. For instance, the fire lane to the new housing development makai of the Park could be used as a pedestrian access for residents of that development to reach the Park's village center.

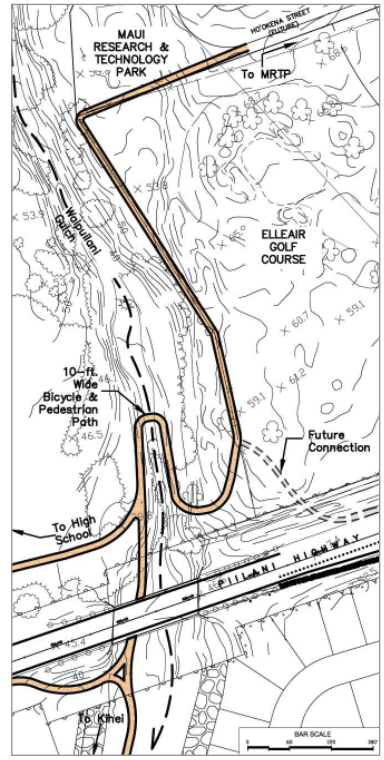
*The Waipuilani Gulch crosses under Pi'ilani Highway with this underpass. This could make an ideal location for a high quality pedestrian and bicycle connection from to the Park and the new High School from makai.*

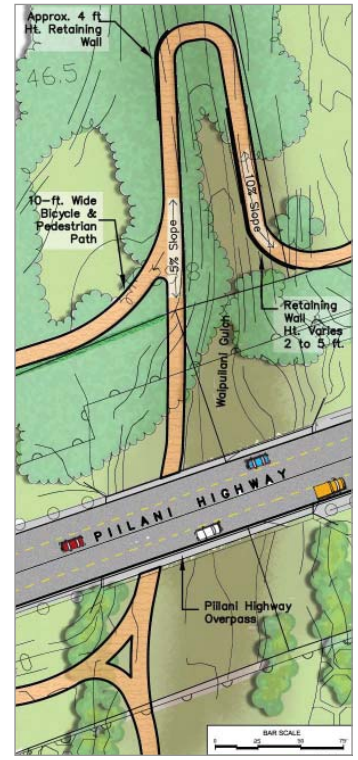
*Trail under an underpass in Livermore, California*

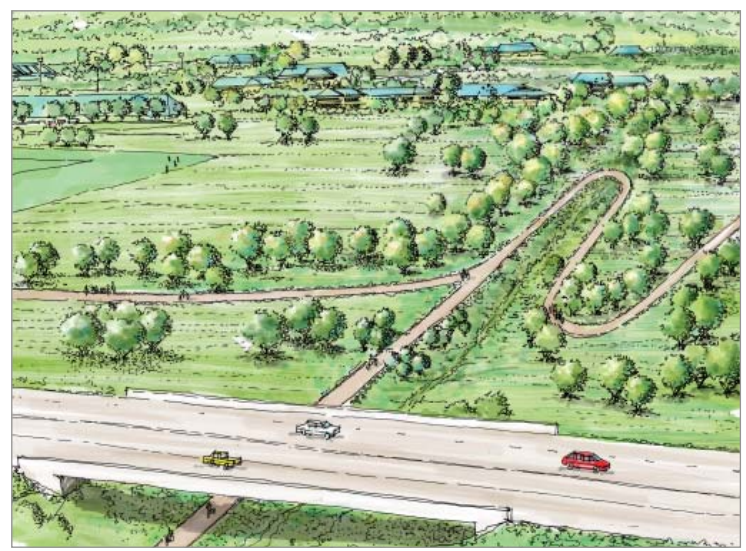
*Bicycle / Pedestrian trail in a drainage way, Denver, Colorado*




*Pedestrian and Bicycle Connections Plan*



*The three drawings at right show a concept for a connection to the Park in the Waipuilani Gulch. The top left drawing shows the trail connecting from the Park, makai into and across the gulch, and then to the proposed high school to the north and across the highway into the rest of Kihei to the west. The top right drawing shows the detailed treatment, including how the trail might handle the topography getting into the gulch. At bottom is a rendering of how this trail would work. At the top of the drawing is the high school, and at the bottom is Pi'ilani Highway. Such a trail could be a safe and effective connection between important locations. It would require the coordination between and cooperation of variety of public and private entities.*

# Mixed-Use Center Illustrative Plan

The Mixed-Use Center Illustrative Plan adds additional detail to the concept for the center. The final commercial and residential development in the Center will depend on market conditions. However, this plan illustrates one possible development scenario which meets the goals of the Plan. The Center is highly connected to the rest of the Park. Two connections into the center from the south are on Ninau and Ho'okena streets. From makai, Ho'okena Street enters the Center from Pi'ilani Highway via the Makai Residential property. Several roads also go into the possible expansion land mauka.

A ribbon of trunk open space connects across the site mauka/makai, adding park uses to retention areas and using portions of the open space for school playgrounds. A public park follows a small area of topography from Ninau Street toward the golf course over the course of several blocks.

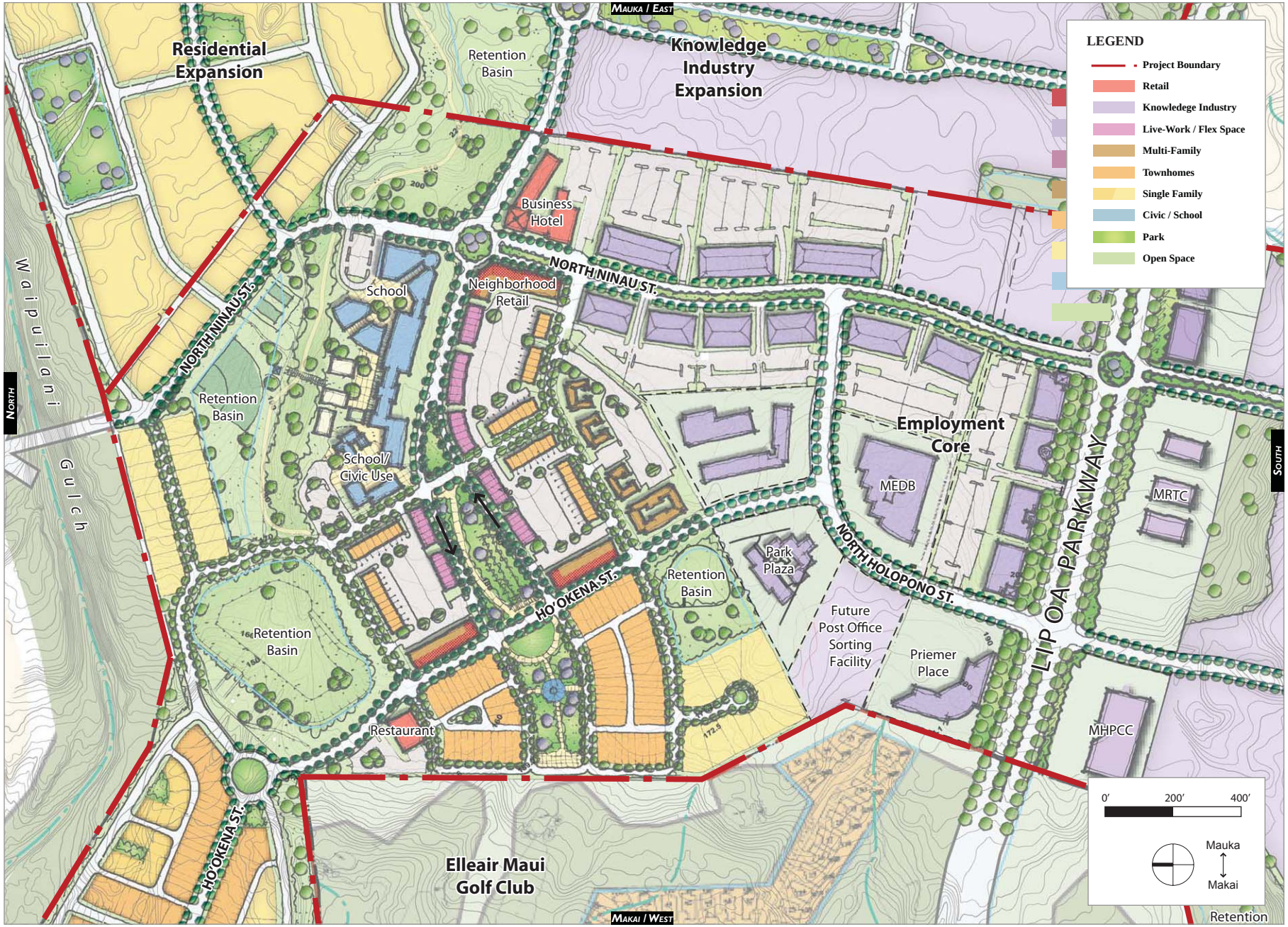
Two schools occupy a site along both the trunk open space spine and the public park blocks. Other uses line the park, providing a mix of activity and 24-hour usage of the park. These uses are small retail spaces, flex space buildings, multifamily buildings with ground floor retail, and townhomes. Townhomes and mixed-use multifamily line Ho'okena Street, creating a small main street. This will be the early heart of the area's retail uses, providing local-serving uses like cafes and business services. A mauka node at the intersection of the park and Ninau Street will provide retail space later on, as the site develops further, including a possible space for a business hotel with small conference facilities to serve the Park's employers.

The residential area makai along Ho'okena Street on the way to Pi'ilani Highway has high amenity value, with views of the golf course to the south and Waipuilani gulch to the north. Houses also line a large local park in the center of the area, with traffic on Ho'okena Street traveling around the edges. A connection to the planned high school on the north side of the gulley allows students who live in the area to reach the school by foot without going onto busy Pi'ilani Highway, and will make programmatic connections between the school and businesses in the park easier.

*Single family housing*

*Mixed-Use building in Lahaina*

*Local retail in Lahaina*




*Mixed-Use Village Center Illustrative Plan*

# Housing Variety

The plan assigns overall densities to the various areas in the Park. Within those areas, it is expected that there will be a wide variety of housing types. Housing variety not only allows development to respond to the changing conditions of the market, it will also make the Park a more vibrant area by supplying housing to a wide variety of people. A diverse housing market will also make the Park more economically vibrant by appealing to a broader portion of the housing market.

As the table below shows, overall densities can be derived with a variety of unit mixes. In the Makai Residential example, an overall density of 14 units per acre for developable land (not including parks, roads, utilities and other non-developable land) is reached with all fee-simple housing in option 1. Most of the homes are townhomes and small lot detached houses. This mix would serve more young families and first-time home buyers. Other options include both a higher percentage of land with compact development, in multifamily and 3 & 4-plex buildings, and more low density units of various types. This type of mix would create a market for singles and couples to get into the neighborhood, and at the same time provide move-up housing for more established families.

The Residential Expansion Land example provides similar variety of housing type mixes in the three options. In all options for both parcels, the overall density remains very similar to the target density. This allows the overall impact of the development on things such as roadways and infrastructure to remain similar in the various options.

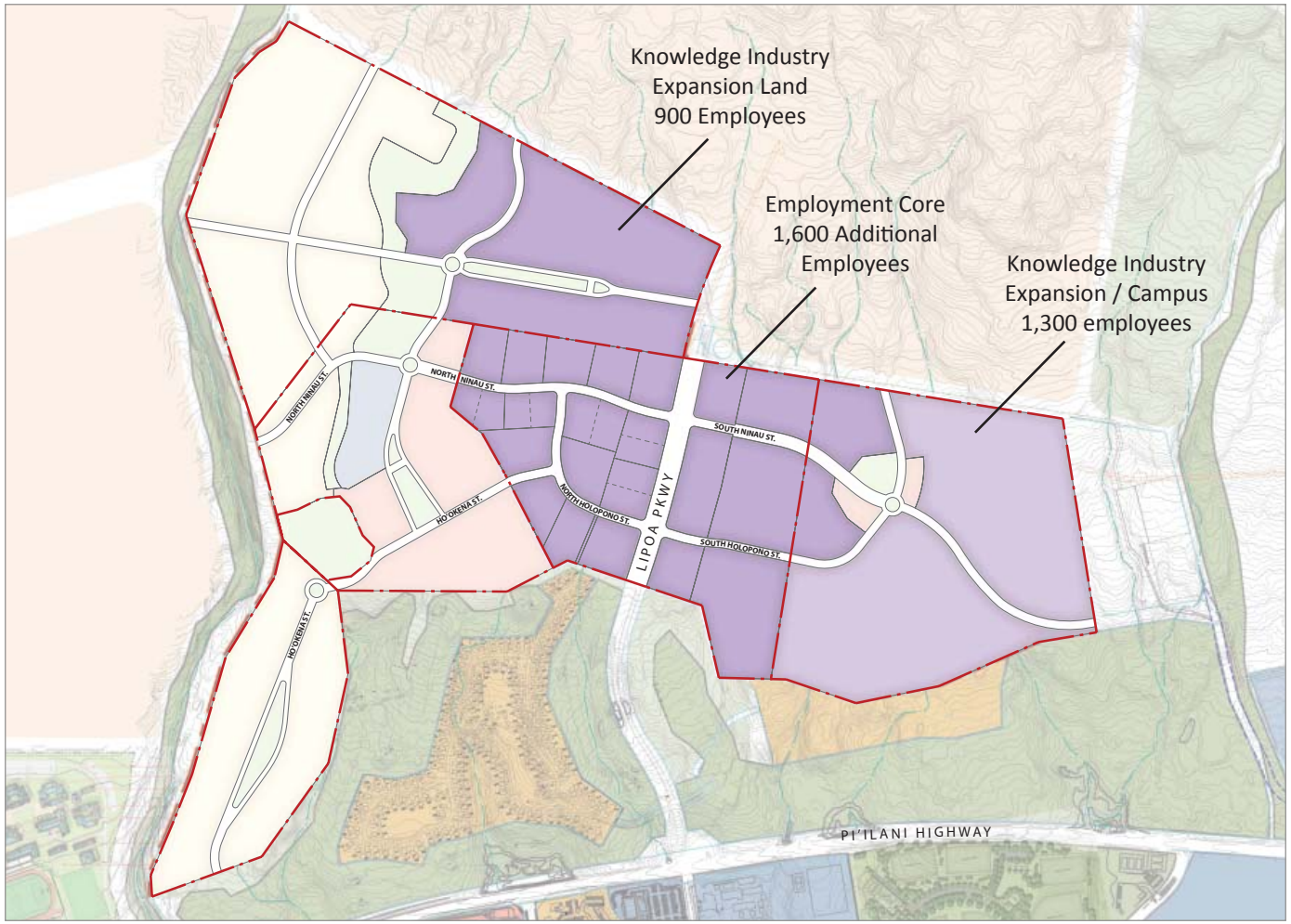
| LAND MIX | | TARGET AVERAGE NET BLOCK DENSITY | PERCENTAGE OF LAND AREA | | | | | | RESULTING DENSITY |
|---|---|---|---|---|---|---|---|---|---|
| PARCEL | | | MULTIFAMILY | 3-PLEX & 4-PLEX | TOWNHOME | GREEN COURT SINGLE FAMILY | SMALL LOT SINGLE FAMILY | LARGE LOT SINGLE FAMILY | |
| | | *UNITS/ACRE* | *30 UNITS / ACRE* | *45 UNITS / ACRE* | *20 UNITS/ACRE* | *12 UNITS/ACRE* | *9 UNITS/ACRE* | *6 UNITS/ACRE* | *UNITS/ACRE* |
| D | MAKAI RESIDENTIAL | 14.0 | | | | | | | |
| | OPTION A | | 0% | 0% | 50% | 0% | 40% | 10% | 14.2 |
| | OPTION B | | 10% | 0% | 30% | 15% | 15% | 30% | 14.0 |
| | OPTION C | | 0% | 20% | 0% | 0% | 20% | 60% | 14.4 |
| E | RESIDENTIAL EXPANSION LAND | 15.0 | | | | | | | |
| | OPTION A | | 20% | 0% | 25% | 0% | 30% | 25% | 15.2 |
| | OPTION B | | 10% | 10% | 15% | 20% | 0% | 45% | 15.6 |
| | OPTION C | | 40% | 0% | 0% | 0% | 0% | 60% | 15.6 |

*Similar overall densities can be achieved with a variety of housing land mix options.*
*Note: the densities listed here for each type are assumptions for the purposes of exploring options. These are net block densities and do not there correspond completely to the densities listed in the building types section of this Code.*

# Employment Capacity

The purpose of the Maui Research and Technology Park is to provide job diversity for the Island of Maui. While the diversification of the uses in the Park is a part of the economic development strategy of this plan and is a way to help the Park to both attract and generate jobs, it is also important to confirm that the Park retains enough space for job creation.

The graphic below shows the areas of the park which are maintained as strictly employment areas. While other areas such as the mixed use center will provide some jobs, the core employment areas are those in purple on the map. As the graphic makes clear, the plan retains a very large capacity for jobs in these areas of the park.




*Employment capacity of the employment-focussed areas of the park*

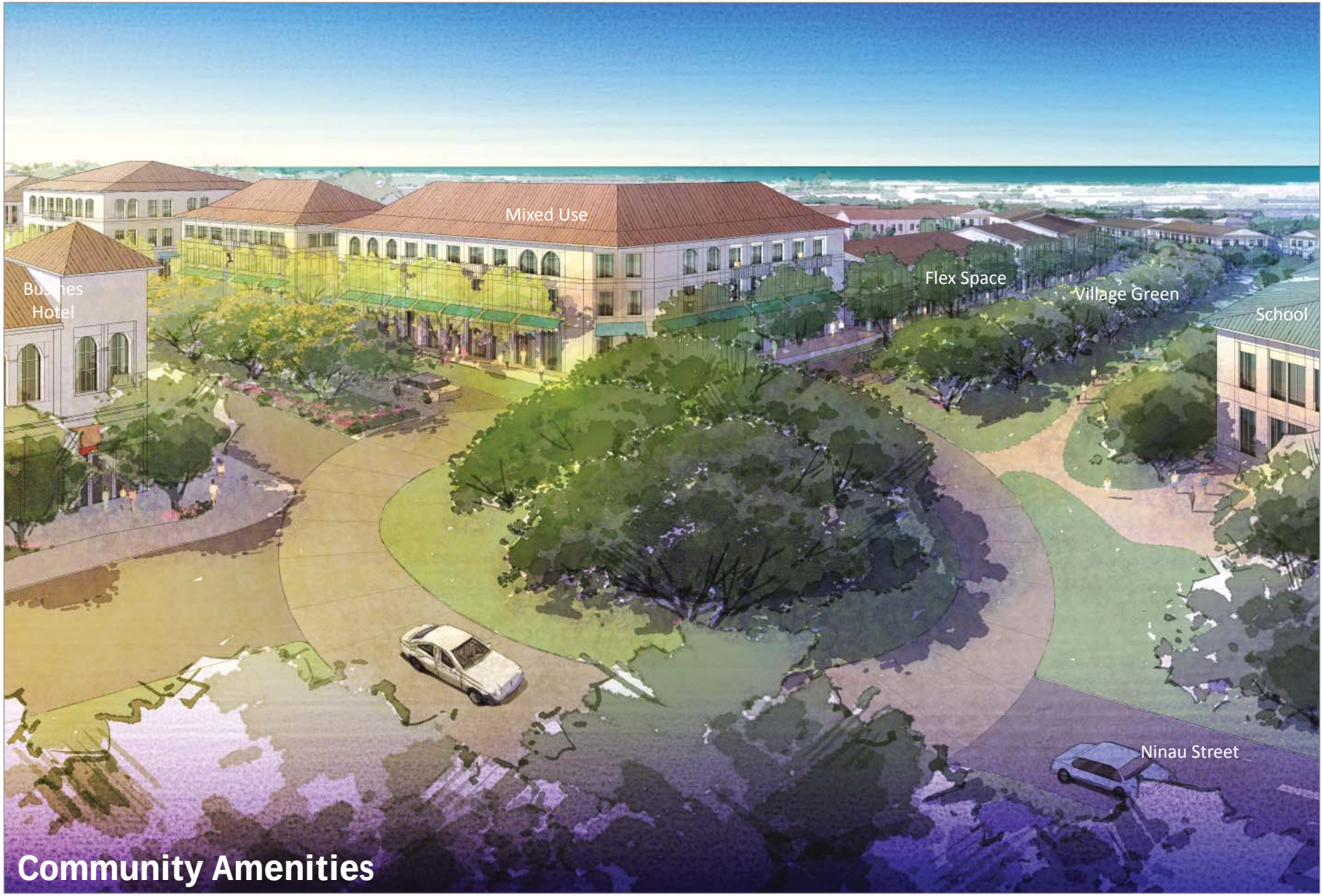
*The employment numbers as shown are calculated based on the capacity for new construction (square feet) in the Park combined with the average number of employees per square foot of area in existing buildings in the park. Because the number of employees per square foot could vary in future businesses, and is somewhat higher in the current market study of the Park's future development, the number of employees in the areas shown in the graphic at left could be even higher.*

# Concept Renderings

The drawings on the following pages illustrate the various areas and elements of the Park. These renderings are meant to be visualizations of the urban design concepts. However, detailed design of the park and the Park's buildings will happen over time, so these should not be taken as literal depictions of planned development.

Village Center

Village Green




## Community Amenities

## Economic Development and Urbanism

Campus Buildings Create
Outdoor Rooms
Employment Campus

## Residential Area

Southern
Employment Zone
Kihei
Employment
Core
Employment
Expansion Land
Village Center

Aerial View

# 5 - FORM BASED CODE

## NEIGHBORHOOD SCALE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Land Use 60

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Circulation & Connectivity 68

Street Network 70

Street Sections 72

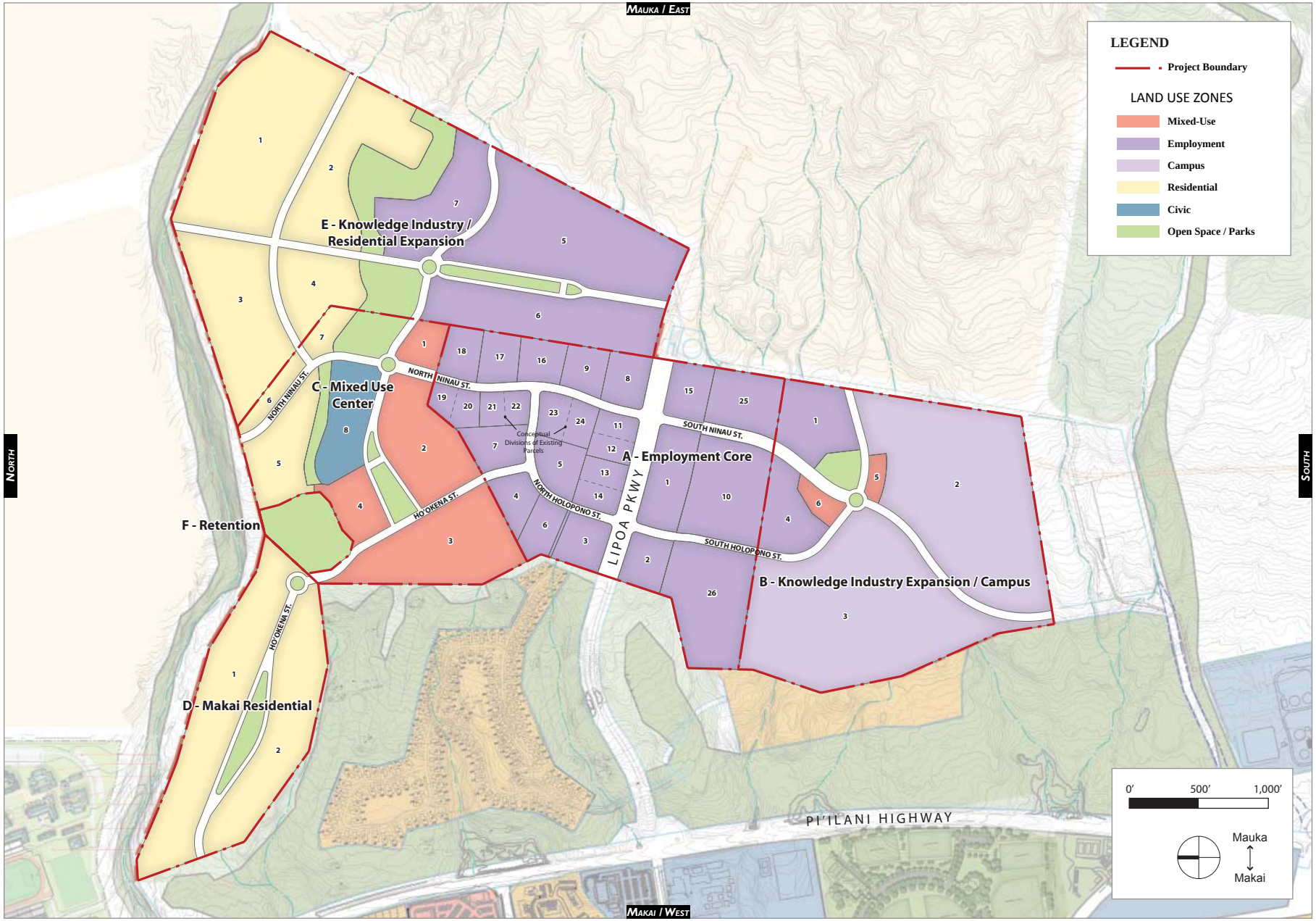
# Controlling Plan

This portion of the form-based code regulates the larger structure of the plan and the Park's relationship to its context. The Controlling Plan and Controlling Plan Matrix establish the layout of the Park's land uses and the building types allowed within the uses. The Development Capacity spreadsheet sets out maximum and minimum development numbers. Following this are multiple sections conveying rules which establish neighborhood-scale characteristics of the Park such as circulation and connectivity.

The Controlling Plan establishes the overall development district for each block in order to focus growth in the appropriate locations while still encouraging a diverse building set within each neighborhood. A maximum unit count is established per block by multiplying average density times the block area, but within each block a range of building types and densities can be used. The allowable building types are established in the Controlling Plan Matrix. Leaving the selection of building type at the discretion of future builders greatly increases the flexibility of the master plan.

## Sold Parcels

There are several parcels within the Park which have already been sold and are not under the control of Park ownership. The Park owners intend that these parcels will be developed in accordance with this Development Code. However, because these parcels were sold with the existing zoning in force, the owners of these sold parcels may choose to develop their parcels under either the previous zoning rules or the rules of this Development Code.




*Controlling Plan*

# Land Use

The land uses in the Park were tightly limited by the original zoning designation. Besides the goal of improving the urban design of the Park, this plan also seeks to broaden the range of uses allowed. The following table lists the land use areas in the park and associated uses permitted within. Since the intent of the Park's development is to create economic development for Maui, in any case where the inclusion of a proposed activity or use in one of the given permitted categories is in question, the benefit of the doubt should go toward including the activity in the Park.

This plan is written with the intent to make the park more flexible and able to adapt to changing needs and market conditions. While the intent is to build the Park as shown in the plan, it may be necessary to make minor changes to respond to future conditions. For this reason, the land use categories for some portions of the Park may be changed at the will of the Park owner, as follows:

- Civic land may be changed to Mixed-Use
- Residential land may be changed to Employment
- Employment parcel B-4 may be changed to Mixed-Use

## Land Use Categories

The plan categories uses based upon function, product or physical characteristics. Characteristics include the type and amount of activity, the type of customers or residents, how goods or services are sold or delivered, likely impact on surrounding properties, and site conditions.

It would be impossible to list every possible use which may be proposed for the park. In the event that a use is not listed or classification is otherwise required, the Park shall classify the use as appropriate into the use most similar, based on the charactistics listed above.

## Accessory Uses

A non-residential use or structure shall be considered an Accessory Use or Accessory Structure if it meets the following criteria:

A. The use or structure serves (though not necessarily exclusively) the primary use and its inhabitants or employees or principal structure.

B. The use is subordinate in area, extent, or purpose to the primary use.

C. The use is located on the same lot as the primary use.

D. The use is included in calculation of maximum built up area.

(see Chapter 6 for a discussion of ohana / residential accessory units)

### Permitted Accessory Uses

Following are permitted accessory uses and accessory structures:

A. Home Businesses.

B. Storage structures not exceeding 10 percent of the maximum lot coverage and maintaining compatibility of scale, materials and design with the principal structure.

C. Solar panels and similar features, awnings, canopies, carports, and other amenities attached or directly related to the primary structure.

D. Recycling storage and enclosures.

E. Temporary uses associated with construction sites.

| PERMITTED USES BY ZONE | LAND USE ZONES | | | | | |
|---|---|---|---|---|---|---|
| | MIXED-USE | EMPLOYMENT | CAMPUS | RESIDENTIAL | CIVIC | OPEN SPACE / PARKS |
| **PERMITTED USES** | | | | | | |
| EMPLOYMENT | | | | | | |
| OFFICE | ● | ● | ● | | | |
| RESEARCH AND DEVELOPMENT | ● | ● | ● | | | |
| LIGHT INDUSTRIAL / STORAGE | | ● | ● | | | |
| COMMERCIAL / RETAIL | | | | | | |
| BUSINESS HOTEL | ● | ● | ● | | | |
| RETAIL, GENERAL SALES (MAXIMUM STORE SIZE 10,000 SQUARE FEET) | ● | ● | ● | ● | | |
| EATING & DRINKING ESTABLISHMENT | ● | ● | ● | ● | | |
| GROCERY STORE / MARKET (MAXIMUM STORE SIZE 20,000 SQUARE FEET) | ● | ● | ● | ● | | |
| PERSONAL SERVICES | ● | | | | | |
| RESIDENTIAL | | | | | | |
| RENTAL APARTMENT | ● | | | ● | | |
| CONDOMINIUM | ● | | | ● | | |
| FEE SIMPLE DWELLINGS (OHANA ALLOWED) | ● | | | ● | | |
| AFFORDABLE HOUSING | ● | | | ● | | |
| LIVE / WORK MIXED USE | ● | ● | ● | ● | | |
| SENIOR HOUSING | ● | | | ● | | |
| INSTITUTIONAL / CIVIC | | | | | | |
| PLACE OF WORSHIP | ● | | | ● | ● | |
| HOSPITAL | ● | ● | ● | | ● | |
| SCHOOL | ● | ● | ● | ● | ● | |
| MEDICAL OFFICE, CLINICS | ● | ● | ● | | ● | |
| LIBRARY / COMMUNITY CENTER | ● | | | ● | ● | |
| RECREATIONAL FACILITY | ● | ● | ● | ● | ● | |
| DAYCARE / NURSERY | ● | ● | ● | ● | ● | |
| GOVERNMENT SERVICES | ● | ● | ● | | ● | |
| POST OFFICE | ● | ● | ● | | ● | |
| POLICE / FIRE STATION | ● | ● | ● | | ● | |
| SHARED / PUBLIC PARKING STRUCTURE | ● | ● | ● | | ● | |

● PERMITTED

*Note: Permitted Use categories are intentionally broad in order to provide unity and flexibility. Uses not specifically listed fall under the most similar use category. Development compatibility is ensured via form controls.*

*Land Use Matrix*

### Prohibited Accessory Uses

The following accessory uses are prohibited:

A. Open storage of vehicles except for resident vehicles.

B. Open storage of any kind (i.e. materials, supplies or equipment).

C. Outdoor display for sale of items such as automobiles, furniture, appliances or other large-scale materials.

### Home Occupation / Home Businesses

The desire for the Park to become a place of innovation and economic development leads to the encouragement of home businesses in the Park's residential areas. Thus, any dwelling unit in the Park could be considered "live/work", regardless of the physical characteristics of the dwelling unit itself. However, the Park should also be a good place to live, and certain business activities may disrupt the viability of residential areas if left unregulated. Therefore, the following conditions apply to home businesses in the Park.

"Home Occupation" means an enterprise or activity conducted by the occupant of the dwelling unit wherein the enterprise or activity takes place and which involves either the growing, processing, or manufacturing of product or the provision of services for consideration and profit provided;

4. That no more than two employees, other than residents of the dwelling unit, shall be employed by the home occupation;

5. That no more than 40% of the floor area of the dwelling unit shall be used by the home occupation;

6. That group instruction classes or group sales meeting shall not include more than four persons, excluding employees of the home occupation;

7. That signs to advertise the home occupation shall be no larger than four square feet and shall be attached to the dwelling unit;

8. That no goods, chattel, materials, supplies, or items of any kind shall be delivered either to or from the premises of the dwelling unit used for a home occupation other than by a vehicle owned by the residents of the dwelling unit and limited to cars, jeeps, vans with a maximum capacity of nine passengers, and four-wheel drives and trucks with a maximum load capacity of three-quart tons, except for the delivery of furniture or large equipment;

9. That any storage of goods samples, materials, or objects used in connection with the home occupation shall be stored within the dwelling unit and shall receive the approval of all appropriate governmental agencies; and

10. That the following occupations shall not be construed to be a home occupation and therefore shall not be permitted;

    a. Harboring, training, or raising dogs, cats, birds, horses, or other animals, and

    b. Automobile and/or body fender repairing.

### Accessory Use Development Standards

The following standards shall apply to all accessory structures:

A. The combination of all structures on a property, including the primary structure and all accessory structures, shall not exceed any requirements established in this chapter for the given parcel.

B. No accessory structure shall be constructed upon a property prior to completion of the primary structure.

### Temporary Uses

#### *Permitted Temporary Uses*

Unless otherwise prohibited by this code, the following temporary uses and structures may be permitted provided that they do not adversely affect surrounding properties nor disrupt the normal activity associated with permitted uses:

A. Contractor's office, construction equipment sheds and lay down areas, haul roads, access roads, borrow/fill sites and other construction related uses.

B. A real estate office.

### *Duration of Temporary Use*

A temporary use may be granted for a maximum time duration determined by the Park owner. An extension of time for continuance of a temporary use may be granted by the Park owner upon request and review.

Within 30 days following expiration of the granted time duration, the parcel shall be cleared of all debris and all temporary structures. A guarantee or signed contract with a disposal firm may be required as part of approval of any Temporary Use Permit.

### *Temporary Use Development Standards*

The following standards shall apply to all temporary uses and structures, unless otherwise noted:

A. Temporary sanitary facilities must be approved by the Park owner.

B. Temporary uses shall meet reasonable landscaping, fencing and sign standards as approved by the Park owner.

C. Parking for the temporary use may be required by the Park owner, including a stabilized drive to the parking area.

D. Temporary uses must provide appropriate mitigation methods approved by the Park owner to minimize noise, storm water runoff, construction dust and pollution.

### *Storage of Materials and Equipment*

No construction materials, supplies, tools, or equipment, including trucks and other vehicles shall at any time be placed or stored in any area within the Park other than the given parcel without approval of the Park owner. Storage shall occur inside a closed, temporary building, or behind a visual barrier or fence of such design and construction to screen the storage area from public view. Such temporary structures, fences and visual barriers shall require approval by the Park owner and shall not extend over the designated boundary.

## Building Types and Land Use

The building types as detailed in Chapter 5 encompass many of the typologies which will be needed for the park. As shown in the Building Type by Zone table below, these can be sorted into appropriate areas of land use, based on the permitted uses in each zone.

Not all possible building types have been detailed. Some, such as the proposed business hotel, are already known and a part of the plan proposal. Others, such as industrial uses, may be placed in the Park if the opportunity arises. And even other building types will undoubtedly be necessary as the park developes more fully. However, these building types are meant to guide the development of the Park, and the principles which guide them, as well as the more general principles detailed throughout Chapter 5, should guide the design of any building types not detailed here.

### Civic Buildings

The plan encourages the location of civic buildings in the Park. The addition of civic uses will help to make the Park a true mixed-use neighborhood. Possible civic uses include public or private schools, a YMCA facility, a community center, or trade schools, among other uses.

Like other building types which are not specifically noted, civic buildings in the park could take any number of forms but should contribute to the quality of the Park's public spaces like any other building. Thus, these buildings must comply with the rules in this code, such as their relationship to the street, or vehicle access and storage.

| BUILDING TYPE BY ZONE | BUILDING TYPE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OFFICE / RESEARCH & DEVELOPMENT | OFFICE OVER RETAIL | RETAIL | FLEX SPACE | RESIDENTIAL OVER RETAIL | MULTI-FAMILY | 4-PLEX | 3-PLEX | TOWNHOMES | GREEN COURT | SINGLE FAMILY SMALL LOT | SINGLE FAMILY LARGE LOT | CIVIC / PUBLIC |
| MIXED-USE | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● | ● | ● |
| EMPLOYMENT | ● | ● | ● | ● | | | | | | | | | ● |
| CAMPUS | ● | ● | ● | ● | | | | | | | | | ● |
| RESIDENTIAL | | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| CIVIC | | | | | | | | | | | | | ● |

*Controlling Plan Matrix*

● PERMITTED

# Controlling Plan Rules

## Substituting Employment

In all parcels employment uses can be substituted for residential or retail uses. In such case, the maximum FAR for the parcel will be 0.65, net of any publicly accessible roads or parks created on the site.

## Subdivision

The site has been divided into a number of larger blocks for the purposes of assigning development capacities. It is not intended that most of these blocks would remain at current sizes, however. Whether developed directly by the Maui Research and Technology Park or sold and developed by others, most of these blocks should be further broken down into more human-scaled blocks and parcels.

The appropriate block size varies by land use. The maximum block sizes for developed land are:

- Residential – 5 acres
- Retail or mixed residential and commercial – 5 acres
- Office – 8 acres
- Industrial – 8 acres
- Campus – 35 acres

These maximums may be exceeded on a case by case basis where conditions such as topography or lack of adjacent road connections make a smaller block impossible or impractical. These instances must be approved by the Park.

There are no minimum block sizes.

## Street Connectivity

The connectivity of the street network is highly important. All roads created in subdivided parcels should connect to other roadways at both ends. This rule may only be broken with permission of Park management, and must be justified based on specific problems such as difficult terrain or land boundaries, and must have no other reasonable solution which would allow the road to maintain connectivity.

## Required Retail Frontage

There is no certainty of the amount of retail which will be able to survive within the Park. The Park's current level of development, as well as its relative isolation from major through roadways, make extensive retail development unlikely. However, as the park adds additional employees and residents, it may be feasible for neighborhood-supporting retail to exist. This retail would be part of the supportive amenities for the Park's economic development and business attraction.

In order to support the plan's creation of neighborhood nodes at the northern and southern ends of the North South Greenway, two parcels in the plan have required retail frontage. This is not to say that retail may not locate in other permitted places in the Park as well, but that these two locations are particularly important. As the locations of the primary transit stops as well, these sites should have active, public uses. Therefore, retail is required along the fronts of the two parcels as shown.

## Road and Open Space Locations

At present, the plan remains conceptual to some degree. Much work remains to be done, such as engineering of the final road alignments. For this reason, the locations of the roads and open spaces as shown in the plan are flexible and may be changed with the creation of the final designs as long as the overall network of roads and open spaces remains. Open space amounts can vary in this process as necessary, to -20% of current amounts.

Park areas as shown will be augmented with active park space as required for residential zones.

# Development Capacity

*Note: The total Maui Research & Technology Park land area is 410.937 acres. The 401 acre total on this page does not include land areas for Lipoa Parkway makai of the Park and the portion of Ninau Street south of the Park boundary (which is shown in the controlling plan on page 59). Both of these areas are roadways and do not contain development.*

| Parcel | Use Type | Acres |
|---|---|---|
| **A** | **Employment Core** | **86.0** |
| | Developed Parcels | 15.8 |
| 6 | Employment | 2.2 |
| 7 | Employment | 2.9 |
| 8 | Employment | 2.7 |
| 9 | Employment | 2.3 |
| 10 | Employment | 9.2 |
| 11 | Employment | 1.2 |
| 12 | Employment | 1.2 |
| 13 | Employment | 1.4 |
| 14 | Employment | 1.4 |
| 15 | Employment | 2.8 |
| 16 | Employment | 2.3 |
| 17 | Employment | 2.3 |
| 18 | Employment | 2.3 |
| 19 | Employment | 0.9 |
| 20 | Employment | 1.2 |
| 21 | Employment | 1.0 |
| 22 | Employment | 1.0 |
| 23 | Employment | 1.6 |
| 24 | Employment | 1.5 |
| 25 | Employment | 4.9 |
| 26 | Employment | 10.7 |
| | Trunk Open Space | 0.2 |
| | Trunk Roads | 13.0 |

| Parcel | Use Type | Acres |
|---|---|---|
| **B** | **Knowledge Industry Expansion / Campus** | **88.2** |
| 1 | Employment | 6.1 |
| 2 | Employment / Campus | 32.3 |
| 3 | Employment / Campus | 34.9 |
| 4 | Employment | 4.8 |
| 5 | Mixed Use / Flex | 0.9 |
| 6 | Mixed Use / Flex | 1.3 |
| | Trunk Open Space | 1.8 |
| | Trunk Roads | 6.0 |
| **C** | **Village Center** | **58.3** |
| 1 | Mixed Use | 2.1 |
| 2 | Mixed Use | 9.5 |
| 3 | Mixed Use | 13.1 |
| 4 | Mixed Use | 3.7 |
| 5 | Residential Mixed | 7.0 |
| 6 | Residential Mixed | 1.8 |
| 7 | Residential Mixed | 1.7 |
| 8 | Civic | 6.2 |
| | Trunk Open Space | 6.3 |
| | Trunk Roads | 6.8 |

| Parcel | Use Type | Acres |
|---|---|---|
| **D** | **Makai Residential** | **39.0** |
| 1 | Residential Mixed | 18.8 |
| 2 | Residential Mixed | 14.5 |
| | Trunk Open Space | 2.3 |
| | Trunk Roads | 3.4 |
| **E** | **Option Land** | **123.8** |
| 1 | Residential Mixed | 24.2 |
| 2 | Residential Mixed | 13.3 |
| 3 | Residential Mixed | 14.6 |
| 4 | Residential Mixed | 6.4 |
| 5 | Employment | 21.2 |
| 6 | Employment | 12.9 |
| 7 | Employment | 9.3 |
| | Trunk Open Space | 12.3 |
| | Trunk Roads | 9.7 |
| **F** | **Retention** | **5.8** |
| | Trunk Open Space | 5.5 |
| | Trunk Roads | 0.3 |

| | *Phase 1* | *Phase 2* | *Total* |
|---|---|---|---|
| **SITE SUMMARY** | **189.0** | **212.0** | **401.0** |
| | *Areas A,C,D* | *Areas B, E* | |
| Employment | 72.7 | 121.5 | 194.2 |
| Mixed Use | 28.4 | 2.3 | 30.7 |
| Civic | 6.2 | 0.0 | 6.2 |
| Residential Mixed | 43.8 | 58.5 | 102.3 |
| Trunk Open Space | 14.3 | 14.1 | 28.3 |
| Trunk Roads | 23.6 | 15.7 | 39.3 |
| **Maximum New Non-Residential BUA** *(square feet)* | **985,200** | **1,014,800** | **2,000,000** |
| **Maximum Residential Units** | **750** | **500** | **1,250** |

## Development Caps

| | |
|---|---|
| Maximum New Non-Residential Built Up Area | **2,000,000 square feet** |
| Maximum Total Retail BUA* | **100,000 square feet** |
| Maximum Combined Retail & Eating & Drink Establishments BUA Per Area for A, B, D & E | **12,000 square feet** |
| Maximum Dwelling Units | **1,250 dwelling units** |

* retail cap does not include Hotels, Eating & Drinking Establishments, and home-based businesses

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# Circulation & Connectivity

The transportation network in the Maui Research and Technology Park will be essential to creating a high quality working and living environment. This code regulates essential elements of the transportation network with that goal in mind.

## Bicycle & Pedestrian Facilities

For parcels bordering open space, pedestrian and bicycle access shall be provided to the open space for persons employed or living on the parcel. Access for customers and guests to the open space is encouraged.

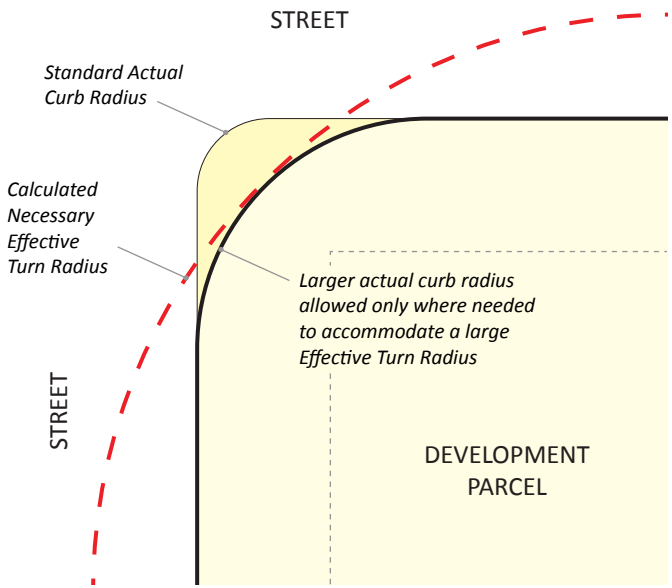
All non-residential and multi-family residential parcels shall promote the option of commuting by bicycle by providing the following:

- One bicycle space for every 20 car spaces. Bicycle racks shall be located within 40 feet of the primary building entrance in an area easily visible from inside the building. 10% of the required bike spaces shall be in the form of covered, secure bike storage. This can be accommodated inside the building or with covered bike storage outdoors.
- Employee shower facilities and changing rooms that are convenient and accessible shall be provided for commercial buildings larger than 50,000 square feet.

## Intersection Curb Radii

As discussed in Chapter 3, there is a critical difference between the actual curb radius and the effective turn radius of an intersection. The aim of this Code is to keep the actual curb radius as small as possible (thereby reducing pedestrian crossing distances and keeping vehicle turning speeds low). At the same time, it is necessary to safely accommodate vehicle turning movements. Both goals can be addressed by calculating curb radii in the Park based on the effective turn radius, not the actual curb radius.

The maximum standard actual curb radius in the Park shall be 10 feet. This radius may only be increased where necessary to keep the curb from overlapping the required effective curb radius. Though it is permissible to allow material changes in the street surface which overlap the effective turn radius, in all cases the effective turn radius shall be free and clear of obstacles such as vertical curbs, curb ramps, or parked cars. It is also permissible to set minimum effective turn radii which require large vehicles to cross into the opposite side of the street to complete a turn when the frequency of turns of these vehicles will be low.




*Curb Geometry Diagram*

## Traffic Calming

Traffic calming measures as discussed in Chapter 3 are encouraged in the park where necessary to manage traffic and to keep automobile speeds at safe levels. Ideally, the Park's network of small-scale streets, short blocks, and human-scale intersections will make traffic calming largely unnecessary. However, as the Park develops and traffic patterns become clear, addition of traffic calming may be required.

Calming measures which are allowed are:

- Speed Hump/Speed Bump
- Pedestrian Table/Speed Table
- Raised Crosswalk
- Raised Intersection
- Chicane/Slalom
- Forced Turn
- Median Island
- Full Roundabout (full or mini)
- Traffic Circle
- Bump-Out/Curb Extension
- Bus Bulb
- Pinch Point/Choker
- Neckdown
- Narrow Planting

Narrow streets and streetside parking are other traffic calming measures which are built into the project's proposed street sections, which follow.

Other measures may be used with approval from the County.

## Parking

As discussed in Chapter 3, the requirement for every parcel to provide on-site parking warps the free market, creates additional driving and its related congestion and pollution, and subsidizes driving at the expense of pedestrians, bicyclists and transit users.

However, the system of requiring the provision of parking for various land uses has been used for many decades and is at this time fully entrenched. There is concern that removing all parking requirements in the Park could jeopardize the approval of the plan as well as create unease among possible employers in the park and the lenders who would serve them.

For these reasons, the plan does not remove all parking requirements. Instead, the amount of parking required is reduced. The new, lower requirements for each use are detailed in the revised section of the County Code which concerns the Park.

In addition, the Code allows on-street parking spaces and off-site parking (such as joint lots) to be counted against the parking requirements of a parcel. Joint use parking, also called shared parking, is also allowed. These strategies will help to strike the right balance between flexibility, sustainability and the adherence to contemporary norms.

# Street Network

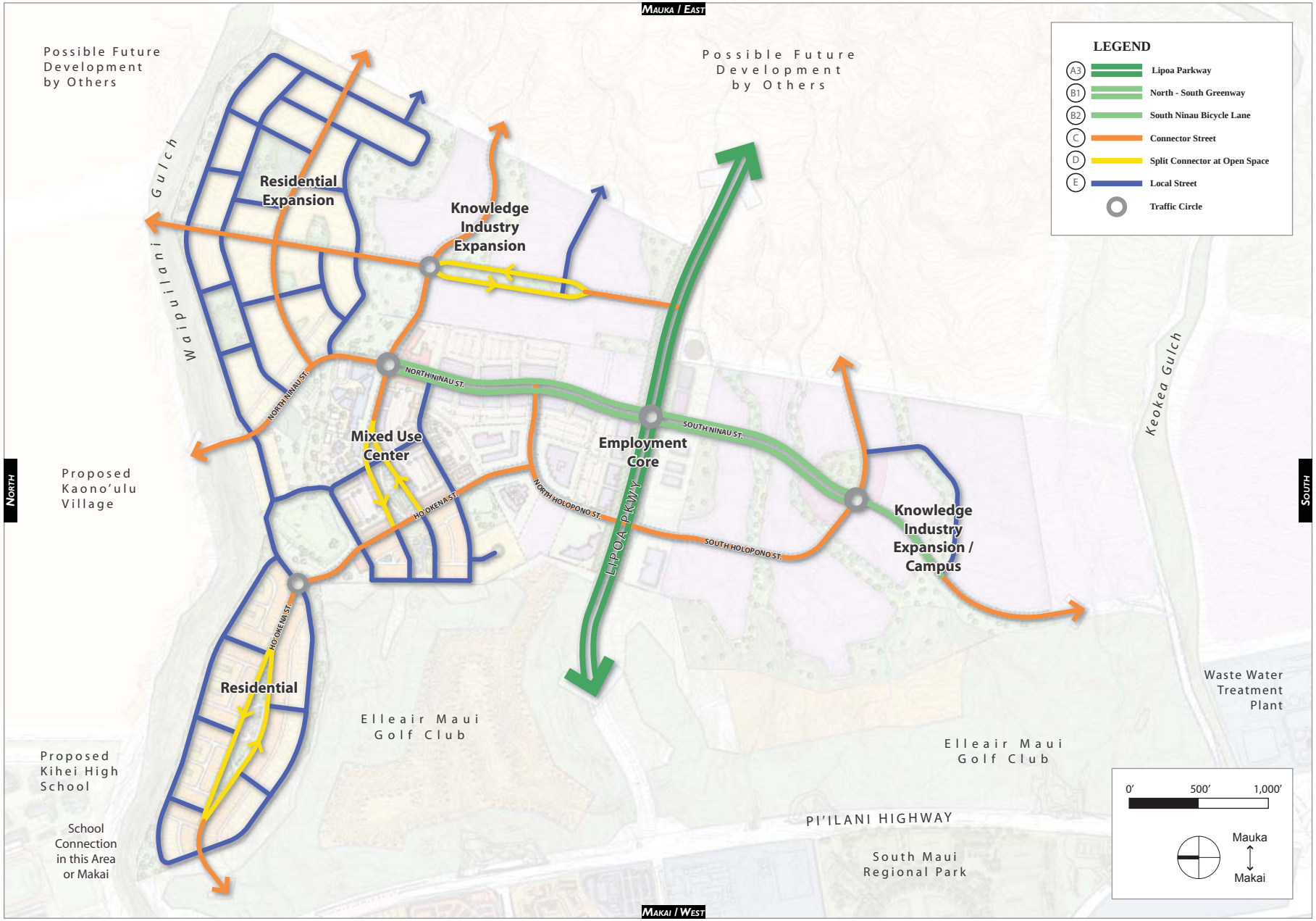
Well-designed streets and their associated sidewalks and pathways function as the primary social space of a community. They offer the opportunity for al fresco dining, dog walking, chance encounters, or conversations with neighbors working in their yards or sitting on their porches. In order for these things to occur, streets must be specifically designed to foster pedestrian comfort. The width and number of vehicle travel lanes should be minimized to encourage pedestrian crossings. Street tree plantings and street furnishings should be scaled appropriately to the pedestrian and should reflect their natural and cultural environments. When properly designed, streets are an integral part of a community and create a vitality that sustains the social interaction of its citizens.

The street sections which follow incorporate the various principles and concepts of good street and network design. The sections include a palette of configurations for use throughout the Park. Specific street sections may be chosen for specific locations at a later date, based on more detailed calculations of traffic volume and network issues.

Stormwater retention or detention in street facilities such as in bulb-outs, curb extensions, or tree lawns can reduce total site runoff and the need for large retention/detention ponds or areas. In addition, this strategy adds additional green space to the street and can reduce the amount of pulluted runoff. In order to encourage this practice, creation of stormwater retention/detention in street facilities in the Park will receive full credit to be applied to overall site requirements, reducing the amount of downstream retention/detention required.

*An good example of on-street stormwater retention is the Green Street Program in Portland, Oregon, described at http://www.portlandonline.com/BES/index.cfm?c=44407.*

*Sustainable stormwater management in Portland, Oregon*



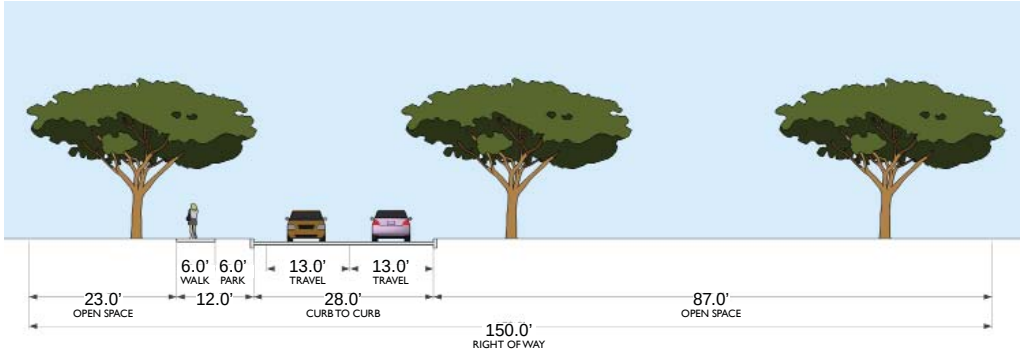

*Circulation Plan*

# Street Sections

*The existing condition on Lipoa Parkway is one of large trees and extensive planting. This plan retains that pattern by creating a mandatory 60 foot setback from the Lipoa Parkway right of way. This setback requirement overrides other setback figures in this book, but applies only to Lipoa Parkway. Setbacks along side streets, even along parcels which front on Lipoa Parkway, remain as noted elsewhere.*

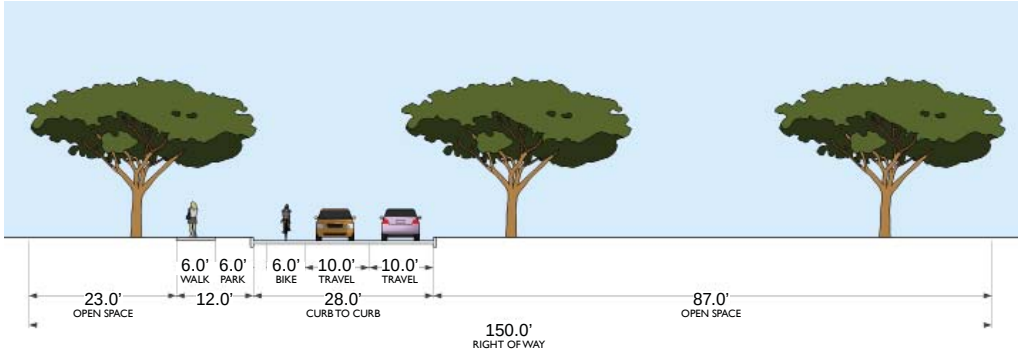
## A1

**LIPOA PARKWAY (Existing)**



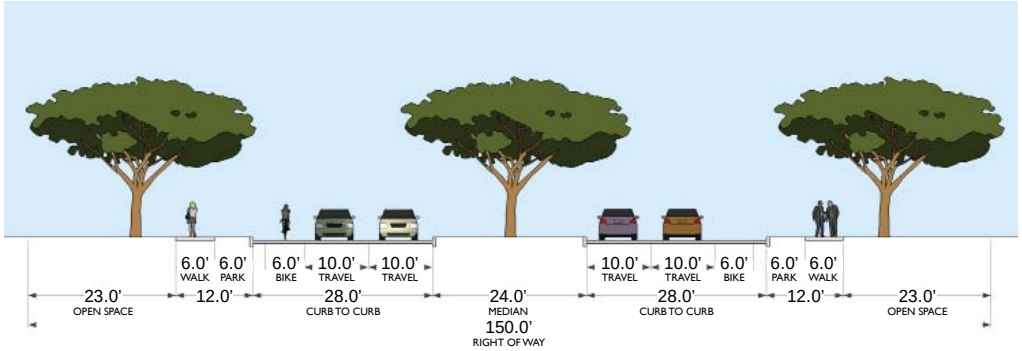

## A2

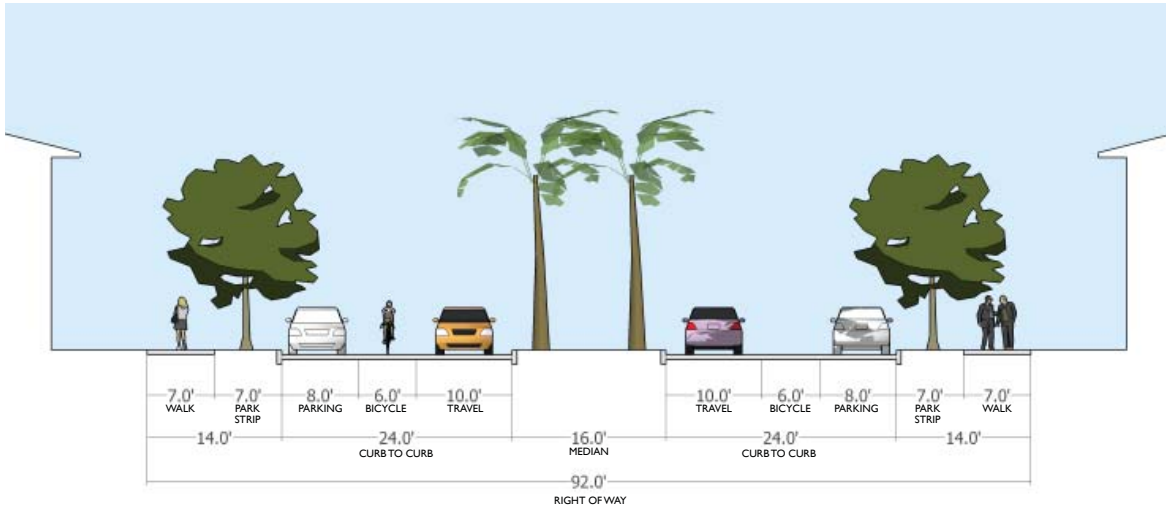
**LIPOA PARKWAY (Interim)**




## A3

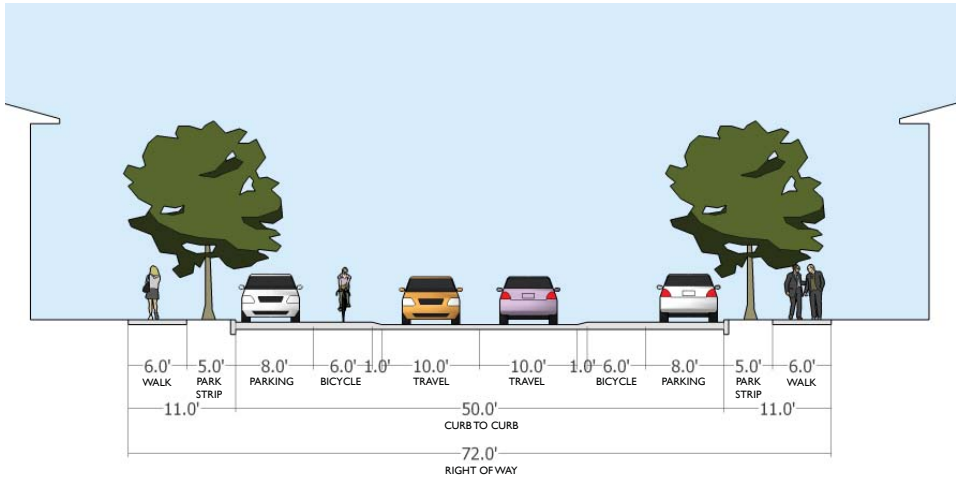
**LIPOA PARKWAY (Final)**






## B1

## NORTH - SOUTH GREENWAY




*The South Ninau Bicycle Lane is intended to be a raised bicycle lane. This configuration raises the bicycle lane and adjacent parking lane above the level of the driving lanes. A small transition area allows bicycles and cars to safely go from the driving lanes into the bicycle and parking lanes. This configuration helps to protect bicyclists and keeps the main surface of the roadway much narrower than with the use of regular at-grade bicycle lanes, reducing the the careless driving behavior that can result from excess road width.*

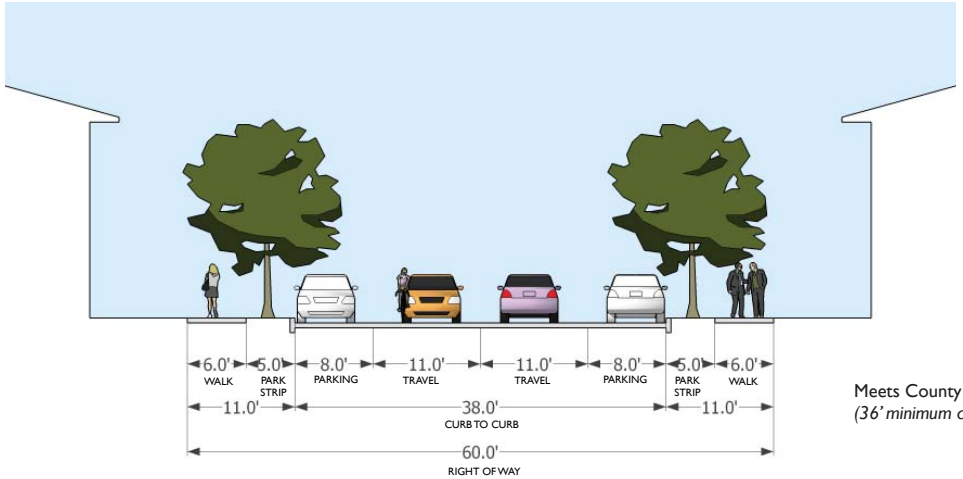
## B2

## SOUTH NINAU BICYCLE LANE

0' 10' 20'

## C

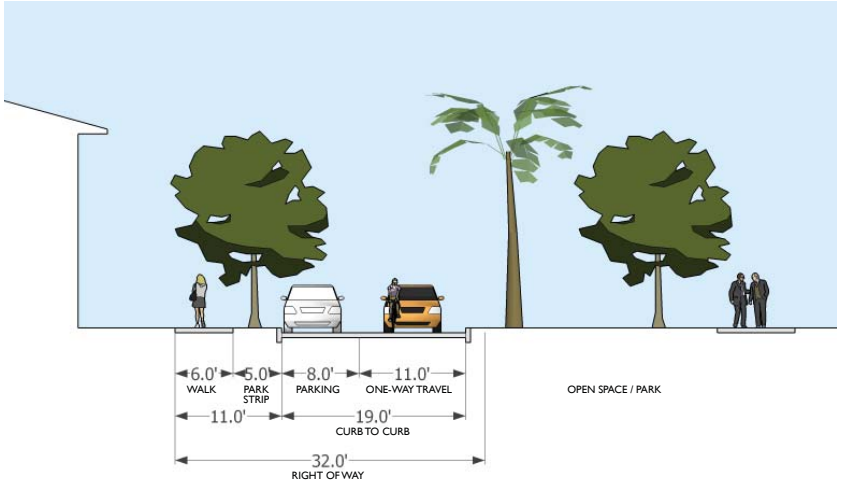
## CONNECTOR STREET



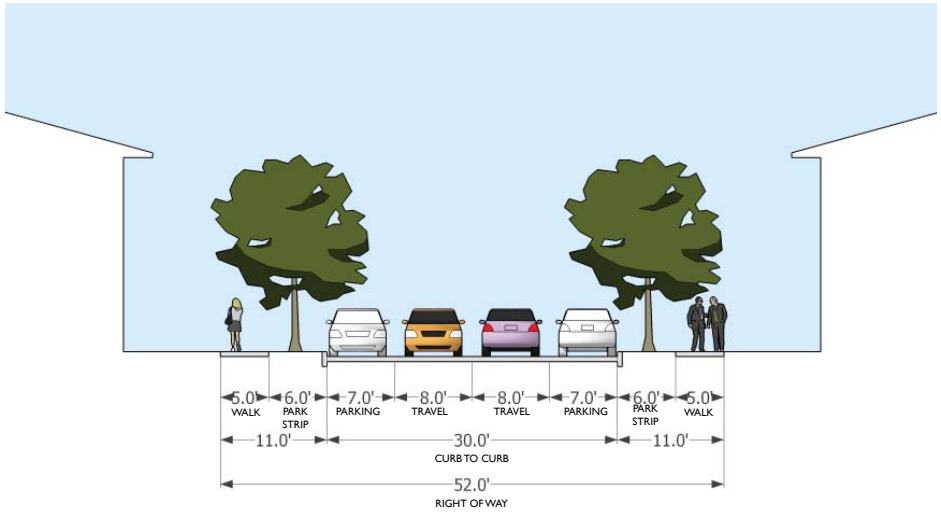

Meets County Standard
*(36' minimum curb to curb)*

## D

## SPLIT CONNECTOR AT OPEN SPACE (One-Way)

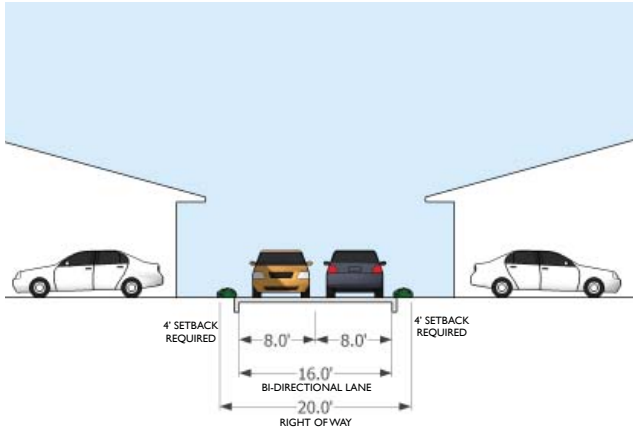



0' 10' 20'




E

## LOCAL STREET




F

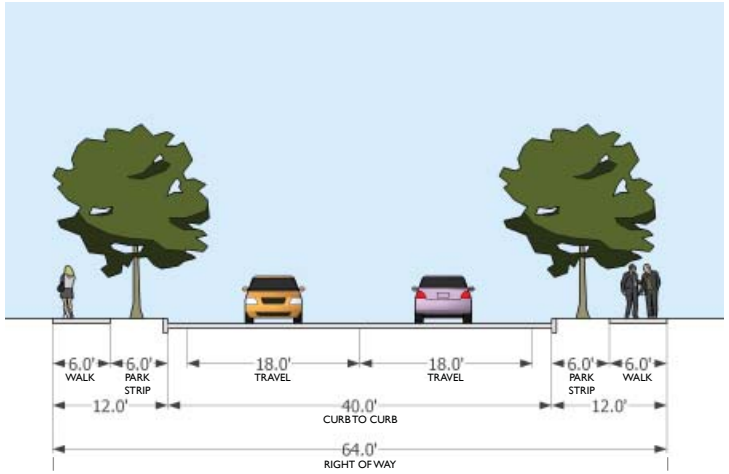
## ALLEY (two-way)

0' 10' 20'

## G1

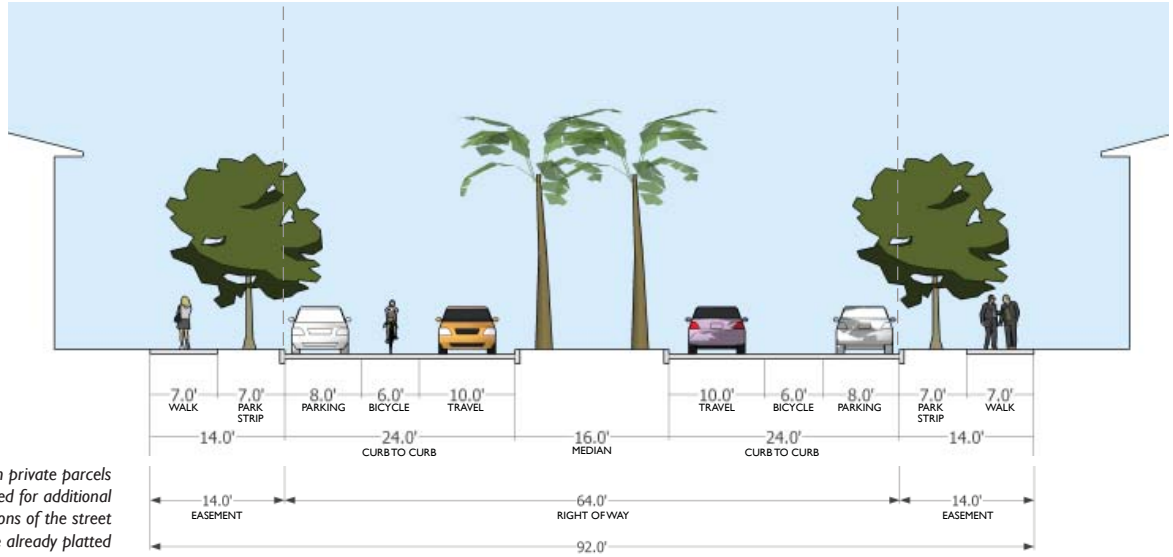
## NINAU STREET (Existing)

*In order to unify the treatment of Ninau Street between the northern and southern portions of the Park, the plan continues the North - South Greenway concept in the existing parcels along Ninau Street by creating easements along which public walkways and open space are located as shown at bottom. For parcels previously purchased, creation of this easement is at the discretion of the owner. Rebuilding of Ninau Street to the configuration shown would happen at the discretion of the Maui Research and Technology Park.*



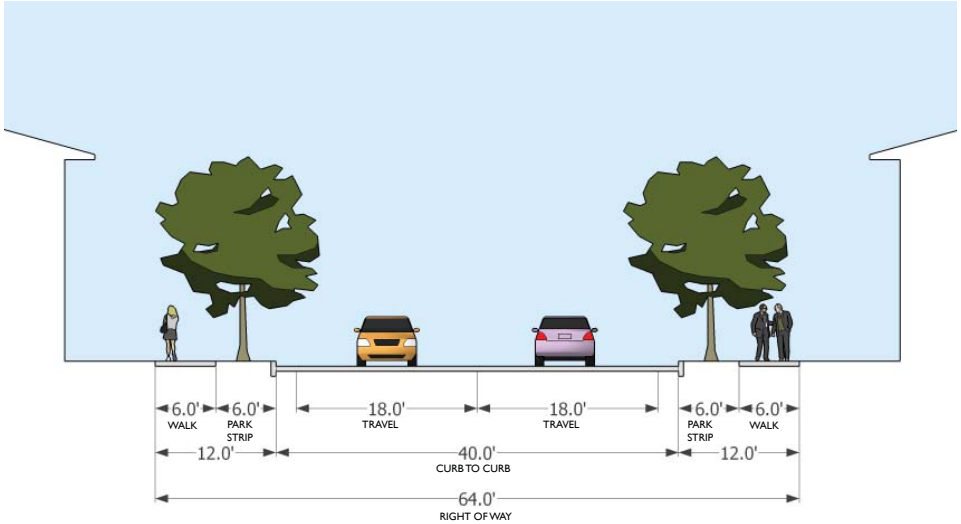

## G2

## NINAU STREET (Final, North - South Greenway Format)



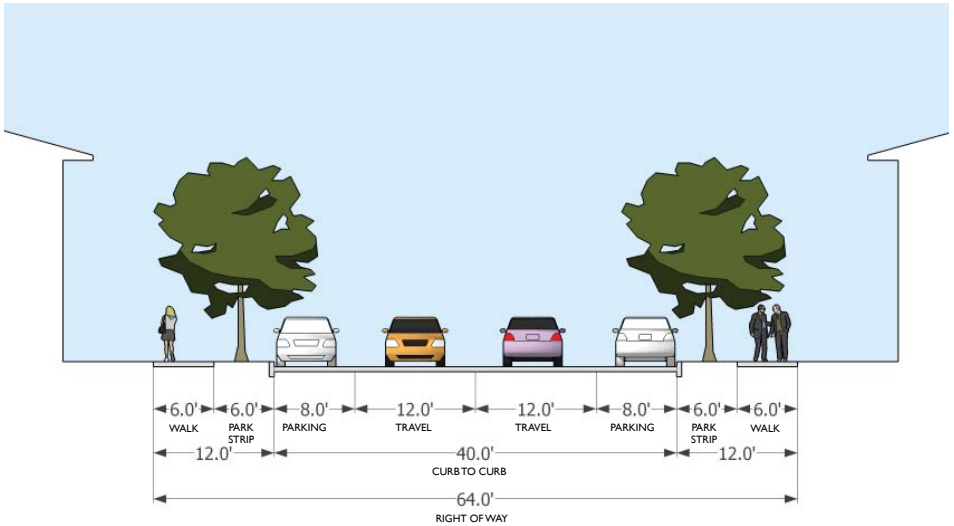

*Easements on private parcels are proposed for additional area in sections of the street which are already platted*

0' 10' 20'




## H1

## HOLOPONO & HO'OKENA STREET (Existing)




## H2

## HOLOPONO & HO'OKENA STREET (Final)

0' 10' 20'

# 6 - FORM BASED CODE

## BUILDING SCALE


| | |
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# BUILDING SCALE DESIGN GOALS

Building design, including the location of buildings, parking and entries, greatly affects a community's social ties, the public realm and the pedestrian experience. Placing buildings close to sidewalks defines a more human-scale street and provides pedestrian interest. Building facades that surround a street or public space create an "outdoor room" – the type of space that has always defined memorable urban places. Entries give pedestrians direct access from buildings to sidewalks, reinforcing the notion that the street is designed for people as well as cars. Parking areas located in block interiors, not at sidewalk edges, further reinforce pedestrian primacy. And the tradition of alleyways sets a simple precedent of site configurations that honor the street and the pedestrian by placing buildings and pedestrians before cars.

Urban design and architecture also establish human scale, foster community, and encourage the use of outdoor spaces. Architectural massing and detailing provide visual interest and a variety of environments for the person on foot or bike. At the same time, they establish the character, durability, and quality of a place. Window locations and treatments reinforce human scale and also ensure that "eyes on the street" will provide casual surveillance. Variation from building to building relieves the monotony of large or repetitious environments. Finally, clearly articulated entries add architectural punctuation to the street. Together, appropriate architectural treatments create a community with a distinct identity that does not facelessly blend into other areas.

This portion of the form-based code regulates the parcel and building scale characteristics of the Park. The Building Typologies and Summary Matrix explain the various buildings which are allowed. Following the building typologies, various sections discuss the relationships of buildings to their context, vehicular access and storage, architectural characteristics, and other important building concepts.

# BUILDING TYPOLOGIES

Building typologies are used in this plan to set parameters for development on the private parcels. The typologies which follow show a wide variety of building types, including many different land uses. All of these types have in common the treatment of the public space as a valued and important realm. Rather than allowing buildings to be hidden behind parking lots or large garages, the intent is to present a human face to the street. Such buildings create a more lively and vital common space, and make an area safer with "eyes on the street." All buildings will have prominent entrances to the street, allowing easy access from street side parking and for pedestrians, bicyclists and transit users.

These typologies are generalized massing diagrams. Final architecture should be culturally and climatically appropriate to Maui, and should fulfill the intent of these guidelines to create a high quality public realm.

## Case Studies

Building typologies originate from an understanding of existing buildings as well as an aim to improve the design of future buildings. Given the Park's focus on technology employment, one of the most important building types to understand is office.

The studies on the opposite page show existing office buildings within the Park. The site sizes are large, conforming with the minimum two acre requirement. This requirement makes it uneconomical to build smaller buildings in the Park, eliminating some possible tenants from consideration.

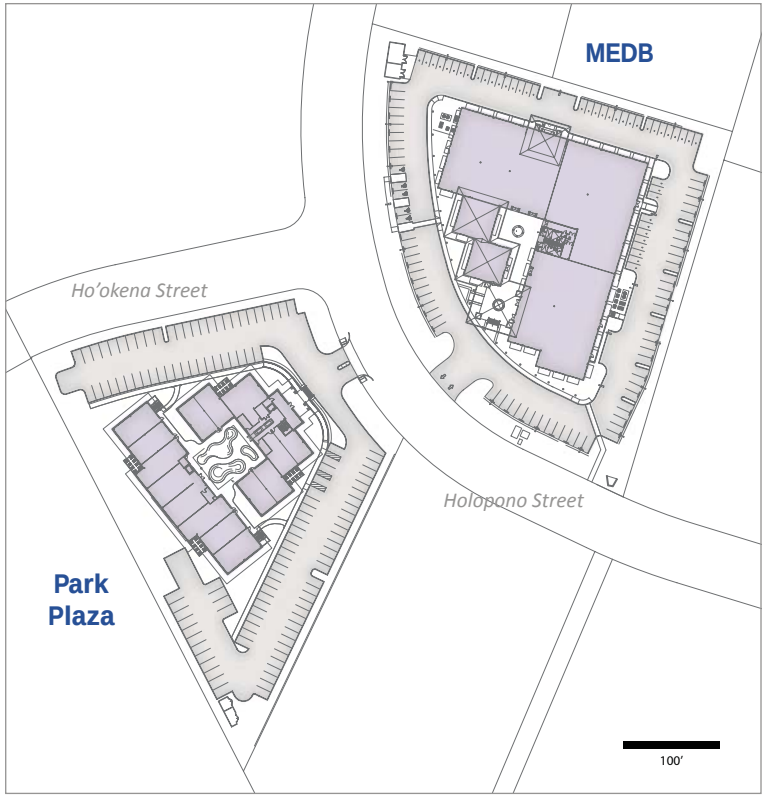
Each building is surrounded by parking. This is a function of the need for parking combined with the Park's current minimum setback requirements. As a result of the setbacks, the building is pushed to the center of each parcel. The only room available for parking is then the site's perimeter. This leaves each building "floating in a sea of parking," making the entrance reachable only through the parking lot.

The densities of the buildings are floor area ratios of 0.27 and 0.36. The floor area ratio, the ratio of a building's built floor area to the area of the parcel on which it sits, is a common measure of built density. These buildings are at typical densities for buildings of this type which have surface parking. Large parking lots consume much of the land area of the site, naturally limiting the possibility for larger buildings.

Parking is provided on these sites at around 3.5 parking spaces for every 1,000 square feet of building area. This ratio is common for office buildings where most people will arrive by automobile. Where other travel options such as walking, bicycling, carpooling, or transit are available, buildings often have much lower parking ratios.

Alternative building arrangements are possible, and becoming increasingly common. Smaller lot sizes make building a possibility for users who do not need large amounts of space. Reduced or eliminated setbacks allow buildings to come close to the public realm, framing the street with a human scale, town-like atmosphere. Reduced or eliminated parking requirements help remove the subsidy which free parking provides for driving, and creates long-term flexibility in the built environment for response the actual need for parking rather than fixed

*Office buildings with street-facing entries and retail on the ground floor*



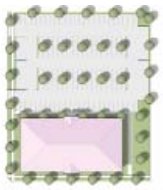
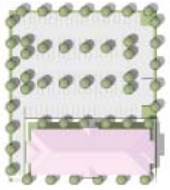
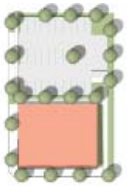
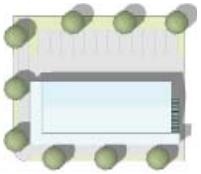
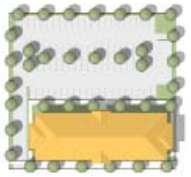

| Park Plaza | |
|---|---|
| *Building* | 37,000 square feet on 2 floors |
| *Site* | 2.34 acres |
| *Density* | FAR 0.36 |
| *Parking* | 121 parking spaces<br>(3.3 per 1,000 square feet) |

| MEDB | |
|---|---|
| *Building* | 33,500 square feet on 1 floor |
| *Site* | 2.80 acres |
| *Density* | FAR 0.27 |
| *Parking* | 118 parking spaces<br>(3.5 per 1,000 square feet) |

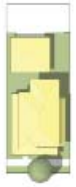
*Park Plaza building*

*MEDB building*

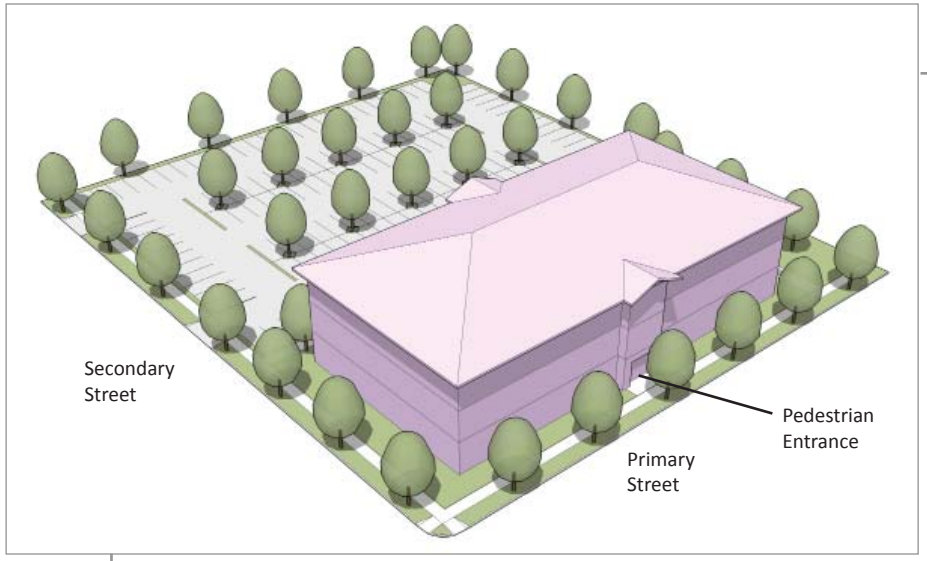
# Building Typologies Summary Matrix

| BUILDING TYPE | OFFICE / RESEARCH and DEVELOPMENT | OFFICE over RETAIL | RETAIL | FLEX SPACE | CIVIC | RESIDENTIAL over RETAIL | MULTI-FAMILY |
|---|---|---|---|---|---|---|---|
| |  Primary Street |  Primary Street |  Primary Street |  Primary Street | Not Illustrated |  Primary Street | Primary Street |
| **OVERALL** | | | | | | | |
| **Lot Size (examples shown above)** | 75,000 sf | 70,000 sf | 23,400 sf | 12,000 sf | Not shown | 49,400 sf | 38,250 sf |
| **Lot Area (minimum square feet)** | 6,000 | 6,000 | 2,400 | 1,800 | 5,000 | 6,000 | 4,500 |
| **FAR (net) (min./max)** | 0.3 - 0.65 | 0.5 - 0.65 | 0.3 - 0.4 | 0.5 - 0.8 | N/A | N/A | N/A |
| **Unit Size (min./max.)** | N/A | N/A | N/A | 1,000 sf - 2000 sf | N/A | 400 sf - 1000 sf | 400 sf - 1,000 sf |
| **Stories / Building Height (maximum)** | 4 / 50 feet | 4 / 50 feet | 2 / 40 feet | 2 / 40 feet | 4 / 50 feet | 4 / 50 feet | 3 / 40 feet |
| **Density (net units/ac) (min./max.)** | N/A | N/A | N/A | 15 - 20 | N/A | 18 - 30 | 28 - 40 |
| **Parking Access** | Alley or side drive or secondary street | Alley or side drive or secondary street | Alley or side drive or secondary street | Alley or secondary street | Alley or side drive or secondary street | Alley or side drive or secondary street | Alley or side drive or secondary street |
| **SETBACKS** | | | | | | | |
| **Setbacks (min./max. feet) - Front, Back, Side** | 0-15, 5 (min), 0 (min) | 0-15, 5 (min), 0 (min) | 0-10, 5 (min), 0 (min) | 0-10, 5 (min), 0 (min.) | 5-15, 5 (min), 0 (min) | 0-10, 5 (min), 0 (min) | 5-15, 5 (min), 5 (min) |
| **Length of Primary Frontage Occupied (minimum)** | 60% | 60% | 70% | 80% | 50% | 70% | 70% |

Notes:
sf = square feet
‘ and ft = feet
N/A = not applicable

| BUILDING TYPE | FOUR-PLEX | TRI-PLEX | TOWNHOME | SINGLE FAMILY/DUPLEX GREEN COURT | SINGLE FAMILY SMALL LOT | SINGLE FAMILY LARGE LOT |
|---|---|---|---|---|---|---|
| | Primary Street | Primary Street | Primary Street | Primary Street |  Primary Street | Primary Street |
| **OVERALL** | | | | | | |
| **Example Lot Sizes (common sizes)** | 40' x 75' (3,000 sf)<br>50' x 85' (4,250 sf) | 30' x 75' (2,250 sf)<br>35' x 90' (3,150 sf) | 20' x 55' (1,100 sf)<br>24' x 100' (2,400 sf) | 55' x 30' (1,650 sf)<br>70' x 50' (3,500 sf) | 50' x 70' (3,500 sf)<br>45' x 100' (4,500 sf) | 55' x 90' (4,950 sf)<br>70' x 100' (7,000 sf) |
| **Lot Size (min./max. square feet)** | 3,000 (min) | 2,200 (min) | 1,100 (min) | 1,650 (min) | 3,600 - 4,800 | 4,801 - 7,250 |
| **FAR (net) (min./max)** | N/A | N/A | N/A | N/A | N/A | N/A |
| **Unit Size (min./max.)** | 500 sf - 1,100 sf | 500 sf - 1,100 sf | 900 sf - 1,400 sf | 800 sf - 1,400 sf | 1,200 sf - 1,800 sf | 1,400 sf - 2,000 sf |
| **Stories / Building Height (maximum)** | 3 / 40 feet | 3 / 40 feet | 3 / 40 feet | 2 / 30 feet | 2 / 30 feet | 2 / 30 feet |
| **Density (net units/ac) (min./max.)** | 40 - 60 | 40 - 60 | 18 - 40 | 12 - 26 | 9 - 12 | 6 - 10 |
| **Parking Access** | Alley or secondary street (side of unit) | Alley or secondary street (side of unit) | Alley or secondary street (side of unit) | Alley | Alley or secondary street (side of unit) | Alley or side drive or secondary street (side of unit) |
| **SETBACKS** | | | | | | |
| **Setbacks (min./max. feet) - Front, Back, Side** | 5-12, 5 (min), 5 (min) | 5-12, 5 (min), 5 (min) | 5-11, 5 (min), 0 (min.) | 5-10, 5 (min), 5 (min) | 5-10, 5 (min), 0 (min.) | 5-15, 6 (min), 6 (min) |
| **Length of Primary Frontage Occupied (minimum)** | 70% | 70% | 70% | 60% | 60% | 40% |

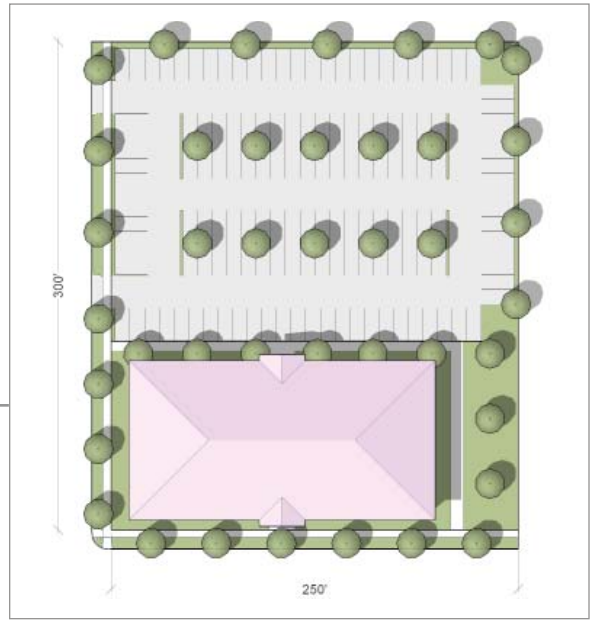
# Commercial




*Typical Condition*

## Office / Research & Development

| | |
|---|---|
| Proposed Height (max.) | 3 stories |
| Total FAR (net) | 0.3 - 0.65 |
| Parking Access | Alley or side drive or secondary street |

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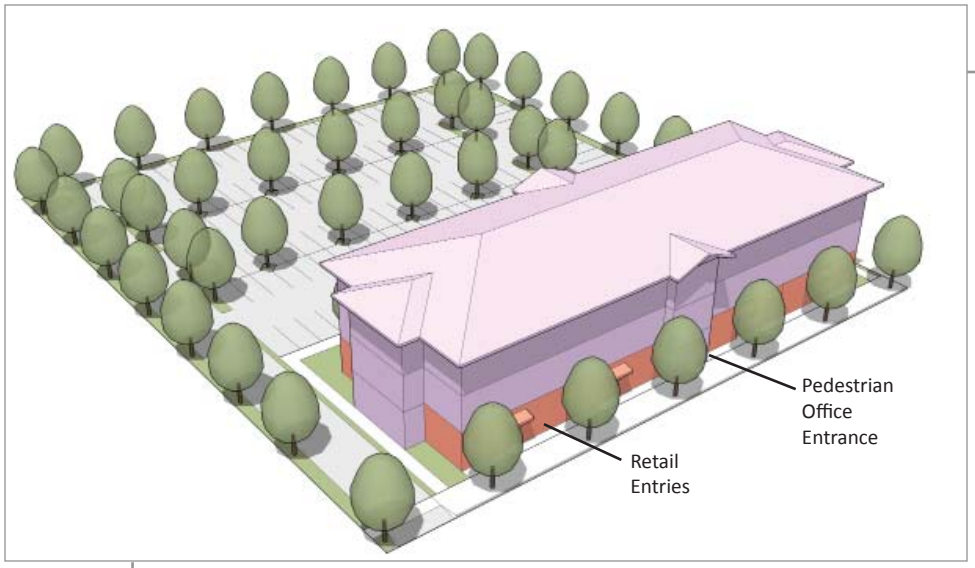
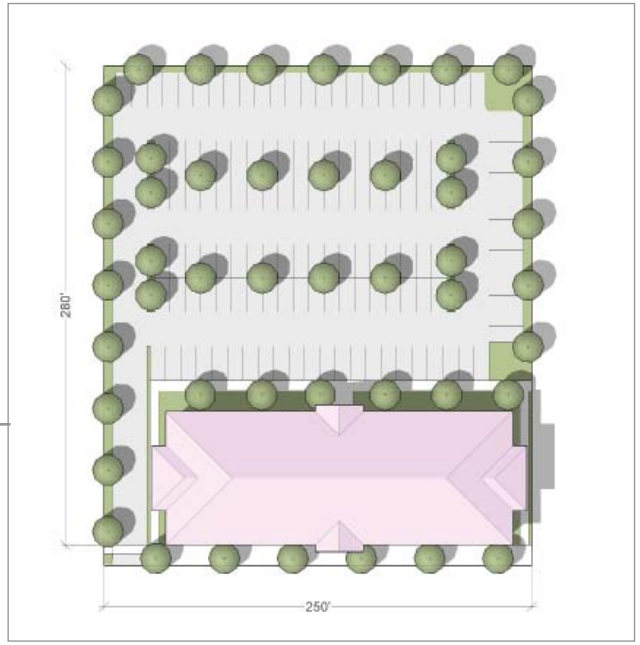



*Typical Condition*

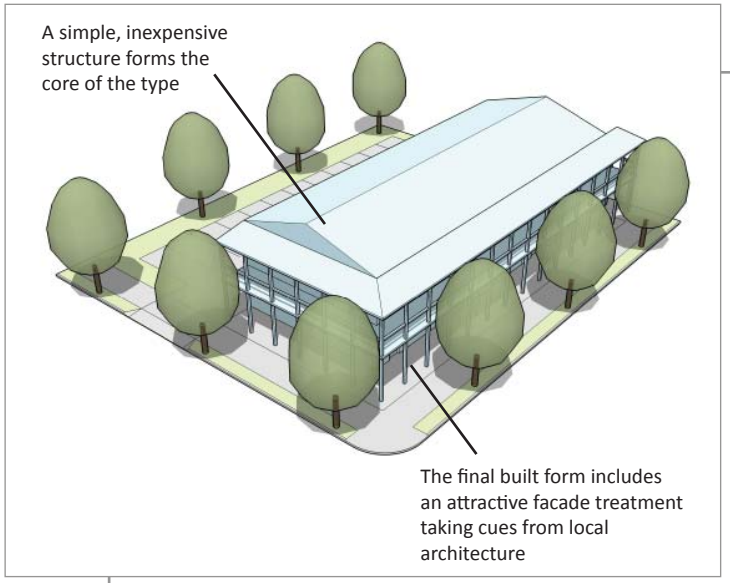
## Office Over Retail

| | |
|---|---|
| Proposed Height (max.) | 3 stories |
| Total FAR (net) | 0.5 - 0.65 |
| Parking Access | Alley or side drive or secondary street |




*Typical Condition*

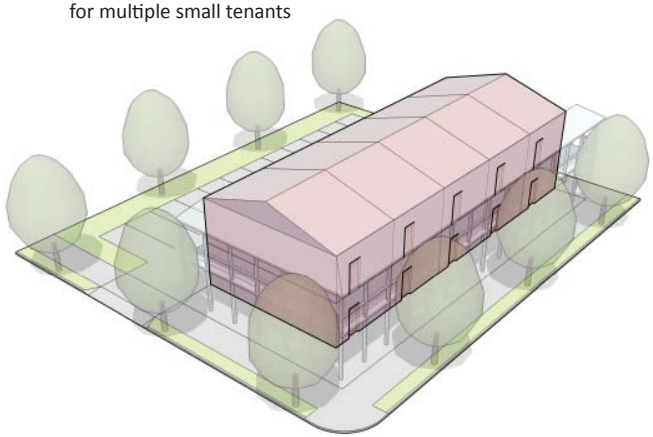
# Flex Space

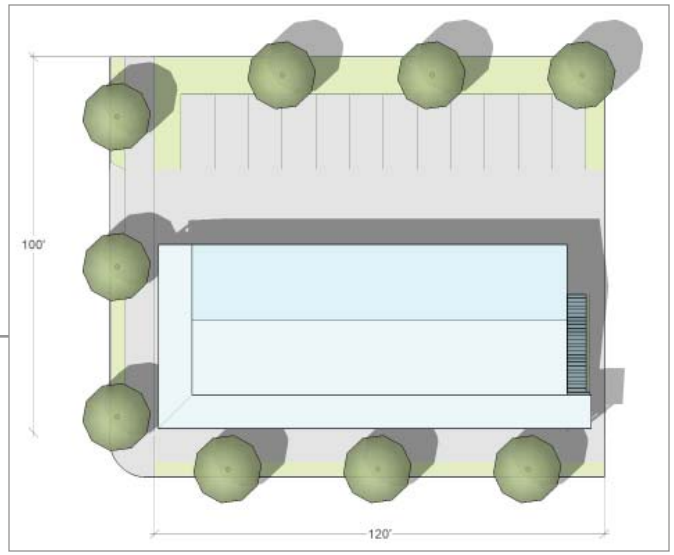



*Typical Condition*

## Flex Space

| | |
|---|---|
| Proposed Height (max.) | 2 stories |
| Total FAR (net) | 0.5 - 0.8 |
| Parking Access | Alley or secondary street |






*Typical Condition*

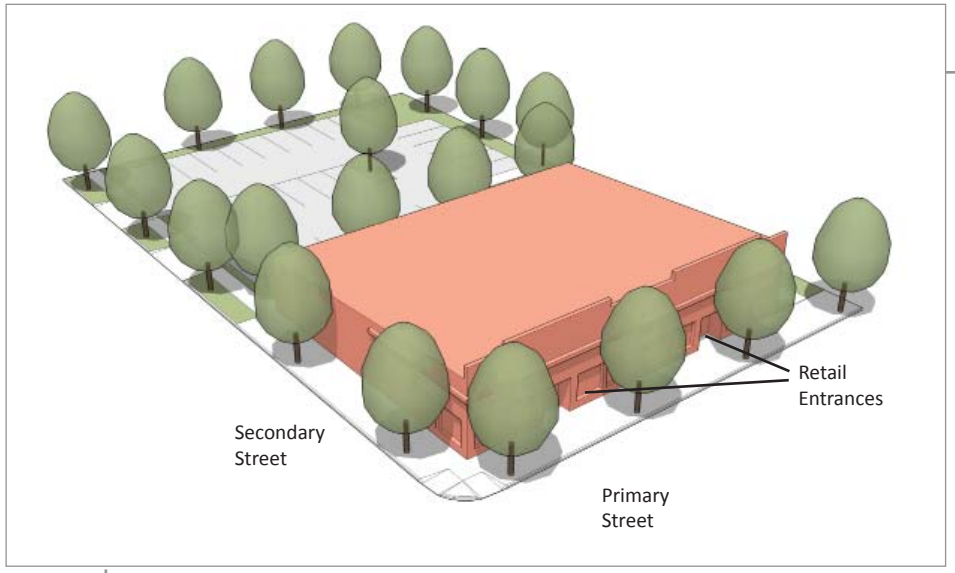
*Local architecture as inspiration*

*Live / Work projects*

*Second Street Studios in Santa Fe*

The flex space or live / work typology facilitates the creation of small business by providing inexpensive space. In some cases, the unit is more like a standard townhome, with some ground floor space which is suitable for in-home business. The type proposed for the Park is more similar to Second Street Studios in Santa Fe, New Mexico. This project provided inexpensive space which users could finish on their own or leave unfinished. It attracted a variety of small businesses, artisans and artists. A similar product in the Park would serve as a technology incubator and add life and variety to the mixed-use center.

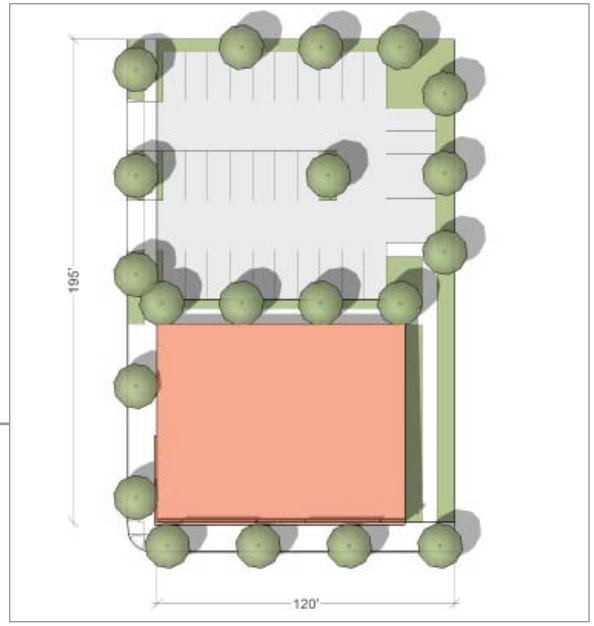
# Retail




*Typical Condition*

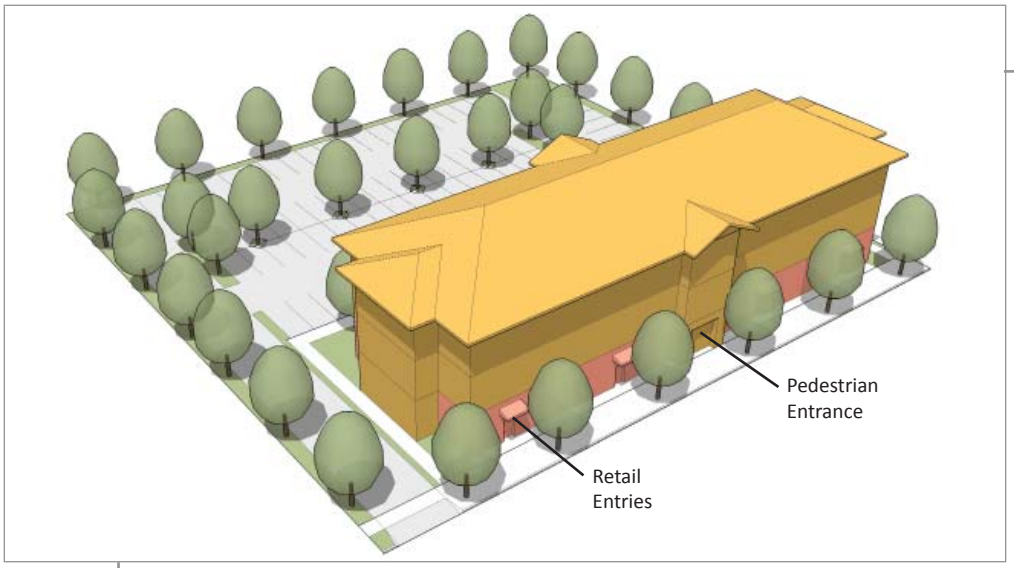
## Retail

| | |
|---|---|
| Proposed Height (max.) | 2 stories |
| FAR (net) | 0.3 - 0.4 |
| Parking Access | Alley or side drive or secondary street |




*Typical Condition*

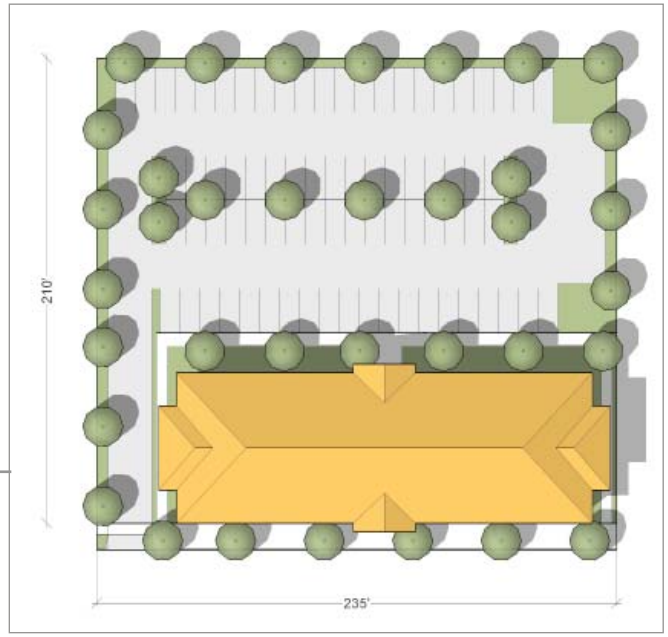
# Mixed Use




*Typical Condition*

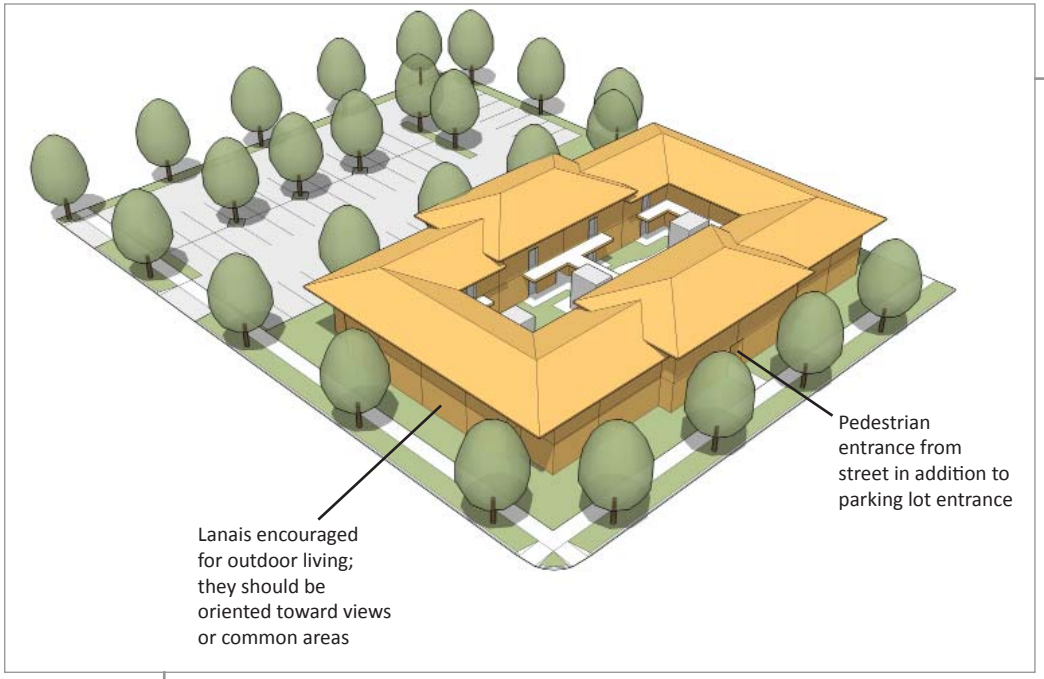
## Residential Over Retail

| | |
|---|---|
| Proposed Height (max.) | 3 stories |
| Density (min.-max.) | 18 du/ac - 30 du/ac |
| Parking Access | Alley or side drive or secondary street |




*Typical Condition*

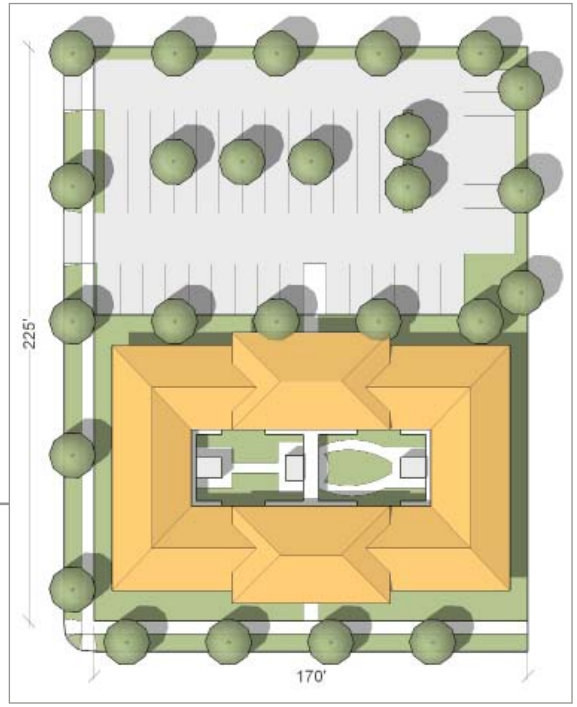
# Residential



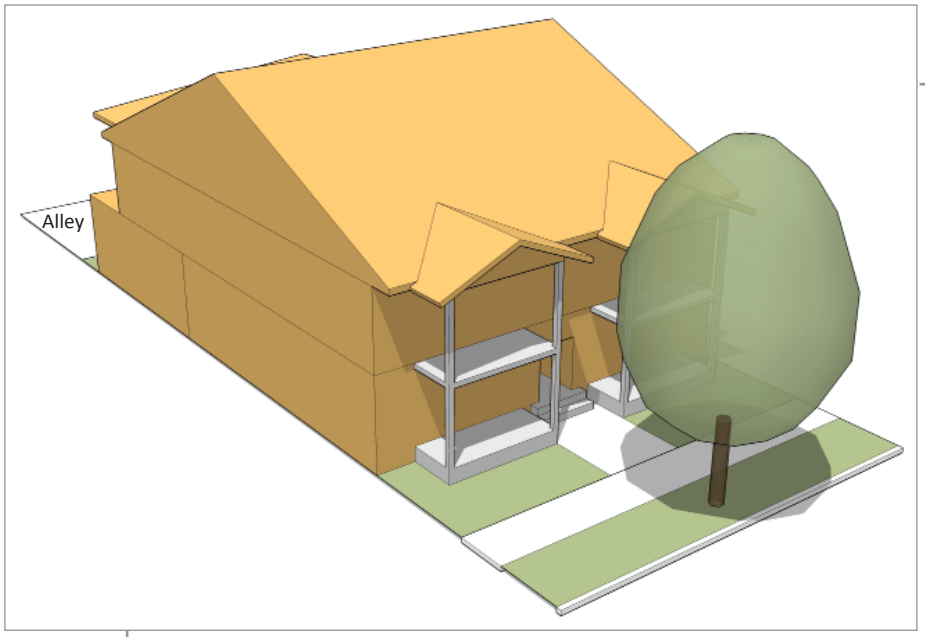

*Typical Condition*

## Multifamily

| | |
|---|---|
| Proposed Height (max.) | 3 stories |
| Density (min.-max.) | 28 du/ac - 40 du/ac |
| Parking Access | Alley or side drive or secondary street |




*Typical Condition*

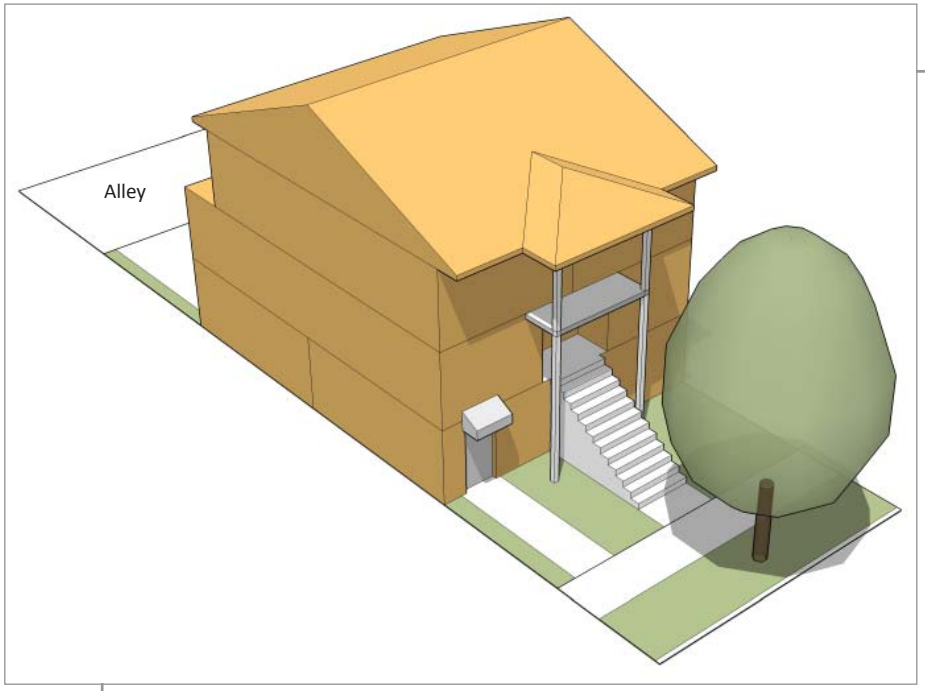



*Typical Condition*

## Four-Plex

| | |
|---|---|
| Proposed Height (max.) | 3 stories |
| Density (min.-max.) | 40 du/ac - 60 du/ac |
| Parking Access | Alley or secondary street (side of unit) |

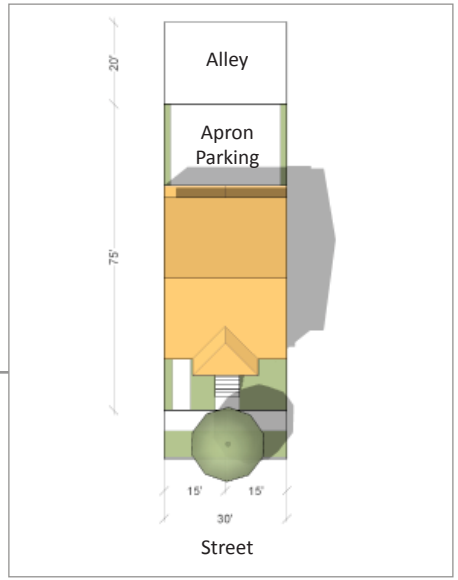
*Typical Condition*



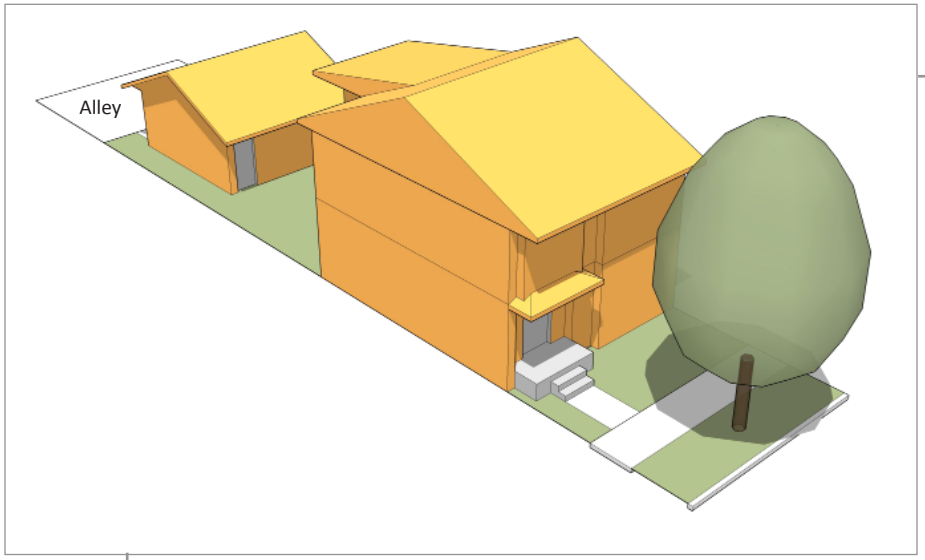

*Typical Condition*

## Tri-Plex

| | |
|---|---|
| Proposed Height (max.) | 3 stories |
| Density (min.-max.) | 40 du/ac - 60 du/ac |
| Parking Access | Alley or secondary street (side of unit) |



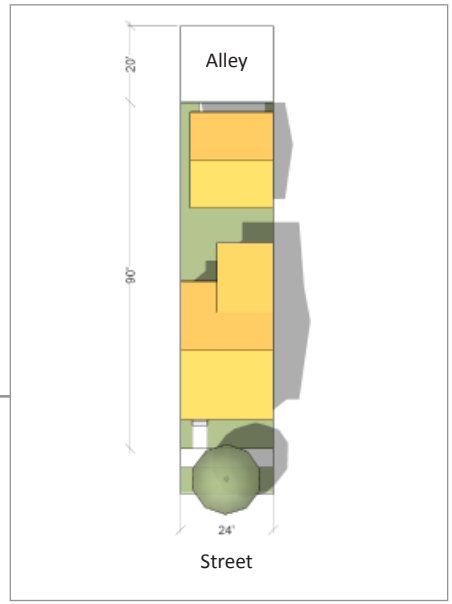

*Typical Condition*



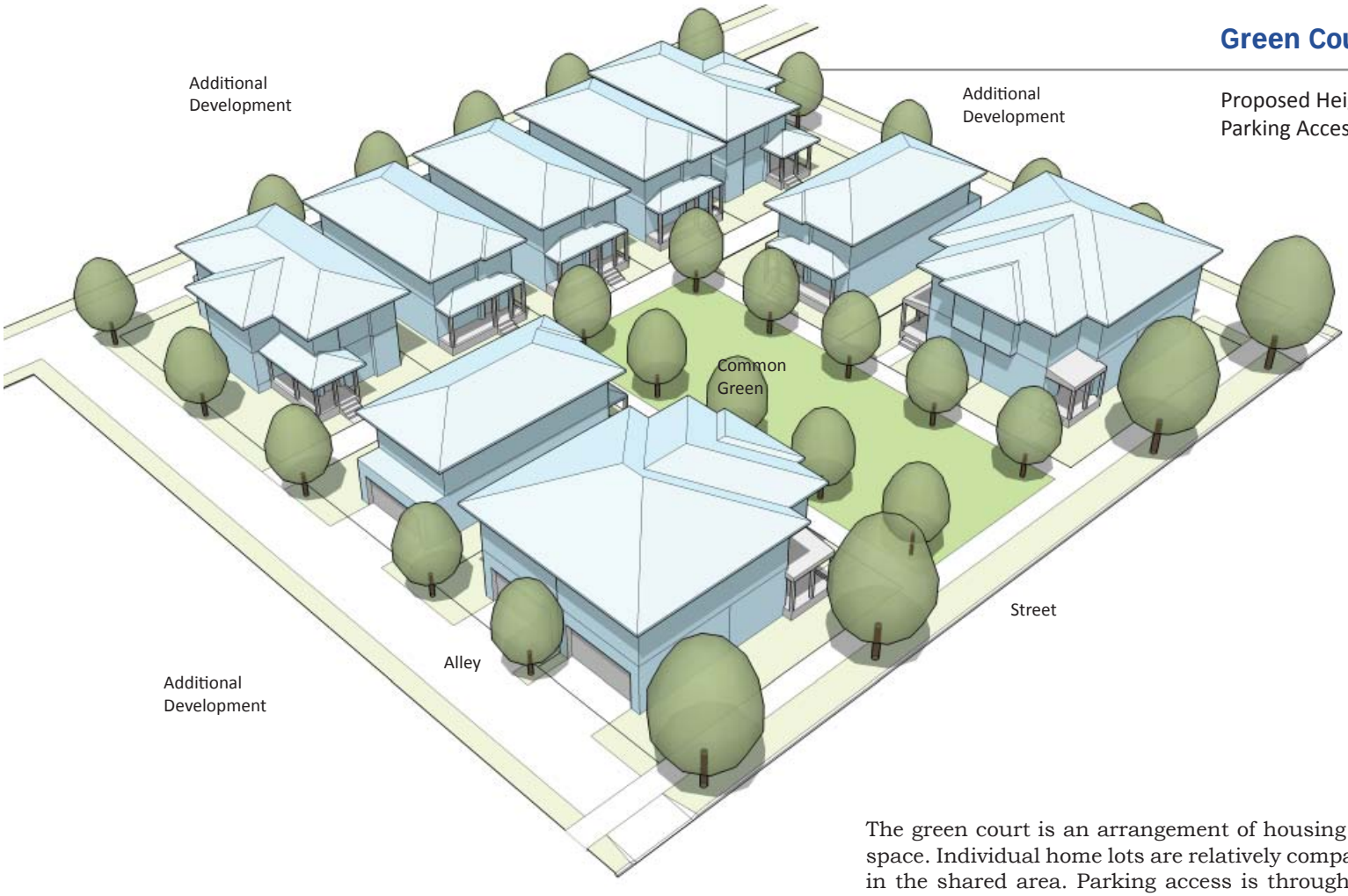

*Typical Condition*

## Townhome

| | |
|---|---|
| Proposed Height (max.) | 3 stories |
| Density (min.-max.) | 18 du/ac - 40 du/ac |
| Parking Access | Alley or secondary street (side of unit) |



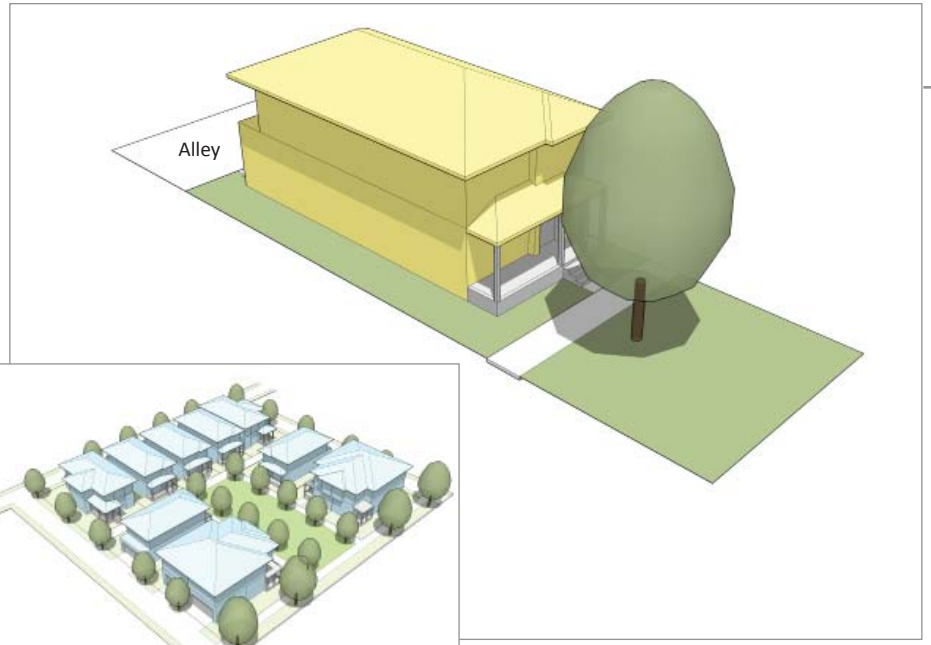

*Typical Condition*




## Green Court Typology

| | |
|---|---|
| Proposed Height | 2 stories |
| Parking Access | Alley |

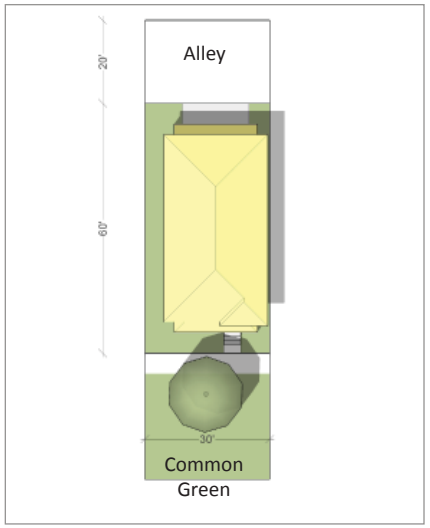
The green court is an arrangement of housing around a central green space. Individual home lots are relatively compact, with most open area in the shared area. Parking access is through alleys, leaving a large, quiet, and protected pedestrian zone. This typology has proven popular in many places and appeals to a wide range of people, from families with children to older people and professionals looking to minimize time spent on yard maintenance.



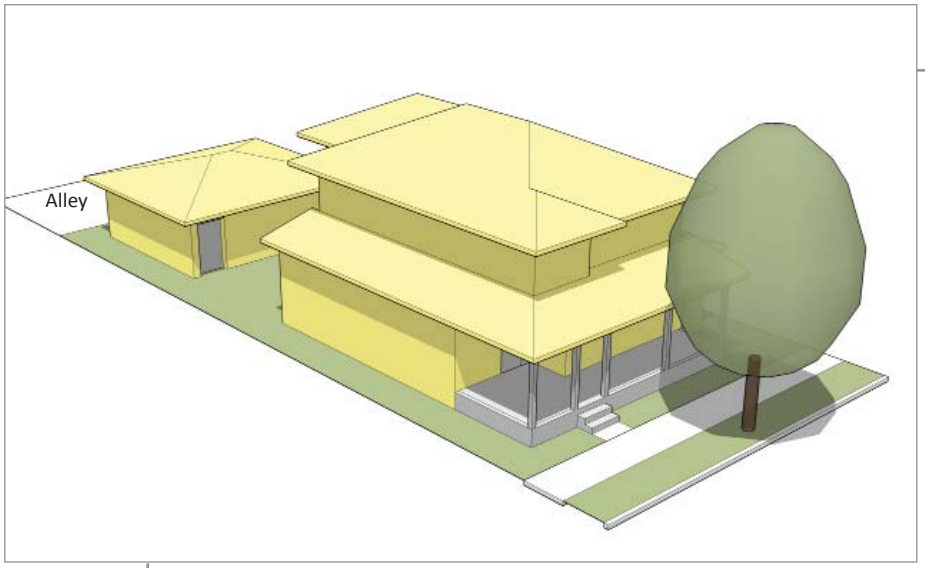

*Typical Condition*

## Single Family / Duplex - Green Court

| | |
|---|---|
| Proposed Height | 2 stories |
| Density (min.-max.) | 12 du/ac - 26 du/ac |
| Parking Access | Alley |



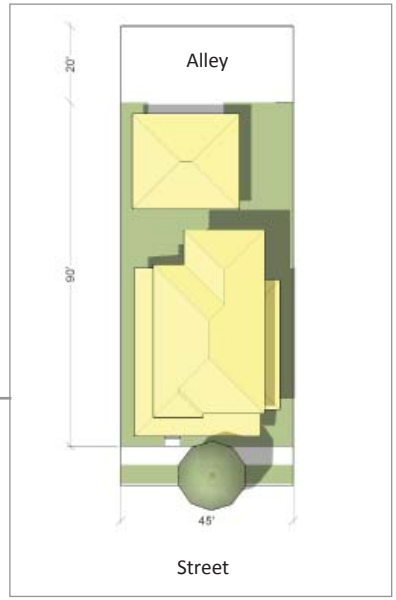

*Typical Condition*



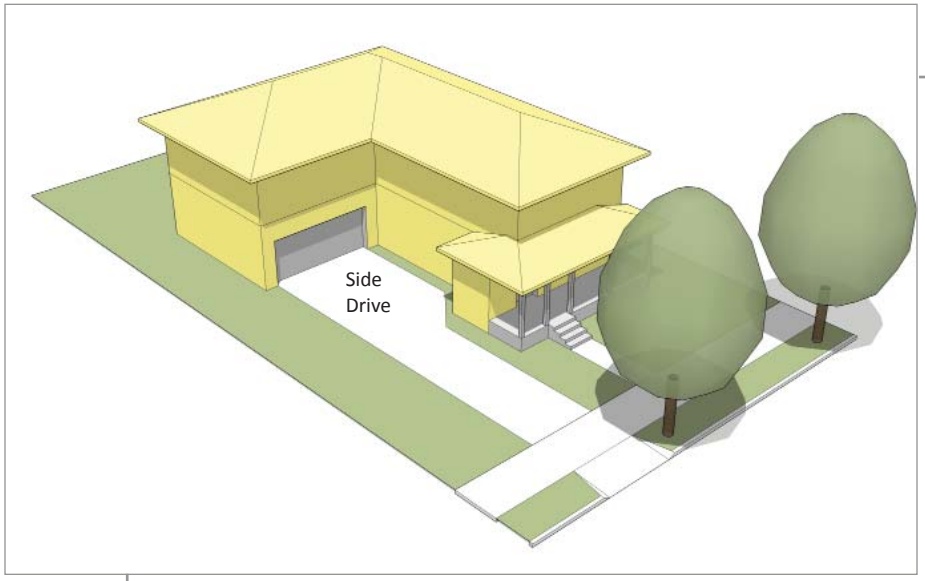

*Typical Condition*

## Single Family - Small Lot

| | |
|---|---|
| Proposed Height | 2 stories |
| Density (min.-max.) | 9 du/ac - 12 du/ac |
| Parking Access | Alley or secondary street (side of unit) |



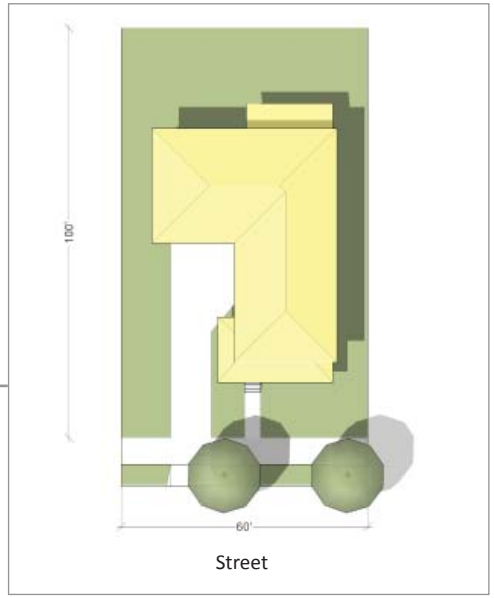

*Typical Condition*




*Typical Condition*

## Single Family - Large Lot

| | |
|---|---|
| Proposed Height | 2 stories |
| Density (min.-max.) | 6 du/ac - 10 du/ac |
| Parking Access | Alley or side drive or secondary street (side of unit) |




*Typical Condition*

# RELATIONSHIPS BETWEEN BUILDING AND STREETS

*Employment Building*

*Primary residential facades face the street*

The spatial character of MRTP's streets should provide a sense of intimacy, community, security, safety, and pedestrian activity. The location of buildings and landscape design in relation to the streets and sidewalks create this spatial character. This section sets up rules for how buildings treat the public realm.

*Retail buildings fronting Ali'i Drive*

# Building Orientation

## Employment Areas

The relatively large blocks of office and campus uses and the need for truck loading access for industrial uses make achieving good urban design particularly difficult in employment areas. For this reason, the regulation of each building's relationship to the public street is critical. Having a building sited in the middle of its parcel, "floating in a sea of parking", divorces it from its context, making it difficult to access for pedestrians, bicyclists and transit users, and reduces the quality of the public realm.

### Goals

To create a pleasant, safe, vital, and interesting work environment which will have a distincet character and will attract and nurture innovation.

To establish a system of building locations that reinforce the urban space, create a pedestrian oriented streetscape, define space and allow for straight forward orientation and convenient access for all modes of transportation

To reinforce the character and quality of public streets through building locations and configurations that provide orientation and access toward the street.

To set standards of quality that will ensure long term value and maintainability of properties

### Standards

The major organizing principle of the public realm in the employment areas of the Park is the road network. Because of the uncertainty about the eventual users of the park, the plan has created a variety of parcel sizes and reduces restrictions on factors such as setbacks and parking ratios. Within that variety, most types of employment users can easily adapt their facility design to support the unified treatment of the public realm. However, certain users such as truck-dependent light industrial facilities and some arrangements such as large employment campuses will not be able to fully adapt their

design to these principles.

Accordingly, employment parcels are regulated by their frontages on specific streets. As defined in the Controlling Plan, the matrix below lists the trunk road network in the Park. These roads form the Park's primary network of public spaces, as well as its transportation network.

Employment uses are grouped into four categories here for urban design treatment. These categories are meant to sort the potential uses by their need for customer and truck access, and the need for larger parcels.

**A. No Truck Access** - common employment-centered uses such as office and research and development. Primary access is by employees, though guest and customer access will be necessary as well.

**B. Public-Serving Commercial** - uses requiring frequent customer access such as is needed for retail or restaurants.

**C. Employment Campus** - employment-centered uses such as office, or uses requiring more customer access such as hospitals, but which require large parcels.

**D. Heavy Truck Access** - uses requiring heavy truck access such as warehousing or light manufacturing.

These groups are allowed or restricted on the various streets in order to ensure a quality public realm on primary streets. The hierarchy creates streets that have a more urban character with buildings lining the streets, and allows industrial and truck intensive activities on minor streets where buildings may be set back from the street. Please also refer to this list for guidance in any instance where there is a question about which road is the "primary" roadway and which is the "secondary". The roads here are listed in order, so that a road with a lower number is always considered the primary road and the higher number road is the secondary road.

All projects will be required to incorporate the following requirements for site design:

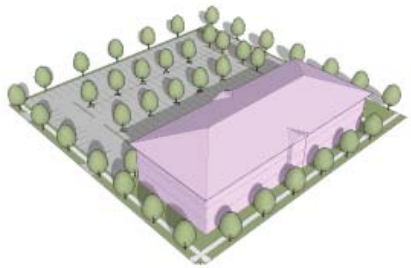
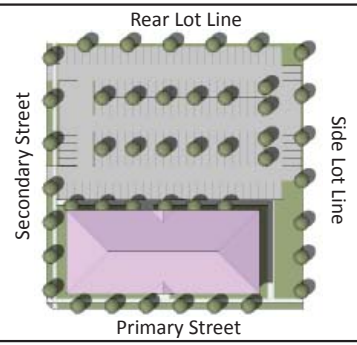
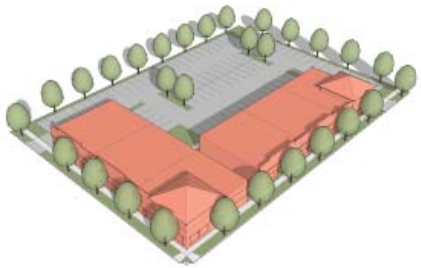
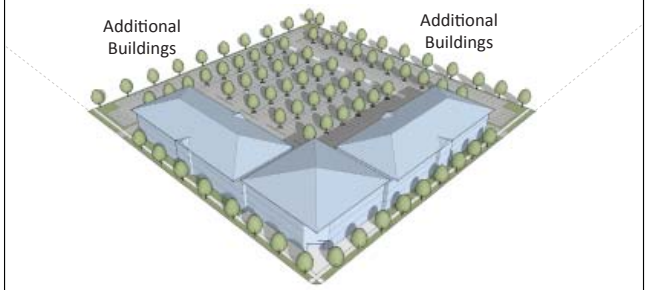
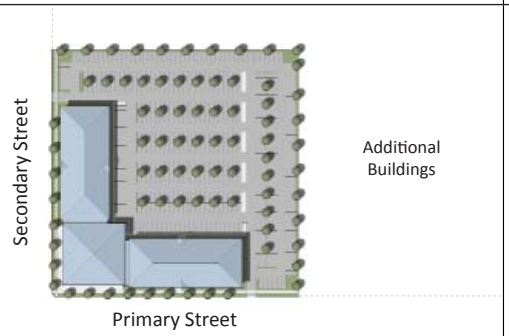
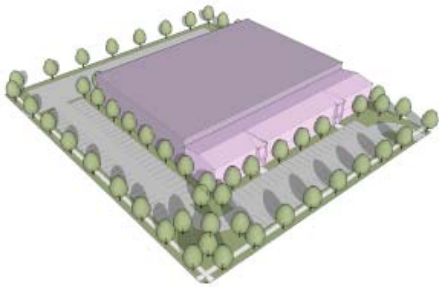
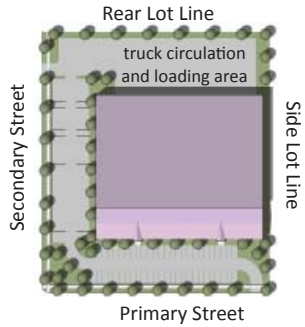
- Buildings shall be located as close to the street as possible, after setback and/or build to zone requirements have been fulfilled
- Office buildings shall be oriented towards and adjacent to the primary street
- For industrial buildings, a maximum of one bay of parking (one drive aisle parked on both sides) is allowed between buildings and primary streets
- No building shall be oriented on a lot in such a way so as to treat the primary street frontages as a rear or side lot line
- For lots located at the intersections of major streets, buildings shall define corners through location and design. Buildings shall be located within the maximum setback in all directions within 70' of major intersections
- Buildings shall address the street with primary entrances, glazing, and signage
- Loading and service areas shall not be located facing the street and shall be screened where visible from the street.
- Drive-up and drive-thru facilities, where permitted, shall be located on the rear of buildings, not visible from the primary street.

## Employment Configuration Allowed based on Street Adjacency

● PERMITTED

ALLOWED EMPLOYMENT CONFIGURATIONS (SEE NEXT PAGE FOR DETAILS)

| ADJACENT STREET | | A - No Truck Access (Office) | B - Public-Serving Commercial (Retail) | C - Employment Campus | D - Heavy Truck Access (Industrial) |
|---|---|---|---|---|---|
| 1 | Lipoa Parkway | ● | | | |
| 2 | North - South Greenway (central Ninau Street) | ● | ● | | |
| 3 | Ninau Street | ● | ● | ● | |
| 4 | Ho'okena Street | ● | ● | | |
| 5 | Holopono Street | ● | ● | ● | |
| 6 | Road 1 | ● | ● | | |
| 7 | Road 2 | ● | ● | | |
| 8 | Road 3 | ● | ● | | |
| 9 | Road 4 | ● | ● | ● | |
| 10 | "Local" roads, not a part of the trunk road network | ● | ● | ● | ● |

| | PERSPECTIVE | PLAN | NOTES |
|---|---|---|---|
| **A - No Truck Access** |  |  | • Buildings shall be oriented towards the primary street<br>• At intersections of public streets, buildings shall define corners through location and design<br>• Parking areas shall be located behind buildings<br>• At least 80% of the parcel length along the primary street must have a building within the minimum and maximum setback distance |
| **B - Public-Serving Commercial** |  | | • Retail facades shall be oriented toward a street, not toward a parking lot<br>• For a parcel at an intersection, at least the 30 feet of the building closest to the intersection along both streets must be an active retail frontage<br>• Parking areas shall be located behind buildings<br>• At least 70% of the parcel length along the primary street must have a building within the minimum and maximum setback distance |
| **C - Employment Campus** |  |  | • Buildings shall be sited along street edge where the parcel meets a public roadway. At least 50% of the parcel length along the public street must have a building within the minimum and maximum setback distance<br>• At intersections of public streets, buildings shall define corners through location and design<br>• Parking areas shall be subdivided into smaller sub-areas and pedestrian paths shall be provided in parking lots |
| **D - Heavy Truck Access** |  |  | • A maximum of one bay of parking between the street and building is permitted<br>• Buildings shall be oriented towards the primary street<br>• Truck circulation and parking areas shall be located behind buildings, not visible from the public right of way |

*Walkable mixed-uses with close proximity to the street*

## Mixed-Use and Residential Areas

Successful mixed-use areas are fronted on pedestrian-oriented streets. Spaces at the street level should be reserved for retail use when feasible. This will attract pedestrians and keep the spaces surrounding the buildings and along roadways active. In mixed-use areas sidewalks should extend to storefronts and be broad enough for sidewalk cafes and displays from retail stores. Storefronts should be attractive and provide views into shops. Street trees should provide shade for pedestrians. Additional vegetation should provide color. Benches, bike racks and other elements of street furniture should be provided to optimize pedestrian comfort.

The spatial character of the residential areas will vary based on density. Near the mixed-use areas where multi-family housing is concentrated, the buildings will be taller and closer to the roadway giving more definition to the street. In these areas, uniform setbacks are generally encouraged to maintain continuity and strong definition of the streetscape. Lower density residential areas will have greater setbacks and be defined less by the buildings and more by the street trees and porches. In all residential areas, inclusion of usable lanais and front porches is encouraged to populate the streets and promote a sense of community.

### Goals

To enhance the pedestrian comfort and safety, and encourage activity by placing buildings, entries, and garages appropriately.

The character and energy in an urban area has everything to do with the surrounding buildings' placement on their parcels. Consistency in lot size, building proximity, form, setback, amount of frontage, height, transparency, detail, and landscaping coverage are the most common (but usually, unconscious) elements of the urban fabric which make a neighborhood recognizable and give it its "feel". All urban spaces are characterized by some variation on the above elements.

In traditional neighborhoods, buildings front the street and garages and parking are placed to the rear or side of a parcel. Buildings with short setbacks from the sidewalk allow employees, customers, and neighbors to interact on a frequent basis, and more "eyes on the street" help create safer and more active streetscapes. Moving garages and driveways to the rear of the parcel puts emphasis on the front entry, both physically and philosophically. Without front-facing parking lots or garages, buildings can have more windows looking onto the street; more attractive, compact, and straightforward floor plans; centrally located entries with less interior space dedicated to circulation; simplified construction; more corner rooms to allow for balanced lighting and cross ventilation; and more landscaping options allowing for more natural and complementary design.

### Standards

- Buildings shall be oriented parallel or nearly parallel to adjacent streets (minor architectural features such as towers, kiosks, and accessory structures may vary from this orientation).
- Primary facades shall face the most active adjacent street.
- On the interior of large sites, mid-block buildings should face pedestrian spaces, such as plazas and/or

*Retail Street with Outdoor Dining*

greenways, where possible.

- Setbacks shall be shallow to bring buildings and activity closer to the street. Setback requirements are detailed in the Building Typologies Summary Matrix.
- Parking lots, garages, and driveways shall be placed in the rear, or to the side, of buildings.

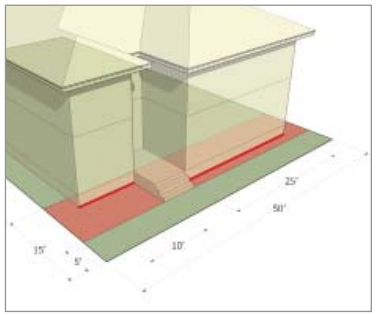
*Higher Density Residential Street*

*Lower Density Residential Street where driveways and garages have too much emphasis but do not overwhelm the street*

# Setbacks

*Efficient and welcoming front setback*

*Some setbacks provide for variety of public spaces*



*This building occupies 70% of the frontage, with 35' of the facade between the maximum and minimum setbacks.*

Requiring buildings to have a certain percentage of street frontage near minimum setback lines prevents sidewalks lined with parking lots or large landscaped areas which often lack visual interest, activity or definition.

Building placement that reinforces the public area through proximity, detail, transparency and entries are especially important for uses typical in employment and mixed-use centers, such as multifamily, mixed-use and commercial buildings. Hence, required street frontage percentages are higher for these uses.

The standards for building placement complement parking location standards, which generally call for parking behind or recessed on the side, rather than in front of buildings.

Recessed garages and alleys place the garage face behind the primary facade of the building, reinforcing the entry as the "face" of the home instead of the blank stare of the garage door. For homes, side-drive configurations place garages towards the rear of the lot, accessed by driveways from the street. This arrangement places the garage apron to the rear where it can be integrated into the yard as a play area.

## Goal

To encourage a well-defined, active streetscape by placing buildings, entries and garages appropriately and to allow for more private outdoor space to the rear of buildings.

## Standards

- Basic setback standards are shown in the Building Typologies Summary Matrix.
- Setback standards vary according to building type.
- Street-facing residential garage facades must be at least 20 feet behind the building's primary facade.

*Retail requires minimal setbacks for accessibility*

*Setbacks required for stoops or different landscaping*

# Principle Entries

Principal entries should be dominant and recognizable features. Entries should not be set off to the side of a building or obscured by other elements, which can create an uninviting character for the streetscape. The design standards call for entries that are clearly visible and directly accessible from the sidewalk.

For business and live/work buildings, entries should be well marked, attractive, and inviting to pedestrians. Entries clearly visible and directly accessible from the street are required in residential buildings. This ensures that buildings orient to the street rather than to parking areas, encouraging social activity and security on the street while providing easy access for residents and guests to buildings.

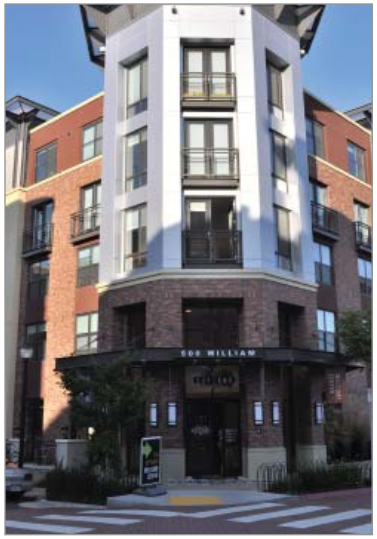
The placement of parking in the rear of a building shall not draw the entry from the street, but rather may necessitate a connective walkway from rear to front of the building, or a second (rear) entry.

## Goal

To identify and give architectural importance to the primary entrance of each building in a way that clearly addresses the street.

## Standards

- Building massing shall highlight the location of building entries
- Primary pedestrian entries shall be clearly expressed
- The principal entrance shall be oriented towards the primary street. The general order of primacy is set in the Street Heirarchy and Employment Uses table.
- Where multiple entries may be required for multi-family and commercial building types, the primary entrance shall be located on the street frontage, not a parking area or garage. If some entrances are closed at certain times, the primary entrance at least must remain open, regardless of which other entries are closed.
- Corner lots are encouraged to have primary entries at or near the corner. This includes buildings on corners where a street and a plaza or greenway intersect.
- Where direct access from the sidewalk for a particular building is not possible, larger multi-family parcels are encouraged to provide internal walkways which physically and visually connect the building's primary entrance to the public sidewalk.
- Secondary entries may provide access from parking lots.
- Multifamily buildings should have individual unit entries to all ground floor, street-side units.



*Corner buildings shall have primary entry at or near major corner*

*Retail or Employment buildings often require multiple entries*

# Building Frontage and Character

*Inviting and active frontages*

*Entries enliven the street and encourage pedestrian interaction*

Street-side building facades are responsible for contributing toward the character of the neighborhood and are often where employees, customers, residents, and their neighbors interact. Building elements which support this interaction and are within close proximity to the public realm are preferred. Semi-public building elements include lanai, entries, common rooms, and operable and partially transparent facades which allow "eyes on the street". Building design elements which create an interesting and appealing facade also adds to the quality of the streetscape.

Non-compatible elements include garages, fences, blank walls, and large setbacks which typically shield or remove the building from the street creating a less inviting neighborhood character, and making the public realm feel more isolated to the pedestrian.

## Goal

To enhance and encourage an active pedestrian environment on the street by placing buildings, entries, and garages appropriately on the parcel.

## Standards

*Residential windows and lanai engage with the public realm*

- All buildings should have fenestration on street-facing facades and avoid blank walls.
- Lanai and covered entries are encouraged on the street-facing facade and may intrude into the required setback up to the right of way line.
- For ground-level walls of retail structures facing public streets, at least 50 percent of the wall area between 2 and 10 feet above grade must be constructed of glass with a visible transmittance rating of 0.6 or higher.
- A variety of architectural treatments and human-scale details shall be used. See the Architectural Guidelines for examples.
- For all building types, facades may not exceed 30 feet without being divided or articulated.
- Rear or side building facades which are visible from public rights-of-way shall be sufficiently articulated to provide visual interest.

# Open Space Frontage

*Parks and open spaces provide amenity for all park users*

Parks and open space corridors will be developed as part of the Park's overall infrastructure as well as within various sub-areas of the Park. These areas will be important public spaces and should be treated as such.

## Goal

To make public open spaces safe and inviting amenities by making them part of a high-quality urban setting.

## Standards

- Provide at least one pedestrian connection from the parcel to the open space
- No opaque fencing or walls over 4 feet tall are allowed adjacent to the open space
- Building facades facing open space shall receive equivalent treatment as the building's primary street facade
- Service areas shall be visually screened from open space
- Buildings shall front onto open space wherever possible unless required to front onto a public street

*Semi-private open space in a green court*

# RELATIONSHIPS OF BUILDINGS TO NEIGHBORS

The Park will contain many buildings of various types. In order for them to fit into a harmonious whole, it is necessary to consider the relationships between these various buildings and land uses. Individual buildings can on their own be beautiful or ugly, functional or dysfunctional. In the same way, the sum of all the Park's buildings can have the same characteristics. This is a quality often lost, except as it comes to simpler ideas such as harmonious color palettes or small details like mail boxes. This section creates guidelines for how buildings in the Park should relate to each other to create a more beautiful and functional district.

# Lot Coverage

*High lot coverage in urban environment*

Lot coverage refers to the portion of a lot covered by the building on that lot. Lot coverage limitations are sometimes used as a way to attempt to ensure the presence of "light and air" on a parcel. However, the resulting open space is typically covered by parking in the case of commercial development, and in any parcel if the area is left as green space it may be fractured and formless, rendering it unusable other than as visual relief. However, if required open areas are reduced or eliminated on individual parcels, there would still be "light and air" in any case due to the requirements of the individual buildings for fenestration, ventilation and daylighting. This reduction in excessive open space requirements then reduces the size of parcel necessary to build a given amount of development (a single family home, for instance), which then frees up land for usable public open spaces and parks.

*High Lot Coverage encourages a more coherent urban fabric and keeps buildings at the property line*

In any case, limits on density in the current plan (by dwelling units per acre and by floor area ratio) are derived from wider concerns over such issues as infrastructure, traffic, and development capacity. These limits area not so high that there will be concern over provision of open area on individual parcels.

# Parcel Dimensions

*Neighborhood structure supported with lot size standards*

The intent of the diversification of the land use mix at the Park is to support the Park's mission of economic development. For this reason, the parcel dimensions of both commercial and residential parcels have been considered.

For employment parcels the current lower parcel size limit of 2 acres places unnecessary limits on the economic development potential of the Park. In order to maximize economic development potential, the Park must be able to accommodate the widest range of possible users. Current understanding of the high technology industry shows that many future successful companies rely on small start-up spaces. Then, as they grow, these companies require successively larger facilities. The Park must be able to provide a place for businesses at any stage, from inception to maturity.

For residential parcels, maximum sizes have been limited. The goal of adding residential uses to the park is to provide a more balanced environment for the creation of economic development. One part of this is the provision of housing types and prices which fit the spectrum of workers in the area. While it will not be feasible to limit residence to people employed in the park, creation of housing which is appropriate in size to park workers will provide the option for them to reside in the Park if they choose. Homes on larger lots run the risk of attracting persons seeking second homes or others who would not support the Park's mission.

### Goal

To ensure that parcel sizes support the Park's economic development strategy.

### Standards

Lot size standards vary according to building type.

Lot size standards are noted in the Building Typologies Summary Matrix table.

*Uniformity of Lot sizes and lot coverage depend on individual building prototypes*

# Building Height

*Residential buildings can meet massing standards, but vary in design*

Building height limits can have a variety of purposes. Among these are the protection of important views, the protection of sunlight falling onto adjacent parcels or onto public streets or parks, the limitation of development intensity, and aesthetic goals of consistency among various buildings. Because of the relatively low intensity of development which can be accommodated in the Park, as regulated by floor area ratio and dwelling units per acre, these issues are of less concern. However, even within the overall and parcel limits on intensity, spot densities within the Park could allow development height to block views or block sunlight unless regulated.

Because of the contrary goal of avoiding monotony in building massing and height, the height limits have been set so that a building could reach the limit on floor area or dwelling unit density by using a variety of configurations of height. For instance, a builder could create a house of a given floor area with one large floor and one smaller second floor, with two mid-size floors, or even with two smaller floors and a small third floor. This variety within limits will help to create interesting variation in the buildings in the park without sacrificing views, sunlight, or aesthetics.

*Office and retail buildings can meet massing standards, but vary in design*

### Goals

To protect views, access to sunlight, and the aesthetic character of the park without creating monotony.

### Standards

Basements are unlikely in the Park. However, due to grading on sloping areas of the park, some below-grade space may be created in some buildings. Such space is not counted in the number of floors when the floor above it is less than 3 feet above grade at the uphill side of the building.

In order to preserve variety in the built environment and flexibility for architects, floor to floor heights for residential or commercial space are not regulated.

Building height standards are noted in the Building Typologies Summary Matrix table.

# Building Plan Variety

The large scale of modern development often leads to the repetition of a building design multiple times in close proximity with minimal variation. This can lead to monotonous streets filled with buildings lacking individual character and identity. More seriously, this sameness can also create large areas with no variation of available built spaces, creating a social and economic monoculture. Such areas, like monocultures in nature, are most vulnerable to changes, since they have no diversity to offer users. A monocultural employment area cannot serve a variety of businesses and is vulnerable to changes in the economy. A monocultural residential area relies on one economic group, and often one social group, removing the possibility of a diverse population and forcing people to move out of the area should their housing needs change.

Therefore, a mix of building types, varied floor plans and even diverse architectural treatments are desirable in both commercial and residential areas. Variation in floor plan or roof configurations may be limited by budget or design intentions, but some differentiation can and should be achieved by shifts in form, massing and materials.

### Goal

To create variety and a unique character for the Park by avoiding the simple repetition of identical buildings.

### Standards

Each block face of 6 or more parcels in commercial and residential areas, regardless of how many builders participate on that block, must contain at least three different building plans with varying architectural treatments. Other than in campus developments, no more than two buildings of the same plan and architectural treatment can be placed on the same block face without prior approval. It is desirable to separate plan and treatments of similar character. In addition to architectural treatments, color variation should be used to provide additional variety to each street.

# Ohana (accessory) Units

*Rear alley with garage access and accessory units*

Ohana or accessory residential units are a positive way to provide affordable rental housing for singles and empty nesters as well as to provide supplementary income for homeowners. Ohana units may be part of the primary dwelling unit or may be attached to or above a garage on single family lots.

## Goal

To best integrate minor structures and to allow affordable rental housing into the neighborhood.

## Standards

Ohana units are encouraged and are allowed on all single family detached lots in the Park.

Ohana units must be no more than 600 square feet in size.

# VEHICLE ACCESS & STORAGE

Automobiles have had a remarkable impact on the urban environment. Since their introduction, they have changed the way people move around, creating a freedom of movement which is hard to imagine doing without today, but must have been a revelation for early users.

Nowhere have cars been more thoroughly integrated into everyday life than in the United States. Through the interaction of a variety of factors, some meant to encourage automobile use, some meant to improve driving safety, and some meant to reduced what was believed to be unhealthy levels of density in cities, automobiles have reshaped cities all over the country.

Accommodating the presence of automobiles has become the single most important factor in urban design. For many years, designers strove to remake the city to fit the automobile at the expense of all other concerns. Recently, however, people have rediscovered the importance of the city in its own right, and have begun to seek ways to strike a balance between automobile users, pedestrians, bicyclists, residents, workers, and all other residents and visitors.

This section is meant to create rules and guidelines to control the impact of automobiles on the Park. They are intended to make the Park safe and accessible for automobile users as well.

# Driveways & Curbcuts

*Unaligned curb-cuts and minimal street parking opportunities*

Controlling the number and size of curb cuts and driveways promotes safer, more efficient, and more attractive streetscapes. In retail areas especially, high volume and frequent driveways fracture the pedestrian environment and create dangerous conditions. In residential areas, curb cuts encourage people leaving their driveways to back across the sidewalk, endangering pedestrians, bicyclists, and any children playing in the drives or on the sidewalk.

## Goal

To reduce interruptions to sidewalks and building facades, and to minimize redundant access points which can claim valuable frontage from businesses and pedestrians.

## Standards

In parcels with alley access, curb cuts on other parcel edges are not allowed.

To reduce total curb cuts, curb cuts and driveways should be shared between multiple projects or buildings where feasible.

Driveways for access to corner parcels must occur on the secondary street, or on the alley if one is available.

Driveways shall be perpendicular to the street to the extent possible.

The width of a commercial or multifamily driveway crossing a sidewalk shall not exceed 18 feet.

The width of a single family residential driveway crossing a sidewalk shall not exceed 10 feet.

In no case will the level or slope of the sidewalk be altered to accommodate ramping where a driveway crosses a sidewalk. Any change in elevation must be accommodated in the vehicular way, outside of the sidewalk.

# Parking Lots

*Well-lighted lots with clearly marked paths and planting*

*Pleasing and functional parking and landscaping design*

The visual and physical impact of a parking lot can be improved through appropriate siting, design, and landscaping. Additionally, good parking planning can help minimize the environmental effects of a parking lot's large expanses of pavement such as "heat islands" and increased storm runoff. Poor parking lot design can isolate people and buildings in the urban environment, and can drain vitality from the urban form by disassociating uses from one another with an uncomfortable expanse of asphalt. Good parking lot design brings a sense of human scale and character to an otherwise auto-dominated development feature.

## Goal

To create parking lots that are pleasant, convenient, and as unobtrusive as possible to the street.

## Standards

Parking or automobile circulation shall not be located between a primary street and building for all uses except industrial uses with loading dock.

Large truck parking areas shall not be located along a primary street.

Landscaped setbacks that provide view screening of a minimum 10-foot-width shall be provided wherever a surface or structured parking lot abuts a street. This may include the use of landscape material, land forms, rockeries, etc.

Surface runoff in parking lots shall be directed to landscaped water harvesting areas.

Landscape islands shall be installed at the ends of all on-grade parking bays.

Service and emergency service lanes shall be designed as part of the site circulation and shall not be dedicated lanes that add impervious surface

Carports are allowed only if materials are closely related to building architecture and by Park approval

Parking lots shall be subdivided by pedestrian paths or landscape areas into zones so that no single zone shall have greater than 100 parking spaces.

Good parking design is comfortable for cars and pedestrians

Pervious parking surface for stormwater infiltration

### *Pedestrian Connections*

There shall be pedestrian paths from the parking lot to proximate building entrances, open spaces, and streets through parking areas in the form of walkways between parking zones. Paths double as a means to break parking lots into parking zones. The minimum clear width of these paths shall be 6 feet

Pedestrian crossings shall be provided where concentrated pedestrian traffic is expected to cross vehicular zones. The crossing path shall be a contrasting color and/or material, such as brick or colored patterned concrete. Crossings shall be a minimum of 6' wide

### *Heat Island Effect*

All lots should attempt to mitigate "heat island" effect through one of the following or equivalent:

- Parking area must achieve 25% or more net permeability (pervious or porous) of the automobile parking and driving surface.
- Vegetative shading of at least 30% of non-roof impervious surfaces within five years from completion of construction.
- A landscaped stall, 160 square feet or larger, shall be integrated into the parking layout at a minimum of every five auto stalls.
- A planting bed (minimum 5 feet wide) shall be provided for the entire length of each parking bay, including shade trees spaced at 60' intervals or less.

Parking lot solar installations may be used in place of shading requirements based on the amount of shade provided. Such solar installations would not be subject to lot setback requirements.

# Structured Parking

*Parking structure providing additional uses*

*Structures can blend in by using retail as a ground floor use*

Structured parking provides the highest density of parking spaces per unit of land. However, parking structures often contrast poorly with their surroundings. The following standards are geared toward making parking structures more visually appealing as well as architecturally compatible with adjacent developments.

## Goal

To allow the use of parking structures while minimizing their negative visual or physical aspects.

## Standards

Parking structures may not be used to fulfill frontage requirements along streets.

Parking structures shall be designed to obscure the view of all parked cars and internal light sources from adjacent public right of way or open space for the full height of the structure.

Parking structures shall be compatible in massing, scale, style, and materials with the buildings they support or surround.

Parking structure facade openings that face any public right of way or open space shall be vertically and horizontally aligned and the floors fronting on such facades shall be level.

Landscape material, such as vines or planters, should be incorporated to soften the edges of parking structures.

# Residential Garages

The location of large residential garages at the front of homes has the effect of blocking the home off from the street, isolating the residents from the public space and from their neighbors and creating a "garagescape." Garages placed beside or behind homes allow gracious front pedestrian entries and the creation of a pleasant streetscape.

## Goal

To make garages accessible and functional while minimizing their deadening impact on the streetscape.

## Standards

As noted in the Setbacks section, street facing residential garage facades must be at least 20 feet behind the building's primary facade.

On residential corner lots, a curb cut for a street facing garage must be on the secondary street, with street primacy as defined in the Street Hierarchy and Employment Uses table, even if that means that the curb cut is on the curb in front of the "front" facade of the home.

Tandem garage parking is allowed in all cases.

*Multi-functional parking and access areas*

# Loading, Service & Utility Areas

Loading, service and utility areas, while necessary, should be located in a way so as not to disrupt the public streetscape.

## Goals

To maintain the quality of the public realm by keeping non-contributing elements screened from view.

## Standards

Service and storage areas, including loading docks, trash compactors and storage yards, shall be located away from pedestrian areas and out of sight of the public right-of-way and where possible, open space areas. Where visible from the street, these areas shall be screened from streets and open space by walls matching the adjacent buildings in materials, detailing and color.

Walls, matching the adjacent buildings in materials detailing and color, shall be used to screen docks, loading areas, electrical equipment, and trash collection areas.

Trash compactors shall be contained within walled enclosures with opaque gates.

Ground mounted utilities shall be screened from streets and open space.

# ARCHITECTURAL GUIDELINES

Commercial, mixed-use and residential buildings within the Maui Research and Technology Park will have architectural characteristics which are culturally and environmentally appropriate to Maui's traditional buildings and the project's climate. The Park should have a variety of architecture and this Code does not impose a specific architectural style. Rather, inspiration should be taken from pedestrian-scaled areas in the island's historical towns such as Wailuku, Lahaina, and Paia. The intention is for the architecture at the Park to reflect but not duplicate this architectural tradition. Each project should bring architectural creativity that honors local architecture yet is unique in this village setting.

Despite the allowance for eclectic architecture, however, each building must maintain the high quality urban character of the Park. Buildings in the park can accommodate a mix of building types and architectural styles while still creating a cohesive sense of place. Buildings should be in scale and character with pedestrian-oriented activities. Materials, especially for portions of buildings near the pedestrian realm, should use materials of quality, durability, and scale appropriate to pedestrian activity and contact. The following guidelines are intended to ensure a high quality public realm while still allowing for architectural freedom and diversity.

*Stores in Holualoa Town*

# Building Mass & Proportion

*Multifamily building types*

*Example of scale for street level retail*

Buildings within the Park shall be characterized by a pedestrian emphasis in their scale, level of detail, and variety of materials. Buildings designed to be seen by passengers in automobiles rely on large, blocky shapes and little detailing because viewers will have no time to see subtle treatments. Buildings in the Park should be designed to be seen at the speed of someone walking.

Monolithic forms should be avoided and the addition of scale-giving elements should be used to reduce the apparent scale of larger buildings. Building masses, especially larger commercial, mixed-use and multifamily buildings, should be articulated and organized with a variety of composite forms. While the physical scale of buildings will vary with building size, "user scale" should be consistently intimate.

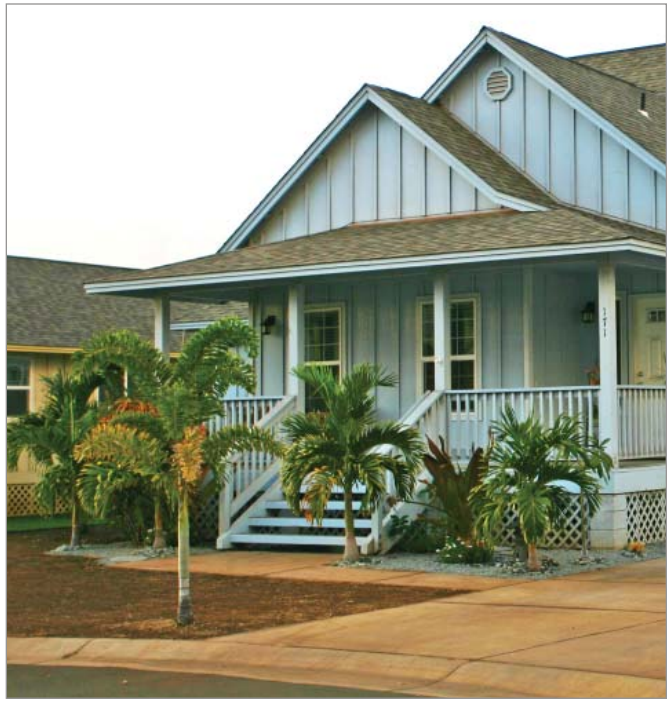
*Example of scale for street level retail*

While individual buildings are encouraged to differ significantly in form, color, and material, all buildings should emphasize common elements, such as consistent horizontal trim lines, roof forms, and awning heights. The design of elements such as awning locations and roof heights will be determined based upon the usage and requirements of each building type. Mixed-use buildings, multi-family and single-family buildings will be differentiated through the variation of these elements.

For larger multi-level buildings, emphasis should be placed on distinguishing three-part massing with distinctive base, body, and roof forms. The care of the building base design should be apparent, including the use of awnings, arcades, canopied entry ways, courtyards, and transparent panes of glass at the building base. Covered pedestrian walkways should be provided whenever possible to create an inviting place for people.

# Facade Articulation

*Example of appropriate articulation for a mixed-use building*



*Example of using entry lanais and balconies for bringing scale to large buildings*

*Different building prototypes shall have appropriate facade articulation to allow for a variety of architectural characters*

Changing from an auto-centric to a pedestrian-oriented streetscape makes facade details and articulation more important. Instead of being viewed at high speed from behind a windshield, buildings in the Park should be of the high quality suitable to be viewed by pedestrians, at slow speed and close proximity.

Facades should meld the architectural characteristics of Maui's historic buildings with modern woods and sustainable design strategies. Facades should also reflect the life of the users and residents. Blank, expressionless facades are discouraged. Lively, animated facades are encouraged.

Project designers are encouraged to use a wide array of details, patterns, textures, and decorations to enhance the facades of their buildings, but must always keep in mind that buildings should not alienate themselves from the development as a whole.

Architectural details, such as balconies, pop-outs and window planters are encouraged. Integration of decorative bands will help to break down scale of larger buildings, as monolithic forms should be avoided. Details such as wood rafter ends, supporting members, columns, hand rails, ventilation grills, capitals and cornices provide a textural quality and charm.

Parking structures must have visually interesting facades, preferably similar to retail or office buildings. The parking structure facades should be of comparable detail and quality to adjoining buildings.

# Roofs

*Parapet False-Fronts in Local Downtowns*

*Hipped and Gabled Roof in Wailuku*

*Examples with roof forms (above) and Flat Roof with Parapet Wall (below)*

Roofs should be reflective of traditional forms. They should generally be articulated rather than monolithic so as to provide richer roofscapes. A variety of roof shapes, forms, and sizes are encouraged in the Park.

## Roof Forms

Roof forms of large buildings should be broken into smaller forms. Where possible, variations in roof profile and parapets shall be used to emphasize entries and create interest on building facades. Gable and hip roof forms on residences should be used in combination for articulation when feasible. Varied roof forms should also be used to provide variation along the streetscape when similar units are adjacent.

Roofs with false-front parapet walls have been historically used in commercial building in local towns and are appropriate for use on commercial and mixed-use buildings. Mansard roofs are appropriate especially on large multi-family, mixed-use and commercial buildings to reduce the height of roofs. The mansard roofs also provide flat roof areas for solar panels that can be screened by the roof.

The design of the roof form and other related elements such as roof material, color, trim and lighting should be an integral part of the architecture. Rooftop equipment shall be screened from view of public streets and open space by architecturally integrated screening elements.

*Trellis Shading Lanai at Entry*

*Combination of Gable and Hip Roof Forms*

*Use of Multiple Roof Materials, Exposed Eaves and Rafter Tails*

*Example of pitched roof in single family building type*

## Dormers

It is typical for dormers to function as vents and skylights in order to give light, air and appropriate height to attic spaces. Dormers are encouraged as functional and visual assets.

## Eaves

Overhangs should be used on primary buildings. The eaves on the roofs of secondary buildings such as garages may be clipped. The use of broad eaves is encouraged where feasible. The expression of rafters is encouraged; however, exterior soffits are allowed.

## Roof Pitches

Roofs in the Park may have single or double pitches at a minimum slope of 4:12 for the primary slope.

## Roof Materials

Visible roof materials may include asphalt shingles, wood shingles or shakes, corrugated, standing or split seam metal or terracotta. Single sheet roofing systems are allowed in flat portions of mansard roofs.

# Exterior Finishes

*Variety of materials, textures and treatments used modernly*

*Traditional use of building form, with adapted or modern materials*

*Variety of colors and finishes break-down the scale of buildings*

*Variety of materials, textures and treatments used traditionally*

## Exterior Wall Design

To reduce scale, exterior wall surfaces should be broken down by the use of different materials and treatments. Wall treatments such as changes in material, color, texture, and plane or parapet height shall be used to provide variety and break up large uninterrupted surfaces.

The use of horizontal or vertical wood siding, ship-lap, vertical board and batten siding or wood shingles is appropriate for the aesthetic of the Park. Plaster is also allowed. However, it should not be the dominant finish but instead used in contrast with other materials.

Fenestration including windows and doors shall be incorporated into facades facing public streets. At least 25% of the total building facade length facing a public street shall be fenestrated. Where spaces which do not allow fenestration occur at these locations, other forms of articulation which provide visual variety shall be incorporated at a minimum interval of 40'.

Ground-level retail in mixed-use building may be predominately store-front glass systems. Upper residential floors of mixed-use buildings should be clad with more traditional residential materials. Wall treatments for larger single family residences and multifamily buildings should be broken down where ground level walls might have a stucco-like character and upper levels may be typically more board and batten and wood-like. Within groupings of homes, a variety of wall materials, textures and treatments should be used to provide variety.

*Wood shingles and trims with plaster base and stone wall*

### Wood Siding

The use of wood or wood-like siding systems including horizontal or vertical siding, ship-lap, and board-and batten is encouraged. It is also encouraged that a variety of wood siding not only be used throughout a project but also within individual structures.

### Broad Corners & Base Trims

It is encouraged that broad corner and base trims be used to complement the trims around doors, windows, soffits, wainscots or any combination thereof. The prominence of wood trims integrated on exterior walls, such as headers at the top of the wall transitioning to the soffit is also encouraged. Trims should be painted in a manner that accents their forms.

### Wood Shingle

Wood shingle should be used as a common wall material. The use of several shingle types within the same project or even the same structure is encouraged. Shingle may be used in combination with horizontal or vertical wood siding or plaster. Shingles must be painted. They might be expressed in a variety of shapes such as fish scale and irregular forms.

### Stone/Rock

The use of local stone, rock, and synthetic stone consistent with the look of local stone is encouraged. Stone and rock may be used especially for base, porch and exterior walls and gardens. Rock should be used as an accent and not as the predominant exterior wall material. When synthetic stone is used it should mimic stone that exists in existing structures on the Island.

### Plaster

Plaster or plaster-like exterior wall systems may be used in a manner subordinate to, and supportive of, other material systems. Large plaster surfaces will not be allowed. Plaster walls should be trimmed with wood when supportive of wood exterior wall systems.

*Use of wood pannels and high glass windows in office buildings*

# Entries & Balconies

*Stoop up to second level with entrance to street level unit tucked to the side.*

## Entries

Commercial and residential entries should have distinctive forms resulting from their shapes, headers, details, building materials, structural details and unique doorways. Entries must face the public way, the street or entry court. Entries shall be treated with some form of sheltering element, such as canopies, portals or arcades, to protect people while entering. Canopies and awnings shall be of a durable material, integrated in material and color with the primary building architecture.

## Balconies

Balconies should be provided in residences where feasible. Balconies provide a form of expression in elevations and well designed railings are decorative elements.

# Lanais & Stoops

*Stoop used for front entry to a local home*

Lanais are a uniquely Hawaiian architectural form. Along with stoops - covered entryways that are either recessed into or protrude from facades - they should feature prominently in the residential areas of the Park. Not only can their design give a sense of individuality and variety to similar home plans, but they serve an important function as intermediate spaces between the public and private realms. Entry lanais are a place of receiving guests and meeting neighbors.

The steps and railings of lanais and stoops provide a physical separation and a psychological sense of protection, creating a comfortable place from which to view and interact in the street scene. As bridges between the inside and outside, they also provide shelter from the elements, offering a dry place to look for keys on rainy days, or a shaded place to sit on warm days. Residences should have lanai spaces off of the kitchen or family room fronting private yards when possible. Lanais should be large enough for outdoor sitting and dining.

## Standards

All street-facing ground floor units in multifamily buildings shall have individual entries to the street. It is encouraged that ground floor units that do not face a street have individual entries to a walkway or court.

In general, all single-family homes shall have an entry lanai where possible.

Homes without lanais shall have stoops.

Homes on corner lots shall have lanais (wrap-around lanais are encouraged).

To differentiate home plans, lanais and stoops should vary in size, roof pitch, materials, and style.

Where possible, lanais should be elevated from grade to provide a physical transition between public, semipublic, and private zones.

*Usable, street-facing lanai*

*Front entry lanai for sitting with balcony above*

*Trellis entrances for Mixed-Use buildings*

*Stoop entrance for Multi-family building*

# Doors

Example of retail doors

Example of residential entry doors

Entry doors should be attractive and inviting. All exterior doors should be paneled and glazed to the extent practicable, especially for entry doors to residences and commercial spaces.

Glazing on entry doors should utilize small light panes. Screened doors may be used for through ventilation especially on residences.

Doors should be painted colors that contrast with adjacent wall surfaces of the homes or buildings. Trims around doors should be broad and painted to contrast with adjacent wall surface.

Example of retail doors

High glass doors with metal frames in Mixed-Use building

# Windows

*Residential windows facing the street*

*Example of local storefronts using double-hung windows*

*Trims highlighted with a bright white*

Windows are to be traditional in shape and form. Double hung, casement and awning windows may be used, but jalousie windows are discouraged.

Broad "picture windows" are discouraged. Multiple windows should be used instead of large picture windows in areas such as living rooms where large penetrations are desirable.

Window shutters, eyebrows, sunshades and screens are encouraged. Detail elements, frames and exterior screens for windows must be appropriately colored.

Windows shall be shaded by some form of architectural treatment as appropriate based on their relative solar orientation. Shading on southeast to west facing facades is the highest priority. This can be accomplished with either added shading elements, deep overhangs, or recessing windows into thickened exterior walls.

In retail buildings, glazing within a facade which adjoins a public street, pedestrian walk or bikeway shall be clear, untinted glass.

Mirrored glass is not permitted.

*Window shading with projections, screenshades or awnings*

# Decorative Elements & Details

*Decorative Braces and Window Shades*

Decorative elements and details which give projects individual character and human scale should be incorporated into the buildings. These details may range from exposed timber, trims, rafter tails, braces, or structural systems, to vents, exterior lights and sconces.

Decorative grills, patterns, trims, and other elements which reflect cultural or naturalistic patterns of the island are encouraged. Patterned grills in walls and roof vents are encouraged. Exterior hand railing that goes beyond vertical pickets is encouraged.

*Variations in Railing Design*

*High glass windows for lighting in Office building*

# Color

*Red tile roof in Wailuku (above) and green metal roof on a home (below)*

*Earth Tones with Vivid Use of Color on Sunshades and Shutters (above) and Vivid reds and greens used in local towns (below)*

*Good combination of materials and colors for more attractive facades*

*Color palettes shall promote variety even within same building groups.*

### Wall Colors

A variety of color is encouraged within the range of earth tones while more vivid colors can be used in the mixed-use center. Traditionally, the vivid colors used in town centers ranged from deep brown, mustard and red to various greens and tans. An attractive, strong composition of compatible colors is encouraged.

### Trims and Accent Colors

Typically, color is used to highlight and differentiate the trim from the building. The combination of several colors on individual facades is encouraged with the minimum requirement being that the exterior wall and trims be differentiated.

### Roof Colors

Roofs are often colored if they are made of metal. Roof materials and colors shall complement the colors and materials of the structure to which they are attached. In general, roof colors should be earth tones in the medium range. Accent colors may be used.

# Fences and Freestanding Walls

The design and materials for walls and fences shall be coordinated with the design and materials of the principal buildings in terms of color, quality, scale and detail.

Where visible where visible from the public right of way, prohibited materials are Portland gray, plain face CMU; fluted CMU; and chain link fencing and concertina wire, except for certain security reasons and with approval by the Park.

The location of any walls or fences exceeding four feet in height closer to a public street than the maximum setback must be approved by the Park. Such walls or fences shall provide variety and articulation at intervals not exceeding 50 feet through either changes in plane or an expression of structure such as a post, column, or pilaster.

*Walls and buffering vegetation create pleasing separations between spaces*

*Traditional lava rock wall with subtle design elements and plantings*

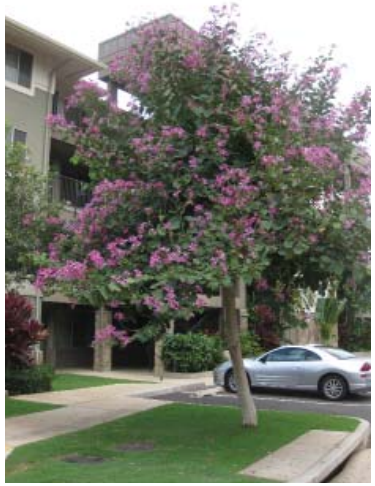
# LANDSCAPE GUIDELINES

In addition to the landscaping requirements set forth in County of Maui Code, 19.36A 'Off-Street Parking and Loading' and the Maui County Planting Plan, the following guidelines are presented with the intention of enhancing the daily experience of the MRTP residents, workers and visitors. These guidelines contribute to a well-planned street tree planting scheme and can be the visual thread that unifies a development, while providing visual appeal, comfort and identity. Landscape planting and irrigation plans shall be prepared for all development at the MRTP, except single-family developments.

*Pink tecoma trees along Market Street, Wailuku*

*Kihei is primarily hot and dry. A well-shaded area offers welcome relief. Monkey pod tree (background) and Plumeria tree (foreground)*

*Shower trees providing shade along Vevau Street, Kahului*



*Hong Kong orchid tree providing shade*

*A large monkey pod tree providing shade*

# General Guidelines

• Landscaping shall be used to enhance the natural site, compliment the built environment, encourage pedestrian circulation, and provide visual variety, color and shade.

• Parking lots shall be landscaped with shade canopy trees and screened from view from adjacent street frontages and neighboring properties with the use of hedges and fences or walls in compliance with Maui County Code 19.36A.

• Native (endemic and indigenous) and Polynesian-introduced plants shall be used to the greatest extent possible.

• Maintain mountain and ocean views.

• Use fewer species of plants, but more of one species to maintain a strong composition. Repetition can be used to create unity.

• Plant material should be matched to appropriate micro-climates and rainfall rates in the Kihei region. Rainfall ranges from ½-inch to 5-inches annually, but can vary, locally, depending on leeward or windward aspects.

• Use plant screening material to block visually unappealing sites such as trash enclosures, transformers and loading areas. Comply with Maui Electric Company recommendations when planting near electrical equipment.

• Do not plant invasive species (as determined by Hawaii Invasive Species Council).

• Irrigation is required for all newly installed plant material.

• This use of drought-tolerant plants and drip-irrigation is encouraged.

• All irrigation must comply with the State Department of Health Regulations for the use of R-1 water.

*Joannis Palm with golden duranta shrubs, Kahului*

# Tree Guidelines

• Consider growth rate, color, time of flower & fruit, fragrance, leaf litter, wind resistance, form, size and shade when selecting trees.

• Transplant rather than eliminate mature trees where feasible. Mature trees are generally greater than 6-inch trunk diameter.

• Shade trees should be used where pedestrians gather or frequently walk

• Tall (columnar or palm) species can be used to frame views.

• Tall (columnar or palm) species can be used where overhead space is limited

• New trees shall be a minimum of 15-gallon size & min. 2" caliper.

• All trees near hard surfaces shall be planted with root barriers at a minimum 2-foot depth.

• Trees within 30-feet of power lines should not be higher than 30-feet tall at maturity.

• Do not plant trees with nuts or fruit that could fall and create tripping hazards near sidewalks or in parking lots.

• Parking lot trees should have a mature canopy spread of min. 20-ft. and preferably 35-ft.

• Plant fruit trees sparingly as rotting fruit can become a maintenance issue.

• Do not plant trees in such a way that will contact buildings or block signs.

• Do not plant trees on top of underground utilities.

• Do not plant trees with aggressive roots near underground utilities or hard surfaces.

• Select trees near intersections that can be pruned so as to not obstruct safe travel and sight lines.

• Do not plant large trees near walls.

• Do not plant trees where roots can invade and damage nearby properties.

• To provide shade and minimize the effects of solar radiation in parking areas, 1 canopy shade tree of minimum 2" caliper size and 6'-0" planted height shall be required for every 5 parking stalls (or portion thereof). Shade trees shall be evenly distributed. Refer to the Maui County Code Chapter 19.36A "Off-street Parking and Loading".

• Vertical form trees shall be planted along the front yard perimeter of parking structures to reduce the visual impact of blank walls and parked vehicles. A tree shall be planted for every 20-feet of linear building length.

• Street trees should be planted no closer than the following horizontal distances:

5 ft. from storm drain

8 ft. from water main or lateral or meter

10 ft. from fire hydrant

15 ft. from utility pole

*Coconut palms with seashore paspalum turf grass at Kai Makani, Kihei*

*Flower of the Jatropha tree*

*Macarthur palms provide screening*

# Recommended Tree Species

20 ft. from electrical transformer

The following are recommendations for trees in the MRTP.

### Large Trees

1. COCONUT PALM – Cocos nucifera "Green"
2. GOLD TREE – Tabebuia donnell-smithii
3. KAMANI - Calophyllum inophyllum
4. KUKUI - Aleurites moluccana
5. MONKEY POD - Samanea saman
6. NARRA – Pterocarpus indicus
7. ROYAL POINCIANA - Delonix regia
8. RAINBOW SHOWER - Cassia fistula x javanica
9. ROYAL PALM - Roystonea regia

### Medium Trees

10. BLACK PALM - Normanbya normanbyi
11. HALA – Pandanus tectorius
12. HAWAIIAN KOU – Cordia subcordata
13. HELIOTROPE - Tournefortia argentea
14. FERN TREE - Filicium decipiens
15. FIJI FAN PALM - Pritchardia pacifica OR thurstonii
16. JOANNIS PALM - Veitchia joaniss
17. LOULU PALM – Pritchardia affinis
18. MILO - Thespesia populnea
19. ORCHID TREE - Bauhinia x blakiana
20. 'OHI'A LEHUA - Metrosideros polymorpha
21. PINK TECOMA - Tabebuia heterophylla
22. QUEEN PALM – Cocos plumose

### Small Trees

23. ALAHE'E - Psydrax odorata (form.Canthium odoratum)
24. GEIGER TREE – Cordia sebestena
25. JATROPHA – Jatropha integerrima
26. MACARTHUR PALM - Ptychosperma macarthurii
27. MANILA PALM - Veitchia merrillii
28. 'OHE MAKAI - Reynoldsia sandwicensis
29. PLUMERIA - Plumeria obtuse 'Singapore'
30. WAUKE – Paper Mulberry - Broussonetia papyifera

*Purple lantana groundcover - 3 months after planting from 4-inch pots*

# Shrubs and Groundcover Guidelines

- Do not plant shrubs over 3-ft. high in view corridors.
- All shrub plantings shall comply with the Maui County Code 12.20 “Hedges at Intersections”.
- Do not plant shrubs or groundcover with thorns near walkways (unless the intent is to create a barrier planting).
- Do not plant shrubs or groundcover with poisonous fruit if accessible to pedestrians.

*Natal plum has thorns, placement should be well-considered*

*The native hala tree growing with beach naupaka shrubs*

*Queen Emma lily with ice plant groundcover throughout*

# Recommended Shrub and Groundcover Species

The following are recommendations for shrubs & ground-cover in the MRTP.

## Shrubs

1. AKIA – Wikstroemia uva-ursi
2. BEACH VITEX - Vitex rotundifolia
3. BIRD-OF-PARADISE - Strelitzia reginae
4. BOUGAINVILLEA – Bougainvillea spp.
5. CROTON - Codiaeum variegatum
6. GOLDEN DURANTA - Duranta repens 'goldii'
7. HIBISCUS - Hibiscus waimeae
8. HO'AWA - Pittosporum hosmeri
9. INDIAN HAWTHORN – Rhaphiolepis indica
10. KULU'I - Nototrichium sandwicensis
11. NAUPAKA – Scaevola taccada
12. NATAL PLUM - Carrissa macrocarpa
13. PIKAKE – Jasmine Sambac
14. SPIDER LILY OR QUEEN EMMA LILY - Crinum augustum
15. RED GINGER – Alpinia purpurata
16. RED / GREEN TI – Cordyline fruiticosa
17. ULEI – Osteomeles anthyllidifolia

## Groundcover

18. ALLAMANDA – Allamanda cathartica "Dwarf"
19. ILIMA PAPA - Sida fallax
20. ICE PLANT – Sesuvium spp.
21. LANTANA – Lantana montevidensis
22. LAUAE FERN – Phymatosorus grossus "Dwarf"
23. MAIAPILO – Capparis sandwichiana
24. NEHE – Lipochaeta integrifolia "Dwarf"
25. RHOEO – Tradescantia spathecea "Dwarf"
26. UKI UKI - Dianella sandwicensis
27. KUPUKUPU - Nephrolepis exaltata

## Turf Grass

28. SALT-TOLERANT : SEASHORE PASPALUM - Paspalum vaginatum
29. SHADE-TOLERANT : St. AUGUSTINE - Steno taphrum secundatum
30. HIGH TRAFFIC : ZOYSIA 'EL TORO' - Steno taphrum secundatum

*Rhoeo groundcover with a spider lily plant*

# UNIVERSAL DESIGN

Universal Design is making environments accessible to as many people as possible, regardless of physical ability. Accessibility is typically required of commercial buildings. For residential buildings, Universal Design is advisable even where not required because it enhances the ability of seniors and the disabled to live independently. Incorporating Universal Design strategies into homes also makes good business sense by expanding the market to a broader range of potential home buyers. It also promotes sustainability by enabling residents to more easily adapt their homes throughout their lifetimes as their needs change with aging, illness, or injury.

Residential visitability is a characteristic of Universal Design that allows for the main level of any home to be accessible to visitors with limited mobility. The three most elementary features necessary for basic access, listed below, are strongly recommended:

A “zero-step” entrance should be provided to each home. It can be located anywhere but should be placed on a route that has no steps, steep slopes, or abrupt level changes from the driveway, sidewalk, or point of arrival. “Zero step” means that the there is a maximum of ¾ inch of level change at the threshold and that the threshold is beveled.

Main floor interior passage doors, including bathroom doors, should have a minimum of 32 inches of clear passage space.

A half-bath, and preferably a full bath, should be provided on the main floor.

In addition, all dwelling units shall comply with the following standards:

Where accessible units are provided, ensure the compatibility of ramps, landings and railings with the architectural design.

*“Zero step” front lanai allow universal access to a house or business*

# GREEN BUILDING STANDARDS

*Designing for building-scale bicycle facilities helps promote greener modes of travel*

*Solar technology can replace conventional energy sources in sun-rich Hawaii*

Employing green building standards to regulate new construction is an excellent way to guarantee a level of environmental integrity. By using creative strategies in architecture, engineering and urbanism, green buildings reduce the overall impact of the built environment on human health and the natural environment. While a number of green building certification systems exist today, all yield benefits in their own regard.

In addition to controlling a building's geometry, size, materials and architecture, green standards stress the importance of an appropriate site for construction, proper building orientation on that site, connectivity to transit, and the efficiency of all building systems. Strategies such as climate-responsive design, passive solar, low-flow water fixtures and double glazed windows assure that the building will significantly reduce its demand on the environment over its lifespan. The benefits are noted not only in a green building's reduced consumption, yet also in the health of all who use it.

Among the benefits of a green building is its capacity to:

- Reduce energy consumption and building operating costs
- Reduce waste streams
- Improve water and air quality
- Improve worker productivity
- Enhance comfort and health
- Enhance and protect biodiversity and ecosystems
- Minimize strain on local infrastructure

Buildings within the park are encouraged to pursue LEED certification.

## Green Roofs

Consistent with its vision for environmentally-conscious growth, the Park allows the use of green roofs. Buildings using a green roof are relieved of the requirements for roof pitch. Among the benefits provided by a green roof are its capacity to improve environmental integrity, regulate building temperatures, reduce interior noise levels and provide additional open space for public enjoyment.

The choice of vegetation used on rooftops will take into consideration issues of irrigation, maintenance, and weight. The right rooftop materials will allow for maximum water harvesting. A proper plant palette will allow for a playful and colorful aesthetic as well as provide an improved air quality and microclimate. It can also encourage a diverse habitat where birds, butterflies and other insects are attracted.

The plant and soil matter of a green roof create thermal insulation that provides for a more comfortable atmosphere within the building. The natural processes of plant and soil matter absorb sunlight in warmer weather, reducing the heat island effect.

As compared to a roof with conventional construction, green roofs also offer a noticeable level of sound reduction. Reducing noise pollution is particularly important in areas with heavy noise pollution, such as alongside highways, railways or beneath aircraft flights. The Park does not suffer from high levels of noise pollution, but green roofs may serve to reduce any spillover sound from Pi'ilani Highway.

Green roofs have the capacity to give ordinary buildings extraordinary open spaces and create new habitats. Their elevated position accommodates unique vistas and provides a more enjoyable rooftop aesthetic for surrounding buildings.

# 7 - IMPLEMENTATION

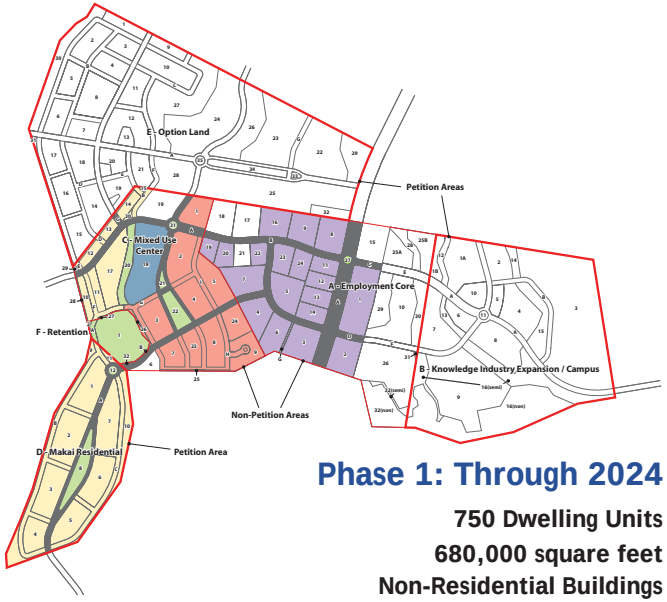

Phasing Concept 146

Project Design Review Process 147

# Phasing Concept

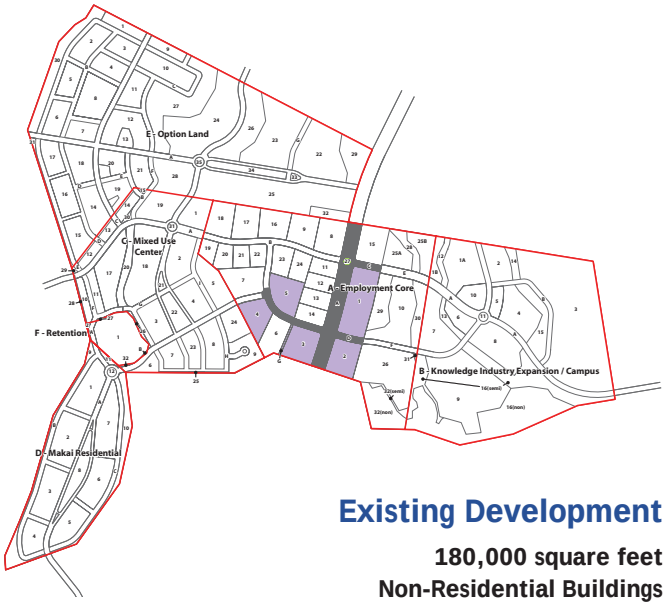
Phasing for the plan stresses flexibility. Given the uncertainty in economic development in general and in the volatile field of high technology in particular, the current phasing plan may change greatly. The amount of time it will take to update the existing Park regulations may also cause the schedule to change. The graphics here illustrate the current concept for development of the park, showing existing development, phase / increment 1, and phase / increment 2. These phases work with the Park's current understanding of the demand for residential and non-residential space on Maui. These plans are by nature an approximation, a good faith guess about the Park's development.

In any case, infrastructure within the Park and associated infrastructure improvements outside the Park will be coordinated with the pace of development. A more detailed consideration of these issues can be found in the Park's Incremental Plan.



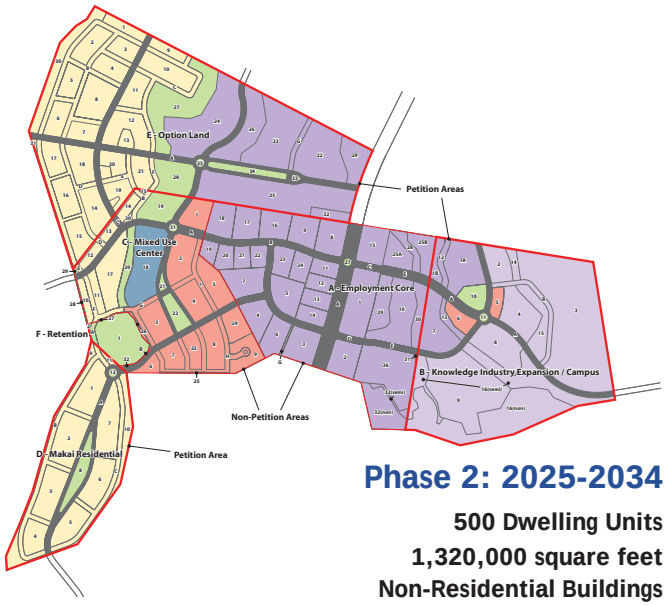

## Phase 1: Through 2024

**750 Dwelling Units**
**680,000 square feet**
**Non-Residential Buildings**




## Existing Development

**180,000 square feet**
**Non-Residential Buildings**




## Phase 2: 2025-2034

**500 Dwelling Units**
**1,320,000 square feet**
**Non-Residential Buildings**

# Project Design Review Process

## Purpose

The purpose of this design review process is to ensure that all development projects at the Maui Research and Technology Park conform to and implement the design concepts and themes set forth in this Development Code and thus contribute to the overall environmental quality desired for the community.

## Applicability

Any construction, installation or alteration upon any lot, building, or other type of structure, or change to surface drainage, may be undertaken only after review and approval in accordance with these procedures.

Nothing herein removes or otherwise affects the responsibility of each project applicant and designer for satisfying all applicable laws, codes and ordinances, and for obtaining all permits and approvals required by law.

## Participants

Maui R&T Partners, LLC (the "Park owner"), and on future delegation by the Park owner, the Maui R&T Park Owners Association, retains design review of projects for all developments within the Park.

In order to assist in the review of projects and interpretation of the provisions of the Development Code, the Park owner will establish a Design Review Board (DRB). The DRB will be comprised of but not limited to professionals in the fields of architecture, planning, sustainability, landscape architecture and engineering.

## General Review Standards

In reviewing plans and specifications, the DRB and the Park owner will be concerned with site planning, the overall design concept, and the details of the design. General concerns will include whether the proposed project:

- Contributes to the implementation of the major themes, planning concepts, architectural typologies and other key design elements set forth in the Development Code.
- Is compatible and in harmony with existing and approved structures and other improvements in the area in terms of exterior design, quality and type of materials and workmanship, and relationship to topography and ground elevation.
- In all other respects including landscape design constitutes a suitable and adequate development of the Park.
- Furthers resource conservation through energy efficiency, water conservation, recycling and other environmentally sensible practices.

Plans found to be inconsistent with Development Code concepts or themes shall be rejected. Major variations from the standards and guidelines contained in this document shall also be rejected. Determinations of consistency, and of whether a project constitutes a "suitable and adequate" development, shall be at the sole discretion of the Park owner.

## Minor and Major Projects

Separate processes are established for the review of "Minor Projects" and "Major Projects." Examples of minor projects include the addition of small structures, changing a building's color, the adding of awnings at ground level, or replacing plant material. The determination of which process is to be applied to each project rests solely with the Park owner.

## Review Procedures: Minor Projects

Upon notice of proposed action, the Park owner will determine whether the project will qualify for minor project processing. If so qualified, the Park owner will consult

*Note: This section explains the process of design review internal to the Park. The revised Maui County Code section which discusses the Park explains the separate, expedited County approval process for construction projects in the Park.*

the chairperson and/or appointed members of the DRB. The entire DRB need not be convened.

The Park owner and consulted DRB members will review the project at its various stages, generally through correspondence. Phases of the review will generally be as follows:

### Pre-Schematic Design Submittal

At the initiation of the project, a verbal and graphic submission should be made which outlines the intent of the action, describes its major characteristics, and briefly assess its impacts on any existing or approved site improvements and adjacent properties.

### Schematic Design Submittal

Upon approval at the Conceptual Phase, appropriate drawings should be submitted for review. Emphasis should be given to relationships (setbacks, colors, materials, etc.) to adjacent properties and existing buildings on them, and to connections beyond the project site.

### Preliminary Design Submittal

Upon approval of the Schematic Design Phase, drawings further developed which confirm the major characteristics of the project, its relationship to adjoining facilities and the materials and methods of constructions should be submitted for approval.

### Final Design Submittal

Should approval be given at the Preliminary Design Phase, final drawings and other documents should be submitted for approval.

## Review Procedures: Major Projects

For actions which are determined to be major projects, the review process below will be followed.

### Pre-Schematic Design Meeting

This meeting is to include the following participants: the project architect, representatives of the Park owner, and a representative of the DRB.

The purpose of the meetings is to introduce the users and the project designers to the design and environmental goals of the Development Code, and to provide a context for further work and reviews. The applicability to the project of the design framework established in the Development Code will be discussed. Information regarding infrastructure and linking elements such as pedestrian ways, bikeways, roadways, and landscaping which require specific interfacing, will be clarified. Information regarding the character of the area and adjacent buildings will also be exchanged.

### Schematic Design Meeting

This meeting is to include the following participants: representative(s) of the applicant, the project architect, representatives of the Park owner, and the DRB.

At least seven days prior to the meeting, the applicant is to submit half-sized schematic plans for the proposed improvements to the Park owner (number of copies to be determined by the Park owner). The schematic plans should include sufficient information to show how the proposed design satisfies the parameters established at the Pre-Schematic Design Meeting and the development standards and specific provisions of the Development Code.

The DRB review will include the following:

a. Site plan considerations including traffic flow, pedestrian linkages, parking, service, etc. The site plan should show linkages and relationships to adjacent areas.

b. Overall building massing considering view planes, heights, setbacks, etc. All major sections and elevations should be indicated.

c. Building characteristics including architectural style, volumetric forms, building materials, colors, etc. Provision of perspective drawings and/or models is en-

couraged.

d. Landscape plans showing concept, general planting characteristics, rock and water work, etc.

e. Basic environmental effects (i.e., sunlight and shade exposure, wind velocity, drainage), especially on adjacent buildings.

f. Energy and water conservation methods utilized in the project.

g. Provisions for recycling and use of recycled material.

Whenever possible, the application review will be completed and recommendations and requirements arising from the review and meeting will be forwarded by the Park owner to the applicant within thirty (30) days of the meeting. Other meetings in the schematic stage may be necessary if the design is not initially approved. The Park owner may extend its initial review period to review plans for large projects or projects which it deems to require more intensive study.

### Design Development Meeting

This meeting is to include the following participants: the applicant, the project architect, any other appropriate consultants, representatives of the Park owner, and the DRB. At least seven days prior to the meeting, the applicant is to submit appropriate sets of half-sized design development plans and outline specifications and a cover letter addressing issues identified in the Schematic Design Meeting to the Park owner (number of copies to be determined by the Park owner).

The information to be provided on the preliminary design plans, and the concerns to be addressed in the DRB review, will include the following:

a. Review of site plan drawings at a scale of 1” = 40’ or larger. Such plans shall, at a minimum, include the following information: all building locations and size, dwelling types and unit counts, number of stories, roof overhangs and setbacks; locations of roads and walks; location and size of parking areas and/or parking structures, and a description of basic parking needs for the project including the ratio of compact to full size stalls; location and size of loading areas; locations, size and intended use of any recreational facilities, courtyards, water features, etc. Ground elevations with existing and finished grades, drainage, earthwork, utility lines, etc. should be indicated. Special attention should be given to relationships to adjacent properties. Also, energy conservation methods should be identified.

b. Review of floor plan drawings at a scale of at least 1/8” = 1’ for all building types. Special attention will be directed at public spaces such as entry lobbies, courtyards, restaurants, stores, etc.

c. Review of elevation drawings. Inclusion of perspective drawings and a model is encouraged. Special attention will be given to roof forms and materials, balcony and arcade treatments, elevator penthouses, mechanical stacks, trellises, etc. Proposed colors for the project will be considered.

d. Review of sections of the buildings and site. Attention will be given to any major changes in ground elevations in regard to their impacts on drainage, views and adjacent properties.

e. Review of landscape drawings. These drawings should show the location of all vegetation, plant species, size of specified plants, walks, landscape lighting, signs, paved areas, water features, rock work, etc.

f. Review of development timetable and phasing plans. The timing of construction and the location, size and sequence of the various phases should be indicated. Attention will be paid to the impacts of the project’s construction schedule on existing and other planned developments in the surrounding area.

The Design Development review will be completed within thirty (30) days, and a report forwarded by the Park owner to the applicant containing the recommendations and

requirements arising from the review and meeting. The Park owner may extend its review period to review plans for large projects or projects which it deems to require more intensive study.

Approval will depend on the extent to which the proposed design satisfies the objectives, standards and criteria established in previous reviews, as well as those identified in these Development Code. Other meetings in the preliminary design stage may be held if the design is not initially approved. In no case should the applicant proceed with construction documents prior to Design Development approval.

### Final Design Review

The DRB or a design professional retained by the Park owner will check construction documents for compliance to Design Development review comments. The appropriate number of sets of half-sized construction drawings and specifications should be submitted to the Park owner. Approval of the documents or a report listing required modifications will be forwarded by the Park owner to the applicant within thirty (30) days of their receipt. The Park owner may extend its review period to review plans for large projects or projects which are deemed to require more intensive study.

Construction documents approval by the Design Advisory Board and the Park owner does not constitute authorization to proceed with the project. Compliance with applicable codes, laws, ordinances, and government agency conditions of approval is the responsibility of the applicant and the project architect.

## Construction Review and Approval

### Duration of Final Approval

Any approval provided shall be effective for a period of 12 months, and shall be deemed revoked if the approved construction, reconstruction, refinishing, alteration, or other work approved thereby has not begun within the 12-month period. The Park owner may upon request extend the 12-month approval period.

If approval lapses hereunder, the owner or lessee shall be required to re-submit the final plans and specifications for approval. The DRB and the Park owner shall not be bound by any previous decision in reviewing such plans and specifications, but shall either approve or disapprove the same in writing within thirty (30) days after such resubmission.

### As-built Plans

Upon completion of construction, a complete set of as-built plans and specifications for infrastructure improvements will be provided to the Park owner.

## Variances

The Park owner, in consultation with the DRB, may in its sole discretion approve variances from this Development Code, if they are found to be minor in nature and consistent with the goals for the Maui Research and Technology Park, and if they meet high development standards. Variances found to be substantially inconsistent with the provisions of this document will not be approved through this procedure.

Applications to amend the Development Code and criteria in order to address substantive inconsistencies may be submitted for consideration, provided they are based on a clearly demonstrated hardship or practical difficulty.

## Fees

Professional fees and the expenses incurred by the DRB members in reviewing and approving plans will be paid by the applicant at each stage of the review.

# 8 - REFERENCE

Glossary 152

# Glossary

This section contains many general terms used within this document and in urban design more broadly. These are intended for general information. For detailed treatment of specific terms along with requirements (Accessory Unit, for example), see the text of this code as well as the section of the Maui County Code which discusses the Parl.

**Accessory Unit** - a separate dwelling unit that contains its own kitchen and bath facilities and is located on the same lot as a principal building.

**Average Net Density** – the number of dwelling units per acre within a block's extents. Streets, parks and large public open spaces are excluded from the calculation, while semi-private spaces such as courtyards, alleyways, and paseos are included.

**Block** – an area of land bounded by public roads or a project edge on all sides.

**Chapter 19.33 "Kihei Research and Technology Park District"** - the portion of the Maui County zoning code which regulates the Park. This section established regulations on things like land uses, setbacks, and lot coverage.

**Commercial** – office, research & development, retail, industrial, or other non-residential use.

**Commercial buildings** - buildings of non-residential use, including office, industrial, retail among other uses.

**Community Plan** - A community plan "provides specific recommendations to address the goals, objectives, and policies contained in the General Plan." "Implementation of the goals, objectives and policies contained in the Community Plan is defined through specific implementing actions, also set forth in each community plan. Implementing actions as well as broader policy recommendations are effectuated through various processes, including zoning, the capital improvements program, and the County budgeting process." (source: Kihei-Makena Community Plan, 1998)

**Entry** – the entrance of a commercial building or residence. This can be in the form of a portico, porch, lanai or stoop.

**Floor Area Ratio (FAR)** – the ratio of building floor area (including all buildings on site) to the land area of the associated parcel.

**Form-Based Code** - a method of regulating development which concentrates on the elements of physical form while allowing more flexibility in land use, as compared to standard zoning.

**Frontage** – the front facade of a structure along the primary street right of way.

**Height** – the number of stories of a building, measured from the highest (uphill) point of the building. Used sometimes instead of an absolute vertical measurement, regulating by the number of stories allows height variation based on differing floor to floor dimensions, even among buildings of the same building type, creating a more interesting and attractive landscape.

**Lot Area** – the total extent of surface, measured in a horizontal plane, within the parcel lines of a lot.

**Lot Coverage** - the total portion of the lot which is covered by building (also sometimes called Building Coverage). This includes the area located between and including the foundation walls of all structures on a lot, including garages and carports, but not including open exterior portals, porches, pergolas, lanais, covered entries, or trellis structures located within 3 feet of adjacent grade.

**Makai** - the direction toward the ocean shore.

**Mauka** - the direction away from the ocean, generally uphill and toward the mountain top.

**Orientation of a Building** - The direction of primary facade, primary entry or entries, and longest edge of the building.

**Outbuilding** - a separate structure on a residential parcel that may contain a garage, workshop, or accessory unit.

**Parapet** - an upward extension of an exterior wall that creates a low wall around the edge of a flat or nearly flat roof.

**Parcels** - individual parcels of land. Regulations on parcels (e.g. bicycle parking requirements) apply only if a parcel contains development.

**The Park** - the Maui Research and Technology Park.

**Parking** – vehicle parking for vehicles used to transport people (automobiles, small trucks, etc.).

**Paseo** - an exterior pedestrian passage, typically between 10 and 40 feet in width, that provides access to and frontage for buildings.

**Principal Building** - the main structure located on an individual parcel.

**Privacy Wall or Fence** - a wall between 5 and 6 feet high and constructed of solid opaque materials to create visual privacy.

**Public Right of Way** - Any of the roads in the Park's controlling plan, regardless of whether these roads are technically "public" or remain under the ownership of the Park.

**Screen Wall** - a wall or fence that provides screening of a service facility, such as a trash container, transformer, or parking area, from public view along a street or alley.

**Setback** – a line, parallel with and measured from the corresponding property line, which defines either the minimum or maximum distance from the property line in which the facade of a building may be constructed.

- When a setback is indicated as a minimum, the exterior building wall must be placed at or behind that line.
- When both a minimum and maximum are given, the exterior building wall may be placed anywhere in between the lines.
- When a setback is indicated as required, the building wall must be placed at that line.
- Eaves or roof overhangs are allowed within all required setbacks.
- When a separate side street setback is not indicated for a side street, the setback shall be the same as the side setback.
- When a separate side setback is not indicated for a garage, the garage shall have the same side setback as the principal building.

**Side Drive** - a residential or commercial driveway located along the side of the parcel and intended to provide access from the street to a garage or parking lot on the parcel.

**Tandem Garage** - a garage with parking spaces configured one behind the other and a single garage door for access.

APPENDIX R
Draft Kihei-Makena Community Plan Maui Research and Technology Park District

## Community Plan Description for the Maui Research and Technology Park

### Current:

***NAME: Project District 6 (R&T Park) 385 acres.***

*The research and technology park project district is located mauka of Piilani Highway between Waipuilani Gulch and Keokea Stream. The objective of the project district is to encourage the development of non-polluting research and technology on individual 1 to 5-acre sites planned and built in accordance with specific standards and guidelines as established by an appropriate county zoning ordinance. Design guidelines should encourage low-rise, low-density developments with ample setbacks and open space, underground utilities, and architectural and signage control is accordance with park's theme.*

### PROPOSED

### NAME: Maui Research and Technology Park (MRTP)

The following description and planning standards are provided in Chapter 8, Directed Growth Plan of the Maui Island Plan, adopted December 2012.

***Maui Research and Technology Park***
The MRTP was the vision of a core group of community leaders in the early 1980s who sought to diversify the economic and employment base on Maui beyond tourism and agriculture. Today, the MRTP is home to a diverse range of companies and government projects that together employ approximately 400 persons in high-technology and related industries. The MRTP is envisioned to continue to be a major employment generator for Maui. The Park's mission of job creation and diversification of the island's economy remains one of vital importance.

**Planned Growth Area Rationale**
Since the opening of the MRTP, experts in the field of economic development have gained a better understanding of innovation clusters and the needs of knowledge workers and businesses. Technology businesses thrive in areas of diversity and activity. A diversity of businesses and workers, and the availability of a variety of commercial and industrial spaces, enhance the viability and success of individual businesses. The intent of the MRTP planned growth area is to create opportunities for a broader range of desirable knowledge-based and emerging industries,(16) which will provide high-skilled and well-paying jobs for Maui residents. As the MRTP develops, it should utilize the principles of new urbanism, smart growth, and the Association of University Research Park's "Power of Place" study to create a community of innovation.

This includes providing diverse housing options within close proximity of the MRTP's employment, and integrating neighborhood-serving retail, civic, and commercial uses in a manner that encourages bicycling, walking, and public transport. The growth area

may also include exhibit halls and meeting space to support the development of the research and technology sector, and to serve the broader needs of South and Central Maui. Build-out of the MRTP should be coordinated with the development of the neighboring Kīhei Mauka planned growth area to ensure efficient intra- and inter-regional transportation connectivity for both motorized and non-motorized transportation. The MRTP should also develop pedestrian and bicycle linkages between the future Kīhei High School and the core commercial and civic uses within Central Kīhei. The MRTP planned growth area is located on Directed Growth Map #S1.

**Table 8 - 12 : MRTP Planned Growth Area**

***Background Information:***
Project Name*:* Maui Research and Technology Park Directed Growth Map #: S1
Type of Growth: Urban Expansion Gross Site Acreage: 437 Acres

***Planning Guidelines***
Dwelling Unit Count: Approximately 1,250 Units (17)

Residential Product Mix: Balance of SF and MF units

Net Residential Density: 9-20 du/acre Commercial: Neighborhood serving retail and commercial

Net acres dedicated to non knowledge-based employment (parks, civic, residential, commercial)

(16) Industries characterized by highly-skilled workers in fields such as science and research, biotechnology, clean technology, information technology, disaster mitigation, education, healthcare and medicine, media production as well as other industries supported in the Emerging Sector's Subelement, Chapter 4, MIP.
(17) Additional units may be permitted through a transfer of development rights program or to provide affordable housing in excess of what is required by law. Unit counts may be further defined through the entitlement process in response to infrastructure and environmental constraints.

APPENDIX S
Affordable Housing Assessment

THE HALLSTROM GROUP INC.
REAL ESTATE
CONSULTANTS
& APPRAISERS

October 24, 2012

Mr. Steve Perkins
Pacific Rim Land, Inc.
P.O. Box 220
1300 North Holopono, Suite 201
Kihei, Hawaii 96753

**Affordable Housing Assessment of the**
**Proposed Maui Research & Technology Park**
**Proposed Master Plan, Kihei, Maui, Hawaii**

Dear Mr. Perkins:

At your request, we have completed an assessment of the proposed Maui Research & Technology Park ("MRTP") master plan in regards to adherence with State of Hawaii and Maui County affordable housing requirements and other workforce housing issues that may be associated with its development.

This letter summarizes the results of our initial analysis, focused on answering six basic questions:

1. What is the projected pricing structure of the MRTP housing inventory?

2. How many of the units will meet established pricing guidelines?

3. Is the number of units sufficient to fulfill statutory requirements?

4. Is the developer willing to commit to meeting the statutory requirements?

5. What will be the impact on workforce/affordable housing demand as a result of in-migration or workers to the MRTP?

6. Will the MRTP inventory be sufficient to meet in-migration housing impacts?

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Based on our review of the subject residential product design, current market pricing levels, prevailing Maui affordable pricing guidelines, and investigation/quantification of in-migration factors, we conclude the proposed MRTP master plan will provide sufficient numbers of appropriately-priced units to meet State and Maui affordable housing requirements and those created by in-migrating workers in the Park.

Projected Pricing Structure of MRTP Housing Inventory

The proposed MRTP master plan calls for a total of 1,250 residential units conceptually divided between product types as follows:

- **Multifamily** -- 250 units (20 percent of the total units), with current market prices ranging from $280,000 to $400,000.

- **Townhouse** -– 250 units (20 percent of total), with current market prices ranging from $400,000 to $650,000.

- **Houselots** -- 175 parcels (14 percent of total), with current market prices ranging from $225,000 to $450,000.

- **Finished Houses** -- 575 homes (46 percent of total), with current market prices ranging from $640,000 to $1,000,000.

The estimated current prices are based on prevailing trends in the South Maui housing market for comparable properties and projected development/construction costs.

Projected Pricing Structure Relative to Affordability Guidelines

The proposed MRTP residential products will fall into the designated affordability groups for Maui households as shown below. Affordability pricing calculations are based on a median household income for Maui in 2012 ($77,100), a five percent down payment, and a 30 year mortgage loan at a 4.5 percent annual interest rate; which is moderate to high in the current financing market.

- **Multifamily** -– "Affordable" to households earning from 70 percent of median income ("Low Income") to 100 percent of median income ("Below Moderate").

- **Townhouse** -– "Affordable" to households earning from 100 percent of median income ("Below Moderate") to 140 percent of median income ("Above Moderate").

- **Houselots –-** Pricing guidelines are not directly applicable. However, the completed homes on the lots would likely have values/prices at the very upper-end of the affordability spectrum ("Gap Income", 140% to 160% of median income) or at "market" levels.

- **Finished Houses –-** "Market" priced for households earning 160 percent or more of median income levels.

A total of 500 units within the project, or 40 percent of the total planned, would have current prices meeting 2012 affordability pricing guidelines for Maui; and, 54 percent of the total inventory would have selling prices of under $600,000.

The inventory types, unit counts, estimated price ranges, and affordability status for the proposed MRTP residential component are summarized on Table 1, on a total basis for the overall project, and as broken-down between the existing entitled area and the petition area seeking entitlements.

Sufficiency of Inventory to Meet Affordability Requirements

The Maui County "Residential Workforce Housing Policy" (Chapter 2.96 Code of Ordinances) calls for all proposed residential developments having five or more units/lots to provide significant numbers of affordably-priced units in accordance with:

- Whether the workforce housing units are built on-site (within the master planned community) or off-site; and

- If more or less than 50 percent of the new units and lots are priced under $600,000.

MRTP will build the workforce/affordable housing units on-site, and 54 percent of the total new units and lots developed are planned to be offered at prices under $600,000.

Under such conditions, the "residential workforce housing requirement is satisfied" when "at least twenty-five percent of the total number of units and/or lots shall be sold or rented to residents within the income-qualified groups" (Chapter 2.96.040, A.1.)

Application of the 25 percent of total units requirement means MRTP must offer 313 units having prices meeting affordability guidelines. As noted foregoing, it is expected that 40 percent of the proposed subject product (500 units) will be within such standards.

TABLE 1

**ESTIMATED SALES PRICES AND AFFORDABILITY STATUS FOR THE RESIDENTIAL COMPONENTS OF THE PROJECT AS ALLOCATED BETWEEN PETITION AND ENTITLED AREAS**
**Workforce/Affordable Housing Analysis of the Proposed MRTP Master Plan**
**Kihei, Maui, Hawaii**

| Residential Unit Types | Petition Area | | | Entitled Area | | | Total Project | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total No. of Units (Pct. of Total) | Estimated Price Range | Affordability Status | Total No. of Units | Estimated Price Range | Affordability Status | Total No. of Units | Estimated Price Range | Affordability Status |
| **Multifamily** | 50 | $280,000 to $400,000 | Affordable -- 70% to 100% of Median | 200 | $280,000 to $400,000 | Affordable -- 70% to 100% of Median | 250 | $280,000 to $400,000 | Affordable -- 70% to 100% of Median |
| Percent of Total Units | 5.9% | | | 50.0% | | | 20.0% | | |
| **Townhouse** | 100 | $400,000 to $560,000 | Affordable -- 100% to 140% of Median | 150 | $400,000 to $560,000 | Affordable -- 100% to 140% of Median | 250 | $400,000 to $560,000 | Affordable -- 100% to 140% of Median |
| Percent of Total Units | 11.8% | | | 37.5% | | | 20.0% | | |
| **Single Family** | | | | | | | | | |
| Vacant Home Sites | 155 | $225,000 to $450,000 | N/A | 20 | $225,000 to $450,000 | N/A | 175 | $225,000 to $450,000 | N/A |
| Percent of Total Units | 18.2% | | | 5.0% | | | 14.0% | | |
| Finished Homes | 545 | $640,000 to $1,000,000 | Market -- 160% and Up of Median | 30 | $640,000 to $1,000,000 | Market -- 160% and Up of Median | 575 | $640,000 to $1,000,000 | Market -- 160% and Up of Median |
| Percent of Total Units | 64.1% | | | 7.5% | | | 46.0% | | |
| **Totals All Units** | **850** | | | **400** | | | **1,250** | | |
| Percentage | 100.0% | | | 100.0% | | | 100.0% | | |
| **Units/Lots Priced Under $600,000** | **305** | | | **370** | | | **675** | | |
| Percentage of Total | 35.9% | | | 92.5% | | | 54.0% | | |

Source: The Hallstrom Group, Inc.

MRTP will provide sufficient inventory to meet Maui County affordability requirements. It will also meet prevailing State of Hawaii affordability requirements, which typically call for a 20 percent workforce housing set-aside.

It is noted, that should a business hotel be constructed in MRTP, the responsibility for meeting any workforce housing requirements associated with that use will be the specific, independent responsibility of the hotel developer.

Developer Willingness to Meeting Affordability Requirements

The developer has confirmed to us their willingness to commit to meeting Maui County workforce housing requirements calling for 313 MRTP units (25 percent of the total)having sales prices "affordable" to the identified household income groups.

The developer will also commit to meeting the other requirements of the Maui ordinance; specifically, the provision of at least 60 percent of the workforce housing units to be priced as affordable for "below-moderate" and "moderate" income households.

Housing Impact for In-Migration Associated with MRTP Workers

We have estimated the number of in-migrating, full-time workers which will be added to the resident population of Maui by build-out of the business park over two decades and their associated demand for affordably-priced housing.

As shown on Table 2, in-migration has historically accounted for between 55 and 60 percent of the net Maui population increase since 1970 during the course of each decade, with wide variance from year-to-year (in 2011 only 29 percent of growth was due to in-migration).

As the resident population increases, the meteoric expansion of the island's economy over the past half-century slows, lessening numbers of resort hotel rooms are built, and the evolution from an agrarian to service-based economy is completed, we anticipate the ratio of in-migration to total population growth will stabilize at about 50 percent by the time MRTP is built-out. And, that the ratio of households per jobs will be at about .59.

Application of these forecasts to the projected employment totals of the Park (taken from our previously submitted economic impact analysis), with the appropriate adjustments are shown on Table 3.

Within the calculations, we have integrated several pertinent factors/adjustments for:

TABLE 2

**HISTORIC AND PROJECTED POPULATION, JOB AND HOUSEHOLD COUNTS**
**FOR MAUI COUNTY 1970 TO 2035**
**Workforce/Affordable Housing Analysis of the Proposed MRTP Master Plan**
**Kihei, Maui, Hawaii**

| | Historic | | | | | Current | Projected | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1970 | 1980 | 1990 | 2000 | 2010 | Yr-end 2011 | 2015 | 2020 | 2025 | 2030 | 2035 |
| **1. Resident Population of County (1)** | **46,156** | **71,600** | **101,709** | **129,078** | **155,214** | **156,764** | **168,000** | **181,000** | **194,200** | **207,300** | **220,200** |
| Numerical Change During Period | | 25,444 | 30,109 | 27,369 | 26,136 | 1,845 | 12,786 | 13,000 | 13,200 | 13,100 | 12,900 |
| % Avg Annual Chg | | 5.5% | 4.2% | 2.7% | 2.0% | 1.2% | 1.6% | 1.5% | 1.5% | 1.3% | 1.2% |
| Increase Due to Natural Growth (2) | | 11,412 | 11,580 | 11,301 | 10,729 | 1,320 | 5,370 | 5,850 | 6,204 | 6,419 | 6,450 |
| Natural Growth as % of Total Population Change | | 44.9% | 38.5% | 41.3% | 41.1% | 71.5% | 42.0% | 45.0% | 47.0% | 49.0% | 50.0% |
| Increase Due to In-Migration (2) | | 14,032 | 18,529 | 16,436 | 15,954 | 525 | 7,416 | 7,150 | 6,996 | 6,681 | 6,450 |
| In-Migration as % of Total Population Change | | 55.1% | 61.5% | 60.1% | 61.0% | 28.5% | 58.0% | 55.0% | 53.0% | 51.0% | 50.0% |
| **2. Total Jobs in County (Including Self-Employed) (3)** | **20,320** | **39,229** | **66,229** | **83,212** | **94,400** | | **102,650** | **110,900** | **119,300** | **127,700** | **136,500** |
| Numerical Change During Period | | 18,909 | 27,000 | 16,983 | 11,188 | | 8,250 | 8,250 | 8,400 | 8,400 | 8,800 |
| % Avg Annual Chg | | 9.3% | 6.9% | 2.6% | 1.3% | | 1.7% | 1.6% | 1.5% | 1.4% | 1.4% |
| **3. Total Resident Households in County** | **13,696** | **22,775** | **33,678** | **43,904** | **53,707** | | **58,741** | **63,958** | **69,357** | **74,838** | **80,073** |
| Numerical Change During Period | | 9,079 | 10,904 | 10,226 | 9,803 | | 5,034 | 5,216 | 5,400 | 5,480 | 5,235 |
| % Avg Annual Chg | | 6.6% | 4.8% | 3.0% | 2.2% | | 1.9% | 1.8% | 1.7% | 1.6% | 1.4% |
| Average Household Size | 3.37 | 3.14 | 3.02 | 2.94 | 2.89 | | 2.86 | 2.83 | 2.80 | 2.77 | 2.75 |
| **Ratio of Households Per Job in County** | | **0.58** | **0.51** | **0.53** | **0.57** | | **0.57** | **0.58** | **0.58** | **0.59** | **0.59** |

(1) From " Table 1.1 Resident Population by County 1980-2040" DBEDT 2040 Series, March 2012.
(2) From State of Hawaii Data Book "Components of Change in the Resident Population by County" table.
(3) From " Table 1.7 Actual and Projected Civilian Jobs" DBEDT 2040 Series, March 2012.

Source: As cited, and The Hallstrom Group, Inc.

TABLE 3

## CALCULATION OF WORKFORCE/AFFORDABLE HOUSING UNIT DEMAND CREATED BY IN-MIGRATING WORKERS TO SUBJECT DEVELOPMENT

### Workforce/Affordable Housing Analysis of the Proposed MRTP Master Plan
### Kihei, Maui, Hawaii

| | Scenario | |
|---|---|---|
| | Minimum | Maximum |
| Total On-Site Full Time Equivalent Positions | 5,878 | 5,878 |
| Less Part-Time Workers (1) | (1,665) | (1,377) |
| **Total Full-Time Workers** | **4,213** | **4,501** |
| Less Full-Time Employees in Businesses Relocating from Elsewhere on Maui (2) | (1,053) | (1,125) |
| **Net Full-Time, New Workers** | **3,160** | **3,376** |
| Ratio of In-Migrating Workers at MRTP (3) | 25.00% | 40.00% |
| **Estimated Full Time In-Migrating Workers to MRTP** | **790** | **1,350** |
| Employee Housing Load Ratio (4) | 0.57 | 0.59 |
| **Total Unit Housing Load Created by MRTP Due to In-Migration** | **450** | **797** |
| Percentage of Housing Load at or Below Affordability Standards (160% of Median Household Income) (5) | 80.0% | 78.0% |
| **WORKFORCE HOUSING UNITS REQUIRED TO MEET IN-MIGRATION ASSOCIATED WITH MRTP** | **360** | **621** |

| | |
|---|---|
| **INDICATED MID-POINT HOUSING UNIT IMPACT** | **491** |

(1) Ranges tested at 35% to 40% of retail/commercial and 20 to 25% of industrial/business park positions.
(2) Relocating businesses will comprise about 25% of Park tenants and a similar ratio of total Park employment.
(3) In-migrants disproportionately drawn to hotel and restaurant positions and self-employment; not light industrial parks.
(4) The ratio of household creation to jobs creation (households per job).
(5) Median household income on Maui for family of four in 2012 is $77,100, with 160% of median, or outside of "affordable" pricing criteria, at $123,360. Current data indicates approximately 20 to 22% of Maui households have incomes above this level.

Source: The Hallstrom Group, Inc.

- Part-time positions, which are not a direct source of in-migration stimulus and would place in-migrating individuals outside the standard housing market spectrum. Estimated at 35 to 40 percent of retail/commercial and 20 to 25 percent of industrial/business park employment.

- Employees being relocated to MRTP by existing Maui businesses, estimated at about 25 percent of the businesses and employees in the Park based on mid-decade surveys we completed in connection with the Maui Business Park and experience in other neighbor island light industrial subdivisions.

- Ratio of in-migrating workers at MRTP relative to existing resident employees. While in-migrants may account for upwards of 50 percent of population growth, they would not be represented among workers in an industrial park to the same degree. First, many in-migrants are retired and/or not seeking employment. Secondly, in-migrant workers are disproportionately attracted to hotel, tourist-oriented restaurant and retail positions, and self-employment. Past surveys completed for proposed Maui industrial projects indicates that about 16 to just over 20 percent of workers are in-migrants. We have tested a ratio range of 25 to 40 percent of total full-time workers at the subject.

- Employee housing load ratio is the proportion at which households are created on Maui per available job. Historically, for every one additional job in the county from 0.57 to 0.59 new households arise.

- Percentage of housing load at or below affordability standards is the number of households which fall into the County affordable housing categories; those making less than 160 percent of the median income ($123,360). Extrapolation of US Census data indicates that 78 to 80 percent of all Maui households earn less than this amount.

Based on our analysis, the total workforce housing impact associated with in-migrating workers to the MRTP will be from 360 to 621 total units, with a mid-point of 491 units.

Sufficiency of MRTP Housing Inventory to Meet In-Migrating Housing Impacts

The indicated workforce housing impact resulting from in-migrating workers to MRTP is estimated at circa 491 units. The total number of residential units in the project with current prices meeting affordability standards is at 500, and perhaps more in accordance with how the vacant house lots are viewed.

The proposed residential components of MRTP are sufficient to meet the demands by in-migrating workers of the industrial/business park and retail/commercial components.

Further, the ability of the demand to be met fully on-site is unique for a major industrial/commercial development; minimizing the region-wide impact on infrastructure systems and housing market.

We appreciate the opportunity to be of service in regards to this issue for the Maui Research & Technology Park. Please contact us if further detail or explanation is required.

Respectfully submitted,

THE HALLSTROM GROUP, INC.

Tom W. Holliday

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as/4031BR01

THE HALLSTROM GROUP INC.

REAL ESTATE
CONSULTANTS
& APPRAISERS

## PROFESSIONAL BACKGROUND AND SERVICES

The Hallstrom Group, Inc. is a Honolulu based independent professional organization that provides a wide scope of real estate consulting services throughout the State of Hawaii with particular emphasis on valuation studies. The purpose of the firm is to assist clients in formulating realistic real estate decisions. It provides solutions to complex issues by delivering thoroughly researched, objective analyses in a timely manner. Focusing on specific client problems and needs, and employing a broad range of tools including after-tax cash flow simulations and feasibility analyses, the firm minimizes the financial risks inherent in the real estate decision making process.

The principals and associates of the firm have been professionally trained, are experienced in Hawaiian real estate, and are actively associated with the Appraisal Institute and the Counselors of Real Estate, nationally recognized real estate appraisal and counseling organizations.

The real estate appraisals prepared by The Hallstrom Group accomplish a variety of needs and function to provide professional value opinions for such purposes as mortgage loans, investment decisions, lease negotiations and arbitrations, condemnations, assessment appeals, and the formation of policy decisions. Valuation assignments cover a spectrum of property types including existing and proposed resort and residential developments, industrial properties, high-rise office buildings and condominiums, shopping centers, subdivisions, apartments, residential leased fee conversions, special purpose properties, and vacant acreage, as well as property assemblages and portfolio reviews.

Market studies are research-intensive, analytical tools oriented to provide insight into investment opportunities and development challenges, and range in focus from highest and best use determinations for a specific site or improved property, to an evaluation of multiple (present and future) demand and supply characteristics for long-term, mixed-use projects. Market studies are commissioned for a variety of purposes where timely market information, insightful trends analyses, and perceptive conceptual conclusions or recommendations are critical. Uses include the formation of development strategies, bases for capital commitment decisions, evidence of appropriateness for state and county land use classification petitions, fiscal and social impact evaluations, and the identification of alternative economic use/conversion opportunities.

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## PROFESSIONAL QUALIFICATIONS OF THOMAS W. HOLLIDAY

**Business Affiliation**

| | |
|---|---|
| Senior Analyst/ Supervisor | The Hallstrom Group, Inc.<br>Honolulu, Hawaii<br>Since 1980 |
| Former Staff Appraiser | Davis-Baker Appraisal Co.<br>Avalon, Santa Catalina Island, California |

**Education**

- California State University, Fullerton (Communications/Journalism)
- SREA Course 201- Principles of Income Property Appraising
- Expert witness testimony before State of Hawaii Land Use Commission and various state and county boards and agencies since 1983.
- Numerous professional seminars and clinics.
- Contributing author to Hawaii Real Estate Investor, Honolulu Star Bulletin

On January 1, 1991, the American Institute of Real Estate Appraisers (AIREA) and the Society of Real Estate Appraisers (SREA) consolidated, forming the Appraisal Institute (AI).

**Recent Neighbor Island Assignments**

- Market Study, Economic Impact Analyses and Public Costs/ Benefits (Fiscal Impact) Assessments

Maui
-- Maui Research & Tech Park (Mixed-Use Community)
-- Maui Lani (Mixed-Use Community)
-- Honuaula (Mixed-Use Community)
-- Makena Beach Resort
-- Maui Business Park, Phase II (Industrial/Commercial)
-- Kapalua Mauka (Master Planned Community)
-- Hailiimaile (Mixed-Use Master Planned Community)
-- Pulelehua (Master Planned Community)
-- Westin Kaanapali Ocean Villas Expansion (Resort/ Timeshare)
-- Upcountry Town Center (Mixed-Use Project)

Big Island
-- Kamakana Villages (Mixed-Use Residential Development)
-- W.H. Shipman Ltd, Master Plan (Various Urban Uses)
-- Nani Kahuku Aina (Mixed-Use Resort Community
-- Kona Kai Ola (Mixed-Use Resort Community)
-- Waikoloa Highlands (Residential)
-- Waikoloa Heights (Mixed-Use Residential Development)

Kauai
-- Hanalei Plantation Resort (Resort/Residential)
-- Kukuiula (Resort/Residential)
-- Waipono/Puhi (Mixed-Use Planned Development)
-- Eleele Commercial Expansion (Commercial)
-- Village at Poipu (Resort/Residential)
-- Ocean Bay Plantation (Resort/Residential)

- Major Neighbor Island Valuation Assignments

  -- Mauna Lani Bay Hotel
  -- Courtyard Kahului Airport Hotel
  -- Maui Oceanfront Days Inn
  -- Holiday Inn Express – Kona Hotel (proposed)
  -- Keauhou Beach Hotel
  -- Courtyard King Kamehameha Kona Beach Hotel
  -- Aloha Beach Resort
  -- Coco Palms Resort
  -- Grand Hyatt Kauai
  -- Islander on the Beach
  -- Waimea Plantation Cottages
  -- Coconut Beach Resort
  -- Sheraton Maui Hotel
  -- Outrigger Wailea Resort Hotel
  -- Maui Lu Hotel
  -- Coconut Grove Condominiums
  -- Palauea Bay Holdings
  -- Wailea Ranch
  -- Maui Coast Hotel
  -- Westin Maui Hotel
  -- Maui Marriott Hotel
  -- Waihee Beach
  -- Kapalua Bay Hotel and The Shops at Kapalua

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