Experience the revitalized International Market Place,
Celebrate the history of the land and its people and
Perpetuate the legacy of the Queen in the gathering place of Waikīkī.

E komo mai, Come and belong!

WCITARCHITECTURE

Experience the Revitalized Center of Waikīkī…

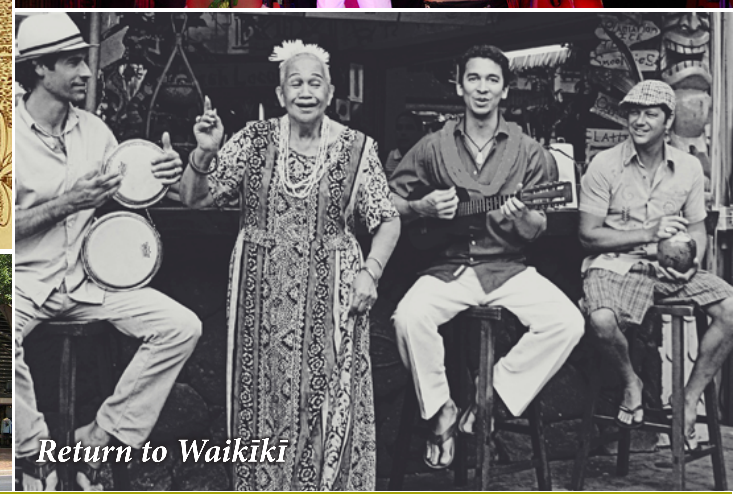
A new world-class retail, entertainment, cultural and educational core for Waikīkī. Reinvented to respond to the desires of today's urban resort destination visitor, expressing a restored and recaptured soul recalling the International Marketplace's **iconic and nostalgic past** and magical charm. A unique and signature **gathering place** for locals and visitors alike. **A Piko revitalized** in Waikīkī.

- *Urban Oasis: Nature as a focal point*
- *Nostalgia + Magic: Reliving the golden age of travel*
- *World-Class Entertainment under the stars & trees*
- *Engaging + Educating the visitor, of nature + culture*
- *World-Class Hospitality*


Entertainment under the stars

Bazzaar & Expo


World-Class Entertainment


Return to Waikīkī

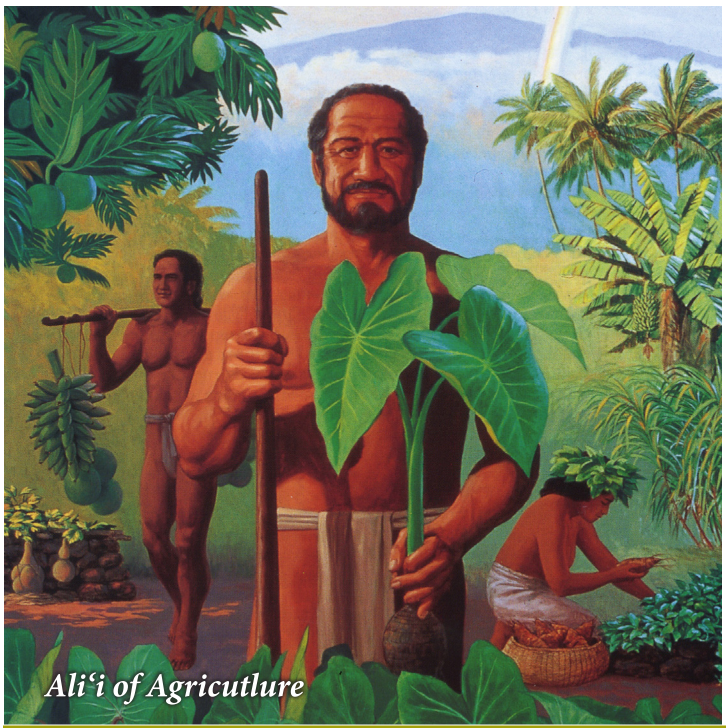

Cultural Experience

Urban Oasis

Celebrate the Rebirth of Kaluaokau…

A land once bestowed with abundant gifts of nature, now enriched through its history retold. Reengage with this **past epicenter of activity** in ancient Hawai'i, a place of watchful **'aumakua**, benevolent **ali'i** and industrious **maka'āinana**. Become reacquainted with this s**acred place** and return Kaulaokau back to a place of prominence. **A Piko reborn** in Waikīkī.

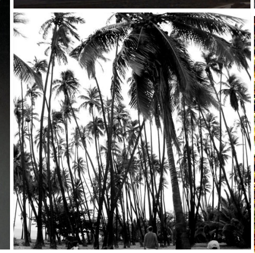
- *Rich Natural + Cultural History of Kaluaokau*
- *Water: Waikīkī, 'Āpuakehau, Rains*
- *Works of the Ali'i + Maka'āinana: Auwai, Lo'i, Loko i'a*
- *Supernatural Ties: Kamo'ili'ili, Kahuna Stones*
- *Celestial Ties: Kau, navigation, harvest Seasons*



Ali'i of Agricutlure

Basket of Dew

Star of Kau



Coconut Groves

'Āpuakehau Stream

Guardian 'Aumakua

Perpetuate the Legacy of the Queen…

Queen Emma Kaleleonālani Naʻea Rooke, and her **ʻohana**, husband King Kamehameha IV Liholiho and son, Prince Albert Edward… a legacy based in her **love for Hawaiʻi and its people** and embodied in her **mission** to provide in perpetuity **quality health care services** to improve the well-being of Native Hawaiians and all the people of Hawaiʻi. **A Piko perpertuated** in Waikīkī.

- ***The Royal Family's Kuleana (responsibility) to the makaʻāinana***
- ***The Royal Family's Legacy of lokomaikaʻi perpetuated***
- ***Cultural Connections: Medicinal plants, caregiver interaction***
- ***Natural Connections: The Queen's love of botanical gardens***


Queen Emalani Kaleleonālani

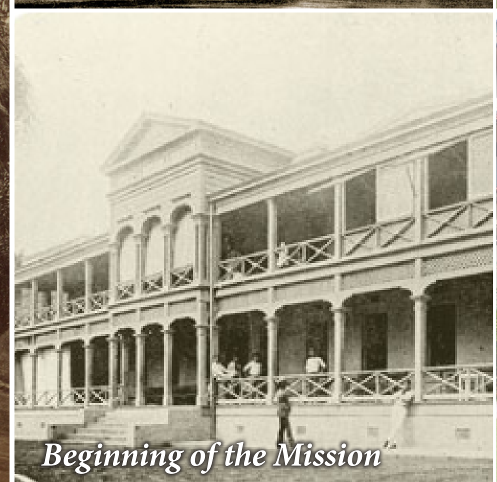

Pīkake


Palm-lined path


Funding the Hospital


Nations Future

Benevolent King


Beginning of the Mission

The Mission Perpetuated

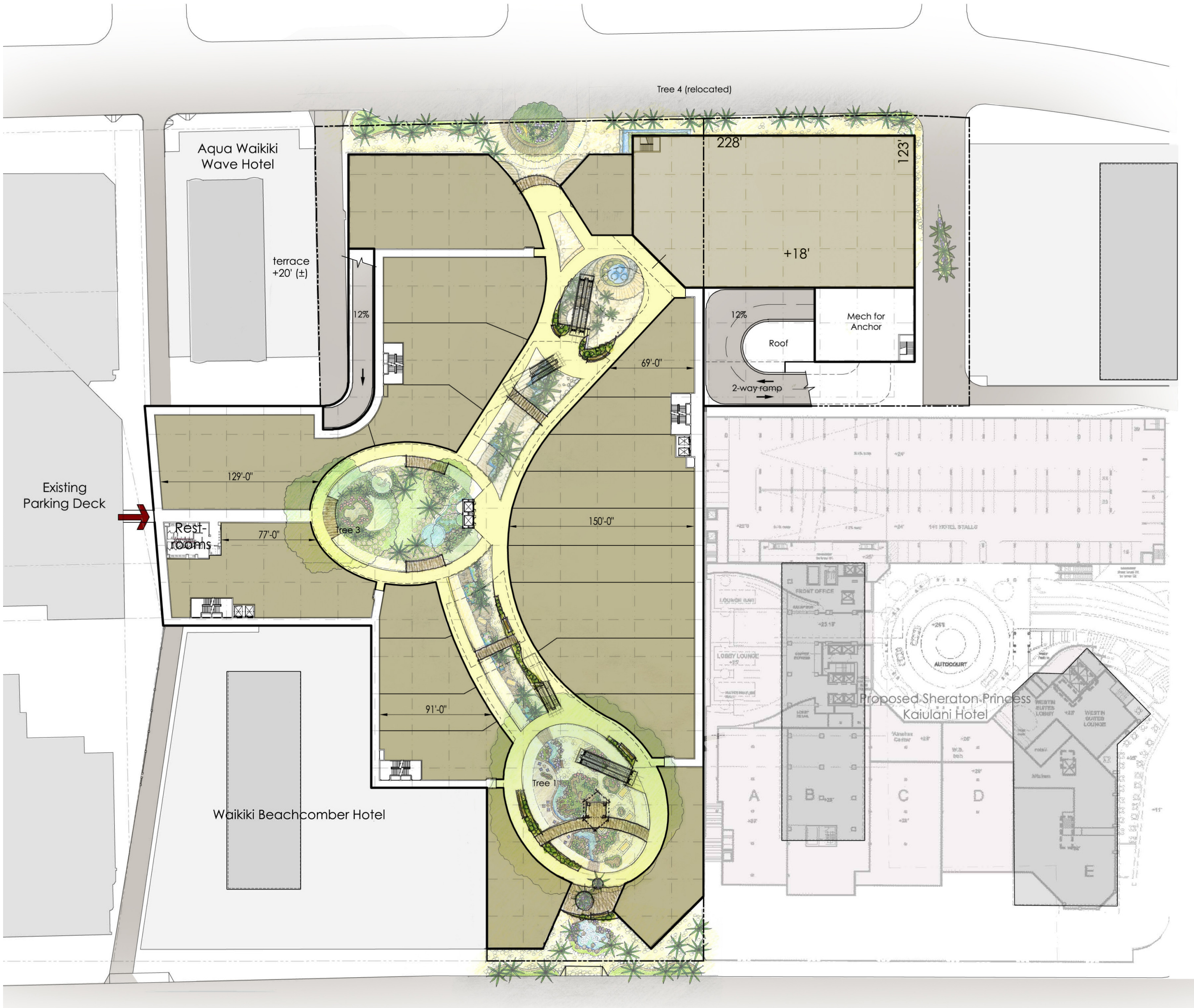
GROUND LEVEL PLAN

0 30 60 120 FT

INTERNATIONAL MARKET PLACE REVITALIZATION PROJECT

WAIKĪKĪ, HONOLULU, O'AHU, HAWAI'I

505 DESIGN | JPRA ARCHITECTS | WALTERS KIMURA MOTODA, INC. | WCIT ARCHITECTURE



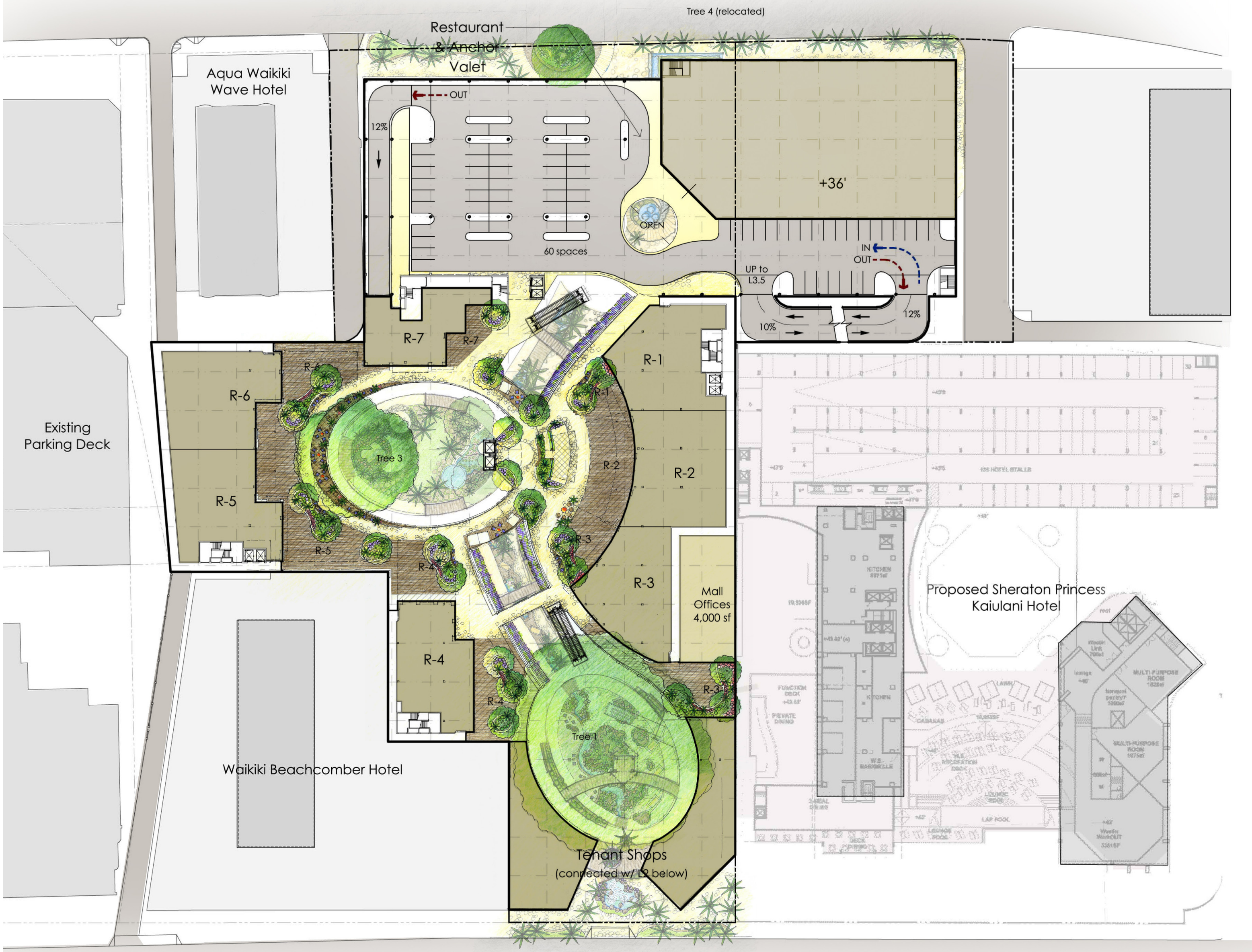
2ND LEVEL PLAN

0 30 60 120 FT

INTERNATIONAL MARKET PLACE REVITALIZATION PROJECT

WAIKĪKĪ, HONOLULU, O'AHU, HAWAI'I

505 DESIGN · JPRA ARCHITECTS · WALTERS KIMURA MOTODA, INC. · WCIT ARCHITECTURE



3RD LEVEL PLAN

0 30 60 120 FT

INTERNATIONAL MARKET PLACE REVITALIZATION PROJECT

WAIKĪKĪ, HONOLULU, O'AHU, HAWAI'I

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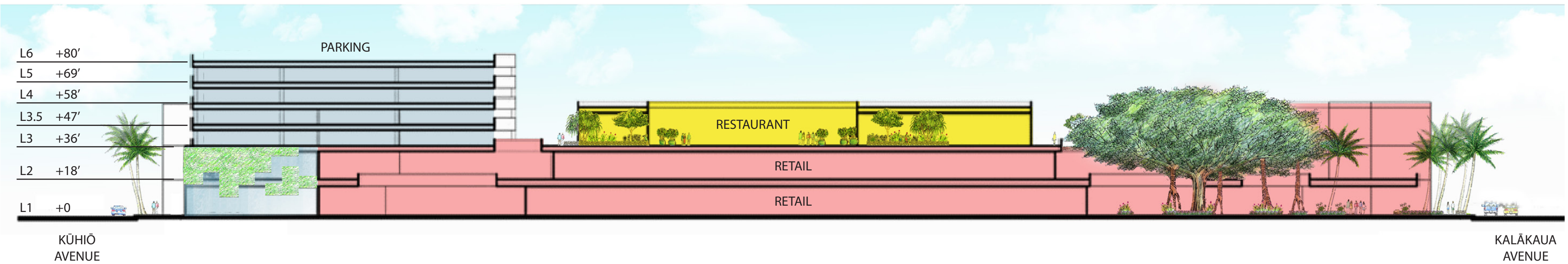
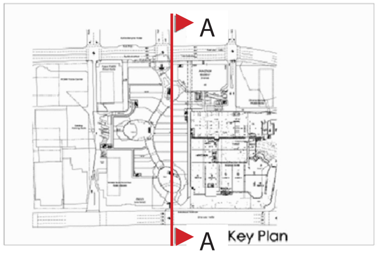
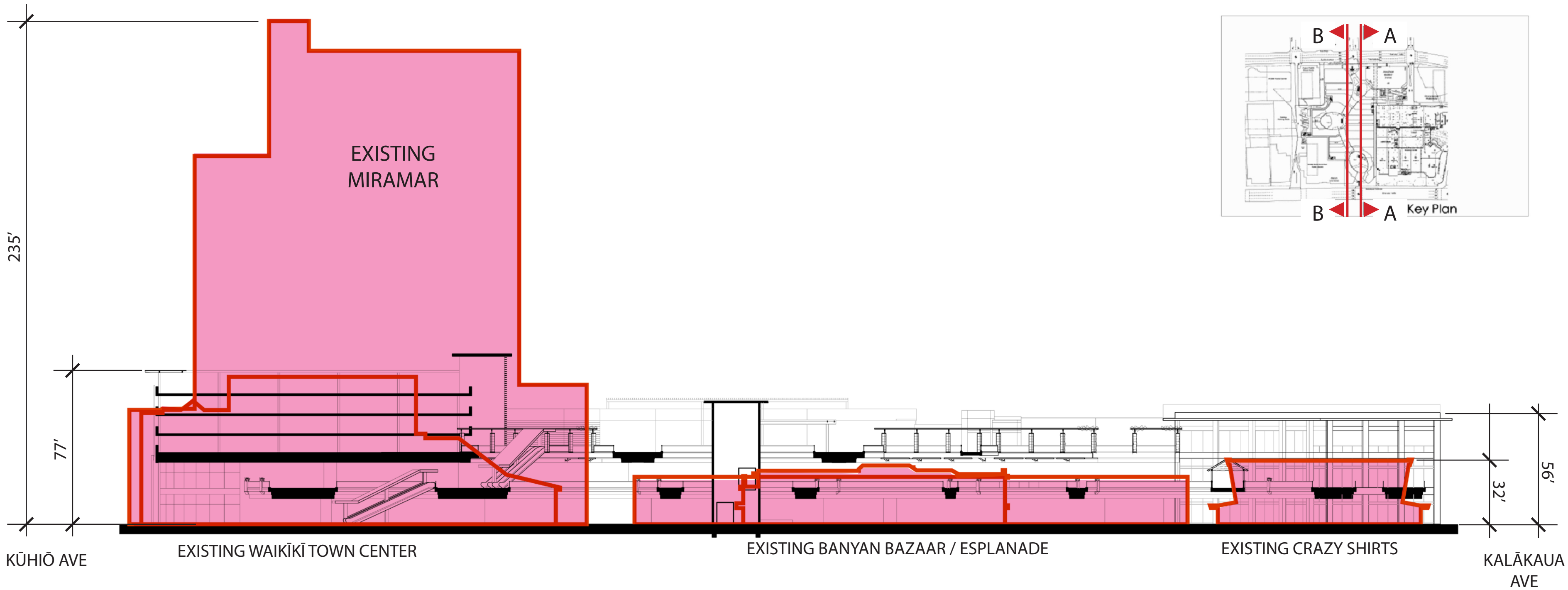




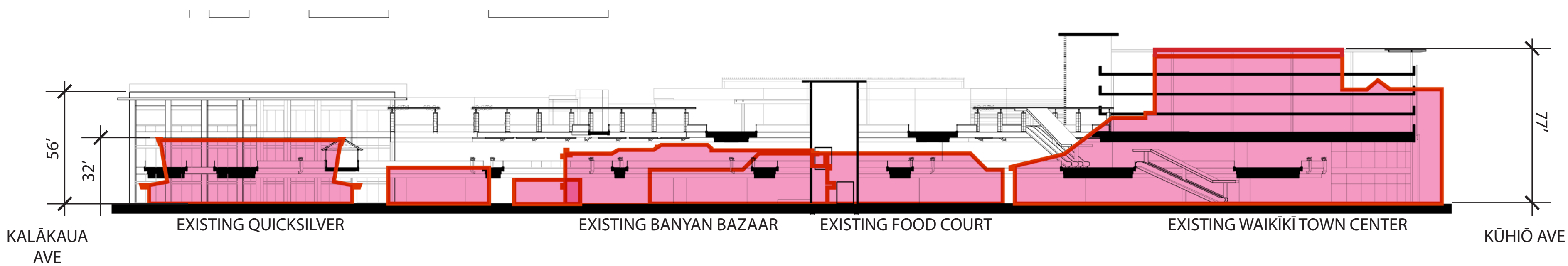
SITE SECTION

0 20 40 80 FT



SITE SECTION A

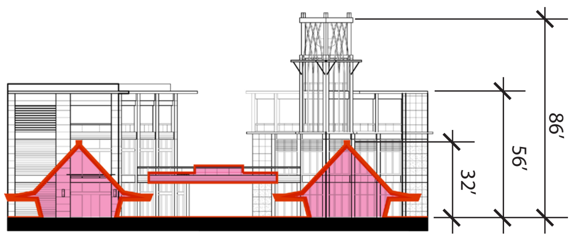
LOOKING DIAMOND HEAD



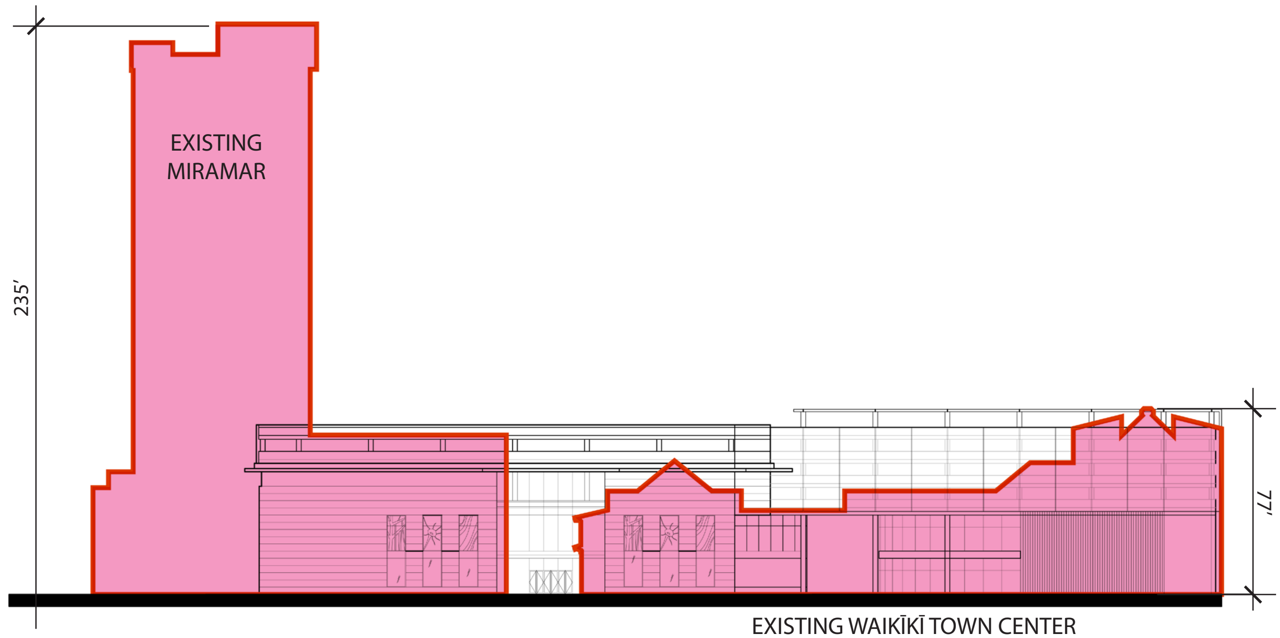
SITE SECTION B

LOOKING EWA

0 20 40 80 FT



ELEVATION AT KALĀKAUA AVE.



ELEVATION AT KŪHIŌ AVE.

0 20 40 80 FT

RENDERING - VIEW ALONG KALĀKAUA AVENUE

RENDERING - VIEW ALONG KŪHIŌ AVENUE

RENDERING - AERIAL PERSPECTIVE

ACOUSTIC STUDY FOR THE INTERNATIONAL MARKET PLACE REVITALIZATION PROJECT WAIKIKI, OAHU, HAWAII

Prepared for:

TRG IMP, LLC

Prepared by:

Y. EBISU & ASSOCIATES
1126 12th Avenue, Room 305
Honolulu, Hawaii 96816

FEBRUARY 2012

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CHAPTER I. SUMMARY

The existing and future traffic noise levels in the vicinity of the proposed International Market Place Revitalization Project in Waikiki (see FIGURE 1) were evaluated for their potential noise impacts and their relationship to current FHA/HUD noise standards. The traffic noise level increases along the major access roadways to and from the project site were calculated. No significant increases in traffic noise are predicted to occur along Kalakaua Avenue, Kuhio Avenue, Ala Wai Boulevard, and the various mauka-makai cross streets as a result of project traffic following project build-out by CY 2015. Traffic noise from Kalakaua Avenue and Kuhio Avenue will continue to control background ambient noise levels in the project environs, with traffic noise levels exceeding 65 DNL at existing resort units which front Kalakaua Avenue and Kuhio Avenue.

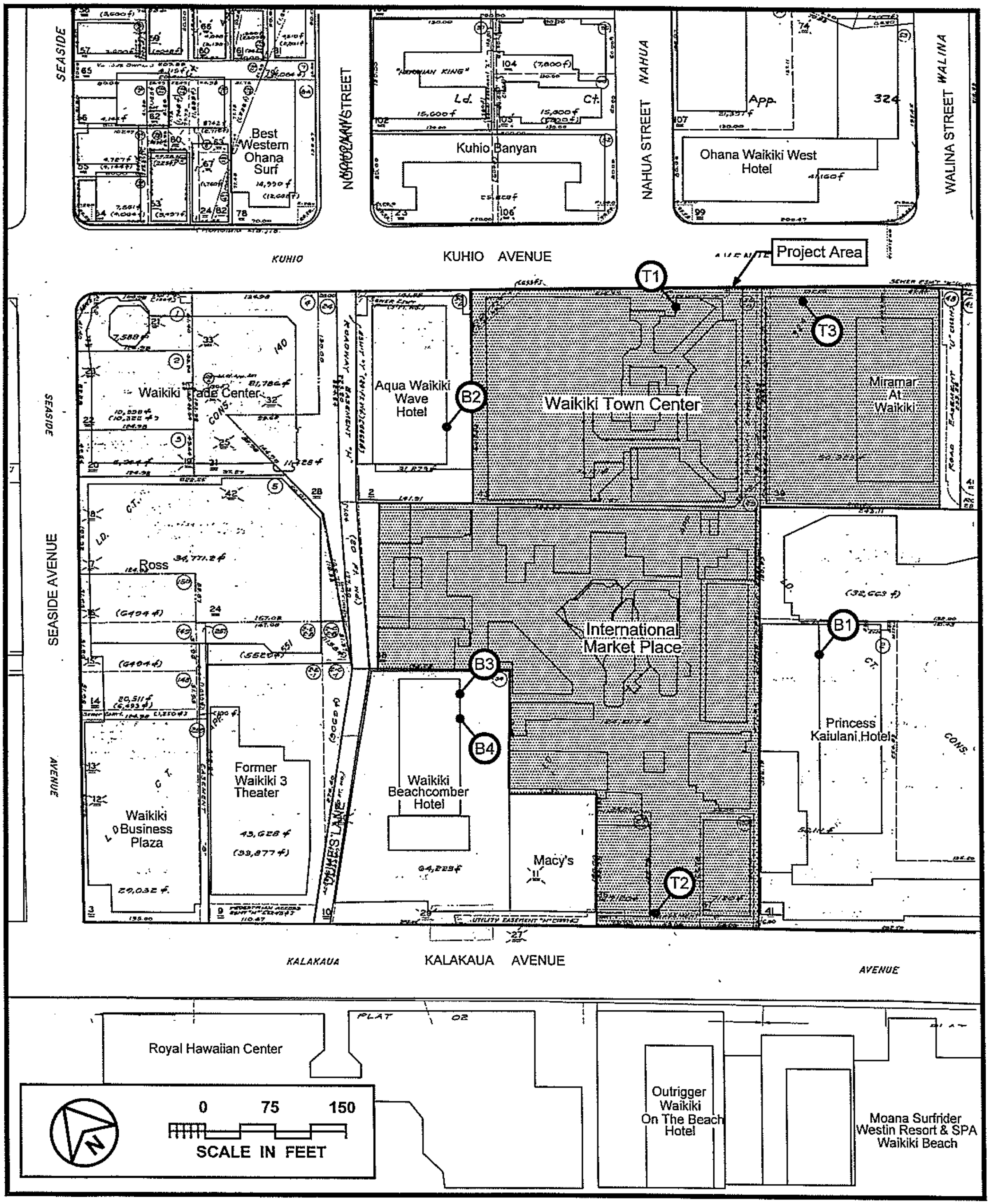
Project traffic will add less than 0.3 DNL additional units of noise along Kalakaua Avenue, Kuhio Avenue, and Ala Wai Boulevard. Along the cross streets where existing traffic noise levels are relatively low, project traffic will add 0.0 to 2.5 DNL units of noise. The increases in future traffic noise levels resulting from project generated traffic are not considered to be significant.

Increases in traffic noise levels of 0.2 to 0.6 DNL are predicted to occur along Kalakaua Avenue, Kuhio Avenue, and Ala Wai Boulevard as a result of the increases in non-project traffic by CY 2015. These increases are expected to occur with or without the proposed revitalization project, are considered to be small, and will be difficult to perceive between 2011 and 2015.

Unavoidable, but temporary, noise impacts may occur during the demolition and construction activities within the project area, and particularly during the demolition and excavation activities on the project site. Because construction activities are predicted to be audible within the project site and at adjoining properties, the quality of the acoustic environment may be degraded during periods of construction. Mitigation measures to reduce construction noise to inaudible levels will not be practical in all cases, but the use of quiet equipment (i.e., construction equipment with factory supplied mufflers and with enclosed engine compartments) is recommended as a standard mitigation measure. The implementation of Hawaii State Department of Health permit procedures and curfew periods for construction activities is also expected for this project.

Concrete pile driving operations will not be required on this project because the use of Auger Cast piles is planned to minimize potential noise and vibration impacts at adjacent properties during construction of the project.

Potential noise impacts from on site mechanical equipment and activities may be minimized through the use of sound attenuating devices at the mechanical equipment, scheduling of maintenance activities to daylight hours, and properly managing the use



PROJECT LOCATION MAP AND NOISE MEASUREMENT LOCATIONS

FIGURE 1

of any outdoor entertainment areas to avoid noise complaints. The proposed activities within the redevelopment area are very similar to existing retail activities, so maintaining the status quo in respect to noise emissions should not be difficult.

CHAPTER II. PURPOSE

The primary objective of this study was to describe the existing and future noise environment in the environs of the proposed International Market Place Revitalization Project in Waikiki on the island of Oahu. Traffic noise level increases and impacts associated with the proposed development were to be determined along the public roadways which are expected to service the project related 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.

Potential noise impacts from the activities and equipment associated with the new seven-level retail/parking complex on the site of the existing International Market Place and Waikiki Town Center were also evaluated. Potential noise impacts associated with the future tenants of the new complex were also evaluated. Assessments of possible future impacts from 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 (Ldn or 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. Land use compatibility guidelines for various levels of environmental noise as measured by the DNL descriptor system are shown in FIGURE 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 Kalakaua Avenue and Kuhio Avenue are greater than 70 DNL along their Rights-of-Way due to the large volumes of traffic and heavy vehicles (trucks and buses) on those major thoroughfares. Adding to the traffic noise from the roadways are the relatively high noise levels of sirens on police and emergency vehicles, outdoor mechanical equipment (fans and air conditioning equipment) at the commercial and resort buildings, maintenance activities, and garbage and delivery truck operations.

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 2), 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 3, 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

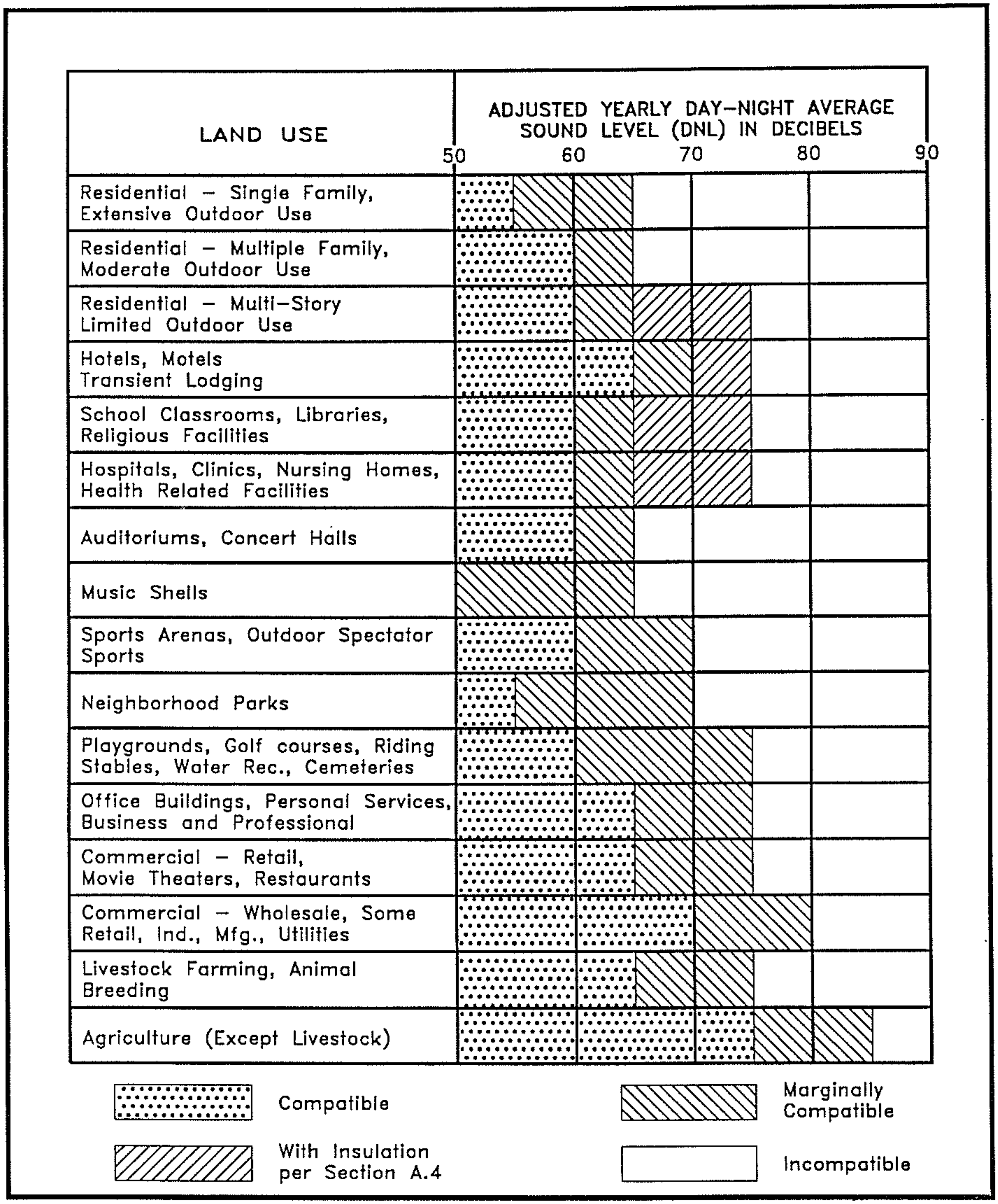
TABLE 1

EXTERIOR NOISE EXPOSURE CLASSIFICATION (RESIDENTIAL LAND USE)

NOISE EXPOSURE CLASS	DAY-NIGHT SOUND LEVEL	EQUIVALENT SOUND LEVEL	FEDERAL (1) STANDARD
Minimal Exposure	Not Exceeding 55 DNL	Not Exceeding 55 Leq	Unconditionally Acceptable
Moderate Exposure	Above 55 DNL But Not Above 65 DNL	Above 55 Leq But Not Above 65 Leq	Acceptable(2)
Significant Exposure	Above 65 DNL But Not Above 75 DNL	Above 65 Leq But Not Above 75 Leq	Normally Unacceptable
Severe Exposure	Above 75 DNL	Above 75 Leq	Unacceptable

Notes: (1) Federal Housing Administration, Veterans Administration, Department of Defense, and Department of Transportation.

(2) FHWA uses the Leq instead of the Ldn descriptor. For planning purposes, both are equivalent if: (a) heavy trucks do not exceed 10 percent of total traffic flow in vehicles per 24 hours, and (b) traffic between 10:00 PM and 7:00 AM does not exceed 15 percent of average daily traffic flow in vehicles per 24 hours. The noise mitigation threshold used by FHWA for residences is 67 Leq.



LAND USE COMPATIBILITY WITH YEARLY AVERAGE DAY-NIGHT AVERAGE SOUND LEVEL (DNL) AT A SITE FOR BUILDINGS AS COMMONLY CONSTRUCTED.
(Source: American National Standards Institute S12.9-1998/Part 5)

FIGURE 2

occur when naturally ventilated office and other commercial establishments are exposed to exterior levels which exceed 65 DNL.

On the island of Oahu, the State Department of Health (DOH) regulates noise from fixed mechanical equipment and construction activities. State DOH noise regulations are expressed in maximum allowable noise limits rather than DNL (see Reference 4). Although they are not directly comparable to noise criteria expressed in DNL, State DOH noise limits for single family residential lands equate to approximately 55 DNL. For multifamily residential, commercial, and resort lands, the State DOH noise limits equate to approximately 60 DNL. For light and heavy industrial lands, the State DOH noise limits equate to approximately 76 DNL. Construction activities, which are typically noisier than the State DOH noise limits, are regulated through the issuance of permits for allowing excessive construction noise during limited time periods.

CHAPTER IV. GENERAL STUDY METHODOLOGY

Historical existing traffic and background ambient noise levels were obtained in the project environs during April 2004, June 2007, May 2011, and November 2011. These readings were used to provide a basis for describing the existing noise environment in the project environs. Traffic noise measurements along Kuhio Avenue and Kalalaua Avenue were obtained at Locations T1, T2, and T3 as shown in TABLE 2. The locations of these measurement sites are shown in FIGURE 1. Location T1 was on the second floor walkway of the Waikiki Town Center fronting Kuhio Avenue at Nahua Street, and Location T2 was at ground level at the makai entrance of the International Market Place fronting Kalakaua Avenue. Location T3 was at the fifth floor lanai of Suite 546 at the Miramar At Waikiki. Additional daytime and nighttime traffic noise measurements along Kuhio Avenue were obtained from the lanai of the Ohana Waikiki West Hotel (May 18-19, 2011). Daytime and nighttime background ambient noise measurements were obtained at four locations overlooking the International Market Place site. Location B1 was at the Ewa lanai of Suite 2743 of the Sheraton Princess Kaiulani Hotel. Location B2 was at the Diamond Head lanai of Suite 1212 of the Aqua Waikiki Wave Hotel. Locations B3 and B4 were at the Diamond Head lanais of Suite 600 and 601, respectively of the Waikiki Beachcomber Hotel. Background ambient noise measurements between 7:00 and 10:00 p.m. were also performed during walk-throughs of the International Market Place and Waikiki Town Center during the nights of November 22 and 25, 2011.

Traffic noise calculations for the existing conditions as well as noise predictions for CY 2015 for a weekday were performed using the Federal Highway Administration (FHWA) Traffic Noise Model Version 2.5 (Reference 5). Traffic data entered into the noise prediction model were: roadway and receiver locations; hourly traffic volumes, average vehicle speeds; estimates of traffic mix; and "Pavement" propagation loss factor. The weekday traffic data and forecasts for the project (Reference 6) were the primary sources of data inputs to the model. APPENDIX C summarizes the weekday and Saturday PM peak hour traffic volumes for CY 2011 and 2015 which were available from the project's traffic study. The Saturday traffic data and forecasts were not sufficiently different from the weekday values to warrant their use in the DNL calculations. For existing and future traffic along the streets surrounding the project site, it was assumed that the average noise levels, or Leq(h), during the weekday PM peak traffic hour were approximately 2 dB less than the 24-hour DNL along Kalakaua Avenue; equal to the 24-hour DNL along Kuhio Avenue; and 1 dB less than the 24-hour DNL along Ala Wai Boulevard. These assumptions were based on calculated traffic noise levels using the traffic counts from References 7 through 9, which are shown graphically in FIGURES 3 through 5.

Traffic noise calculations for both the existing and future conditions in the project environs were developed at various distances from the centerlines of the roadways. Traffic noise levels were also calculated for future conditions with (Build Alternative) and without (No Build Alternative) the proposed project. The forecasted changes in traffic noise levels over existing levels were calculated with and without the project, and noise

TABLE 2

TRAFFIC AND BACKGROUND NOISE MEASUREMENT RESULTS

LOCATION	Time of Day (HRS)	Ave. Speed (MPH)	-------- Hourly Traffic Volume -------- AUTO	M.TRUCK	H.TRUCK	Measured Leq (dB)	Predicted Leq (dB)
T1. 69 FT from the center-line of Kuhio Avenue (4/15/04)	1538 TO 1638	32	1,111 88.2%	38 3.0%	111 8.8%	70.5	70.4
T2. 60 FT from the center-line of Kalakaua Avenue (4/15/04)	1646 TO 1744	32	1,604 96.3%	45 2.7%	17 1.0%	69.2	68.9
T1. 69 FT from the center-line of Kuhio Avenue (4/16/04)	0633 TO 0733	32	653 81.9%	46 5.8%	98 12.3%	69.3	69.6
T3. 69 FT from the center-line of Kuhio Avenue (11/22/11)	1600 TO 1700	32	957 87.9%	30 2.8%	102 9.4%	68.9	68.6
T3. 69 FT from the center-line of Kuhio Avenue (11/23/11)	0700 TO 0800	32	627 84.4%	44 5.9%	72 9.7%	67.3	67.7

FIGURE 3

HOURLY VARIATIONS OF TRAFFIC NOISE LEVELS AT 50 FEET FROM THE CENTERLINE OF KALAKAUA AVENUE BETWEEN LEWERS AND BEACHWALK (FEBRUARY 4, 2011)

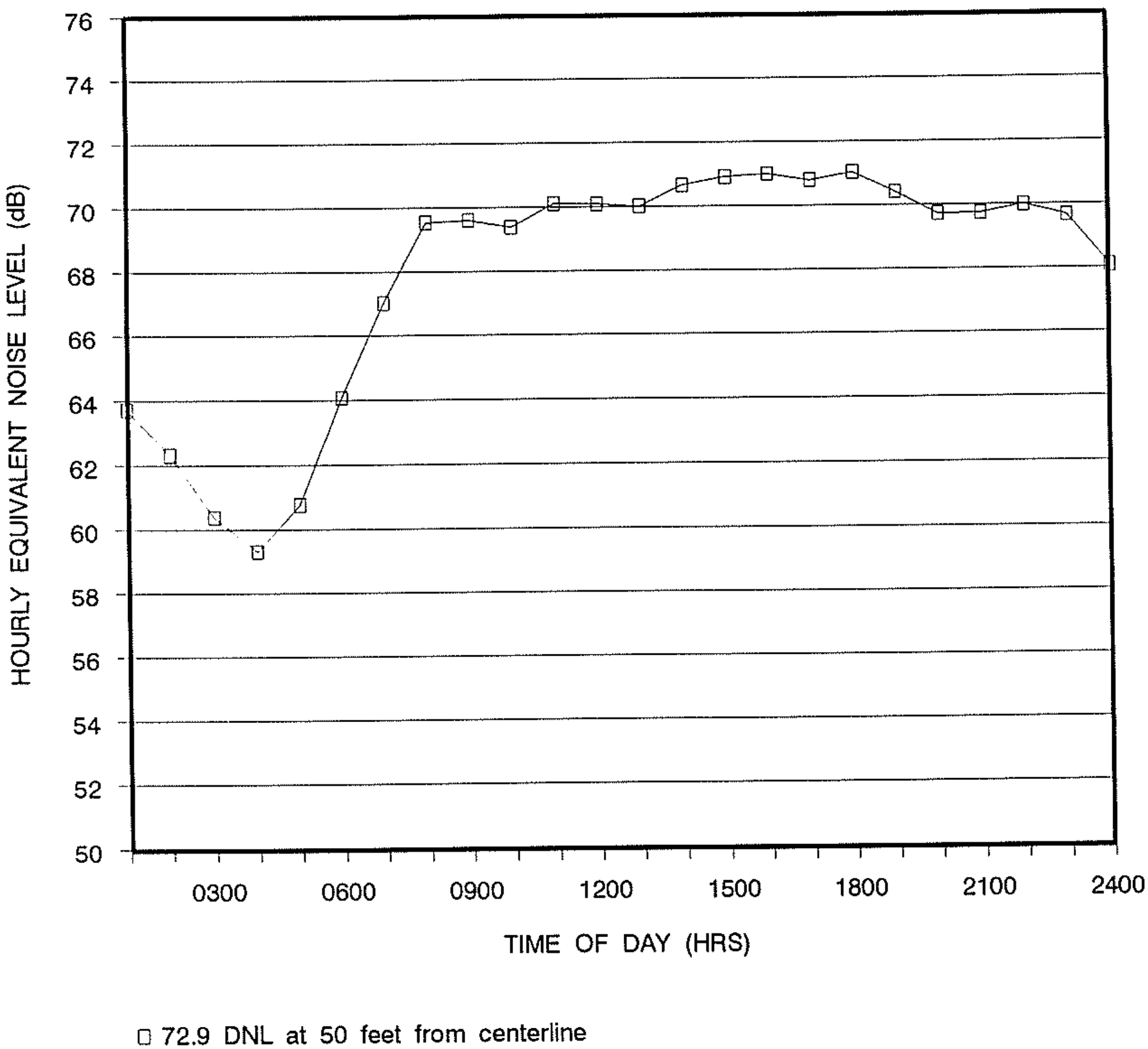


FIGURE 4

HOURLY VARIATIONS OF TRAFFIC NOISE LEVELS AT 50 FEET FROM THE CENTERLINE OF ALA WAI BOULEVARD BETWEEN OHUA AND LILIUOKALANI (APRIL 22, 2010)

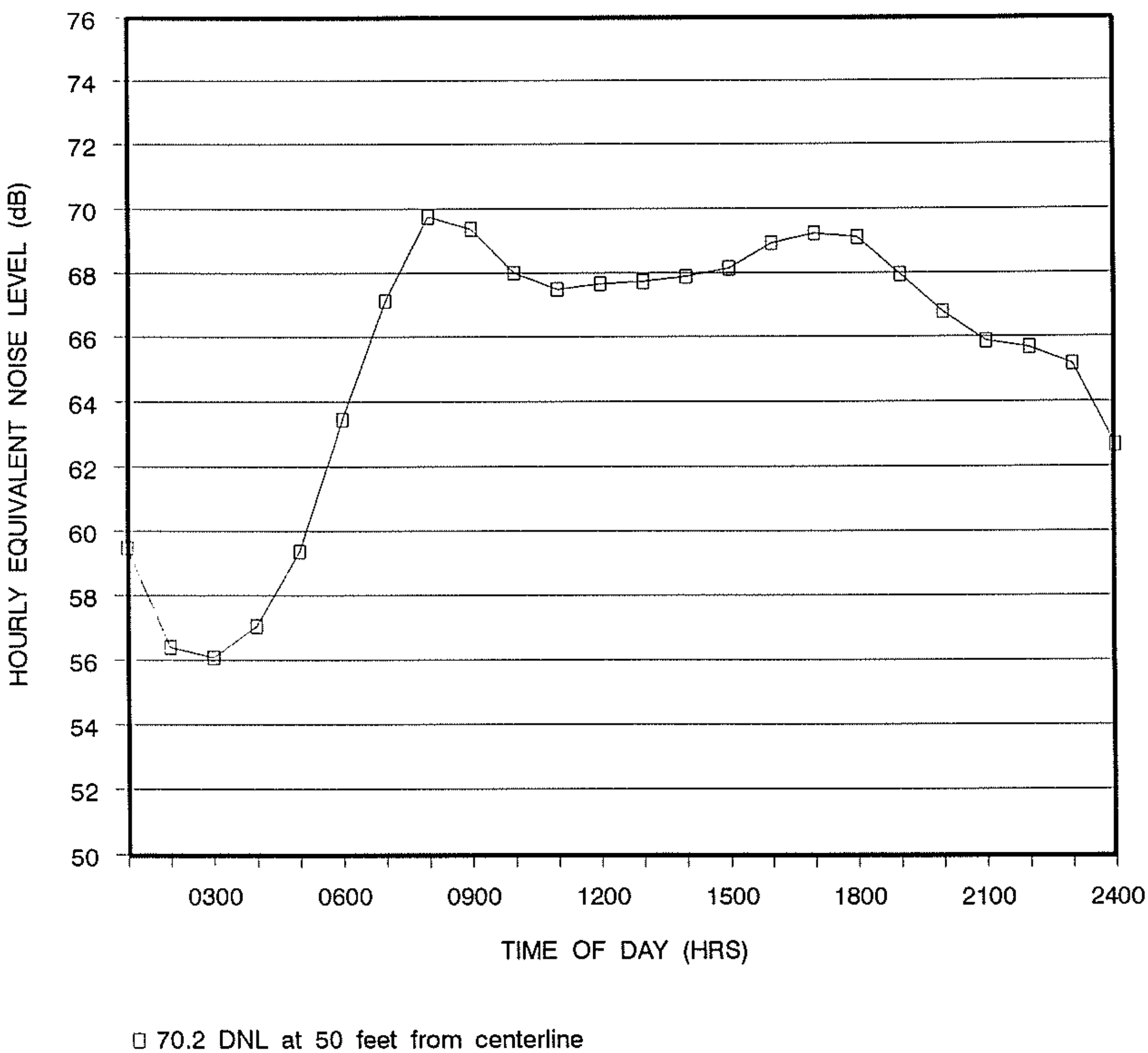
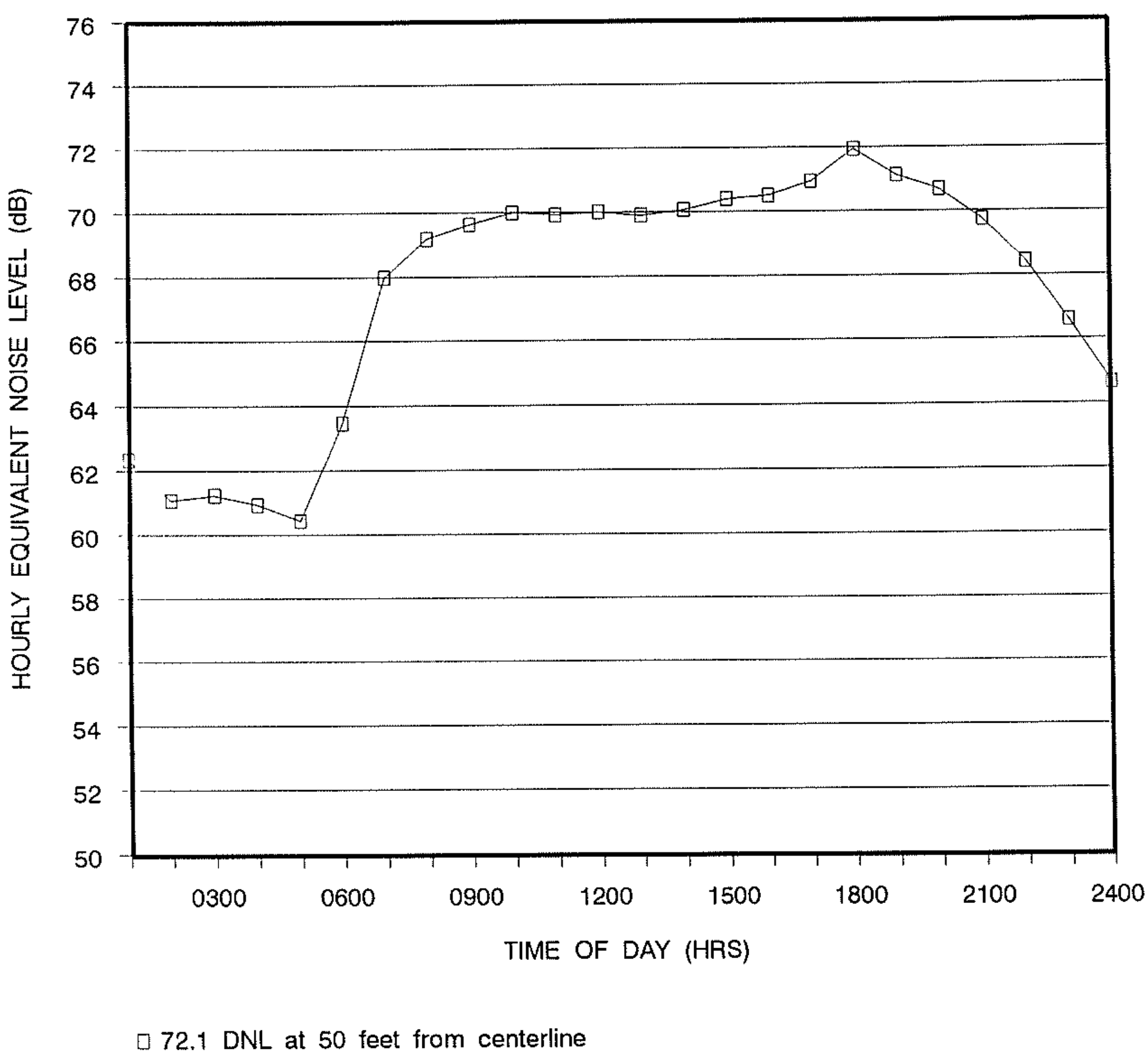


FIGURE 5

HOURLY VARIATIONS OF TRAFFIC NOISE LEVELS AT 50 FEET FROM THE CENTERLINE OF KUHIO AVENUE BETWEEN NAHUA AND WALINA (MAY 5, 2010)



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.

In addition to the traffic noise measurements, background ambient noise measurements were obtained at Locations B1 through B4 (see FIGURE 1), where the noise from distant traffic, refuse trucks, emergency sirens, outdoor mechanical equipment, and loud voices controlled the background ambient noise levels. The results of these measurements plus the results of the traffic noise measurements and predictions were used to describe the existing and future noise levels in the project environs.

Calculations of average exterior and interior noise levels from construction activities were performed for typical naturally ventilated and air conditioned living units. Predicted noise levels were compared with existing background ambient noise levels, and the potential for noise impacts was assessed.

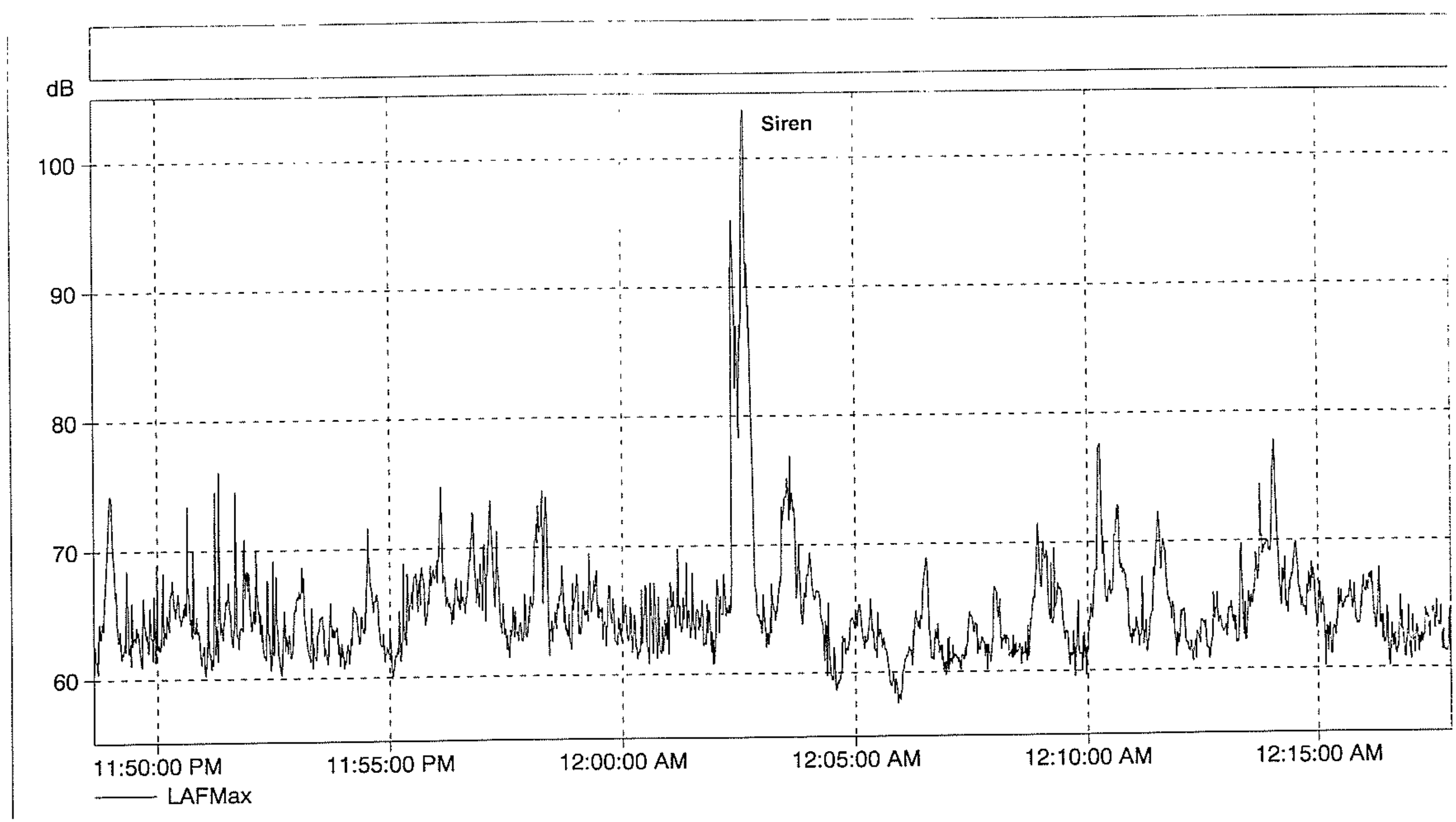
V. EXISTING ACOUSTICAL ENVIRONMENT

Major contributors to the existing background ambient noise levels within the project area are: traffic along Kalakaua Avenue and Kuhio Avenue; refuse collection trucks; tour buses and delivery trucks which are idling or positioning at curbside; loud motorcycles; the sirens of emergency and police vehicles; outdoor mechanical equipment, and nearby construction activities. Sample strip charts of the typical noise events which were recorded at the noise measurement locations are shown in FIGURES 6 through 13. The louder noise events, such as the sirens, refuse trucks, and live music, were clearly audible above the other background ambient noise sources.

The typical hourly variations in noise levels within the project environs are controlled by motor vehicle traffic along the high volume roadways such as Kalakaua Avenue and Kuhio Avenue, loud sirens, outdoor entertainment events at the International Market Place, or by nearby operating mechanical equipment. FIGURES 14 through 17 depict the hourly variations in average background noise levels at hotel suites (Locations B1 through B4) which overlook the International Market Place. Nighttime background noise levels at the International Market Place are currently lower due to the absence of live music performances at the former Coconut Willy's and Sparky's nightclubs. Live music performances currently continue at the Food Court Stage. Background ambient noise levels tend to be lowest during the early morning hours between 3:00 and 5:00 AM, and are typically near 60 dBA. At Location B3, the Waikiki Beachcomber's cooling tower's noise level of 67 to 70 dBA dominated the background noise levels at the mauka end of the tower building (see FIGURE 16). At Location B4, one suite makai of the corner suite (Location B3), background ambient noise levels were lower at 60 dBA during the quieter periods and less influenced by the noise from the cooling tower (see FIGURE 17).

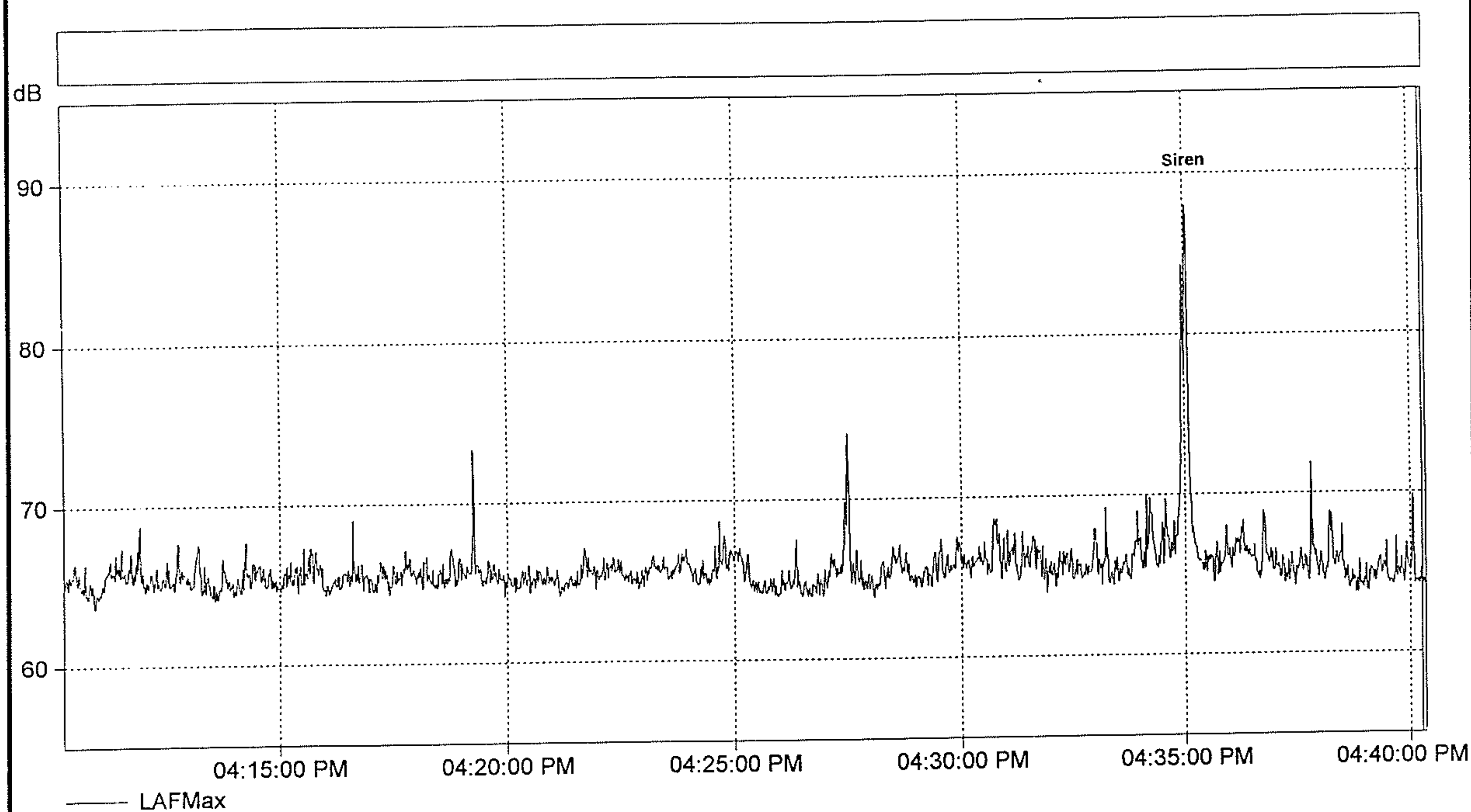
Traffic noise levels tend to be lowest during the early morning hours between 3:00 and 5:00 AM, and tend to be highest during the PM commuting hours. The measured variations in average hourly noise levels at locations overlooking Kuhio Avenue are shown in FIGURES 18 and 19. During the quietest early morning hours, background noise levels also hovered near 60 dBA as was characteristic of the quietist times at the interior locations (B1, B2, and B4) surrounding the International Market Place. Superimposed on the hourly variations associated with traffic noise along Kuhio Avenue are the very large increases in average hourly noise levels caused by the louder noise sources, such as the sirens and refuse trucks.

FIGURES 20 and 21 present the variations of measured average (or Leq) sound levels at ground level within the existing International Market Place and Waikiki Town Center. The measured sound levels tend to be highest along Kalakaua Avenue and Kuhio Avenue due to road traffic noise, as well as street vendors playing musical instruments at the Kalakaua Avenue entrance to the International Market Place. Sound levels were also highest along the east alley adjoining the Sheraton Princess Kaiulani



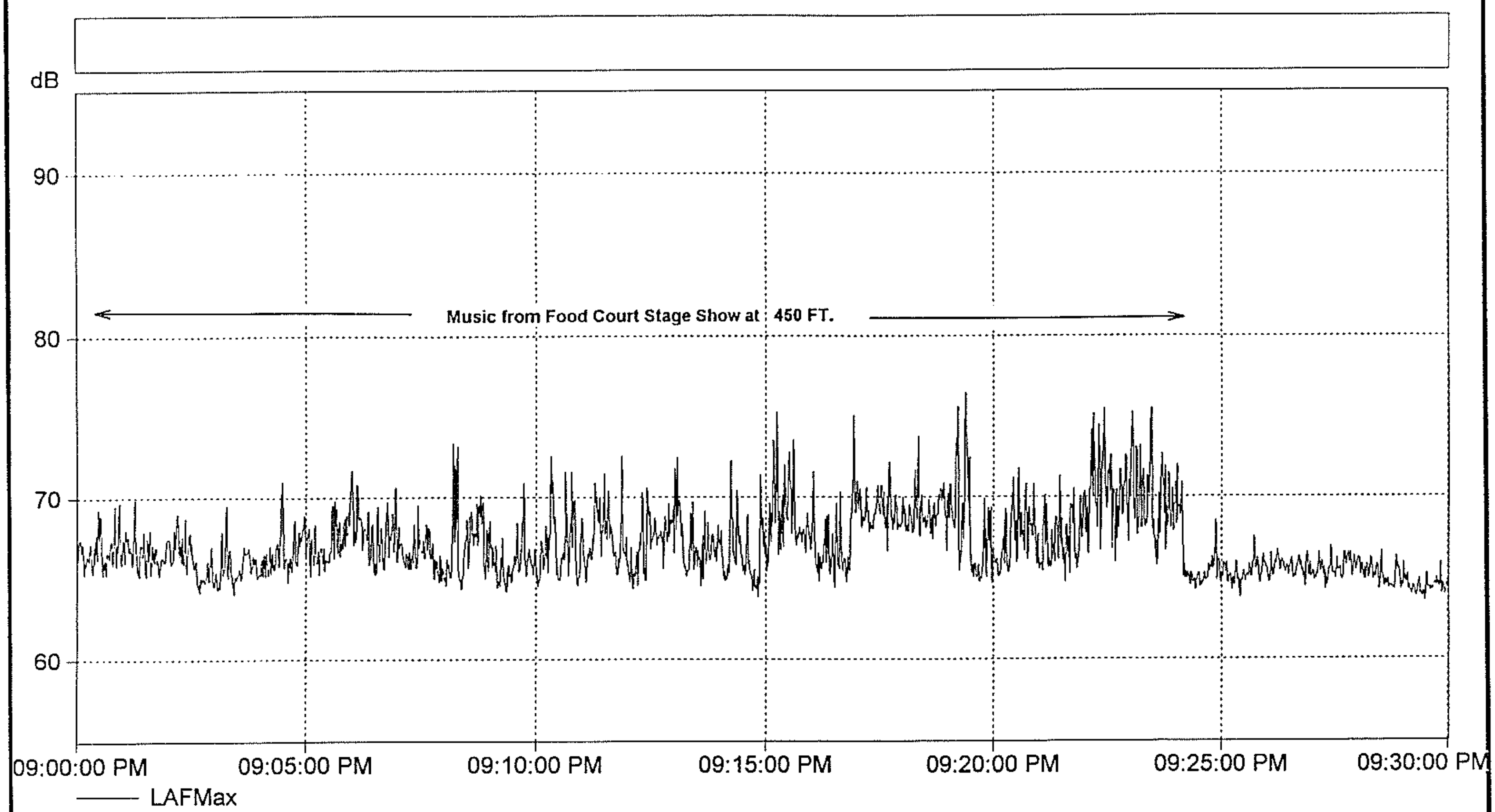
MAXIMUM SOUND LEVEL VS. TIME MEASURED AT LOCATION "T3" (11/23/11; 12:02 AM)

FIGURE 6



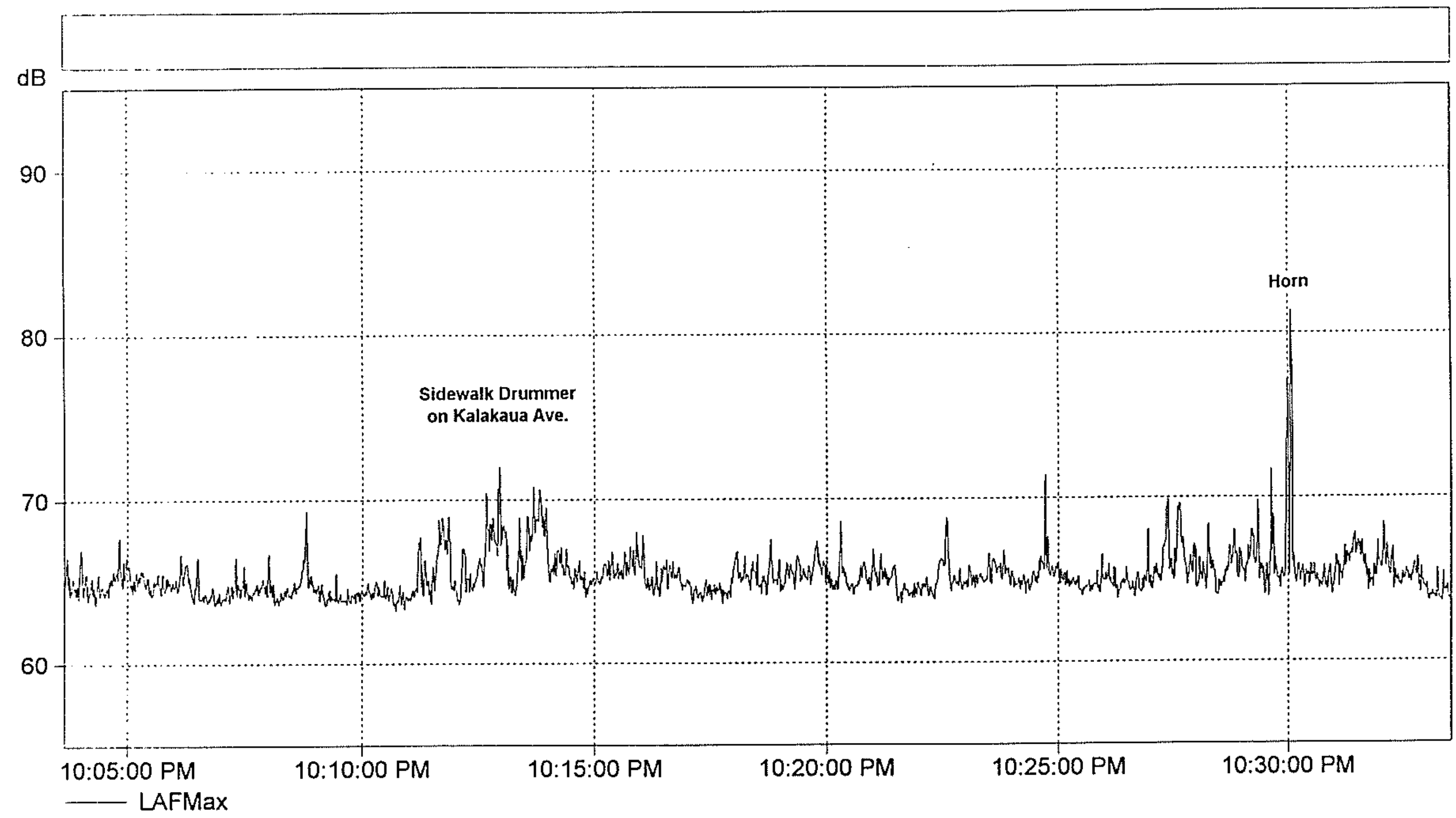
MAXIMUM SOUND LEVEL VS. TIME MEASURED AT LOCATION "B1" (4/19/04; 4:25 PM)

FIGURE 7



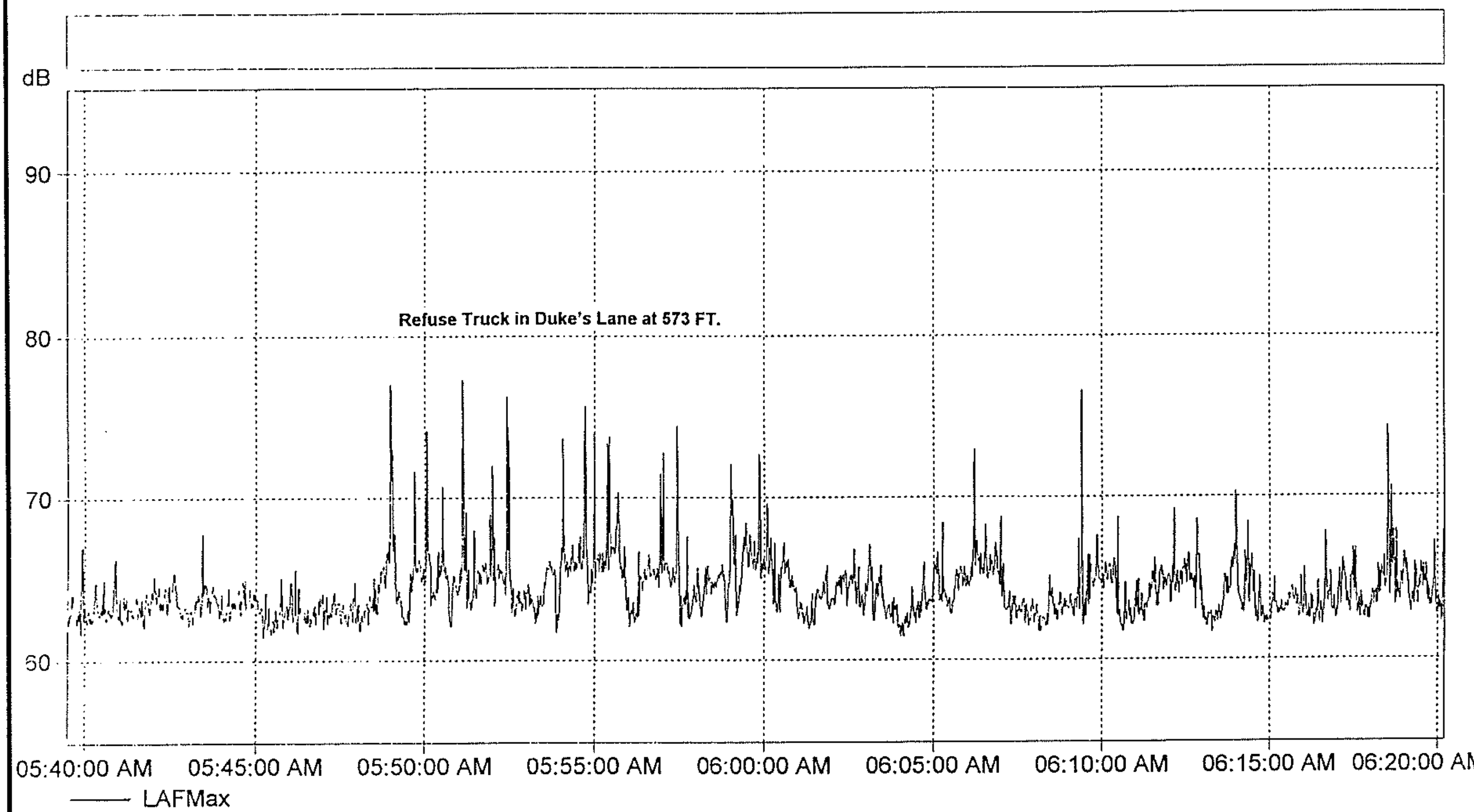
MAXIMUM SOUND LEVEL VS. TIME MEASURED AT LOCATION "B1" (4/19/04; 9:15 PM)

FIGURE 8



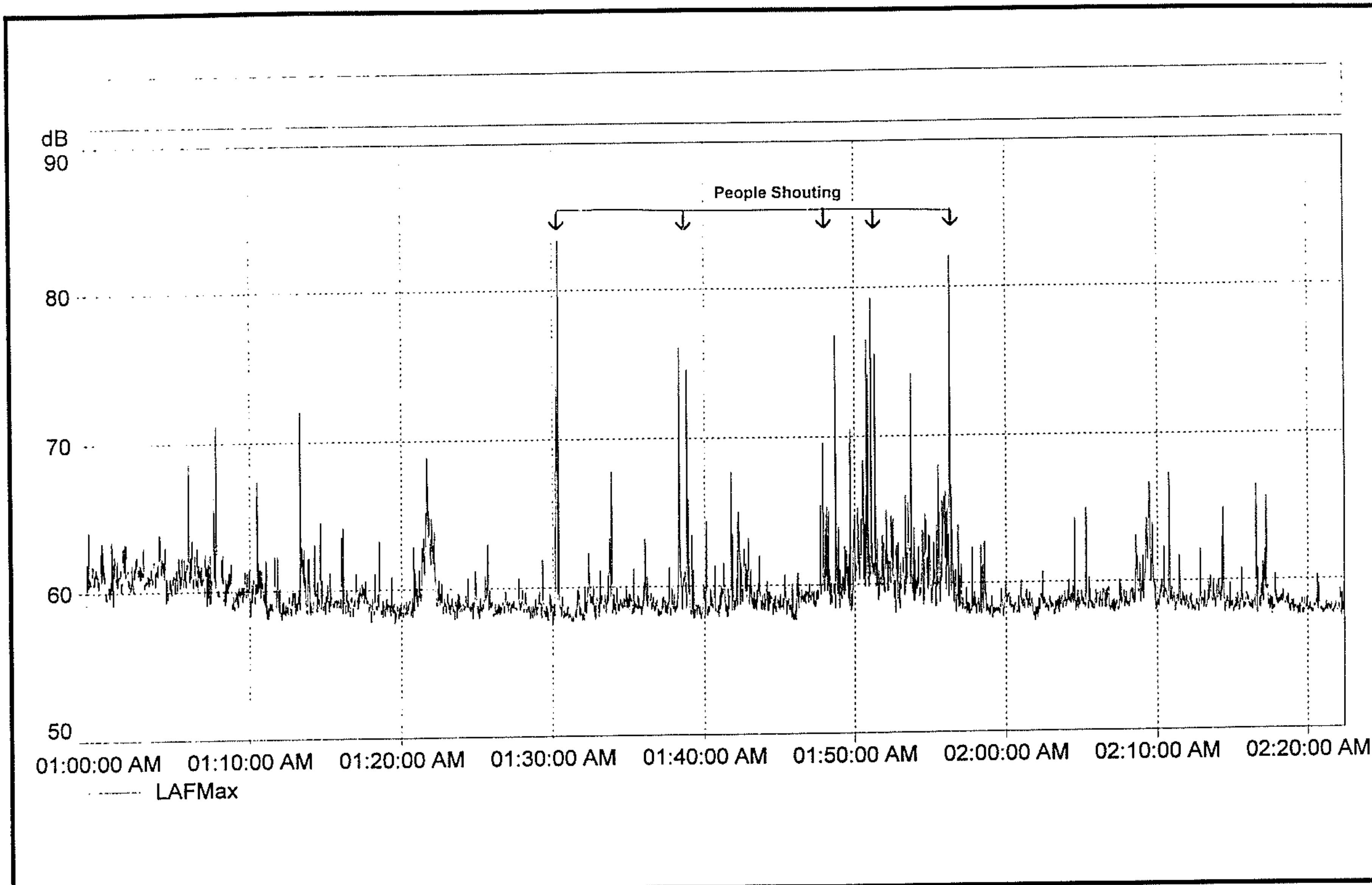
MAXIMUM SOUND LEVEL VS. TIME MEASURED AT LOCATION "B1" (4/19/04; 10:20 PM)

FIGURE 9



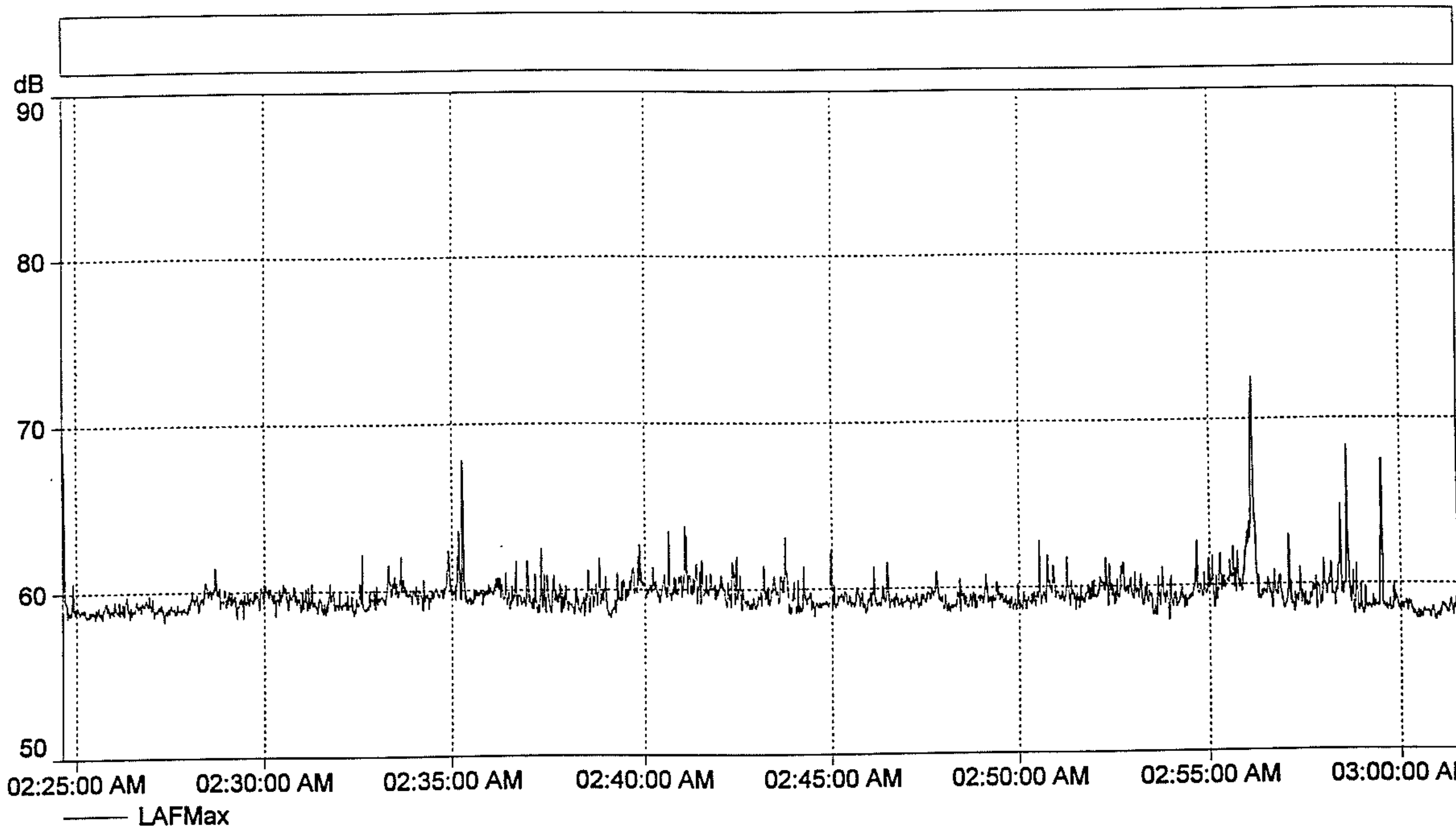
MAXIMUM SOUND LEVEL VS. TIME MEASURED AT LOCATION "B1" (4/20/04; 6:00 AM)

FIGURE 10



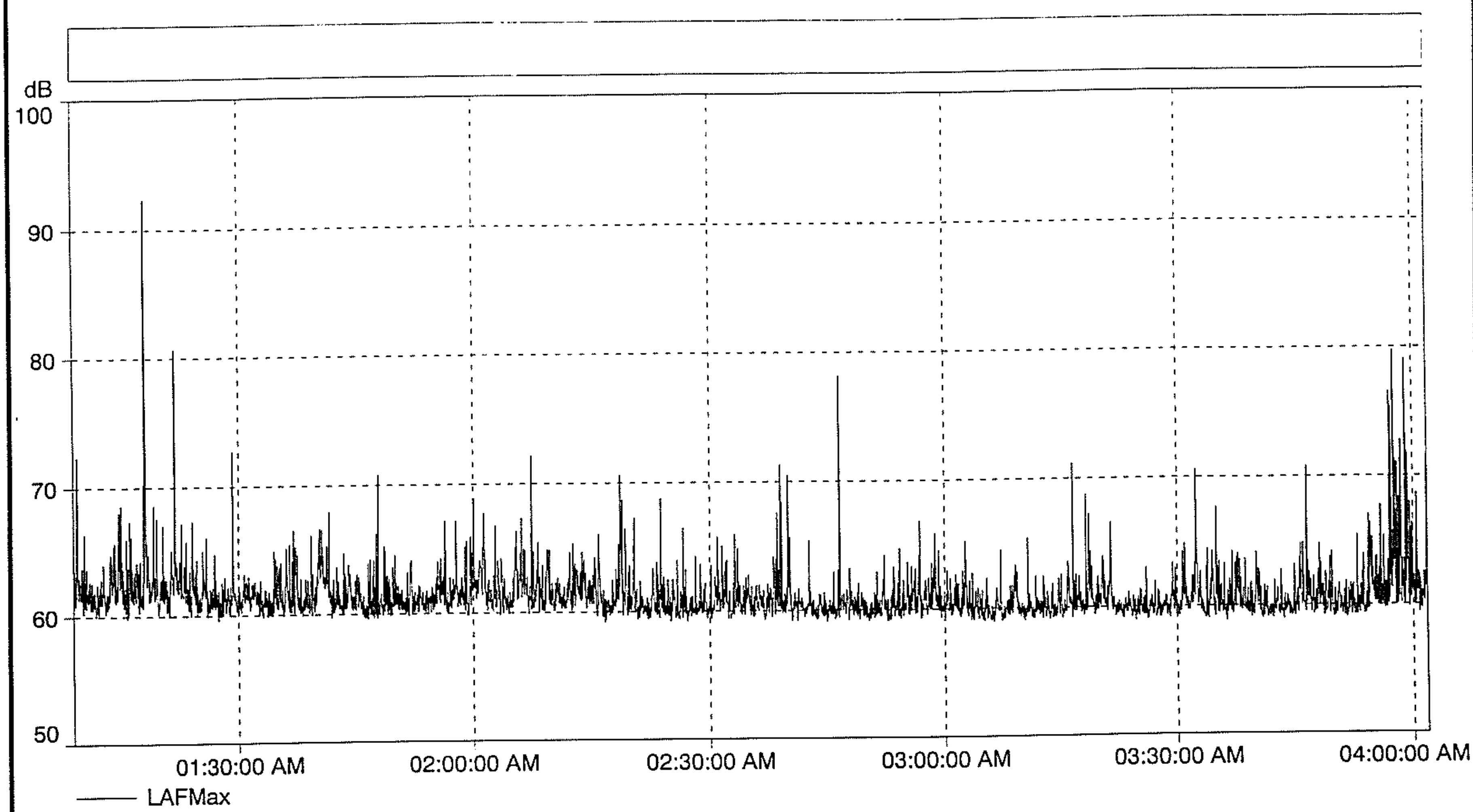
MAXIMUM SOUND LEVEL VS. TIME MEASURED AT LOCATION "B4" (6/17/07; 1:40 AM)

FIGURE 11



MAXIMUM SOUND LEVEL VS. TIME MEASURED AT LOCATION "B4" (6/17/07; 2:45 AM)

FIGURE 12



MAXIMUM SOUND LEVEL VS. TIME MEASURED AT LOCATION "B2" (6/14/07; 2:30 AM)

FIGURE 13

FIGURE 14

MEASURED HOURL VARIATIONS OF AVERAGE NOISE LEVELS AT LANAI OF SUITE 2743 OF SHERATON PRINCESS KAIULANI HOTEL (APRIL 19–20, 2004)

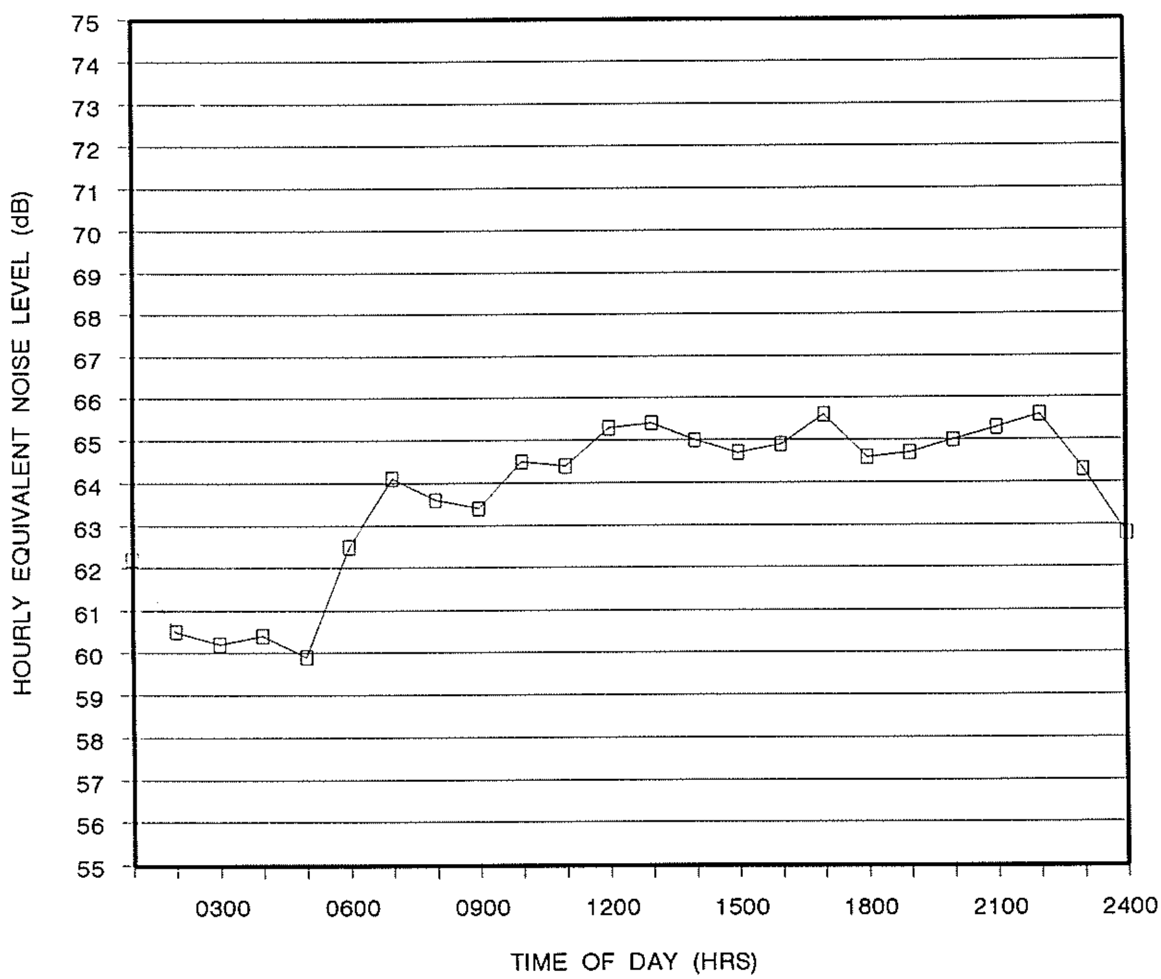


FIGURE 15

MEASURED HOURLY VARIATIONS OF AVERAGE NOISE LEVELS AT LANAI OF SUITE 1212 OF AQUA WAIKIKI WAVE HOTEL (JUNE 13 – 14, 2007)

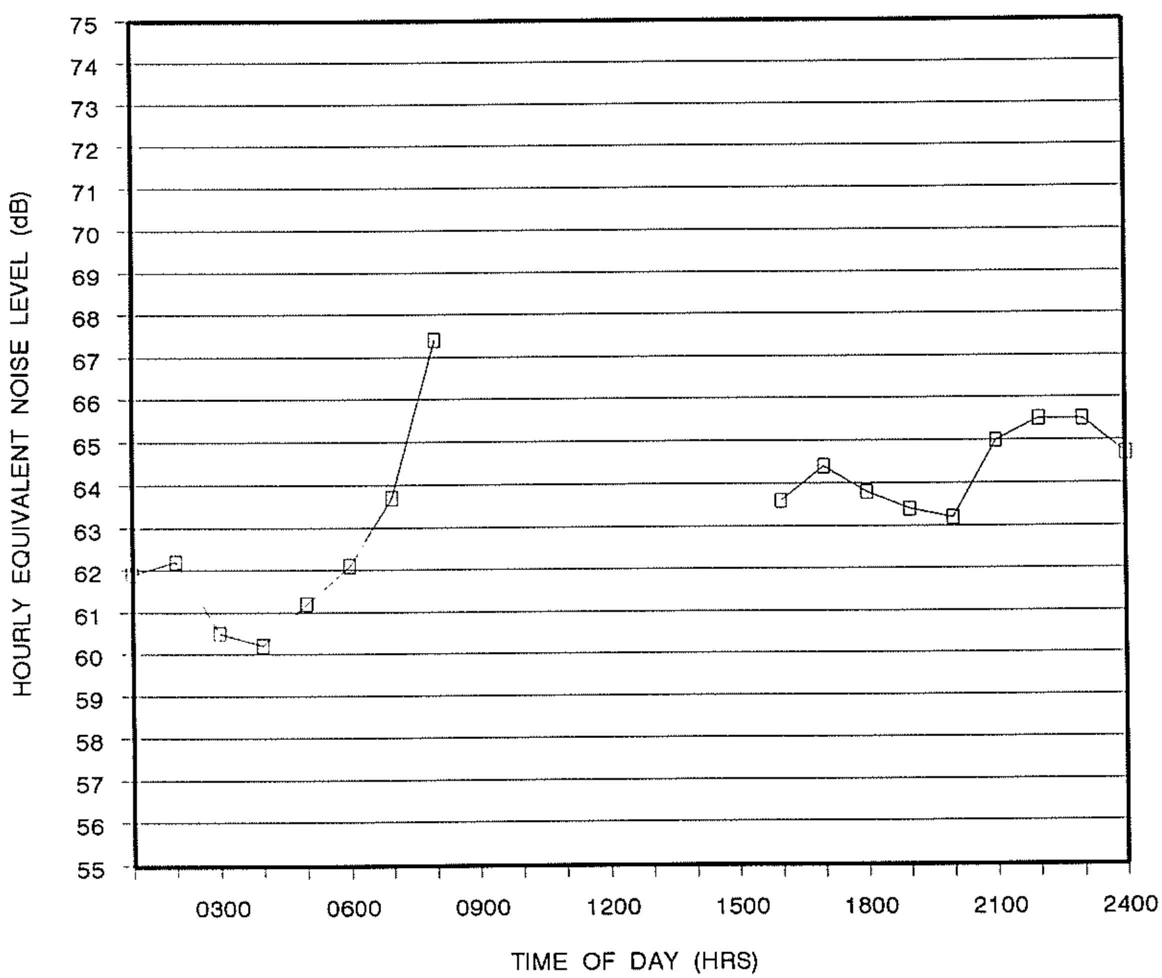


FIGURE 16

MEASURED HOURLY VARIATIONS OF AVERAGE NOISE LEVELS AT LANAI OF SUITE 600 OF WAIKIKI BEACHCOMBER HOTEL (NOVEMBER 25 – 26, 2011)

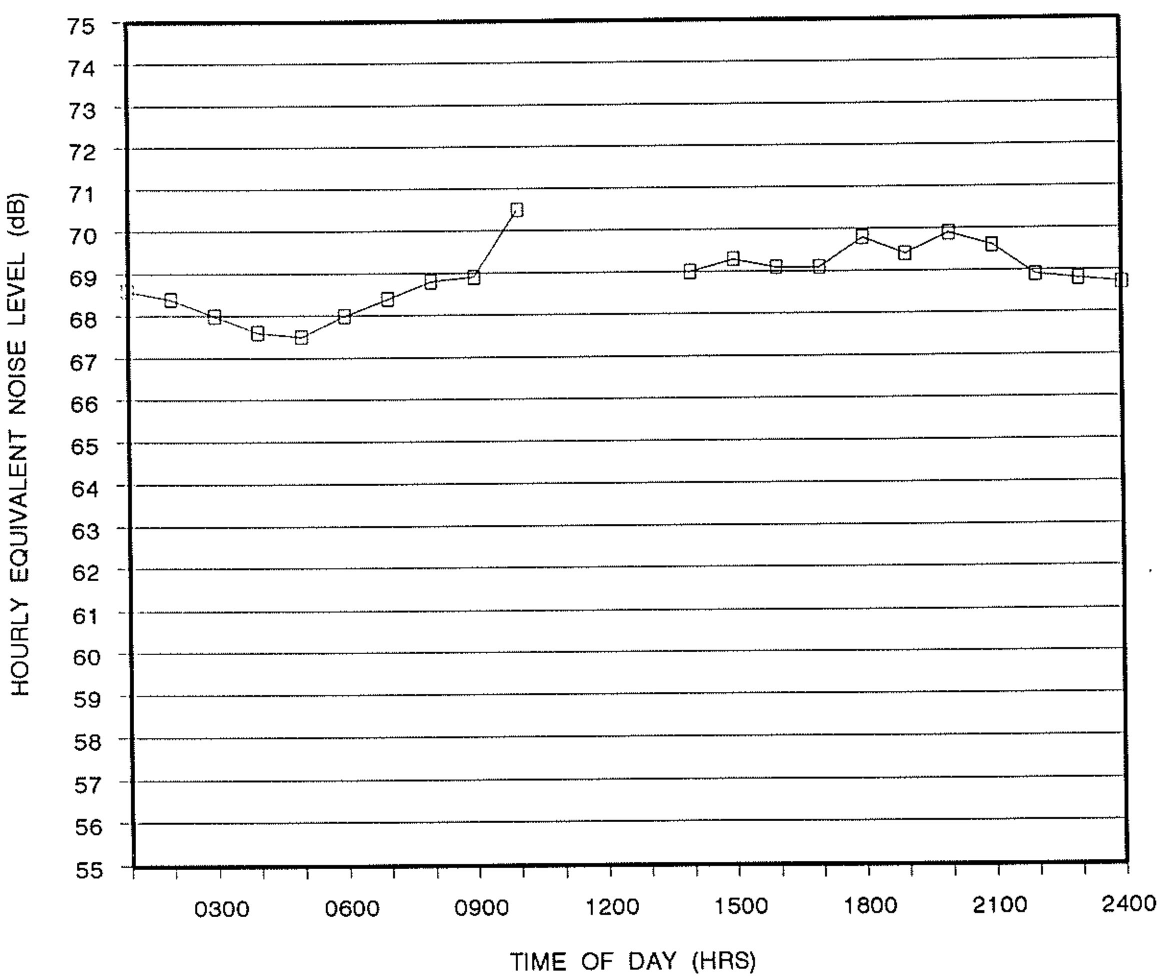


FIGURE 17

MEASURED HOURLY VARIATIONS OF AVERAGE NOISE LEVELS AT LANAI OF SUITE 601 OF WAIKIKI BEACHCOMBER HOTEL (JUNE 17 – 18, 2007)

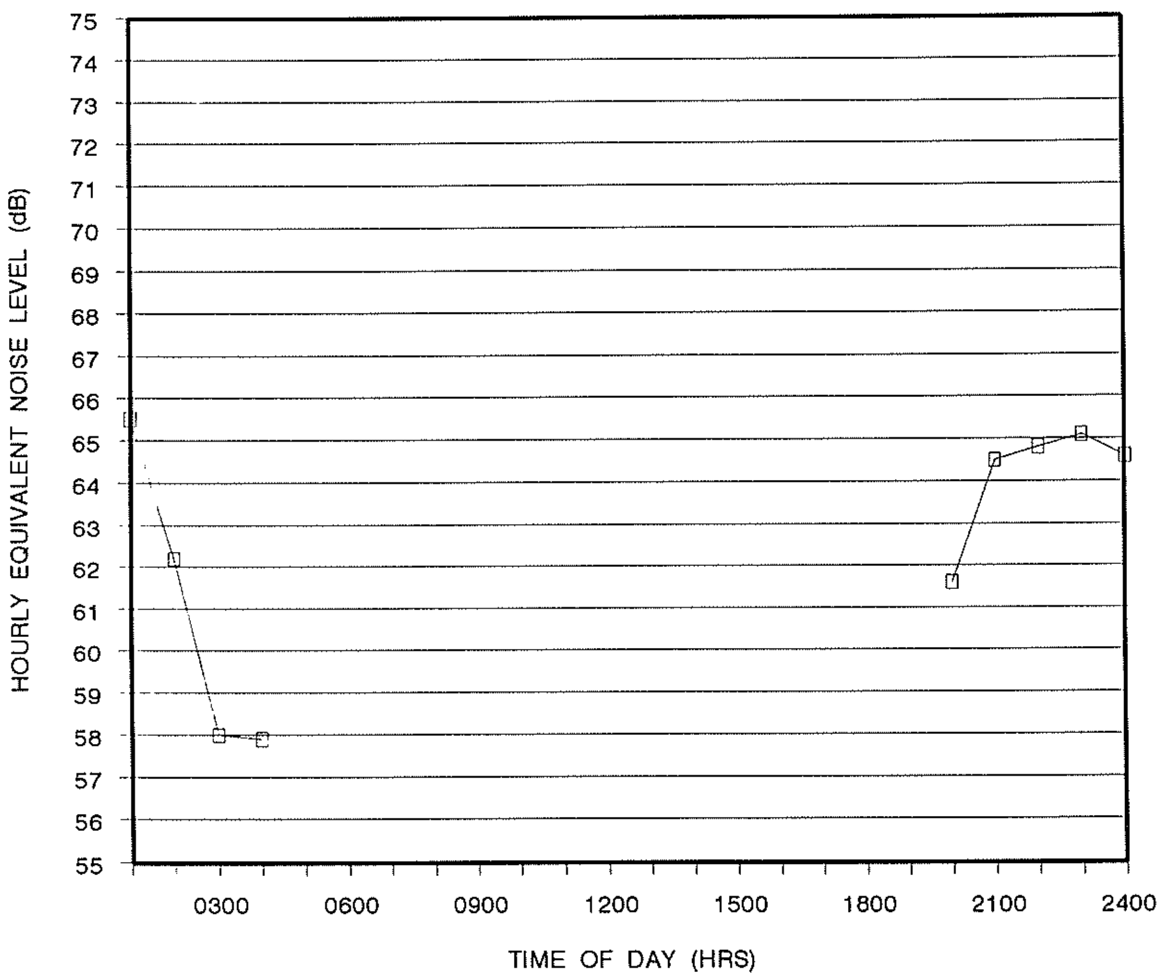


FIGURE 18

MEASURED HOURLY VARIATIONS OF AVERAGE NOISE LEVELS AT LANAI OF SUITE 936 OF OHANA WAIKIKI WEST HOTEL (MAY 18 – 19, 2011)

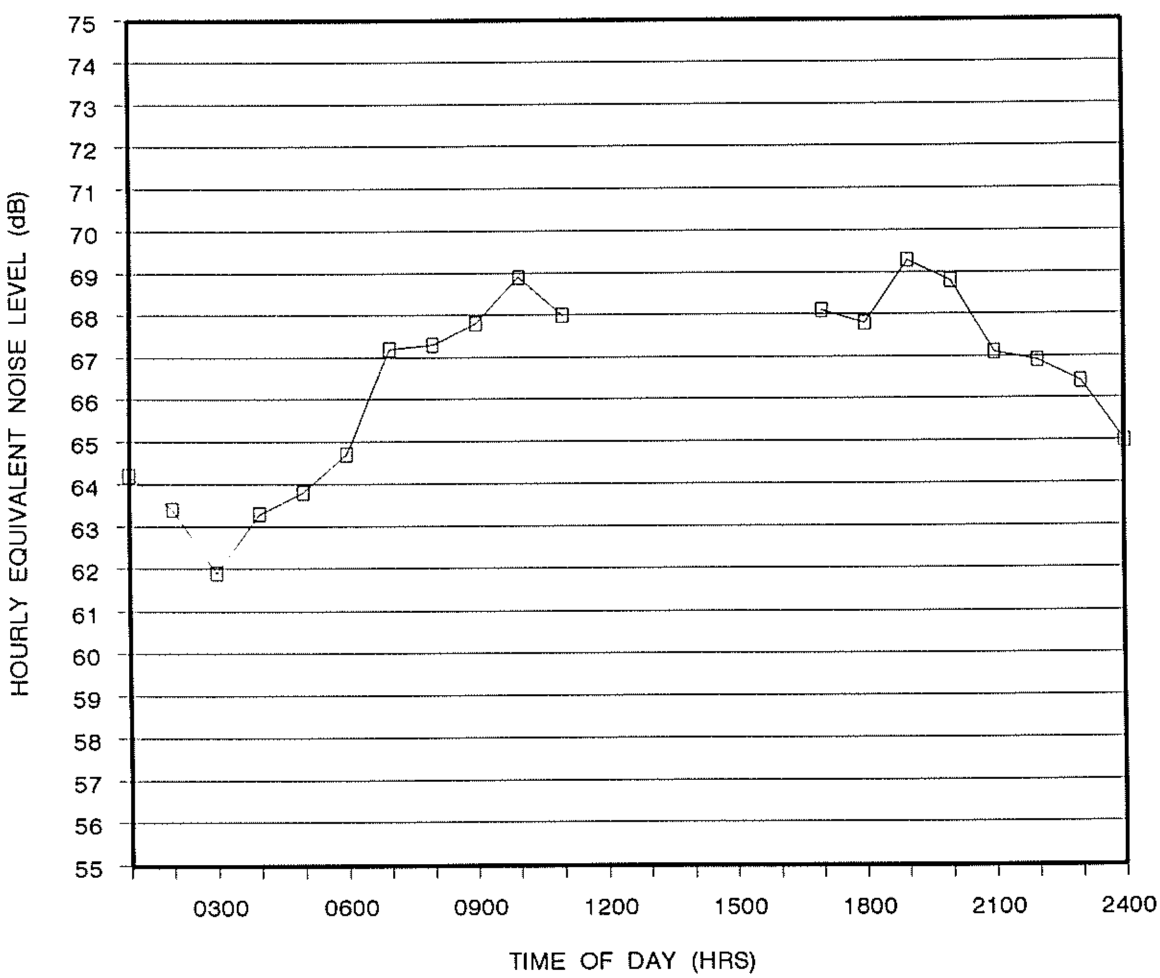
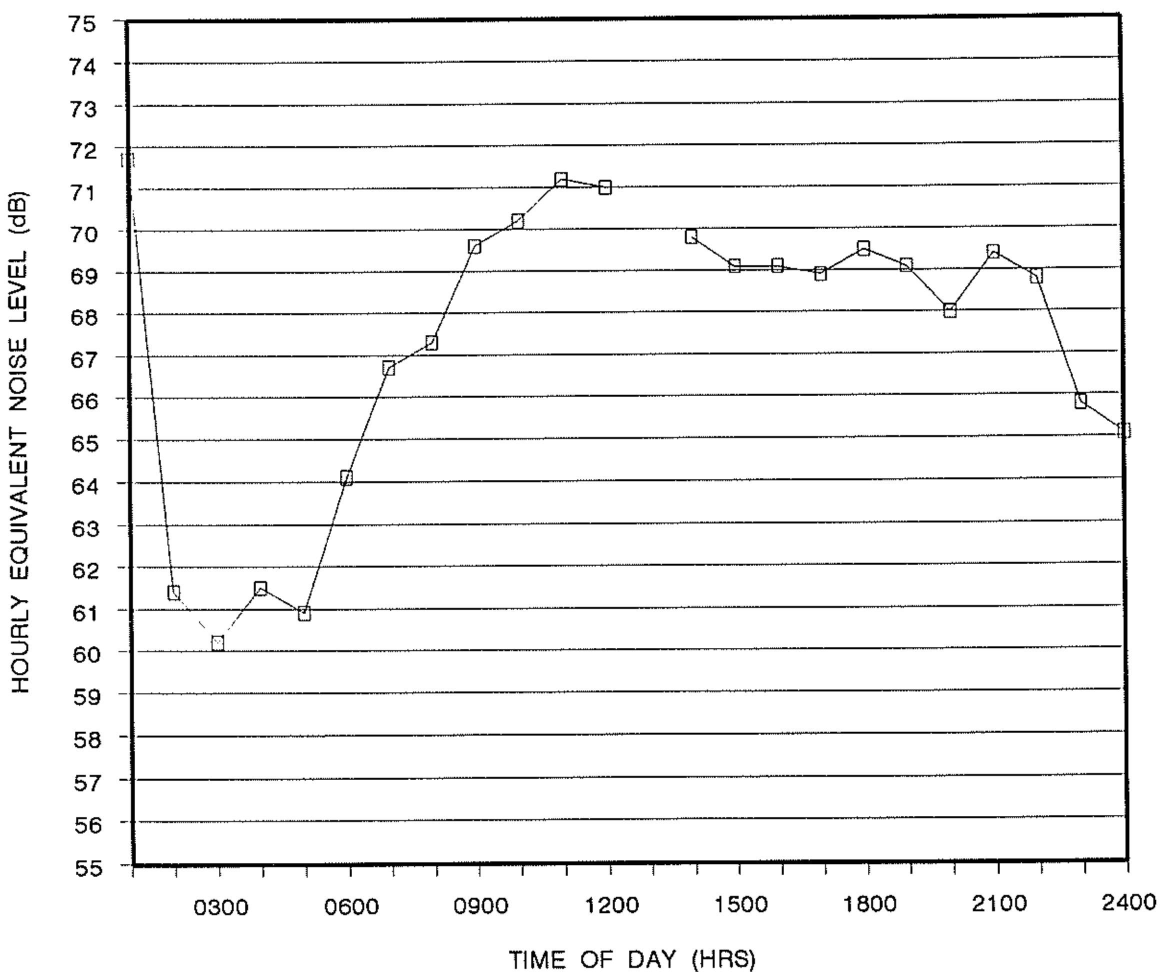
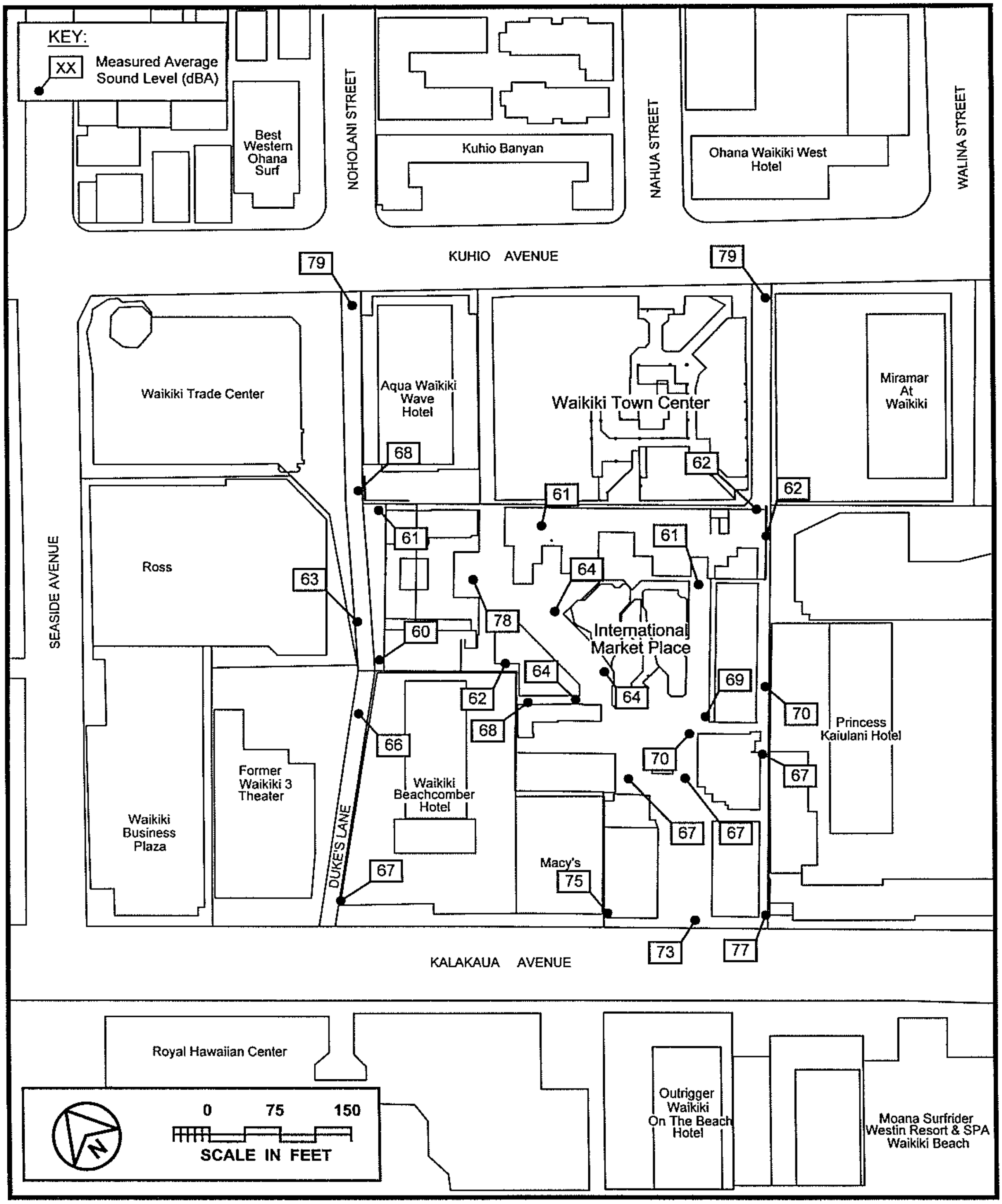


FIGURE 19

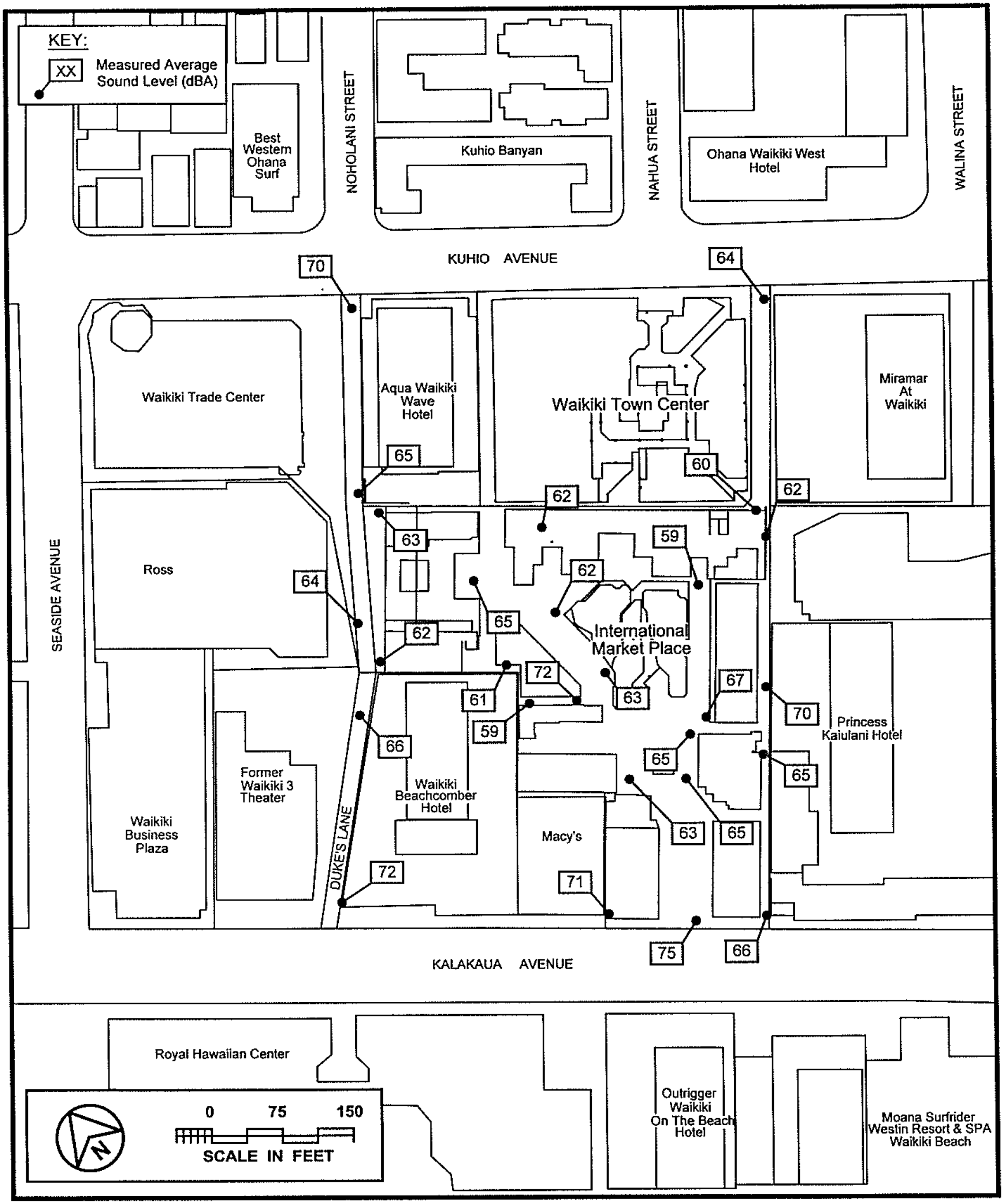
MEASURED HOURLY VARIATIONS OF AVERAGE NOISE LEVELS AT LANAI OF SUITE 546 OF MIRAMAR AT WAIKIKI HOTEL (NOVEMBER 22 – 23, 2011)





MEASURED VARIATIONS OF BACKGROUND NOISE LEVELS THROUGHOUT INTERNATIONAL MARKET PLACE (11/22/11; 7:15 PM)

FIGURE 20



MEASURED VARIATIONS OF BACKGROUND NOISE LEVELS THROUGHOUT INTERNATIONAL MARKET PLACE (11/25/11; 9:15 PM)

FIGURE 21

Hotel, where air conditioning equipment are located. At other locations within the International Market Place, music over the PA system or music from vendor equipment and the voices of shoppers and merchants controlled the background ambient levels.

The existing traffic volumes and their noise contributions at 50, 75, and 100 feet setback distances from the centerlines of the roadways servicing the project are shown in TABLE 3 for the weekday PM peak traffic hour. The corresponding setback distances from the roadways' centerlines to their corresponding 65, 70, and 75 DNL traffic noise contours for ground level receptors are shown in TABLE 4. Based on the results shown in TABLES 3 and 4, as well as the predicted (see FIGURES 3 through 5) and measured (see FIGURES 18 and 19) sound levels at the various locations along the major roadways, it was concluded that existing background noise levels in the project environs currently exceed 65 DNL at essentially all buildings which front Ala Wai Boulevard, Kalakaua Avenue, and Kuhio Avenue. In addition, at the upper floors of buildings located between Kalakaua Avenue and Kuhio Avenue, distant traffic plus the other non-traffic noise sources in the area cause ambient noise levels to exceed 65 DNL. At those receptor locations which front Kalakaua Avenue and Kuhio Avenue, existing background ambient noise levels exceed 70 DNL, but are less than 75 DNL. For those high-rise receptor locations with visual line of sight to Kalakaua Avenue or Kuhio Avenue, background ambient noise levels can be expected to exceed 65 DNL due to the extremely large setback distances from these two roadways to their 65 DNL noise level contours.

At receptor locations which front roadways, emergency and police vehicles, noisy motorcycles, mopeds, and buses, and garbage trucks are typically the loudest noise sources, with intermittent noise levels ranging as high as 90 to 103 dBA. Parked tour buses idling at curbside were also relatively noisy at 70 to 80 dBA. Noise from delivery truck movements and loading dock activities can also be relatively loud at 70 to 90 dBA.

At receptor locations which are shielded from roadway or loading area noise, existing background ambient noise levels are lower due to the noise shielding effects of surrounding buildings. Noise reductions of 5 to 20 dBA can be expected from these noise shielding effects. Background ambient noise levels at these locations can range from 55 to 65 DNL, and are controlled by nearby mechanical equipment or nearby human activities rather than by traffic noise. At receptor locations which are more elevated above ground level, the noise shielding effects from surrounding buildings can diminish as the visual field of views to nearby roadways (and resulting noise levels) increase with increasing elevations. Under these conditions with unobstructed field of views, the traffic noise level contributions and setback distances will tend to approach those for the ground level receptors shown in TABLES 3 and 4.

TABLE 3

EXISTING (CY 2011) TRAFFIC VOLUMES AND NOISE LEVELS ALONG ROADWAYS IN PROJECT AREA (PM PEAK HOUR, WEEKDAY)

LOCATION	SPEED (MPH)	TOTAL VPH	****** VOLUMES (VPH) ********			50' Leq	75' Leq	100' Leq
			AUTOS	M TRUCKS	H TRUCKS			
Ala Wai Blvd. W. of Seaside Ave.	30	2,078	2,026	35	17	69.8	67.8	66.5
Ala Wai Blvd. Between Seaside & Nohonani	30	1,896	1,849	32	15	69.3	67.4	66.1
Ala Wai Blvd. Between Nohonani & Nahua	30	1,992	1,942	34	16	69.5	67.5	66.2
Ala Wai Blvd. Between Nahua & Walina	30	1,798	1,753	31	14	68.9	66.9	65.6
Ala Wai Blvd. Between Walina & Kanekapolei	30	1,983	1,933	34	16	69.5	67.6	66.3
Ala Wai Blvd. E. of Kanekapolei St.	30	1,828	1,782	31	15	69.2	67.2	65.9
Kuhio Ave. W. of Seaside Ave.	32	1,067	917	43	107	72.0	69.4	68.0
Kuhio Ave. Between Seaside & Nohonani	32	1,066	916	43	107	72.0	69.4	68.0
Kuhio Ave. Between Nohonani & Nahua	32	1,071	921	43	107	72.0	69.5	68.0
Kuhio Ave. Between Nahua & Walina	32	1,016	873	41	102	71.9	69.3	67.8
Kuhio Ave. Walina & Kanekapolei	32	1,088	935	44	109	72.2	69.6	68.1
Kuhio Ave. E. of Kanekapolei	32	1,009	868	40	101	71.8	69.2	67.7
Kalakaua Ave. W. of Seaside Ave.	32	1,616	1,537	47	32	70.2	68.3	67.0
Kalakaua Ave. Between Seaside & Duke's Ln.	32	1,469	1,397	43	29	69.8	67.9	66.6
Kalakaua Ave. Between Duke's Ln. & Kaiulani	32	1,459	1,388	42	29	69.8	67.9	66.6
Kalakaua Ave. E. of Kaiulani Ave.	32	1,101	1,047	32	22	68.6	66.6	65.3
Seaside Ave. Between Ala Wai & Kuhio	25	593	564	17	12	63.6	61.8	60.6
Nohonani St. Between Ala Wai & Kuhio	25	208	202	4	2	57.8	56.1	54.8
Nahua St. Between Ala Wai & Kuhio	25	201	197	3	1	56.9	55.2	54.0
Walina St. Between Ala Wai & Kuhio	25	125	115	5	5	58.3	56.5	55.3
Kanekapolei St. Between Ala Wai & Kuhio	25	492	452	20	20	64.3	62.5	61.3
Seaside Ave. Between Kalakaua & Kuhio	25	291	284	5	2	58.9	57.2	55.9
Duke's Ln. Between Kalakaua & Kuhio	10	64	64	0	0	45.8	44.1	42.9
Kaiulani Ave. Between Kalakaua & Kuhio	25	456	444	8	4	61.1	59.3	58.1

TABLE 4

EXISTING AND CY 2015 DISTANCES TO 65, 70, AND 75 DNL CONTOURS (WEEKDAY)

STREET SECTION	65 DNL SETBACK (FT)		70 DNL SETBACK (FT)		75 DNL SETBACK (FT)	
	EXISTING	CY 2015	EXISTING	CY 2015	EXISTING	CY 2015
Ala Wai Blvd. W. of Seaside Ave.	174	178	59	60	21	22
Ala Wai Blvd. Between Seaside & Nohonani	159	166	53	56	18	20
Ala Wai Blvd. Between Nohonani & Nahua	163	174	55	59	20	21
Ala Wai Blvd. Between Nahua & Walina	142	156	49	53	18	19
Ala Wai Blvd. Between Walina & Kanekapolei	166	186	56	62	19	23
Ala Wai Blvd. E. of Kanekapolei St.	152	166	52	56	19	20
Kuhio Ave. W. of Seaside Ave.	185	185	68	68	31	31
Kuhio Ave. Between Seaside & Nohonani	185	174	68	68	31	30
Kuhio Ave. Between Nohonani & Nahua	178	174	69	68	31	31
Kuhio Ave. Between Nahua & Walina	171	174	67	68	31	31
Kuhio Ave. Walina & Kanekapolei	181	199	70	76	32	34
Kuhio Ave. E. of Kanekapolei	168	185	66	72	30	33
Kalakaua Ave. W. of Seaside Ave.	242	259	80	86	28	31
Kalakaua Ave. Between Seaside & Duke's Ln.	222	237	73	78	25	28
Kalakaua Ave. Between Duke's Ln. & Kaiulani	222	237	73	78	25	27
Kalakaua Ave. E. of Kaiulani Ave.	166	182	56	61	20	21
Seaside Ave. Between Ala Wai & Kuhio	46	46	15	15	< 12	< 12
Nohonani St. Between Ala Wai & Kuhio	< 12	12	< 12	< 12	< 12	< 12
Nahua St. Between Ala Wai & Kuhio	< 12	< 12	< 12	< 12	< 12	< 12
Walina St. Between Ala Wai & Kuhio	14	24	< 12	< 12	< 12	< 12
Kanekapolei St. Between Ala Wai & Kuhio	53	51	17	16	< 12	< 12
Seaside Ave. Between Kalakaua & Kuhio	15	16	< 12	< 12	< 12	< 12
Duke's Ln. Between Kalakaua & Kuhio	< 12	< 12	< 12	< 12	< 12	< 12
Kaiulani Ave. Between Kalakaua & Kuhio	26	24	< 12	< 12	< 12	< 12

Notes:

(1) All setback distances are from the roadways' centerlines.
(2) See TABLES 3 and 5 for traffic volume, speed, and mix assumptions.
(3) Setback distances are for ground level receptors.
(4) "Pavement" conditions assumed along all roadways.

CHAPTER VI. FUTURE NOISE ENVIRONMENT

Predictions of future traffic noise levels were made using the traffic volume assignments of Reference 6 for CY 2015 with and without the proposed project. The future projections of non-project and project traffic volumes for the No Build and Build Alternatives are shown in APPENDIX C. Future traffic volumes were provided for a weekday and a Saturday PM peak traffic hour, but future traffic noise level predictions were performed only for the weekday PM peak traffic hour.

TABLE 5 contains the CY 2015 traffic volumes and noise levels at 50, 75, and 100 feet from the roadways' centerlines for the Build Alternative during a weekday PM peak hour. TABLE 4 contains the setback distances to the 65, 70, and 75 DNL contours for CY 2015 on a weekday. Future average vehicle speeds along all roadways were assumed to be identical to those used for CY 2011 (see TABLE 3).

In CY 2015, the dominant traffic noise sources in the project area will continue to be traffic along Kalakaua Avenue and Kuhio Avenue. Future traffic noise levels are expected to increase by less than 1.0 dB (or DNL) along the major roadways in the project area (including Ala Wai Boulevard) by CY 2015 due to non-project traffic (see TABLE 6). Project traffic will add 0.2 dB or less to the noise levels along Kuhio Avenue, and will not contribute to traffic noise levels along Kalakaua Avenue. Along Ala Wai Boulevard, project traffic noise contributions should not exceed 0.3 dB by CY 2015. Project related traffic noise increases will typically be lower than those associaed with non-project traffic along the three major roadways. The predicted increases in future traffic noise levels attributable to project traffic are considered to be minimal, and will be difficult to measure or perceive.

The greatest increase in traffic noise from project traffic is expected to occur along Walina Street between Ala Wai Boulevard and Kuhio Avenue. Although a 2.5 dB increase in traffic noise is predicted by CY 2015, the existing traffic volumes and noise levels along Walina Street are relatively low, so the future traffic noise levels should remain below 65 DNL at 50 feet setback distance from the roadway's centerline.

In CY 2015, traffic noise from Kalakaua Avenue and Kuhio Avenue will continue to be the dominant traffic noise sources in the project area. Significant increases in traffic noise levels in the project environs are not expected to occur by CY 2015 under the No Build or Build Alternatives. The other loud noise sources in the project area are not expected to change between CY 2011 and CY 2015, and will continue to be emergency and police sirens, motorcycles and mopeds, garbage and delivery trucks, and tour buses.

Essentially all locations which front Kalakaua Avenue and Kuhio Avenue will continue to experience relatively high noise levels above 70 DNL. Lower elevation receptors which benefit from the noise shielding from existing and new buildings may experience traffic noise levels less than 70 DNL. In addition, those receptor locations which are also removed from the major roadways as well as those shielded by existing

TABLE 5

FUTURE (CY 2015) TRAFFIC VOLUMES AND NOISE LEVELS ALONG ROADWAYS IN PROJECT AREA (WEEKDAY PM PEAK HOUR, BUILD)

LOCATION	SPEED (MPH)	TOTAL VPH	****** VOLUMES (VPH) ******** AUTOS	M TRUCKS	H TRUCKS	50' Leq	75' Leq	100' Leq
Ala Wai Blvd. W. of Seaside Ave.	30	2,170	2,116	37	17	69.9	67.9	66.6
Ala Wai Blvd. Between Seaside & Nohonani	30	1,988	1,938	34	16	69.6	67.6	66.3
Ala Wai Blvd. Between Nohonani & Nahua	30	2,108	2,055	36	17	69.8	67.8	66.5
Ala Wai Blvd. Between Nahua & Walina	30	1,887	1,840	32	15	69.3	67.3	66.0
Ala Wai Blvd. Between Walina & Kanekapolei	30	2,164	2,110	37	17	70.1	68.1	66.8
Ala Wai Blvd. E. of Kanekapolei St.	30	2,020	1,970	34	16	69.6	67.6	66.3
Kuhio Ave. W. of Seaside Ave.	32	1,065	915	43	107	72.0	69.4	68.0
Kuhio Ave. Between Seaside & Nohonani	32	1,043	897	42	104	71.9	69.4	67.9
Kuhio Ave. Between Nohonani & Nahua	32	1,049	902	42	105	72.0	69.4	67.9
Kuhio Ave. Between Nahua & Walina	32	1,045	898	42	105	72.0	69.4	67.9
Kuhio Ave. Walina & Kanekapolei	32	1,230	1,058	49	123	72.6	70.1	68.6
Kuhio Ave. E. of Kanekapolei	32	1,124	967	45	112	72.3	69.7	68.2
Kalakaua Ave. W. of Seaside Ave.	32	1,732	1,647	50	35	70.6	68.6	67.3
Kalakaua Ave. Between Seaside & Duke's Ln.	32	1,584	1,506	46	32	70.2	68.2	66.9
Kalakaua Ave. Between Duke's Ln. & Kaiulani	32	1,568	1,492	45	31	70.1	68.2	66.9
Kalakaua Ave. E. of Kaiulani Ave.	32	1,194	1,135	35	24	68.9	67.0	65.7
Seaside Ave. Between Ala Wai & Kuhio	25	593	564	17	12	63.6	61.8	60.6
Nohonani St. Between Ala Wai & Kuhio	25	232	226	4	2	58.1	56.4	55.1
Nahua St. Between Ala Wai & Kuhio	25	228	223	4	1	57.5	55.8	54.6
Walina St. Between Ala Wai & Kuhio	25	217	199	9	9	60.8	59.0	57.8
Kanekapolei St. Between Ala Wai & Kuhio	25	481	443	19	19	64.1	62.4	61.1
Seaside Ave. Between Kalakaua & Kuhio	25	294	287	5	2	59.0	57.2	56.0
Duke's Ln. Between Kalakaua & Kuhio	10	80	80	0	0	46.8	45.1	43.9
Kaiulani Ave. Between Kalakaua & Kuhio	25	450	438	8	4	61.0	59.3	58.0

TABLE 6

CALCULATIONS OF PROJECT AND NON-PROJECT TRAFFIC NOISE CONTRIBUTIONS (CY 2015) (WEEKDAY PM PEAK HOUR; LEQ OR DNL)

STREET SECTION	NOISE LEVEL INCREASE DUE TO: NON-PROJECT TRAFFIC	PROJECT TRAFFIC
Ala Wai Blvd. W. of Seaside Ave.	0.2	-0.1
Ala Wai Blvd. Between Seaside & Nohonani	0.4	-0.1
Ala Wai Blvd. Between Nohonani & Nahua	0.4	-0.1
Ala Wai Blvd. Between Nahua & Walina	0.6	-0.2
Ala Wai Blvd. Between Walina & Kanekapolei	0.3	0.3
Ala Wai Blvd. E. of Kanekapolei St.	0.3	0.1
Kuhio Ave. W. of Seaside Ave.	0.4	-0.4
Kuhio Ave. Between Seaside & Nohonani	0.3	-0.4
Kuhio Ave. Between Nohonani & Nahua	0.4	-0.4
Kuhio Ave. Between Nahua & Walina	0.3	-0.2
Kuhio Ave. Walina & Kanekapolei	0.3	0.1
Kuhio Ave. E. of Kanekapolei	0.3	0.2
Kalakaua Ave. W. of Seaside Ave.	0.4	0.0
Kalakaua Ave. Between Seaside & Duke's Ln.	0.4	0.0
Kalakaua Ave. Between Duke's Ln. & Kaiulani	0.3	0.0
Kalakaua Ave. E. of Kaiulani Ave.	0.3	0.0
Seaside Ave. Between Ala Wai & Kuhio	0.0	0.0
Nohonani St. Between Ala Wai & Kuhio	0.0	0.3
Nahua St. Between Ala Wai & Kuhio	0.0	0.6
Walina St. Between Ala Wai & Kuhio	0.0	2.5
Kanekapolei St. Between Ala Wai & Kuhio	0.0	-0.2
Seaside Ave. Between Kalakaua & Kuhio	0.0	0.1
Duke's Ln. Between Kalakaua & Kuhio	0.0	1.0
Kaiulani Ave. Between Kalakaua & Kuhio	0.2	-0.3

and new buildings should experience traffic noise levels less than 70 DNL. The relatively high traffic noise levels within the project area are characteristic of Waikiki, and will remain high through CY 2015, with or without the project.

The future project tenant spaces which front Kalakaua Avenue and Kuhio Avenue are predicted experience traffic noise levels between 65 to 75 DNL and are exptected to be in the "Marginally Compatible" noise category for commercial uses (see FIGURE 2). Closure and air conditioning of the affected spaces would mitigate the high noise levels from the two roadways at the storefronts along Kalakaua Avenue and Kuhio Avenue. The interior tenant spaces benefit from their greater setback distances from the two major roadways and should also be shielded from traffic noise by the planned structures within the revitalized International Market Place. Noise levels within the interior areas of the project should be similar to those shown in FIGURES 20 and 21, with the ambient noise levels controlled by pedestrian traffic conversations, background music amplifier/speakers, water features, and live entertainment.

The proposed outdoor dining areas of the revitalized International Market Place complex may need to be insulated from the noise of existing elevated air conditioning equipment (cooling towers, air cooled condensers, etc.), which are located on the mid-rise structures of the Waikiki Beachcomber Hotel, Macy's, and the Sheraton Princess Kaiulani Hotel. The planned renovations at the Sheraton Princess Kaiulani Hotel may result in changes to the existing rooftop equipment at that hotel. The noise from the existing cooling towers of the Waikiki Beachcomber Hotel, in particular, are relatively high at 76 dBA at 50 feet, and could adversely affect the outdoor dining area R-5. Enclosed retail and indoor dining areas can be insulated from the outdoor equipment on the neighboring properties, but it will be difficult to provide a high degree of sound attenuation at the outdoor dining areas.

CHAPTER VII. DISCUSSION OF PROJECT-RELATED NOISE IMPACTS AND POSSIBLE MITIGATION MEASURES

Traffic Noise. Noise impacts from project related traffic along the roadways which are expected to service the project traffic (Kalakaua Avenue, Kuhio Avenue, and Ala Wai Boulevard) are not expected due to the relatively low levels of project related traffic noise when compared to the noise levels of non-project related traffic and other noise sources. In addition, the existing resort units which are located in the immediate vicinity of the project are currently provided with air conditioning.

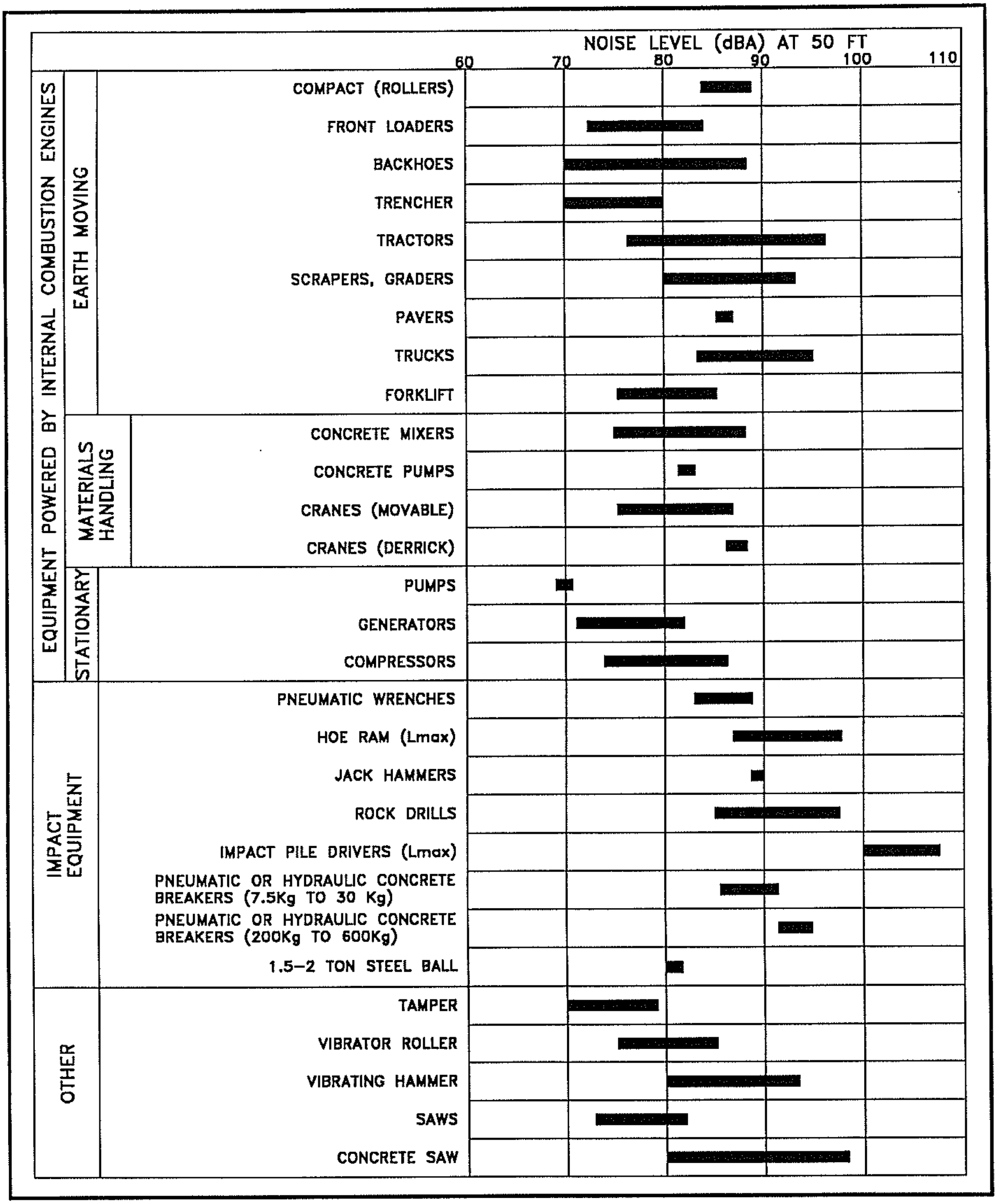
For those new tenant spaces in the revitalized International Market Place complex which front Kuhio Avenue and Kalakaua Avenue, as well as those spaces which may be close to existing air conditioning equipment, noise mitigation measures are recommended. Closure and air conditioning of the affected spaces can be an effective noise mitigation measure for this project.

General Construction Noise. Audible construction noise will probably be unavoidable during the entire project construction period. The total time period for demolition and construction is anticipated to be 24 months. It is anticipated that actual construction 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. FIGURE 22 depicts the range of noise levels of various types of construction equipment when measured at 50 FT distance from the equipment.

Demolition of the existing structures on the International Market Place and Waikiki Town Center complex, and the Miramar At Waikiki Hotel will occur during the initial phase of work. The International Market Place, Waikiki Town Center complex, and Miramar At Waikiki Hotel will probably be demolished using excavators, wrecking ball, bulldozers, front end loaders, saws, and/or jack hammers. Noise during preparation for the actual demolition of the structures, during the actual demolition by jack hammer, wrecking ball, excavator, and/or front end loaders, and during site cleanup and removal of the debris can be expected.

Following demolition and cleanup, the noise from site excavation, grading, and preparation activities will be present. Typical levels of exterior noise from construction activity (excluding building implosion or pile driving activity) at various distances from the job sites are shown in FIGURE 23. The impulsive noise levels of impact pile drivers are approximately 15 dB higher than the levels shown in FIGURE 23, while the intermittent noise levels of vibratory pile drivers are at the upper end of the noise level ranges depicted in the figure.

FIGURE 23 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



RANGES OF CONSTRUCTION EQUIPMENT NOISE LEVELS

FIGURE 22

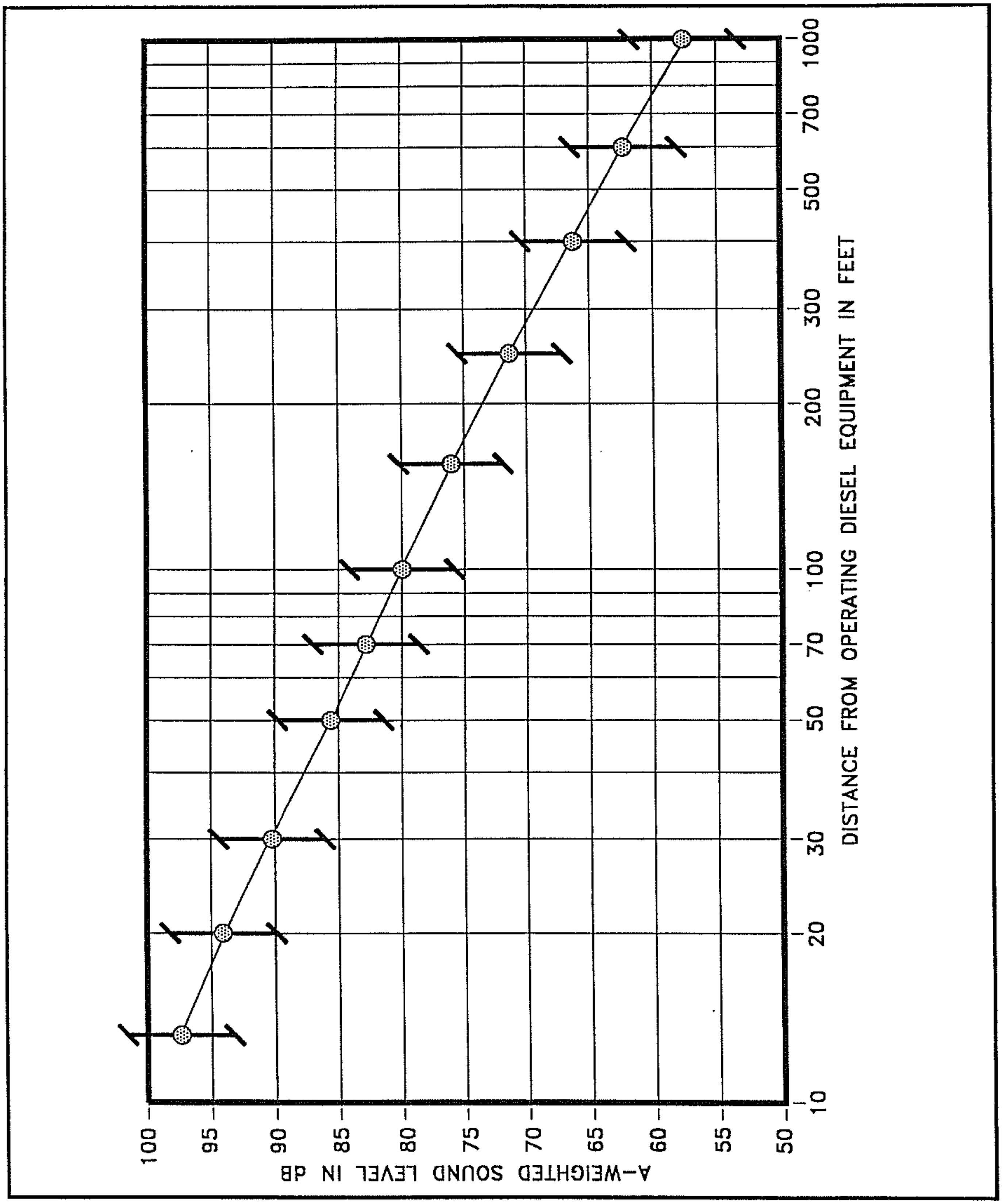
Following demolition and cleanup, the noise from site excavation, grading, and preparation activities will be present. Typical levels of exterior noise from construction activity (excluding building implosion or pile driving activity) at various distances from the job sites are shown in FIGURE 23. The impulsive noise levels of impact pile drivers are approximately 15 dB higher than the levels shown in FIGURE 23, while the intermittent noise levels of vibratory pile drivers are at the upper end of the noise level ranges depicted in the figure.

FIGURE 23 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 resort, apartment, and commercial buildings will range from 20 FT to 600+ FT, with corresponding average noise levels of 94 to 62 dBA (plus or minus 5 dBA). For receptors along a cross-street, the construction noise level vs. distance curve of FIGURE 23 should be reduced by approximately 8 dBA when the work is occurring at the intersection with the cross street, and should be reduced by 15 dBA when work is occurring at least 100 FT from the intersection (and the visual line-of-sight is blocked by intervening buildings). 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 23.

TABLE 7 presents the predicted ranges of construction noise during three phases of work (demolition/site preparation, and building erection) at receptor locations in the three hotels which surround the project site. The demolition by implosion of the Miramar At Waikiki Hotel should not result in comparable average noise levels to the other construction noise activities anticipated at the adjacent "Anchor" location due to the relatively short duration of the implosion noise event. The risks of adverse noise impacts would be greatest during the site preparation phase, and the risks would be least during the building erection phase. During the building erection phase, the noise levels at the three receptor locations should be more similar to existing background noise.

The units in the resort and commercial buildings which are adjacent to the project site are predicted to experience the highest noise levels during construction activities due to their close proximity to the construction sites. 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, the availability of closure and air conditioning for noise mitigation at the majority of the resort and commercial units in the project area, 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 to 90+ dB at 50 FT



ANTICIPATED RANGE OF CONSTRUCTION NOISE LEVELS VS. DISTANCE

FIGURE 23

equipment to existing resort, apartment, and commercial buildings will range from 20 FT to 600+ FT, with corresponding average noise levels of 94 to 62 dBA (plus or minus 5 dBA). For receptors along a cross-street, the construction noise level vs. distance curve of FIGURE 23 should be reduced by approximately 8 dBA when the work is occurring at the intersection with the cross street, and should be reduced by 15 dBA when work is occurring at least 100 FT from the intersection (and the visual line-of-sight is blocked by intervening buildings). 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 23.

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Mitigation of construction noise to inaudible levels will not be practical in all cases due to the intensity of construction noise sources (80 to 90+ dB at 50 FT distance), and due to the exterior nature of the work (demolition, excavation, grading, trenching, concrete pouring, hammering, etc.). The use of properly muffled construction equipment should be required on the job site.

Severe noise impacts are not expected to occur inside air conditioned structures which are beyond 70 to 450 FT of the project construction sites. Inside naturally ventilated structures, interior noise levels (with windows or doors opened) are estimated to range between 73 to 55 dBA at 70 FT to 450 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 4), is

TABLE 7
SUMMARY OF PREDICTED NOISE LEVELS DURING CONSTRUCTION

Receptor Location	Puka 1	Puka 2	Puka 3	Anchor
	-------- Location of Construction Work --------			
Demolition, Earthwork, & Site Prep. Phase (Range of Ave. Levels, dBA):				
Princess Kaiulani	72 to 80	67 to 75	66 to 74	63 to 76
Waikiki Beachcomber	70 to 78	70 to 78	64 to 72	61 to 72
Aqua Waikiki Wave	64 to 72	72 to 80	70 to 78	66 to 76
Building Erection Phase (Range of Ave. Levels, dBA):				
Princess Kaiulani	59 to 67	54 to 62	53 to 61	52 to 60
Waikiki Beachcomber	57 to 65	57 to 65	51 to 59	48 to 56
Aqua Waikiki Wave	51 to 59	59 to 67	57 to 65	53 to 61

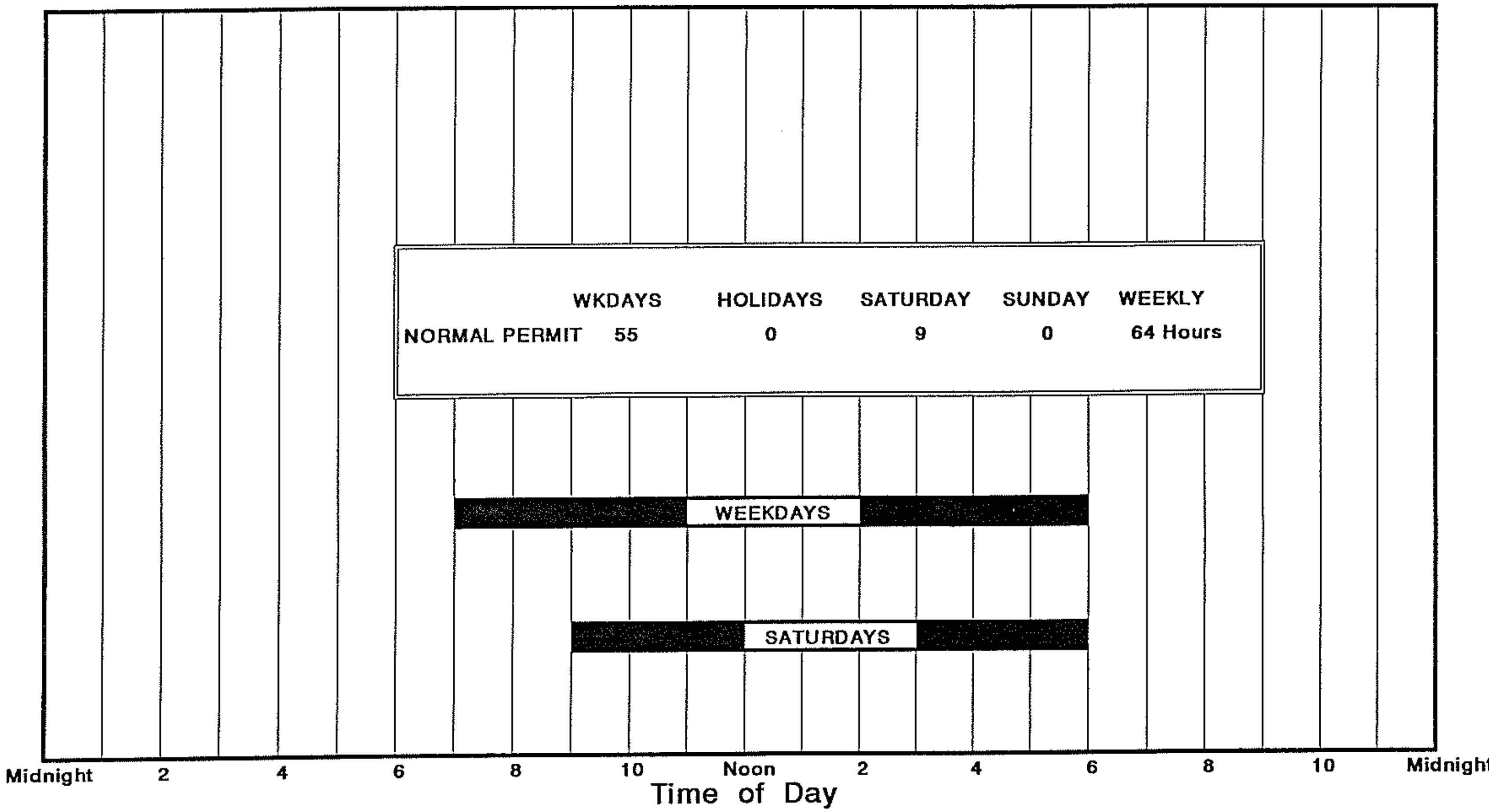
Notes:

1. Receptor at Princess Kaiulani Hotel located 90 feet above ground and at center of Ewa face of tower building.
2. Receptor at Waikiki Beachcomber Hotel located 90 feet above ground and at center of Diamond Head face of tower building.
3. Receptor at Aqua Waikiki Wave Hotel located 90 feet above ground and at makai/Diamond Head corner of tower building.

another noise mitigation measure which is normally applied to construction activities. FIGURE 24 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.

New On Site Activities. The retail shops, restaurants, and any impromptu outdoor entertainment areas do not represent totally new activity centers for the project site. Risks of adverse noise impacts from the new shops, restaurants, and entertainment areas are therefore considered to be low. Compliance with local noise regulations will be required at the new establishments. The applicable State Department of Health (DOH) noise limits (see Reference 4) are 60 dBA and 50 dBA during the daytime and nighttime periods, respectively, and these limits apply to fixed machinery and equipment, such as outdoor air conditioning equipment, emergency generator, and exhaust fans. Control of noise emissions from the new outdoor equipment will be required during the design of the new facilities. The Honolulu Liquor Commission also applies similar noise limits to music and other noises which may emanate from an establishment where alcohol is served. Because existing background ambient noise levels in Waikiki and within the International Market Place and Waikiki Town Center revitalization project area are generally higher than the State Department of Health noise limits, the noise limits of 60 and 50 dBA will probably not apply to the project area, and noise levels from project sources will generally be allowed to be as high as existing daytime and nighttime background ambient noise levels.

Tire squeal noise can occur if the circulation roadway surfaces within the planned parking garage structure are smooth or slick. In general, the use of coarse or brush concrete finishes, asphalt, or nonskid coatings on these circulation roadway surfaces will prevent the inception of tire squeal noise for typical circulation speeds within the parking garage structure. The use of these types of surfaces is recommended to prevent tire squeal noise.



AVAILABLE WORK HOURS UNDER DOH PERMIT PROCEDURES FOR CONSTRUCTION NOISE

FIGURE 24

APPENDIX A. REFERENCES

(1) "Guidelines for Considering Noise in Land Use Planning and Control;" Federal Interagency Committee on Urban Noise; June 1980.

(2) "Environmental Criteria and Standards, Noise Abatement and Control, 24 CFR, Part 51, Subpart B;" U.S. Department of Housing and Urban Development; July 12, l979.

(3) "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety;" Environmental Protection Agency (EPA 550/9-74-004); March 1974.

(4) "Title 11, Administrative Rules, Chapter 46, Community Noise Control;" Hawaii State Department of Health; September 23, 1996.

(5) "FHWA Traffic Noise Model User's Guide;" FHWA-PD-96-009, DOT-VNTSC-FHWA-98-1, Federal Highway Administration; Washington, D.C.; January 1998 and Version 2.5 Upgrade (April 14, 2004).

(6) Traffic Impact Report; International Market Place Revitalization Project; Wilson Okamoto Corporation; October 2011.

(7) Hourly traffic counts at Station #B72761200109, Kalakaua Avenue Between Lewers and Beachwalk; Hawaii State Department of Transportation; February 4, 2011.

(8) Hourly traffic counts at Station #B72771000000, Ala Wai Boulevard Between Ohua and Liliuokalani; Hawaii State Department of Transportation; April 22, 2010.

(9) Hourly traffic counts at Station #B72771100000, Kuhio Avenue Between Nahua and Walina; Hawaii State Department of Transportation; May 5, 2010.

(10) Wiss, John F., Janney, Elstner and Assoc.; "Damage of Pile Driving Vibration;" Highway Research Record, Number 155.

(11) Gutowski, T.G.; Wittig, L.E.; and Dym, C.L.; "Some Aspects of the Ground Vibration Problem;" Noise Control Engineering; May-June 1978.

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 C

SUMMARY OF BASE YEAR AND YEAR 2015 TRAFFIC VOLUMES DURING PM PEAK HOUR

ROADWAY LANES	******** CY 2011 ********* WEEKDAY	SATURDAY	*** CY 2015 (NO BUILD) ** WEEKDAY	SATURDAY	*** CY 2015 (BUILD) **** WEEKDAY	SATURDAY
Ala Wai Blvd. W. of Seaside Ave. (WB)	2,078	1,803	2,220	1,968	2,170	1,912
Ala Wai Blvd. Btwn. Seaside & Nohonani (WB)	1,896	1,713	2,038	1,878	1,988	1,822
Ala Wai Blvd. Btwn. Nohonani & Nahua (WB)	1,992	1,810	2,134	1,975	2,108	1,947
Ala Wai Blvd. Btwn. Nahua & Walina (WB)	1,798	1,641	1,940	1,806	1,887	1,747
Ala Wai Blvd. Btwn. Walina & Kanekapolei (WB)	1,983	1,768	2,125	1,933	2,164	1,916
Ala Wai Blvd. E. of Kanekapolei St. (WB)	1,828	1,554	1,970	1,718	2,020	1,775
Kuhio Ave. W. of Seaside Ave. (EB)	673	652	721	711	631	609
Kuhio Ave. W. of Seaside Ave. (WB)	394	409	427	455	434	409
Two-Way	1,067	1,061	1,148	1,166	1,065	1,018
Kuhio Ave. Btwn. Seaside & Nohonani (EB)	658	651	706	710	619	612
Kuhio Ave. Btwn. Seaside & Nohonani (WB)	408	428	441	474	424	428
Two-Way	1,066	1,079	1,147	1,184	1,043	1,040
Kuhio Ave. Btwn. Nohonani & Nahua (EB)	721	729	383	433	707	719
Kuhio Ave. Btwn. Nohonani & Nahua (WB)	350	385	769	431	342	385
Two-Way	1,071	1,114	1,152	864	1,049	1,104
Kuhio Ave. Btwn. Nahua & Walina (EB)	599	611	450	670	585	601
Kuhio Ave. Btwn. Nahua & Walina (WB)	417	486	647	532	460	517
Two-Way	1,016	1,097	1,097	1,202	1,045	1,118
Kuhio Ave. Btwn. Walina & Kanekapolei (EB)	721	647	769	706	830	776
Kuhio Ave. Btwn. Walina & Kanekapolei (WB)	367	429	398	475	400	451
Two-Way	1,088	1,076	1,167	1,181	1,230	1,227
Kuhio Ave. E. of Kanekapolei St. (EB)	720	552	768	611	823	674
Kuhio Ave. E. of Kanekapolei St. (WB)	289	343	317	382	301	366
Two-Way	1,009	895	1,085	993	1,124	1,040
Kalakaua Ave. W. of Seaside Ave. (EB)	1,616	1,721	1,729	1,864	1,732	1,868
Kalakaua Ave. Btwn. Seaside & Duke's Ln. (EB)	1,469	1,474	1,584	1,617	1,584	1,617
Kalakaua Ave. Btwn. Duke's Ln. & Kaiulani (EB)	1,459	1,416	1,568	1,550	1,568	1,550
Kalakaua Ave. E. of Kaiulani Ave. (EB)	1,101	1,063	1,194	1,174	1,194	1,174
Seaside Ave. Btwn. Ala Wai & Kuhio. (NB)	392	314	392	314	392	314
Seaside Ave. Btwn. Ala Wai & Kuhio. (SB)	201	194	201	194	201	194
Two-Way	593	508	593	508	593	508

APPENDIX C (CONTINUED)

SUMMARY OF BASE YEAR AND YEAR 2015 TRAFFIC VOLUMES DURING PM PEAK HOUR

ROADWAY LANES	******** CY 2011 *********		*** CY 2015 (NO BUILD) **		*** CY 2015 (BUILD) ****	
	WEEKDAY	SATURDAY	WEEKDAY	SATURDAY	WEEKDAY	SATURDAY
Nohonani St. Btwn. Ala Wai & Kuhio (NB)	60	56	60	56	60	56
Nohonani St. Btwn. Ala Wai & Kuhio (SB)	148	129	148	129	172	157
Two-Way	208	185	208	185	232	213
Nahua St. Btwn. Ala Wai & Kuhio (NB)	201	194	201	194	228	225
Walina St. Btwn. Ala Wai & Kuhio (SB)	125	129	125	129	217	170
Kanekapolei St. Btwn. Ala Wai & Kuhio (NB)	323	358	323	359	312	348
Kanekapolei St. Btwn. Ala Wai & Kuhio (SB)	169	162	169	162	169	162
Two-Way	492	520	492	521	481	510
Seaside Ave. Btwn. Kalakaua & Kuhio. (NB)	291	285	291	285	294	289
Duke's Ln. Btwn. Kalakaua & Kuhio. (NB)	64	58	64	58	80	77
Kaiulani Ave. Btwn. Kalaukaua & Kuhio (NB)	310	334	314	345	304	332
Kaiulani Ave. Btwn. Kalaukaua & Kuhio (SB)	146	162	146	162	146	162
Two-Way	456	496	460	507	450	494

AIR QUALITY STUDY

FOR THE PROPOSED

INTERNATIONAL MARKET PLACE REVITALIZATION PROJECT

WAIKIKI, OAHU, HAWAII

Prepared for:

TRG IMP, LLC

February 2012

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CONTENTS

FIGURES

TABLES

TABLES(cont.)

1.0 SUMMARY

TRG IMP, LLC is proposing to redevelop the International Market Place in Waikiki on the island of Oahu. The proposed project will consist of the replacement and expansion of the existing retail facilities and removal of the Miramar Hotel. This study examines the potential short- and long-term air quality impacts that could occur as a result of construction and use of the proposed facilities and suggests mitigative measures to reduce any potential air quality impacts where possible and appropriate.

Both federal and state standards have been established to maintain ambient air quality. At the present time, seven parameters are regulated including: particulate matter, sulfur dioxide, hydrogen sulfide, nitrogen dioxide, carbon monoxide, ozone and lead. Hawaii air quality standards are comparable to the national standards except those for nitrogen dioxide and carbon monoxide which are more stringent than the national standards.

Regional and local climate together with the amount and type of human activity generally dictate the air quality of a given location. The climate of the Waikiki area is very much affected by its leeward and coastal situation. Winds are predominantly trade winds from the east northeast except for occasional periods when kona storms may generate strong winds from the south or when the trade winds are weak and landbreeze-seabreeze circulations may develop. Wind speeds typically vary between about 5 and 15 miles per hour providing relatively good ventilation much of the time. Temperatures in leeward areas of Oahu are generally very moderate with average daily temperatures ranging from about 70°F to 84°F. The extreme minimum temperature recorded at Honolulu Airport is

54°F, while the extreme maximum temperature is 95°F. This area of Oahu is one of the drier locations in the state with rainfall often highly variable from one year to the next. Monthly rainfall has been measured to vary from as little as a trace to as much as 10 inches. Average annual rainfall amounts to about 21 inches with summer months being the driest.

The present air quality of the project area appears to be reasonably good based on nearby air quality monitoring data. Air quality data from the nearest monitoring stations operated by the Hawaii Department of Health suggest that all national air quality standards are currently being met, although occasional exceedances of the more stringent state standards for carbon monoxide may occur near congested roadway intersections.

If the proposed project is given the necessary approvals to proceed, there may be some short- and/or long-term impacts on air quality that may occur either directly or indirectly as a consequence of project construction and use. Short-term impacts from fugitive dust could occur during the project construction phase. To a lesser extent, exhaust emissions from stationary and mobile construction equipment, from the minor 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 to consider include limiting the area that is 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.

To assess the potential long-term impact of emissions from project-related motor vehicle traffic operating on roadways in the project area after construction is completed, a computerized air quality modeling study was undertaken. The air quality modeling study estimated current worst-case concentrations of carbon monoxide at intersections in the project vicinity and predicted future levels both with and without the proposed project. During worst-case conditions, model results indicated that present 1-hour and 8-hour worst-case carbon monoxide concentrations are well within both the state and the national ambient air quality standards. In the year 2015 without the project, worst-case carbon monoxide concentrations were predicted to remain nearly unchanged, and concentrations would remain well within standards. With the project in the year 2015, estimated worst-case carbon monoxide concentrations indicated essentially no impact compared to the without project case. Concentrations would remain well within standards. Due to the negligible impact the project is expected to have, implementing mitigation measures for long-term traffic-related air quality impacts is unnecessary and unwarranted.

2.0 INTRODUCTION

TRG IMP, LLC is proposing the International Market Place Revitalization Project in Waikiki on the island of Oahu (see Figure 1 for project location). The project site is located in the heart of Waikiki between Kalakaua Avenue and Kuhio Avenue. The site currently has 213,000 square feet of commercial space with a variety of shops, carts and restaurants and a 357-room hotel. The proposed project would replace those existing uses with a new retail complex that would include approximately 390,000 square feet of retail/restaurant space. Project construction would begin in 2013 and be completed by 2015.

The purpose of this study is to describe existing air quality in the project area and to assess the potential short- and long-term direct and indirect air quality impacts that could result from construction and use of the proposed facilities as planned. Measures to mitigate project impacts are suggested where possible and appropriate.

3.0 AMBIENT AIR QUALITY STANDARDS

Ambient concentrations of air pollution are regulated by both national and state ambient air quality standards (AAQS). National AAQS are specified in Section 40, Part 50 of the Code of Federal Regulations (CFR), while State of Hawaii AAQS are defined in Chapter 11-59 of the Hawaii Administrative Rules. Table 1 summarizes both the national and the state AAQS that are specified in the cited documents. As indicated in the table, national and state AAQS have been established for particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and lead. The state has also set a standard for hydrogen sulfide. National AAQS are stated in terms of both primary and secondary standards for most of the regulated air pollutants. National primary standards are designed to protect the public health with an "adequate margin of safety". National secondary standards, on the other hand, define levels of air quality necessary to protect the public welfare from "any known or anticipated adverse effects of a pollutant". Secondary public welfare impacts may include such effects as decreased visibility, diminished comfort levels, or other potential injury to the natural or man-made environment, e.g., soiling of materials, damage to vegetation or other economic damage. In contrast to the national AAQS, Hawaii State AAQS are given in terms of a single standard that is designed "to protect public health and welfare and to prevent the significant deterioration of air quality".

Each of the regulated air pollutants has the potential to create or exacerbate some form of adverse health effect or to produce environmental degradation when present in sufficiently high concentration for prolonged periods of time. The AAQS specify a maximum allowable concentration for a given air pollutant for one or more averaging times to prevent harmful effects. Averaging times vary from one hour to one year depending on the pollutant and type of exposure necessary to cause adverse effects. In the case of the short-term (i.e., 1- to 24-hour) AAQS, both national and state standards allow a specified number of exceedances each year.

The Hawaii AAQS are in some cases considerably more stringent than the comparable national AAQS. In particular, the Hawaii

1-hour AAQS for carbon monoxide is four times more stringent than the comparable national limit.

The national AAQS are reviewed periodically, and multiple revisions have occurred over the past 30 years. In general, the national AAQS have become more stringent with the passage of time and as more information and evidence become available concerning the detrimental effects of air pollution. Changes to the Hawaii AAQS over the past several years have tended to follow revisions to the national AAQS, making several of the Hawaii AAQS the same as the national AAQS.

4.0 REGIONAL AND LOCAL CLIMATOLOGY

Regional and local climatology significantly affects the air quality of a given location. Wind, temperature, atmospheric turbulence, mixing height and rainfall all influence air quality. Although the climate of Hawaii is relatively moderate throughout most of the state, significant differences in these parameters may occur from one location to another. Most differences in regional and local climates within the state are caused by the mountainous topography.

Hawaii lies well within the belt of northeasterly trade winds generated by the semi-permanent Pacific high pressure cell to the north and east. On the island of Oahu, the Koolau and Waianae Mountain Ranges are oriented almost perpendicular to the trade winds, which accounts for much of the variation in the local climatology of the island. The site of the proposed project is located in the leeward area of the Koolau Mountains.

Wind frequency data for Honolulu International Airport (HIA), which is located about 10 miles to the east of the project site, are given in Table 2. These data can be expected to be reasonably representative of the project area. Wind frequency for HIA show that the annual prevailing wind direction for this area of Oahu is east northeast. On an annual basis, 34.7 percent of the time the wind is from this direction, and more than 70 percent of the time the wind is in the northeast quadrant. Winds from the south are infrequent occurring only a few days during the year and mostly in winter in association with kona storms. Wind speeds average about 10 knots (12 mph) and mostly vary between about 5 and 15 knots (6 and 17 mph).

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 variations of temperature depend to a large degree on elevation above sea level, distance inland and exposure to the trade winds. Average temperatures at locations near sea level generally are warmer than those at higher elevations. Areas exposed to the trade winds tend to have the least temperature variation, while inland and leeward areas often have the most. Based on more than 25 years of data collected at Honolulu International Airport, average annual daily minimum and maximum temperatures in the project area are about 70^{o}F and 84^{o}F, respectively [1]. The extreme minimum temperature on record at the airport is 54^{o}F, and the extreme maximum is 95^{o}F.

Small scale, random motions in the atmosphere (turbulence) cause air pollutants to be dispersed as a function of distance or time from the point of emission. Turbulence is caused by both mechanical and thermal forces in the atmosphere. It is oftentimes measured and described in terms of Pasquill-Gifford stability class. Stability class 1 is the most turbulent and class 6 the least. Thus, air pollution dissipates the best during stability class 1 conditions and the worst when stability class 6 prevails. In the Waikiki area, stability class 5 is probably the highest stability class that occurs, developing during clear, calm nighttime or early morning hours when temperature inversions form due to radiational cooling. Stability classes 1 through 4 occur during the daytime, depending mainly on the amount of cloud cover and incoming solar radiation and the onset and extent of the sea breeze.

Mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Low mixing heights can result in high ground-level air pollution concentrations because contaminants emitted from or near the surface can become trapped within the mixing layer. In Hawaii, minimum mixing heights tend to be high because of mechanical mixing caused by the trade winds and because of the temperature moderating effect of the surrounding ocean. Low mixing heights may sometimes occur, however, at inland locations and even at times along coastal areas early in the morning following a clear, cool, windless night. Coastal areas also may experience low mixing levels during sea breeze conditions when cooler ocean air rushes in over warmer land. Mixing heights in Hawaii typically are above 3000 feet (1000 meters).

Rainfall can have a beneficial effect on the air quality of an area in that it helps to suppress fugitive dust emissions, and it also may "washout" gaseous contaminants that are water-soluble. Rainfall in Hawaii is highly variable depending on elevation and on location with respect to the trade wind. The Waikiki area is one of the drier areas on Oahu due to its leeward and near sea level location. Average annual rainfall measured at nearby Black Point amounts to about 21 inches [2]. Most of the rainfall usually occurs during the winter months. Monthly rainfall may vary from as little as a trace to more than 10 inches.

5.0 PRESENT AIR QUALITY

Present air quality in the project area is mostly affected by air pollutants from motor vehicles due to the urban situation. Table 3 presents an air pollutant emission summary for the island of Oahu for calendar year 1993. These are the most recent data available. The emission rates shown in the table pertain to manmade emissions only, i.e., emissions from natural sources are not included. As suggested in the table, much of the particulate emissions on Oahu originate from area sources, such as the mineral products industry and agriculture. Sulfur oxides are emitted almost exclusively by point sources, such as power plants and refineries. Nitrogen oxides emissions emanate predominantly from industrial point sources, although area sources (mostly motor vehicle traffic) also contribute a significant share. The majority of carbon monoxide emissions occur from area sources (motor vehicle traffic), while hydrocarbons are emitted mainly from point sources. Based on previous emission inventories that have been reported for Oahu, emissions of particulate and nitrogen oxides may have increased during the last several years, while emissions of sulfur oxides, carbon monoxide and hydrocarbons probably have declined.

Natural sources of air pollution emissions that could affect the project area at times but cannot be quantified very accurately include the ocean (sea spray), plants (aero-allergens), wind-blown dust, and perhaps distant volcanoes on the island of Hawaii.

The State Department of Health operates a network of air quality monitoring stations at various locations on Oahu. Each station, however, typically does not monitor the full complement of air quality parameters. Table 4 shows annual summaries of air quality measurements that were made nearest to the project area for several of the regulated air pollutants for the period 2005 through 2009. These are the most recent data that are currently available.

During the 2005-2009 period, sulfur dioxide was monitored by the State Department of Health at an air quality station located at downtown Honolulu. Concentrations monitored were consistently low compared to the standards. Annual second-highest 3-hour concentrations (which are most relevant to the air quality standards) ranged from 0.011 to 0.022 parts per million (ppm), while the annual second-highest 24-hour concentrations ranged from 0.002 to 0.007 ppm. Annual average concentrations were only about 0.001 ppm. There were no exceedances of the state/national 3-hour or 24-hour AAQS for sulfur dioxide during the 5-year period. It should be noted that the national AAQS for sulfur dioxide were revised during 2010, and data pertaining to the revised standards have not yet been reported.

Particulate matter less than 10 microns in diameter (PM-10) is also measured at the downtown Honolulu monitoring station. Annual second-highest 24-hour PM-10 concentrations ranged from 23 to 34 micrograms per cubic meter ($\mu g/m^3$) between 2005 and 2009. Average annual concentrations ranged from 13 to 15 $\mu g/m^3$. All values reported were within the state and national AAQS.

Carbon monoxide measurements were obtained at the downtown Honolulu monitoring station. The annual second-highest 1-hour concentrations ranged from 1.6 to 2.7 ppm. The annual second-highest 8-hour concentrations ranged from 1.0 to 1.4 ppm. No exceedances of the state or national 1-hour or 8-hour AAQS were reported.

Nitrogen dioxide is monitored by the Department of Health at the Kapolei monitoring station, which is about 16 miles west of the project area. Annual average concentrations of this pollutant ranged from 0.004 to 0.005 ppm, safely inside the state and national AAQS. A new 1-hour standard for nitrogen dioxide was implemented during 2010. Data pertaining to this new standard have not yet been reported.

The nearest available ozone measurements were obtained at Sand Island (about 3 miles west of the project area). The annual fourth-highest 8-hour concentrations (which are most relevant to the standards) for the period 2005 through 2009 ranged between 0.033 and 0.048 ppm, which is well inside the state and federal standards. The 8-hour standard for ozone did not exist prior to 2002. Prior to 2002, the now obsolete state 1-hour standard was typically exceeded several times each year.

Although not shown in the table, the nearest and most recent measurements of ambient lead concentrations that have been reported were made at the downtown Honolulu monitoring station between 1996 and 1997. Average quarterly concentrations were near or below the detection limit, and no exceedances of the state AAQS were recorded. Monitoring for this parameter was discontinued during 1997.

Based on the data and discussion presented above, it appears likely that the State of Hawaii AAQS for sulfur dioxide, nitrogen dioxide, particulate matter, ozone and lead are currently being met in the project area. While carbon monoxide measurements at the downtown Honolulu monitoring station suggest that concentrations are within the state and national standards, local "hot spots" may exist near traffic-congested intersections. The potential for this within the project area is examined later in this report.

6.0 SHORT-TERM IMPACTS OF PROJECT

Short-term direct and indirect impacts on air quality could potentially occur due to project construction. For a project of this nature, there are two potential types of air pollution emissions that could directly result in short-term air quality impacts during project construction: (1) fugitive dust from vehicle movement, soil excavation and demolition activities; 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 roadway lane closures.

Fugitive dust emissions may arise from the grading and dirt-moving activities associated with site clearing and preparation work. The emission rate for fugitive dust emissions from construction activities is difficult to estimate accurately. This is because of its elusive nature of emission and because the potential for its generation varies greatly depending upon the type of soil at the construction site, the amount and type of dirt-disturbing activity taking place, the moisture content of exposed soil in work areas, and the wind speed. The EPA [3] has provided a rough estimate for uncontrolled fugitive dust emissions from construction activity of 1.2 tons per acre per month under conditions of "medium" activity, moderate soil silt content (30%), and precipitation/evaporation (P/E) index of 50. Uncontrolled fugitive dust emissions at the project site could be somewhere near that level, depending on the amount of rainfall that occurs. In any case, State of Hawaii Air Pollution Control Regulations [4] prohibit visible emissions of fugitive dust from construction activities at the property line. Thus, an effective dust control plan for the project construction phase is essential.

Adequate fugitive dust control can usually be accomplished by the establishment of a frequent watering program to keep bare-dirt surfaces in construction areas from becoming significant sources of dust. In dust-prone or dust-sensitive areas, other control measures such as limiting the area that can be disturbed at any given time, applying chemical soil stabilizers, mulching and/or using wind screens may be necessary. Control regulations further stipulate that open-bodied trucks be covered at all times when in motion if they are transporting materials that could be blown away. Haul trucks tracking dirt onto paved streets from unpaved areas is often a significant source of dust in construction areas. Some means to alleviate this problem, such as road cleaning or tire washing, may be appropriate. Paving of parking areas and/or establishment of landscaping as early in the construction schedule as possible can also lower the potential for fugitive dust emissions. Monitoring dust at the project boundaries could be considered to quantify and document the effectiveness of dust control measures.

On-site mobile and stationary construction equipment also will emit air pollutants from engine exhausts. The largest of this equipment is usually diesel-powered. Nitrogen oxides emissions from diesel engines can be relatively high compared to gasoline-powered equipment, but the annual standard for nitrogen dioxide is not likely to be violated by short-term construction equipment emissions. Also, the new short-term (1-hour) standard for nitrogen dioxide is based on a three-year average; thus it is unlikely that relatively short-term construction emissions would exceed the standard. Carbon monoxide emissions from diesel engines are low and should be relatively insignificant compared to vehicular emissions on nearby roadways.

Project construction activities could obstruct the normal flow of traffic for short periods of times such that overall vehicular emissions in the project area could 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

After construction is completed, use of the proposed roadway improvements by motor vehicle traffic could potentially cause long-term impacts on ambient air quality in the project area. 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 next decade. The added restrictions on emissions from new motor vehicles will lower average emissions each year as more and more older vehicles leave the state's roadways. It is estimated that carbon monoxide emissions, for example, will go down by an average of about 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 ambient air quality impact of motor vehicle traffic using the proposed new roadway facilities, computerized emission and atmospheric dispersion models can be used to estimate ambient carbon monoxide concentrations along roadways within the project area. 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 project.

For this project, three scenarios were selected for the carbon monoxide modeling study: (1) year 2011 with present conditions, (2) year 2015 without the project, and (3) year 2015 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, six of the key intersections identified in the traffic study were also selected for air quality analysis. These included the following intersections:

- Kalakaua Avenue at Seaside Avenue
- Kuhio Avenue at Seaside Avenue

- Kuhio Avenue at Nohonani Street
- Kuhio Avenue at Nahua Street
- Kuhio Avenue at Walina Street
- Kuhio Avenue at Kanekapolei Street.

The traffic impact report for the project [5] describes the existing and projected future traffic conditions and laneage configurations of the study 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 weekday and weekend afternoon peak traffic periods. These same periods were evaluated in the air quality impact assessment.

The EPA computer model MOBILE6.2 [6] was used to calculate vehicular carbon monoxide emissions for each year studied. One of the key inputs to MOBILE6.2 is vehicle mix. Unless very detailed information is available, national average values are typically assumed, which is what was used for the present study. Based on national average vehicle mix figures, the present vehicle mix in the project area was estimated to be 34.2% light-duty gasoline-powered automobiles, 52.9% light-duty gasoline-powered trucks and vans, 3.6% heavy-duty gasoline-powered vehicles, 0.2% light-duty diesel-powered vehicles, 8.6% heavy-duty diesel-powered trucks and buses, and 0.5% motorcycles. For the future scenarios studied, the vehicle mix was estimated to change slightly with fewer light-duty gasoline-powered automobiles and more light-duty gasoline-powered trucks and vans.

An ambient temperature of 68 degrees F was used for the afternoon peak-hour emission computations. This is a conservative assumption since afternoon ambient temperatures will generally be warmer than this, and carbon monoxide emission estimates given by MOBILE6.2 generally have an inverse relationship to the ambient temperature.

After computing vehicular carbon monoxide emissions through the use of MOBILE6.2, these data were then input to an atmospheric dispersion model. EPA air quality modeling guidelines [7] currently recommend that the computer model CAL3QHC [8] be used to assess carbon monoxide concentrations at roadway intersections, or in areas where its use has previously been established, CALINE4 [9] may be used. 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 had 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.

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. 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 or design 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 acknowledges that pedestrian sidewalks already exist in these locations. 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 4 was assumed. This is the most conservative stability category that is generally used for estimating worst-case pollutant dispersion within urban areas for an afternoon period. 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 1.0 ppm to all predicted concentrations for 2011. Although increased traffic is expected to occur within the project area within 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 1.0 ppm was assumed to persist for the future scenarios studied.

Predicted Worst-Case 1-Hour Concentrations

Table 5 summarizes the final results of the modeling study in the form of the estimated worst-case 1-hour weekday and weekend afternoon ambient carbon monoxide concentrations. These results can be compared directly to the state and the national AAQS. Estimated worst-case carbon monoxide concentrations are presented in the table for three scenarios: year 2011 with existing traffic, year 2015 without the project and year 2015 with the project. The locations of these estimated worst-case 1-hour concentrations all occurred at or very near the indicated intersections.

As indicated in the table, the highest estimated 1-hour concentration within the project vicinity for the present (2011) case was 3.0 ppm. This was projected to occur during a weekend afternoon peak traffic hour near the intersection of Kalakaua Avenue at Seaside Avenue. Concentrations at other locations and times studied were 2.9 ppm or lower. Predicted worst-case 1-hour concentrations at all locations studied for the 2011 scenario were well within both the national AAQS of 35 ppm and the state standard of 9 ppm.

In the year 2015 without the proposed project, the highest worst-case 1-hour concentration was predicted to continue to occur during a weekend afternoon at the intersection of Kalakaua Avenue and Seaside Avenue. A value of 3.1 ppm was predicted to occur at this location and time. Peak-hour worst-case values at the other locations and times studied for the 2015 without project scenario ranged between 2.1 and 2.9 ppm. Compared to the existing case, predicted concentrations for the year 2015 without the project remained nearly unchanged at all locations, and worst-case concentrations remained well within the state and national standards.

Predicted 1-hour worst-case concentrations for the 2015 with project scenario remained nearly unchanged at the study intersections. Similar to the 2015 without project case, the maximum concentration was predicted to occur during a weekend afternoon at the intersection of Kalakaua Avenue at Seaside Avenue, remaining unchanged compared to the without project scenario at a concentration of 3.1 ppm. Other concentrations ranged between 2.2 and 2.9 ppm. Worst-case concentrations at all locations studied remained well within the state and federal standards.

Predicted Worst-Case 8-Hour Concentrations

Worst-case 8-hour carbon monoxide concentrations were estimated by multiplying the worst-case 1-hour values by a persistence factor of 0.5. This accounts for two factors: (1) traffic volumes averaged over eight hours are lower than peak 1-hour values, and (2) meteorological conditions are more variable (and hence more favorable for dispersion) over an 8-hour period than they are for a single hour. Based on monitoring data, 1-hour to 8-hour persistence factors for most locations generally vary from 0.4 to 0.8 with 0.6 being the most typical. One study based on modeling [10] concluded that 1-hour to 8-hour persistence factors could typically be expected to range from 0.4 to 0.5. EPA guidelines [11] recommend using a value of 0.7 unless a locally derived persistence factor is available. Recent monitoring data for locations on Oahu reported by the Department of Health [12] suggest that this factor may range between about 0.2 and 0.6 depending on location and traffic variability. Considering the location of the project and the traffic pattern for the area, a 1-hour to 8-hour persistence factor of 0.5 will likely yield reasonable estimates of worst-case 8-hour concentrations.

The resulting estimated worst-case 8-hour concentrations are indicated in Table 6. For the 2011 scenario, the estimated worst-case 8-hour carbon monoxide concentrations for the six locations studied ranged from 1.1 to 1.5 ppm, with the highest concentration occurring at the intersection of Kalakaua Avenue and Seaside Avenue. The estimated worst-case concentrations for the existing case were well within both the state standard of 4.4 ppm and the national limit of 9 ppm.

For the year 2015 without project scenario, worst-case concentrations ranged between 1.1 and 1.6 ppm, with the highest concentration occurring at the intersection of Kalakaua Avenue and Seaside Avenue. All predicted concentrations were within the standards.

For the 2015 with project scenario, worst-case concentrations remained nearly unchanged compared to the without project case, indicating minimal project impact. 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.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The major potential short-term air quality impact of the project could occur from the emission of fugitive dust during demolition and construction. Uncontrolled fugitive dust emissions from construction activities could 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. Establishment of landscaping early in the construction schedule will also help to control dust. Monitoring dust at the project boundary during the period of construction could be considered as a means to evaluate the effectiveness of the project dust control program and to adjust the program if necessary.

During construction phases, emissions from engine exhausts (primarily consisting of carbon monoxide and nitrogen oxides) will also occur both from on-site construction equipment and from vehicles used by construction workers and from trucks traveling to and from the project. Increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers can be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

After the proposed project is completed, any long-term impacts on air quality in the project area due to emissions from project-related motor vehicle traffic should be negligible. Worst-case concentrations of carbon monoxide should remain within both the state and the national ambient air quality standards. Implementing any air quality mitigation measures for long-term traffic-related impacts is probably unnecessary and unwarranted.

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Figure 1 - Project Location

Table 1

SUMMARY OF STATE OF HAWAII AND NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Units	Averaging Time	Maximum Allowable Concentration		
			National Primary	National Secondary	State of Hawaii
Particulate Matter (<10 microns)	µg/m^3	Annual	-	-	50
		24 Hours	150[a]	150[a]	150[b]
Particulate Matter (<2.5 microns)	µg/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	µg/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	-	-	35[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

ANNUAL WIND FREQUENCY FOR HONOLULU INTERNATIONAL AIRPORT (%)

Wind Direction	Wind Speed (knots)									Total
	0-3	4-6	7-10	11-16	17-21	22-27	28-33	34-40	>40	
N	0.5	2.5	1.3	0.5	0.0	0.0	0.0	0.0	0.0	4.8
NNE	0.3	1.2	1.6	1.5	0.2	0.0	0.0	0.0	0.0	4.7
NE	0.3	2.1	6.1	11.0	3.2	0.3	0.0	0.0	0.0	23.0
ENE	0.2	2.5	10.9	16.6	4.1	0.3	0.0	0.0	0.0	34.7
E	0.1	1.0	2.5	2.8	0.5	0.0	0.0	0.0	0.0	7.0
ESE	0.0	0.3	0.4	0.3	0.0	0.0	0.0	0.0	0.0	1.1
SE	0.0	0.3	0.8	1.0	0.1	0.0	0.0	0.0	0.0	2.2
SSE	0.1	0.4	1.2	0.7	0.1	0.0	0.0	0.0	0.0	2.4
S	0.1	0.5	1.4	0.6	0.1	0.0	0.0	0.0	0.0	2.7
SSW	0.0	0.3	0.8	0.3	0.0	0.0	0.0	0.0	0.0	1.5
SW	0.0	0.2	0.8	0.4	0.0	0.0	0.0	0.0	0.0	1.5
WSW	0.0	0.3	0.5	0.4	0.0	0.0	0.0	0.0	0.0	1.2
W	0.1	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.1
WNW	0.2	1.4	0.3	0.1	0.0	0.0	0.0	0.0	0.0	2.0
NW	0.4	2.3	0.8	0.1	0.0	0.0	0.0	0.0	0.0	3.8
NNW	0.5	2.3	0.8	0.2	0.0	0.0	0.0	0.0	0.0	3.8
Calm	2.5									2.5
Total	5.4	18.3	30.6	36.5	8.5	0.7	0.0	0.0	0.0	100.0

Source: Climatography of the United States No. 90 (1965-1974), Airport Climatological Summary, Honolulu International Airport, Honolulu, Hawaii, U.S. Department of Commerce, National Climatic Center, Asheville, NC, August 1978.

Table 3

AIR POLLUTION EMISSIONS INVENTORY FOR ISLAND OF OAHU, 1993

Air Pollutant	Point Sources (tons/year)	Area Sources (tons/year)	Total (tons/year)
Particulate	25,891	49,374	75,265
Sulfur Oxides	39,230	nil	39,230
Nitrogen Oxides	92,436	31,141	123,577
Carbon Monoxide	28,757	121,802	150,559
Hydrocarbons	4,160	421	4,581

Source: Final Report, "Review, Revise and Update of the Hawaii Emissions Inventory Systems for the State of Hawaii", prepared for Hawaii Department of Health by J.L. Shoemaker & Associates, Inc., 1996

Table 4

ANNUAL SUMMARIES OF AIR QUALITY MEASUREMENTS FOR MONITORING STATIONS NEAREST INTERNATIONAL MARKET PLACE REVITALIZATION PROJECT

Parameter / Location	2005	2006	2007	2008	2009
Sulfur Dioxide / Downtown Honolulu					
3-Hour Averaging Period:					
No. of Samples	1483	1138	2827	2876	2858
Highest Concentration (ppm)	0.029	0.016	0.021	0.011	0.023
2nd Highest Concentration (ppm)	0.022	0.014	0.018	0.011	0.021
No. of State AAQS Exceedances	0	0	0	0	0
24-Hour Averaging Period:					
No. of Samples	187	146	359	363	360
Highest Concentration (ppm)	0.009	0.005	0.007	0.004	0.005
2nd Highest Concentration (ppm)	0.007	0.002	0.005	0.004	0.004
No. of State AAQS Exceedances	0	0	0	0	0
Annual Average Concentration (ppm)	0.001	0.001	0.001	0.001	0.001
Particulate (PM-10) / Downtown Honolulu					
24-Hour Averaging Period:					
No. of Samples	173	141	344	343	351
Highest Concentration ($\mu g/m^3$)	64	25	33	33	34
2nd Highest Concentration ($\mu g/m^3$)	28	23	29	31	34
No. of State AAQS Exceedances	0	0	0	0	0
Annual Average Concentration ($\mu g/m^3$)	15	13	14	14	13
Carbon Monoxide / Downtown Honolulu					
1-Hour Averaging Period:					
No. of Samples	4197	3612	8627	8732	8628
Highest Concentration (ppm)	3.4	2.5	2.0	2.1	1.6
2nd Highest Concentration (ppm)	2.7	1.7	1.6	1.8	1.6
No. of State AAQS Exceedances	0	0	0	0	0
8-Hour Averaging Period:					
No. of Samples	4180	3610	8635	8735	8627
Highest Concentration (ppm)	1.4	1.1	1.1	1.0	0.9
2nd Highest Concentration (ppm)	1.4	1.0	1.0	1.0	0.9
No. of State AAQS Exceedances	0	0	0	0	0
Nitrogen Dioxide / Kapolei					
Annual Average Concentration (ppm)	0.005	0.005	0.005	0.004	0.004
Ozone / Sand Island					
8-Hour Averaging Period:					
No. of Samples	8670	8591	357	305	341
Highest Concentration (ppm)	0.047	0.042	0.036	0.050	0.049
2nd Highest Concentration (ppm)	0.047	0.042	0.035	0.048	0.048
4th Highest Concentration (ppm)	0.046	0.042	0.033	0.043	0.048
No. of State AAQS Exceedances	0	0	0	0	0

Source: State of Hawaii Department of Health, "Annual Summaries, Hawaii Air Quality Data, 2004 - 2009"

Table 5

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR INTERNATIONAL MARKET PLACE REVITALIZATION PROJECT
(parts per million)

Roadway Intersection	Year/Scenario					
	2011/Present		2015/Without Project		2015/With Project	
	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
Kalakaua Avenue at Seaside Avenue	2.9	3.0	2.9	3.1	2.9	3.1
Kuhio Avenue at Seaside Avenue	2.6	2.7	2.5	2.6	2.4	2.5
Kuhio Avenue at Nohonani Street	2.3	2.5	2.2	2.3	2.2	2.3
Kuhio Avenue at Nahua Street	2.3	2.5	2.2	2.6	2.2	2.4
Kuhio Avenue at Walina Street	2.2	2.2	2.1	2.2	2.4	2.5
Kuhio Avenue at Kanekapolei Street	2.9	2.7	2.7	2.6	2.7	2.6

Hawaii State AAQS: 9
National AAQS: 35

Table 6

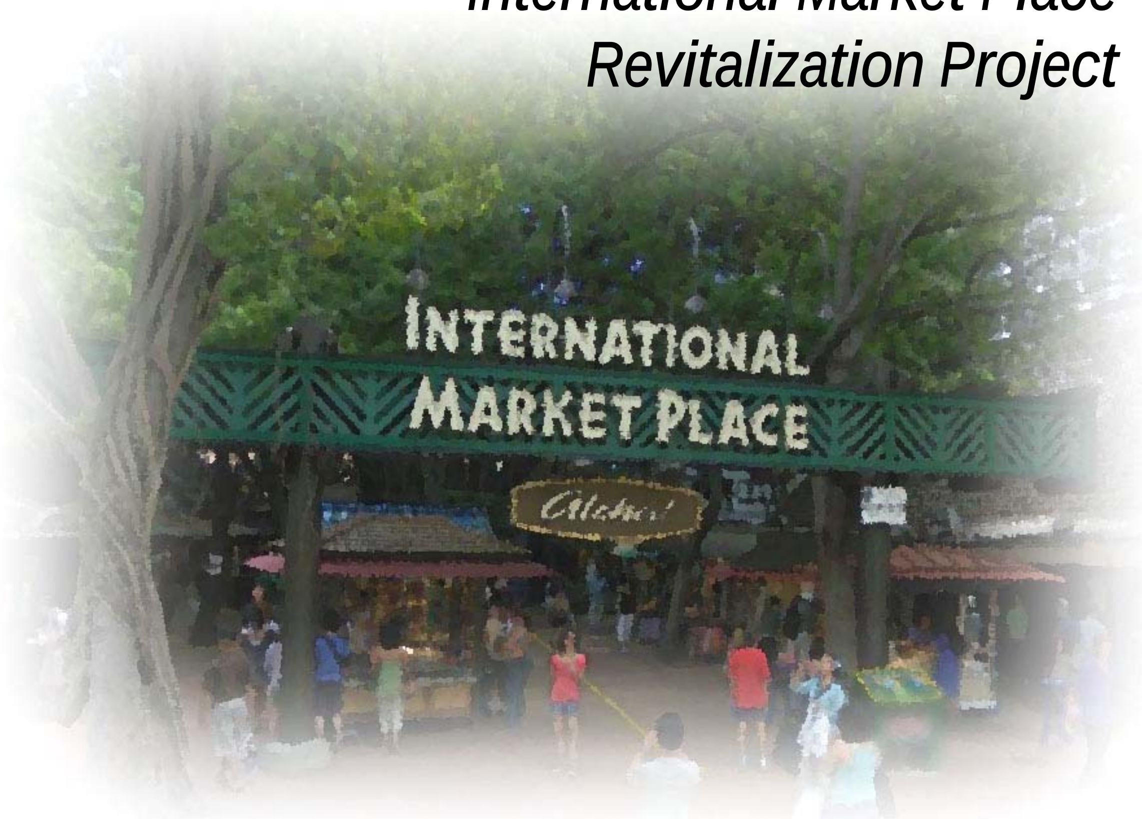
ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR INTERNATIONAL MARKET PLACE REVITALIZATON PROJECT
(parts per million)

Roadway Intersection	Year/Scenario		
	2011/Present	2015/Without Project	2015/With Project
Kalakaua Avenue at Seaside Avenue	1.5	1.6	1.6
Kuhio Avenue at Seaside Avenue	1.4	1.3	1.2
Kuhio Avenue at Nohonani Street	1.2	1.2	1.2
Kuhio Avenue at Nahua Street	1.2	1.3	1.2
Kuhio Avenue at Walina Street	1.1	1.1	1.2
Kuhio Avenue at Kanekapolei Street	1.4	1.4	1.4

Hawaii State AAQS: 4.4
National AAQS: 9

Traffic Impact Report

International Market Place Revitalization Project



Prepared for:
The Taubman Company

Prepared by:
Wilson Okamoto Corporation

October 2011

TRAFFIC IMPACT REPORT

FOR THE

INTERNATIONAL MARKET PLACE REVITALIZATION PROJECT

Prepared for:

The Taubman Company
200 East Long Lake Road, Suite 300
Bloomfield Hills, MI 48304-2324

Prepared by:

Wilson Okamoto Corporation
1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826
WOC Ref: 8243-01

October 2011

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I. INTRODUCTION

A. Purpose of Study

The purpose of this study is to identify and assess the potential traffic impacts resulting from the proposed International Market Place revitalization project in Waikiki on the island of Oahu. The proposed project entails the replacement of the existing International Market Place and Miramar Hotel with a new retail complex.

B. Scope of Study

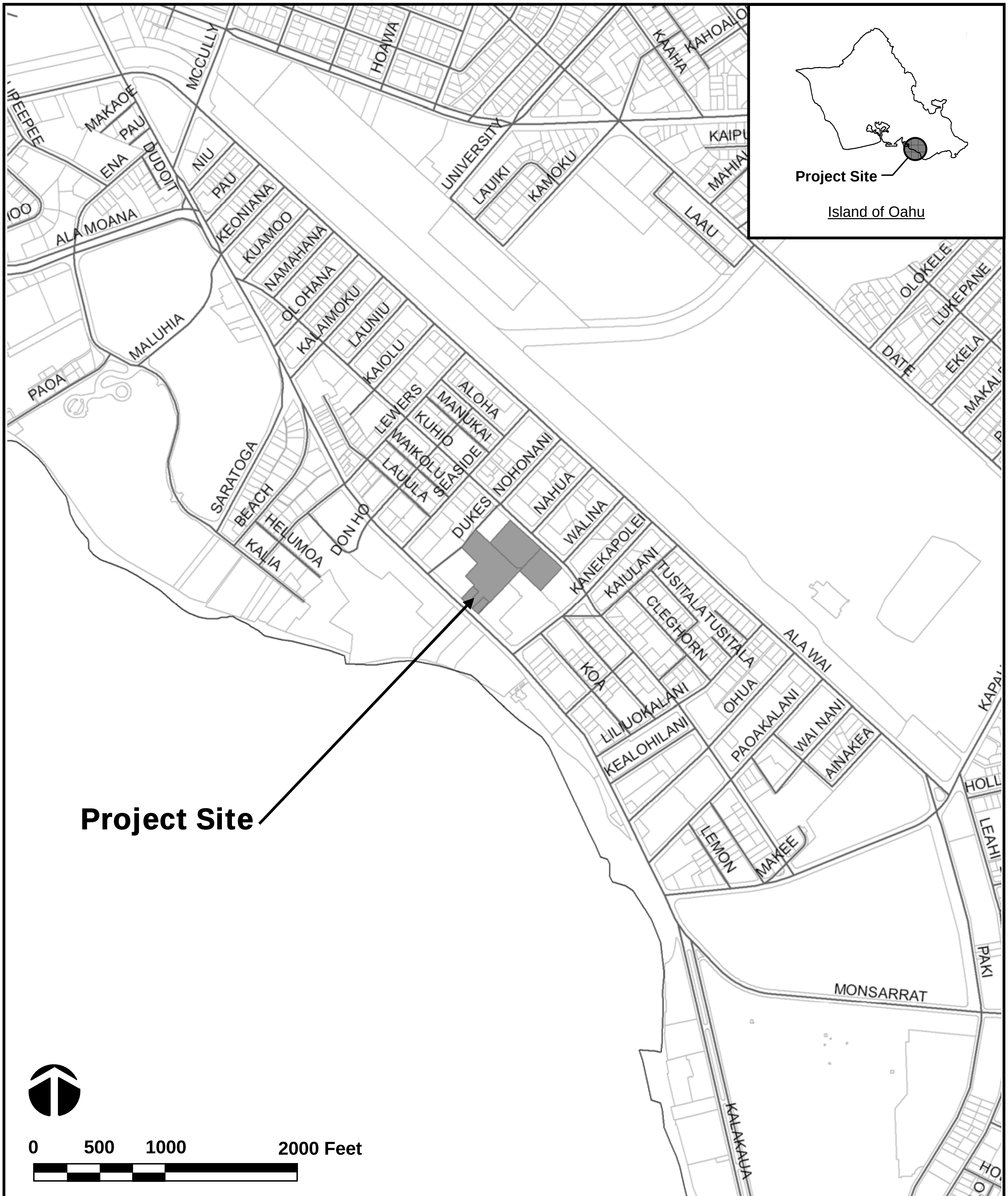
This report presents the findings and conclusions of the traffic study, the scope of which includes:

1. Description of the proposed project.
2. Evaluation of existing roadway and traffic operations in the vicinity.
3. Analysis of future roadway and traffic conditions without the proposed project.
4. Analysis and development of trip generation characteristics for the proposed project.
5. Superimposing site-generated traffic over future traffic conditions.
6. The identification and analysis of traffic impacts resulting from the proposed project.
7. Recommendations of improvements, if appropriate, that would mitigate the traffic impacts resulting from the proposed project.

II. PROJECT DESCRIPTION

A. Location

The existing International Market Place and Miramar Hotel are located between Kalakaua Avenue and Kuhio Avenue east of Duke's Lane in Waikiki on the island of Oahu (See Figure 1). The project site is further identified as Tax Map Keys 2-6-22: 36, 37, 38, 39, and 43. Primary vehicular access to the proposed redeveloped complex would be provided at the intersection of Kuhio Avenue and Walina Street with secondary access provided off Duke's Lane. In addition, a valet pull-out will be provided off Kuhio Avenue between Duke's Lane and Nahua Street.



WILSON OKAMOTO CORPORATION ENGINEERS - PLANNERS	**INTERNATIONAL MARKET PLACE** LOCATION AND VICINITY MAP	FIGURE 1

B. Project Characteristics

The project site currently houses a variety of shops, carts, and restaurants (~192,000 square feet), as well as, a hotel (~357 rooms). The proposed project entails the replacement of these uses with a new retail complex that will include approximately 355,000 square feet of retail/restaurant space. Primary vehicular access will be provided via a new access roadway on the south side of the Kuhio Avenue and Walina Street intersection with secondary access provided via a driveway off Duke's Lane. Valet service areas will be provided on-site, as well as, fronting the project site along Kuhio Avenue. There is also an existing access off Kaiulani Avenue on the east edge of the project site. However, this access will be restricted to service vehicles only. Figure 2 shows the proposed site plan.

III. EXISTING TRAFFIC CONDITIONS

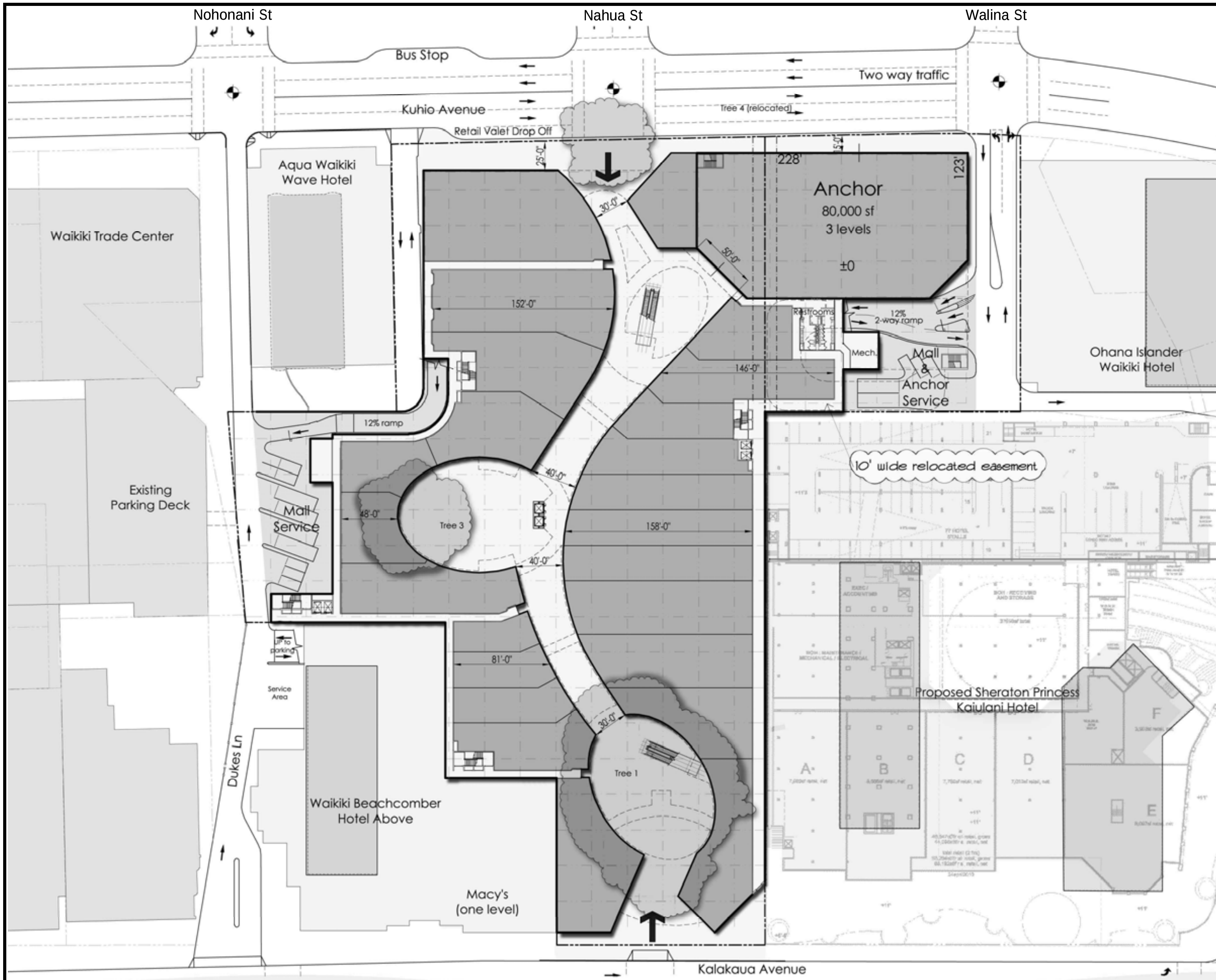
A. General

The proposed project will be located adjacent to Kalakaua Avenue, a predominantly four-lane, one-way (eastbound) City and County of Honolulu roadway generally oriented in the east-west direction that with Ala Wai Boulevard forms a couplet system that provides access through Waikiki. Kuhio Avenue runs parallel to this couplet and also serves as an access roadway through Waikiki.

B. Area Roadway System

West of the project site, Kalakaua Avenue intersects Seaside Avenue, a connector roadway between Kalakaua Avenue and Ala Wai Boulevard generally oriented in the north-south direction. At this signalized intersection, Kalakaua Avenue has an exclusive left-turn lane, a shared left-turn and through lane, and three through lanes while Seaside Avenue has two northbound departure lanes.

East of the intersection with Seaside Avenue, Kalakaua Avenue intersects Kaiulani Avenue. Kaiulani Avenue originates at Kalakaua Avenue as a one-way (northbound) roadway that transitions to a two-way roadway at the intersection with Kanekapolei Street. At this signalized intersection, Kalakaua Avenue has an exclusive left-turn lane and three through lanes while Kaiulani Avenue has two northbound departure lanes.



PROGRAM

Total Site Area		260,489 sf (5.98 Acres)
Total Entitled Area		529,342 sf
IMP Retail		
Tenant Shops	1st Level	108,000 sf
	2nd Level	102,000 sf
	3rd Level	10,000 sf
Sub-total Tenant Shops		**220,000 sf**
Restaurants (7)	3rd Level	55,000 sf
Sub-total In line GLA	3 Levels	275,000 sf
Anchor	3 Levels	80,000 sf
Total GLA:		**355,000 sf**
Parking Required		**= 275 spaces**
No requirement for Grade Level		
1 sp/800 sf for Levels 2 & 3		(220,000 sf)
Parking Provided		on Roof Deck
Level 3 (+36')		60 spaces ±
Level 3.5 (+47')		100 spaces ±
Level 4 (+58')		175 spaces ±
Level 5 (+69')		175 spaces ±
Level 6 (+80')		200 spaces ±
TOTAL		**710 spaces ±**
Loading / Service Provided		**= 11 stalls**
(6 @ 12' x 35' + 5 @ 8'6" x 19')		

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INTERNATIONAL MARKET PLACE

PROPOSED SITE PLAN

FIGURE 2

North of the intersection with Kalakaua Avenue, Seaside Avenue intersects Kuhio Avenue, an alternate east-west access roadway through Waikiki that runs parallel to Kalakaua Avenue and Ala Wai Boulevard. At this signalized intersection, the eastbound approach of Kuhio Avenue has two lanes that serve left-turn and through traffic movements, and the westbound approach has two lanes that serve through and right-turn traffic movements, while the northbound approach of Seaside Avenue has exclusive turning lanes and one through lane.

East of the intersection with Seaside Avenue, Kuhio Avenue intersects Duke's Lane and Nohonani Street, a connector roadway between Kuhio Avenue and Ala Wai Boulevard generally oriented in the north-south direction. At this signalized intersection, the eastbound approach of Kuhio Avenue has two through lanes while the westbound approach has two lanes that serve through and right-turn traffic movements. The Duke's Lane approach of the intersection has one lane that serve all traffic movements while the Nohonani Street approach has one lane that serves left-turn and right-turn traffic movements.

Further east, Kuhio Avenue intersects Nahua Street, a one-way (northbound) connector roadway between Kuhio Avenue and Ala Wai Boulevard. At this signalized intersection, the eastbound approach of Kuhio Avenue has two lanes that serve left-turn and through traffic movements, and the westbound approach has two lanes that serve through and right-turn traffic movements while Nahua Street has one northbound departure lane.

Near the eastern edge of the project site, Kuhio Avenue intersects Walina Street, a one-way (southbound) connector roadway between Kuhio Avenue and Ala Wai Boulevard. At this signalized intersection, the eastbound approach of Kuhio Avenue has two lanes that serve through and right-turn traffic movements, and the westbound approach has two lanes that serve left-turn and through traffic movements while the Walina Street approach has two lanes that serve all traffic movements.

East of the intersection with Walina Street, Kuhio Avenue intersects Kanekapolei Street, a connector roadway between Kaiulani Avenue and Ala Wai Boulevard generally oriented in the north-south direction. At this signalized intersection, the eastbound approach of Kuhio Avenue has an exclusive left-turn lane, one through lane, and a shared through and right-turn lane while the westbound approach has two lanes that serve all traffic movements. The northbound approach of Kanekapolei Street has two lanes that serve left-turn and through traffic movements while the southbound approach has two lanes that serve all traffic movements.

North of the intersection with Kuhio Avenue, Seaside Avenue intersects Ala Wai Boulevard. At this signalized intersection, Ala Wai Boulevard has three westbound lanes that serve left-turn and through traffic movements while the Seaside Avenue approach has two exclusive left-turn lanes.

East of the intersection with Seaside Avenue, Ala Wai Boulevard intersects Nohonani Street. At this unsignalized intersection, Ala Wai Boulevard has three westbound lanes that serve left-turn and through traffic movements while Nohonani Street has one lane that serves left-turn traffic movements.

Further east, Ala Wai Boulevard intersects Nahua Street. At this unsignalized intersection, Ala Wai Boulevard has three westbound through lanes while Nahua Street has one lane that serves left-turn traffic movements.

At the eastern end of the study area, Ala Wai Boulevard intersects Kanekapolei Street. At this signalized intersection, Ala Wai Boulevard has three westbound lanes that serve left-turn and through traffic movements while Kanekapolei Street has two exclusive left-turn lanes.

C. Traffic Volumes and Conditions

1. General

a. Field Investigation

Field investigations were conducted in November 2010 and August 2011, and consisted of manual turning movement count surveys in the project vicinity. The manual turning movement count surveys were conducted during the weekday afternoon peak hours of 3:00 PM to 6:00 PM and Saturday afternoon peak hours of 3:00 PM to 7:00 PM at the following intersections:

- Kalakaua Avenue and Seaside Avenue
- Kalakaua Avenue and Duke's Lane
- Kalakaua Avenue and Mid-Block Crossing Near International Market Place
- Kalakaua Avenue and Kaiulani Avenue
- Kuhio Avenue and Seaside Avenue
- Kuhio Avenue, Nohonani Street, and Duke's Lane
- Kuhio Avenue and Nahua Street
- Kuhio Avenue and Walina Street
- Kuhio Avenue and Kanekapolei Street
- Ala Wai Boulevard and Seaside Avenue
- Ala Wai Boulevard and Nohonani Street
- Ala Wai Boulevard and Nahua Street
- Ala Wai Boulevard and Walina Street
- Ala Wai Boulevard and Kanekapolei Street

Appendix A includes the existing traffic count data.

b. Capacity Analysis Methodology

The highway capacity analysis performed in this study is based upon procedures presented in the "Highway Capacity Manual", Transportation Research Board, 2000, and the "Synchro", developed by Trafficware. The analysis is based on the concept of Level of Service (LOS).

LOS is a quantitative and qualitative assessment of traffic operations. Levels of Service are defined by LOS "A" through "F"; LOS "A" representing ideal or free-flow traffic operating conditions and LOS "F" representing unacceptable or potentially congested traffic operating conditions.

"Volume-to-Capacity" (v/c) ratio is another measure indicating the relative traffic demand to the roadway carrying capacity. A v/c ratio of one (1.00) indicates that the roadway is operating at or near capacity. A v/c ratio of greater than 1.00 generally indicates that the traffic demand exceeds the road's carrying capacity. The LOS definitions are included in Appendix B.

2. Existing Peak Hour Traffic

a. General

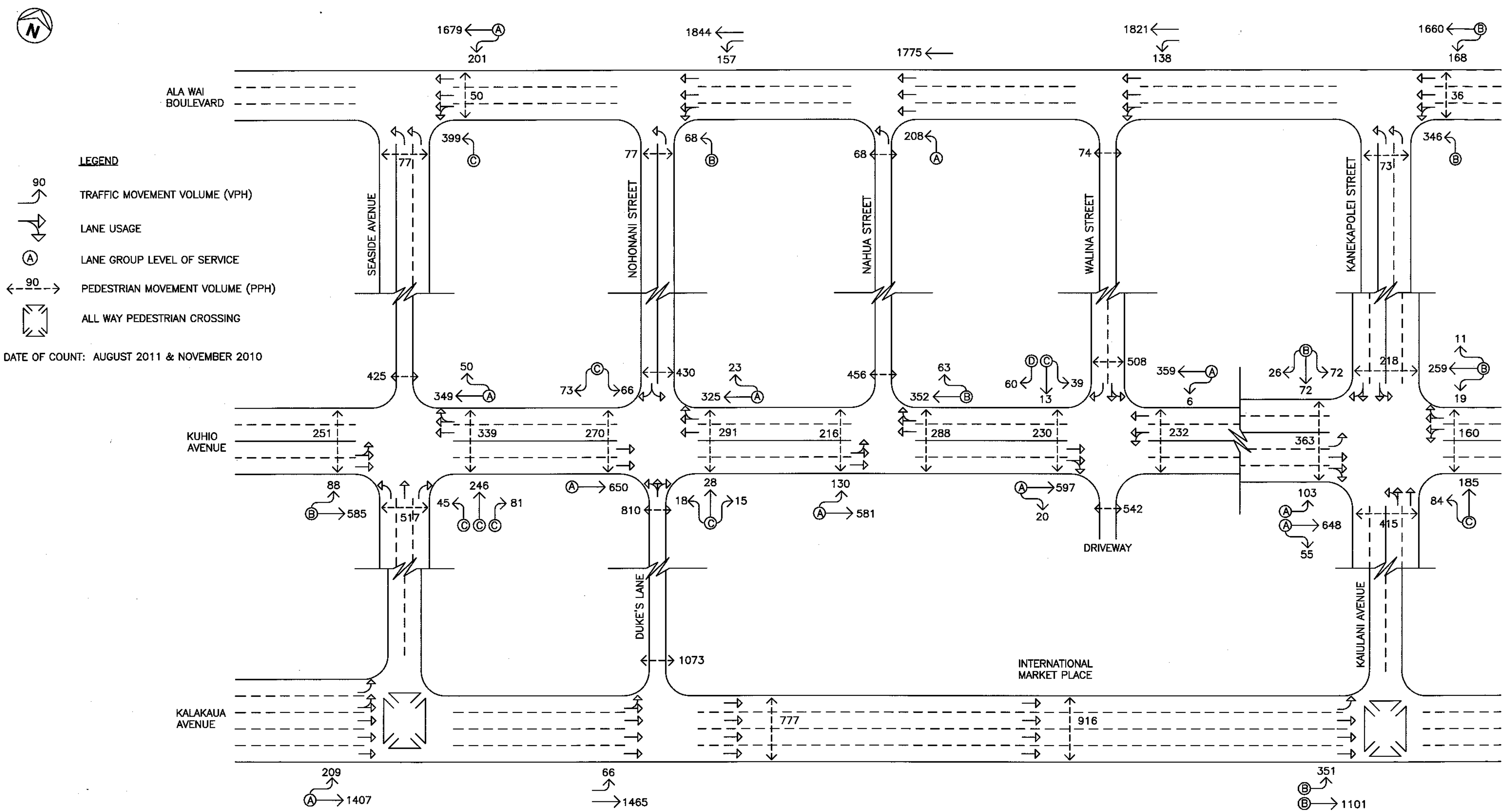
Figures 3 and 4 show the existing weekday and Saturday PM peak period traffic volumes and traffic operating conditions. The weekday and Saturday PM peak hour of traffic generally occurs between the hours 4:00 PM and 5:00 PM. The analysis is based on these peak hour time periods for each intersection. LOS calculations are included in Appendix C.

b. Kalakaua Avenue and Seaside Avenue

At the intersection with Seaside Avenue, Kalakaua Avenue carries 1,616 vehicles and 1,721 vehicles eastbound at this intersection during the weekday and Saturday PM peak periods, respectively. This approach operates at the LOS "A" and LOS "B" during the weekday and Saturday PM peak periods, respectively. Traffic queues periodically formed on the Kalakaua Avenue approach of the intersection with average queue lengths of 4-6 vehicles observed during both peak periods. These queues were observed to clear the intersection after each traffic signal cycle change.

c. Kalakaua Avenue and Kaiulani Avenue

At the intersection with Kaiulani Avenue, Kalakaua Avenue carries 1,452 vehicles and 1,400 vehicles eastbound during the weekday and Saturday PM peak periods, respectively. The eastbound left-turn and through traffic movements operate at LOS "B" during both peak periods. Traffic queues periodically formed on the Kalakaua Avenue approach of the intersection with average queue lengths of 6-8 vehicles observed during both peak periods. These queues were observed to clear the intersection after each traffic signal cycle change.



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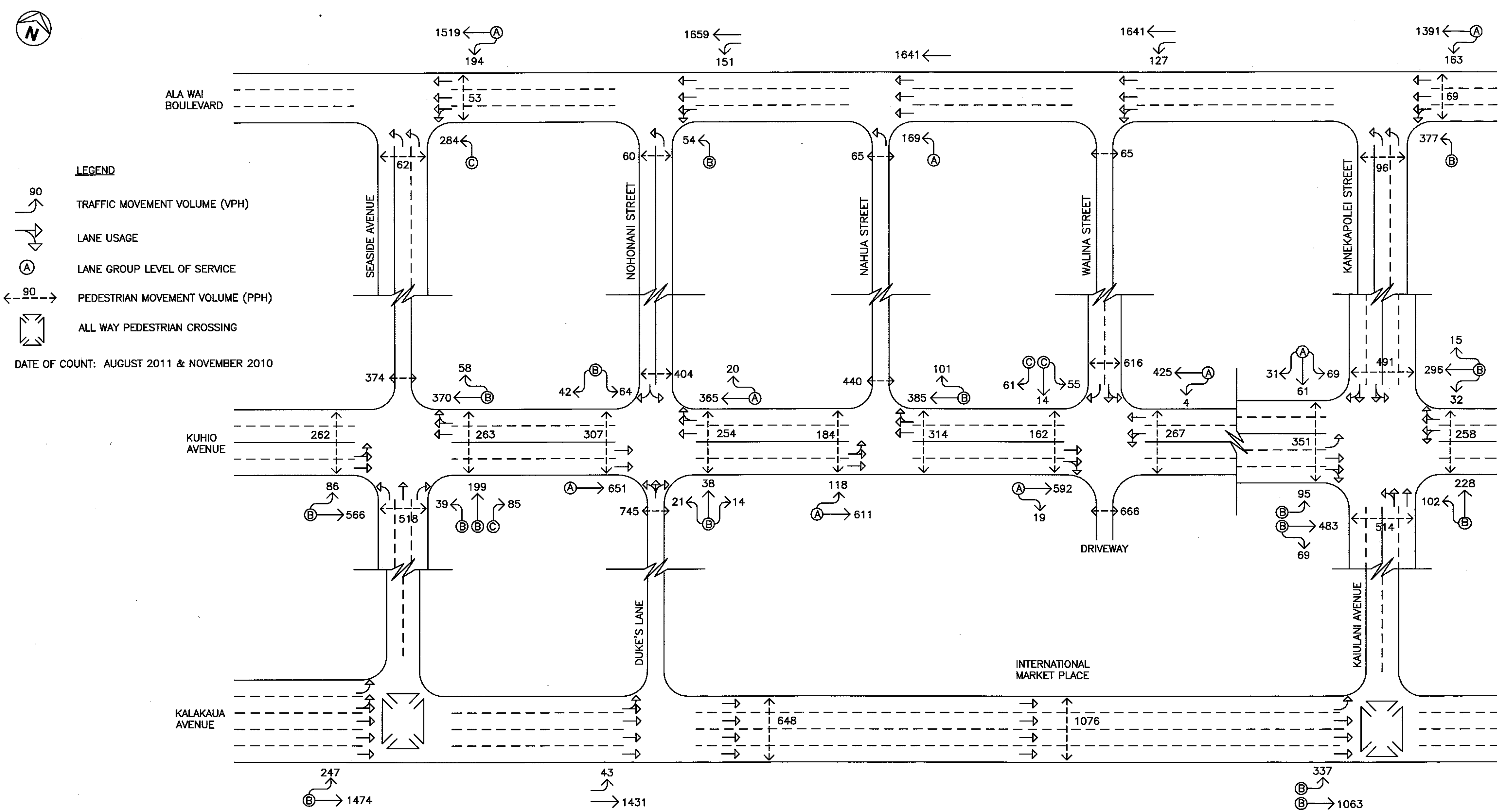
EXISTING WEEKDAY PM PEAK HOUR OF TRAFFIC

FIGURE 3



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EXISTING SATURDAY PM PEAK HOUR OF TRAFFIC

FIGURE 4

d. Kuhio Avenue and Seaside Avenue

At the intersection with Seaside Avenue, Kuhio Avenue carries 673 vehicles eastbound and 399 vehicles westbound during the weekday PM peak period, and 652 vehicles eastbound and 428 vehicles westbound during the Saturday PM peak period. The eastbound approach of Kuhio Avenue operates at LOS "B" during both peak periods while the westbound approach operates at LOS "A" and LOS "B" during the weekday and Saturday PM peak periods, respectively.

The Seaside Avenue approach of the intersection carries 372 vehicles and 323 vehicles northbound during the weekday and Saturday PM peak periods, respectively. The northbound left-turn and through traffic movements operate at LOS "C" and LOS "B" during the weekday and Saturday PM peak periods, respectively, while the right-turn traffic movement operates at LOS "C" during both peak periods.

Traffic queues periodically formed on the approaches of the intersection with average queue lengths of 3-5 vehicles observed during both peak periods. These queues were observed to clear the intersection after each traffic signal cycle change.

e. Kuhio Avenue, Nohonani Street, and Duke's Lane

At the intersection with Nohonani Street and Duke's Lane, Kuhio Avenue carries 650 vehicles eastbound and 348 vehicles westbound during the weekday PM peak period, and 651 vehicles eastbound and 385 vehicles westbound during the Saturday PM peak period. The Kuhio Avenue approaches of the intersection operate at LOS "A" during both peak periods.

The Duke's Lane approach of the intersection carries 61 vehicles and 73 vehicles northbound during the weekday and Saturday PM peak periods, respectively, while the Nohonani Street approach carries 139 vehicles and 106 vehicles southbound during the weekday and Saturday PM peak periods, respectively. The Duke's Lane and Nohonani Street approaches operate at LOS "C" and LOS "B" during the weekday and Saturday PM peak periods, respectively.

Traffic queues periodically formed on the approaches of the intersection with the most significant queuing occurring along Kuhio Avenue. Average queue lengths of 2-4 vehicles were observed during both peak periods. These queues were observed to clear the intersection after each traffic signal cycle change.

f. Kuhio Avenue and Nahua Street

At the intersection with Nahua Street, Kuhio Avenue carries 711 vehicles eastbound and 415 vehicles westbound during the weekday PM peak period, and 729 vehicles eastbound and 486 vehicles westbound during the Saturday PM peak periods. The eastbound approach of Kuhio Avenue operates at LOS "A" during both peak periods while the westbound approach operates at LOS "B" during both peak periods. Traffic queues periodically formed on the Kuhio Avenue approaches of the intersection with average queue lengths of 2-4 vehicles observed during both peak periods. These queues were observed to clear the intersection after each traffic signal cycle change.

g. Kuhio Avenue and Walina Street

At the intersection with Walina Street, Kuhio Avenue carries 617 vehicles eastbound and 365 vehicles westbound during the weekday PM peak period, and 611 vehicles eastbound and 429 vehicles westbound during the Saturday PM peak period. Both approaches of Kuhio Avenue operate at LOS "A" during both peak periods.

The Walina Street approach of the intersection carries 112 vehicles and 130 vehicles southbound during the weekday and

Saturday PM peak periods, respectively. The southbound left-turn and through traffic movement operates at LOS "C' during both peak periods while the right-turn traffic movement operates at LOS "D" and LOS "C" during the weekday and Saturday PM peak periods, respectively.

Traffic queues periodically formed on the approaches of the intersection with the most significant queuing occurring along Kuhio Avenue. Average queue lengths of 3-5 vehicles were observed during both peak periods. These queues were observed to clear the intersection after each traffic signal cycle change.

h. Kuhio Avenue and Kanekapolei Street

At the intersection with Kanekapolei Street, Kuhio Avenue carries 806 vehicles eastbound and 289 vehicles westbound during the weekday PM peak period while 647 vehicles eastbound and 343 vehicles westbound during the Saturday PM peak period. The traffic movements on the eastbound approach of Kuhio Avenue operate at LOS "A" and LOS "B" during the weekday and Saturday PM peak periods, respectively, while the westbound approach operates at LOS "B" during both peak periods.

Kanekapolei Street carries 269 vehicles northbound and 170 vehicles southbound during the weekday PM peak period, and 330 vehicles northbound and 161 vehicles southbound during the Saturday PM peak period. The northbound approach of Kanekapolei Street operates at LOS "C" and LOS "B" during the weekday and Saturday PM peak periods, respectively, while the southbound approach operates at LOS "B" and LOS "A" during the weekday and Saturday PM peak periods, respectively.

Traffic queues periodically formed on the approaches of the intersection with average queue lengths of 2-4 vehicles observed during both peak periods. These queues were observed to clear the intersection after each traffic signal cycle change.

i. Ala Wai Boulevard and Seaside Avenue

At the intersection with Seaside Avenue, Ala Wai Boulevard carries 1,880 vehicles and 1,713 vehicles eastbound during the weekday and Saturday PM peak periods, respectively, while Seaside Avenue carries 399 vehicles and 284 vehicles northbound during the weekday and Saturday PM peak periods, respectively. The Ala Wai Boulevard approach operates at LOS "A" during both peak periods while the Seaside Avenue approach operates at LOS "C" during both peak periods. Traffic queues periodically formed on the approaches of the intersection with average queue lengths of 8-10 vehicles observed along Ala Wai Boulevard during both peak periods and 4-6 vehicles observed along Seaside Avenue during both peak periods. These queues were observed to clear the intersection after each traffic signal cycle change.

j. Ala Wai Boulevard and Nohonani Street

At the intersection with Nohonani Street, Ala Wai Boulevard carries 2,001 vehicles and 1,810 vehicles eastbound during the weekday and Saturday PM peak periods, while Nohonani Street carries 68 vehicles and 54 vehicles northbound during the weekday and Saturday PM peak periods, respectively. The critical movement at the intersection is the Nohonani Street approach which operates at LOS "B" during both peak periods. Traffic queues occasionally formed on the Nohonani Street approach of the intersection with average queue lengths of 1-2 vehicles observed during both peak periods.

k. Ala Wai Boulevard and Nahua Street

At the intersection with Nahua Street, Ala Wai Boulevard carries 1,775 vehicles and 1,641 vehicles eastbound during the weekday and Saturday PM peak periods, respectively, while Nahua

Street carries 208 vehicles and 169 vehicles northbound during the weekday and Saturday PM peak periods, respectively. The critical movement at this intersection is the northbound approach which operates at LOS "A" during both peak periods. Traffic queues occasionally formed on the Nahua Street approach of the intersection with average queue lengths of 1-3 vehicles observed during both peak periods.

I. Ala Wai Boulevard and Kanekapolei Street

At the intersection with Kanekapolei Street, Ala Wai Boulevard carries 1,828 vehicles and 1,554 vehicles westbound during the weekday and Saturday PM peak periods, respectively, while Kanekapolei Street carries 346 vehicles and 377 vehicles northbound during the weekday and Saturday PM peak periods, respectively. The Ala Wai Boulevard approach operates at LOS "B" and LOS "A" during the weekday and Saturday PM peak periods, respectively, while the Kanekapolei Street approach operates at LOS "B" during both peak periods. Traffic queues periodically formed on the approaches of the intersection with average queue lengths of 8-10 vehicles observed along Ala Wai Boulevard during both peak periods and 5-7 vehicles observed along Kanekapolei Street during both peak periods. These queues were observed to clear the intersection after each traffic signal cycle change.

IV. PROJECTED TRAFFIC CONDITIONS

A. Site-Generated Traffic

1. Trip Generation Methodology

The trip generation methodology used in this study is based upon generally accepted techniques developed by the Institute of Transportation Engineers (ITE) and published in "Trip Generation, 8th Edition," 2008. The ITE trip generation rates are developed empirically by correlating the vehicle trip generation data with various land use characteristics such as the number of vehicle trips generated per 1,000 square feet of development or hotel room. The site currently houses approximately 192,000 square feet of retail/restaurant uses and 357 hotel rooms. Since the project site is be located in a neighborhood with limited parking, high volumes of pedestrian traffic, and a high density of attractive destinations, many guests elect to walk to their destinations rather than drive. As such, the total number of trips assumed generated by the existing retail/restaurant areas was reduced by 70% to more accurately reflect existing conditions. In addition, a significant number of hotel guests elect to utilize abundant shuttle or bus services available to/from and within Waikiki. As such, the total number of trips assumed generated by the existing hotel rooms was reduced by 70% to more accurately reflect existing conditions. Table 1 summarizes the existing project site trip generation characteristics.

Table 1: Adjusted Existing Peak Hour Trip Generation

Shopping Center (Retail/Restaurant) INDEPENDENT VARIABLE: 1,000 sf of development = 192		
		PROJECTED TRIP ENDS
WEEKDAY PM PEAK	ENTER	105
	EXIT	109
	TOTAL	214
SATURDAY PM PEAK	ENTER	122
	EXIT	127
	TOTAL	249
Hotel INDEPENDENT VARIABLE: Hotel rooms = 357		
		PROJECTED TRIP ENDS
WEEKDAY PM PEAK	ENTER	34
	EXIT	30
	TOTAL	64
SATURDAY PM PEAK	ENTER	34
	EXIT	30
	TOTAL	64

Table 1: Adjusted Existing Peak Hour Trip Generation (Cont'd)

TOTALS		
		PROJECTED TRIP ENDS
WEEKDAY PM PEAK	ENTER	139
	EXIT	139
	TOTAL	278
SATURDAY PM PEAK	ENTER	156
	EXIT	157
	TOTAL	313

Similar to existing conditions, a portion of the guests destined for the proposed retail/restaurant areas are assumed to walk to the project site rather than drive. As such, the total number of trips generated by the proposed retail/restaurant areas was reduced by 70% to more accurately reflect anticipated conditions. Table 2 summarizes the projected site trip generation characteristics and the net difference from existing conditions applied to the weekday and Saturday PM peak periods of traffic.

Table 2: Adjusted Peak Hour Trip Generation

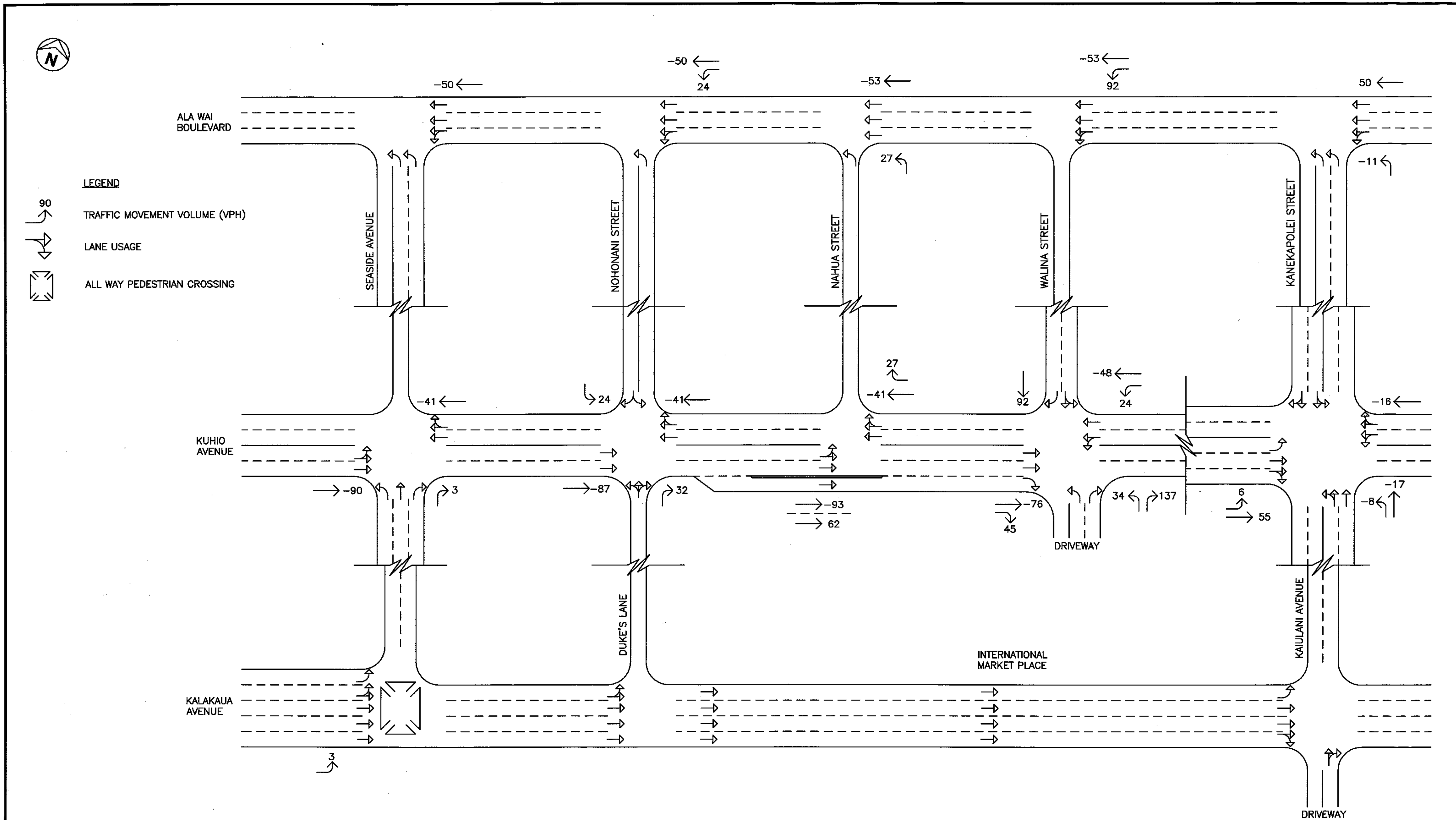
Shopping Center (Retail/Restaurant) INDEPENDENT VARIABLE: 1,000 sf of development = 355		
		PROJECTED TRIP ENDS
WEEKDAY PM PEAK	ENTER	195
	EXIT	203
	TOTAL	398
SATURDAY PM PEAK	ENTER	226
	EXIT	236
	TOTAL	462
NET DIFFERENCE		
		PROJECTED TRIP ENDS
WEEKDAY PM PEAK	ENTER	56
	EXIT	64
	TOTAL	120
SATURDAY PM PEAK	ENTER	70
	EXIT	79
	TOTAL	149

2. Trip Distribution

Figures 5 and 6 show the distribution of site-generated vehicular trips at the study intersections during the weekday and Saturday PM peak hours of traffic. Since the existing on-site hotel is not expected to be replaced with similar uses, traffic volumes along the surrounding roadway network were adjusted to account for the trips associated with the existing hotel uses. In addition, the trips associated with the existing retail/restaurant uses were reassigned to the network based upon the anticipated changes in access for the project site. Currently, there is limited on-site parking so most patrons utilize other parking areas within Waikiki. As such, trips associated with the existing retail/restaurant uses are assumed to already be utilizing the surrounding roadways and are expected to reroute to utilize the proposed on-site parking instead.

The directional distribution of all new site-generated vehicles was based upon a marketing study conducted for The Taubman Company which indicated that approximately 90% of patrons are expected to originate or be destined for neighborhoods east of the project site. However, for the purpose of this study, a more conservative 80%/20% split was assumed between patrons originating/destined for the east and those originating/destined for the west. Eastbound vehicles were assumed to either utilize Kuhio Avenue, directly or via Kalakaua Avenue, to access the project site while westbound vehicles were assumed to utilize either Ala Wai Boulevard or Kuhio Avenue. The distribution of eastbound vehicles between Kuhio Avenue and Kalakaua Avenue was based upon the existing directional distribution of traffic at the intersection of Kuhio Avenue with Seaside Avenue while westbound vehicles were distributed between Ala Wai Boulevard and Kuhio Avenue based upon the relative distribution of westbound vehicles between these two roadways.

Patrons of the new retail complex can elect to self-park or utilize the provided valet services. Based upon surveys of similar uses in the area, for



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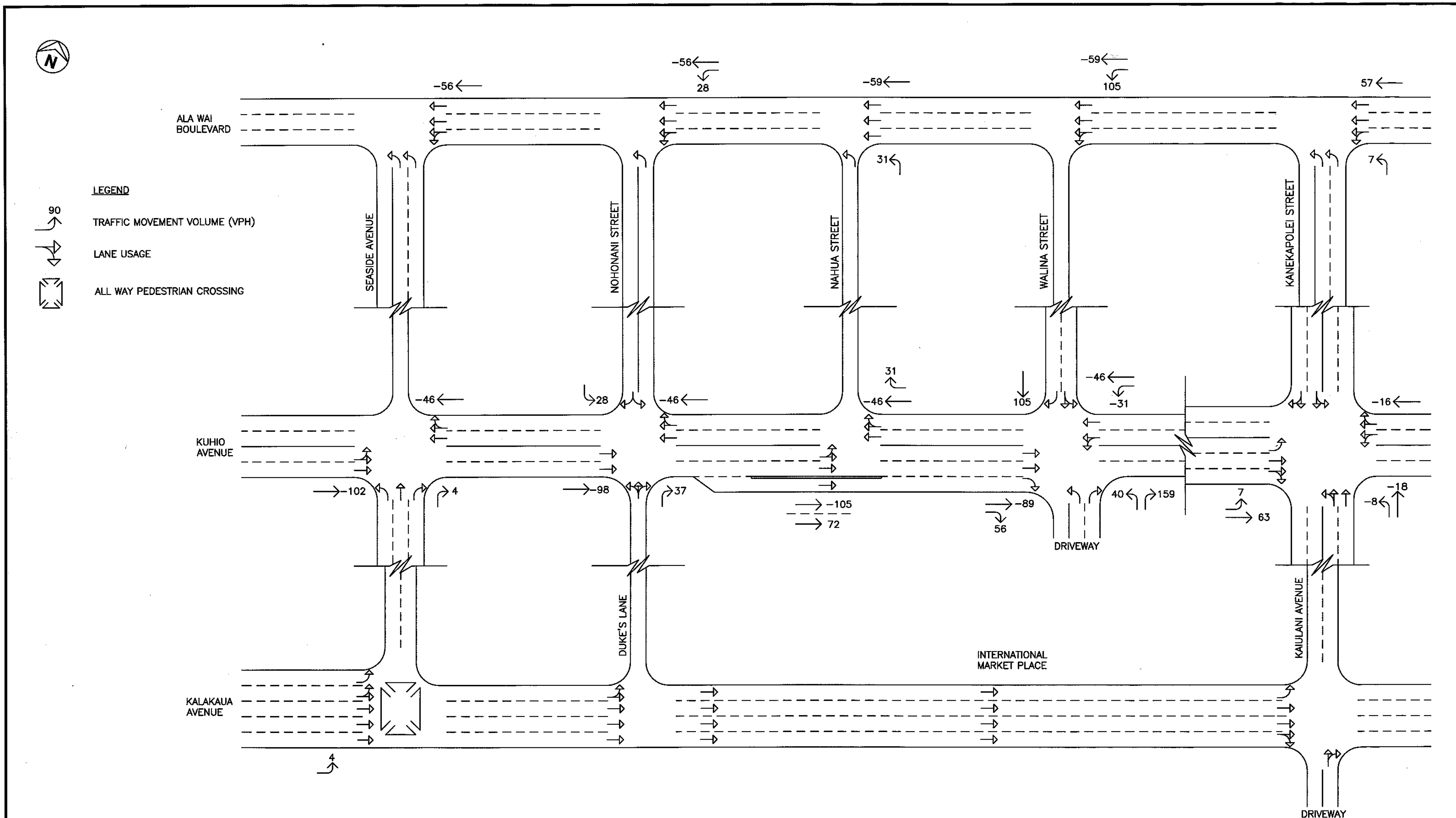
INTERNATIONAL MARKET PLACE

DISTRIBUTION OF SITE-GENERATED VEHICLES - WEEKDAY PM PEAK HOUR OF TRAFFIC

FIGURE 5



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INTERNATIONAL MARKET PLACE

DISTRIBUTION OF SITE-GENERATED VEHICLES - SATURDAY PM PEAK HOUR OF TRAFFIC

FIGURE 6

the purpose of this report, approximately 25% of the patrons were assumed to utilize the provided valet services. All patrons electing to self-park are assumed to utilize the primary access at the intersection of Kuhio Avenue and Walina Street while those electing to utilize valet services were distributed between the two valet service areas based upon the relative distribution of on-site uses. Vehicles accessing the valet service area near the east edge of the project site were assumed to utilize the primary access at the Kuhio Avenue/Walina Street intersection to access the valet services located on the first level of parking within the parking structure (Level 3) with valet personnel transferring the vehicles to and from this area via internal connections. Vehicles dropped off at the valet service area along Kuhio Avenue were assumed to be transferred to the garage by valet personnel via the primary vehicular access off Kuhio Avenue then returned to Kuhio Avenue via the driveway off Duke's Lane. All site-generated trips were assigned to the roadway network based upon their assumed origin or destination.

B. Through Traffic Forecasting Methodology

There are no State of Hawaii or City and County of Honolulu traffic count station in the immediate vicinity of the project site with sufficient available historical data to obtain a historical trend for the growth of traffic in the project vicinity. However, for the purpose of this report, an average annual growth rate of 2.0% per year was conservatively assumed along Kalakaua Avenue, Kuhio Avenue, and Ala Wai Boulevard to account for ambient growth in traffic. As such, using 2010 and 2011 as the Base Years, growth rate factors of 1.10 and 1.08, respectively, were applied to the existing through traffic demands along Kalakaua Avenue, Kuhio Avenue, and Ala Wai Boulevard to achieve the projected Year 2015 traffic demands.

C. Other Considerations

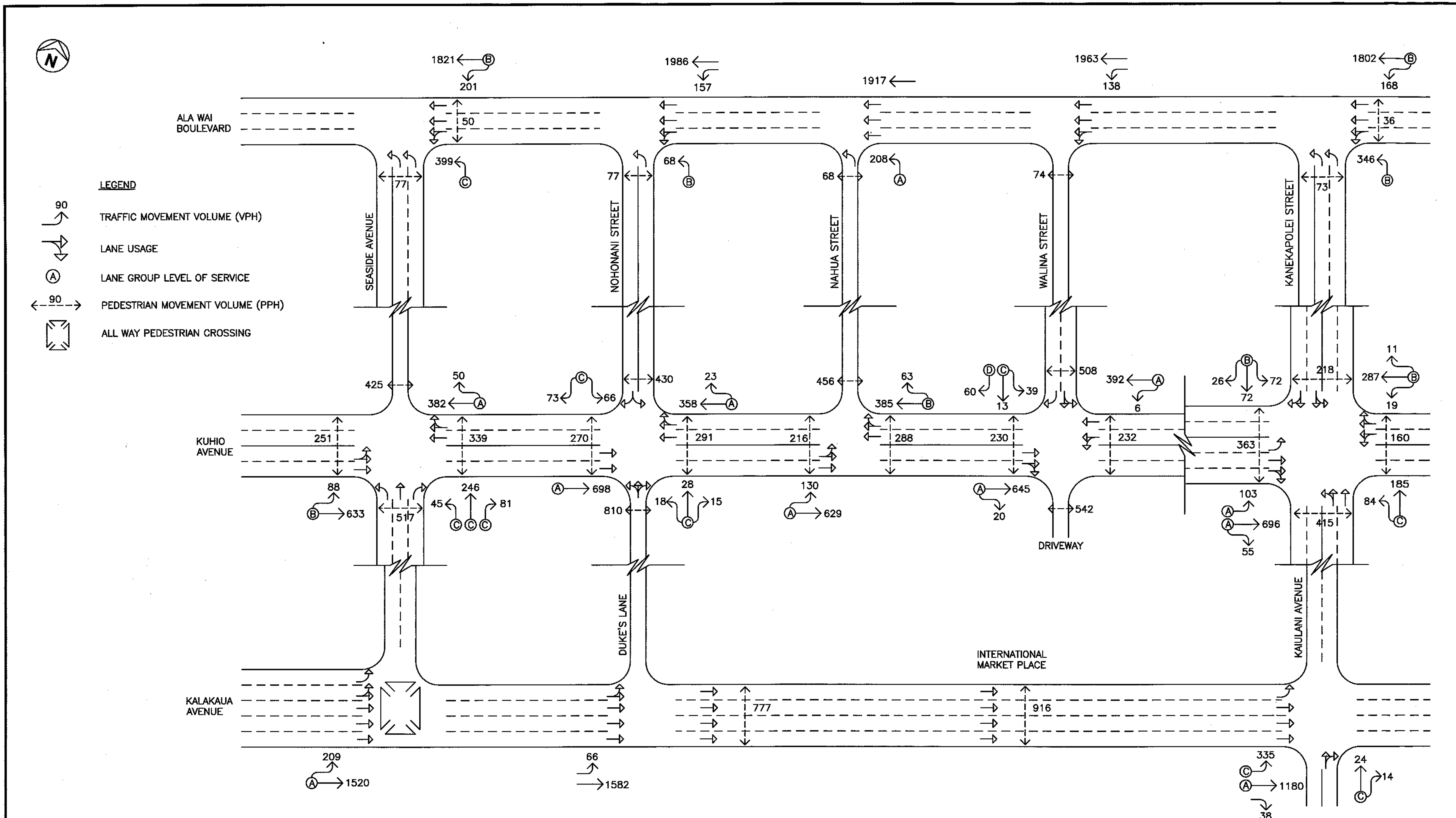
The Princess Kaiulani Hotel is located adjacent to Kaiulani Avenue between Kalakaua Avenue and Kanekapolei Street. As detailed in the "Traffic Impact Report for the Princess Kaiulani Renovation and Diamond Head Tower Development," there are plans to renovate one of the existing hotel towers and construct a new parking garage, tower, and commercial podium. In addition, there are plans to replace the existing diamond head wing of the Moana Surfrider Hotel, located south of Kalakaua Avenue at the intersection with Kaiulani Avenue, with a new condominium/hotel. In conjunction with the Diamond Head Tower development, a new two-way driveway will be constructed on the south side of the Kalakaua Avenue and Kaiulani Avenue intersection necessitating the modification of the existing traffic signal phasing to accommodate the new vehicular approach. These projects are expected to be completed by the Year 2012 and, as such, were incorporated into without project conditions to account for proposed projects.

D. Total Traffic Volumes Without Project

The projected year 2015 weekday and Saturday PM peak period traffic volumes and operating conditions without the proposed International Market Place revitalization project are shown in Figures 7 and 8, and summarized in Table 3. The intersection of Kalakaua Avenue and Kaiulani Avenue is assumed to be modified to accommodate the inclusion of the northbound driveway approach from the Diamond Head Tower development. The existing levels of service are included for comparison purposes. LOS calculations are included in Appendix D.

Table 3: Existing and Projected (Without Project) LOS Traffic Operating Conditions

Intersection	Critical Traffic Movement		Weekday PM		Saturday PM	
			Exist	Year 2015 w/out Proj	Exist	Year 2015 w/out Proj
Kalakaua Ave/ Seaside Ave	Eastbound	LT-TH	A	A	B	B
Kalakaua Ave/ Kaiulani Ave	Eastbound	LT	B	C	B	C
		TH	B	A	B	A
	Northbound	TH-RT	-	C	-	C



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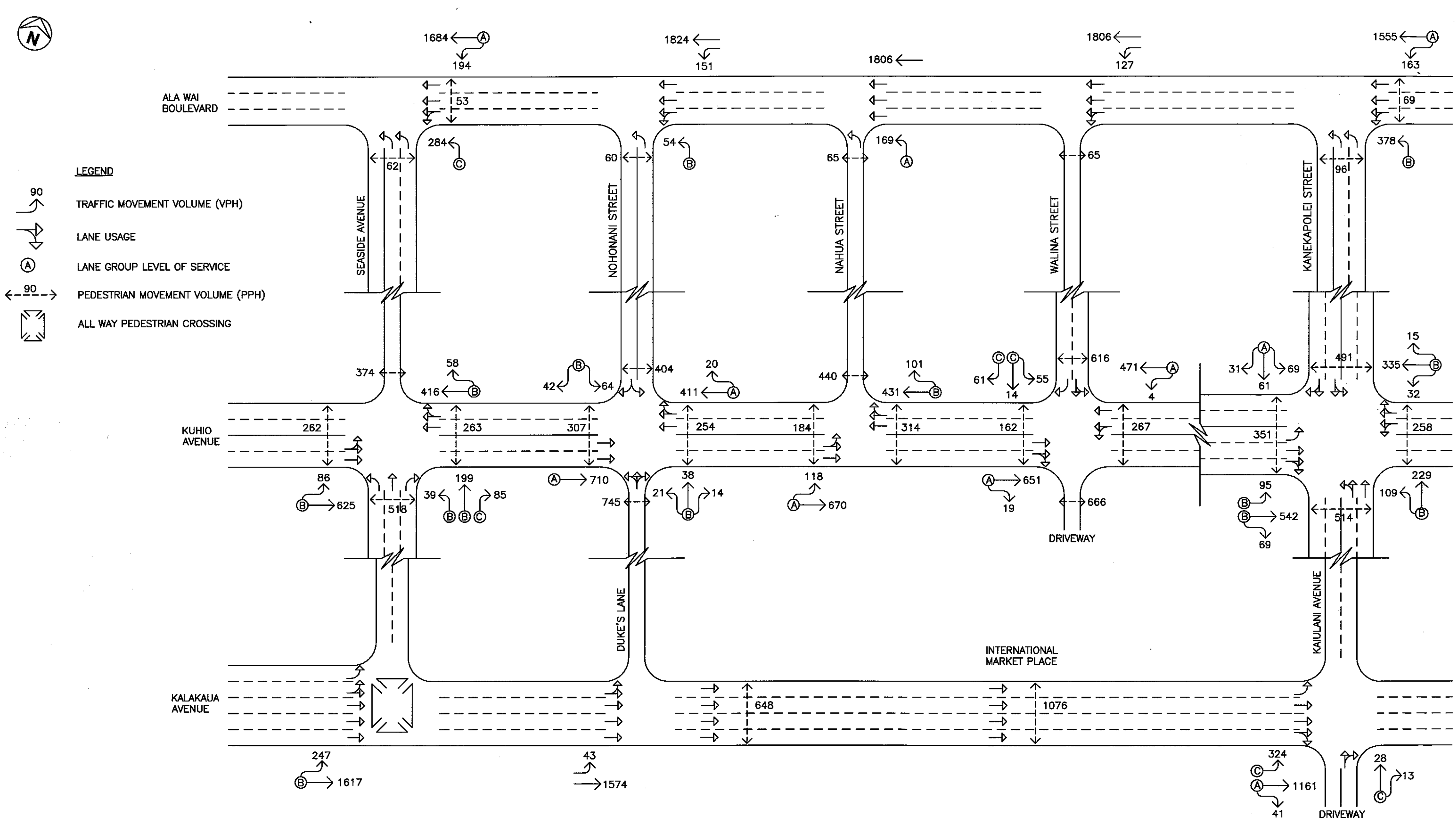
INTERNATIONAL MARKET PLACE

YEAR 2015 WEEKDAY PM PEAK HOUR OF TRAFFIC WITHOUT PROJECT

FIGURE
7



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INTERNATIONAL MARKET PLACE

YEAR 2015 SATURDAY PM PEAK HOUR OF TRAFFIC WITHOUT PROJECT

FIGURE 8

Table 3: Existing and Projected (Without Project) LOS Traffic Operating Conditions (Cont'd)

Intersection	Critical Traffic Movement		Weekday PM		Saturday PM	
			Exist	Year 2015 w/out Proj	Exist	Year 2015 w/out Proj
Kuhio Ave/ Seaside Ave	Eastbound	LT-TH	B	B	B	B
	Westbound	TH-RT	A	A	B	B
	Northbound	LT	C	C	B	B
		TH	C	C	B	B
		RT	C	C	C	C
Kuhio Ave/ Nohonani St/ Duke's Ln	Eastbound	TH	A	A	A	A
	Westbound	TH-RT	A	A	A	A
	Northbound	LT-TH-RT	C	C	B	B
	Southbound	LT-TH-RT	C	C	B	B
Kuhio Ave/ Nahua St	Eastbound	LT-TH	A	A	A	A
	Westbound	TH-RT	B	B	B	B
Kuhio Ave/ Walina St	Eastbound	TH-RT	A	A	A	A
	Westbound	LT-TH	A	A	A	A
	Southbound	LT-TH	C	C	C	C
		RT	D	D	C	C
Kuhio Ave/ Kanekapolei St	Eastbound	LT	A	A	B	B
		TH-RT	A	A	B	B
	Westbound	LT-TH-RT	B	B	B	B
	Northbound	LT-TH	C	C	B	B
	Southbound	LT-TH-RT	B	B	A	A
Ala Wai Blvd/ Seaside Ave	Westbound	LT-TH	A	B	A	A
	Northbound	LT	C	C	C	C
Ala Wai Blvd/ Nohonani St	Northbound	LT	B	B	B	B
Ala Wai Blvd/ Nahua St	Northbound	LT	A	A	A	A
Ala Wai Blvd/ Kanekapolei St	Westbound	LT-TH	B	B	A	A
	Northbound	LT	B	B	B	B

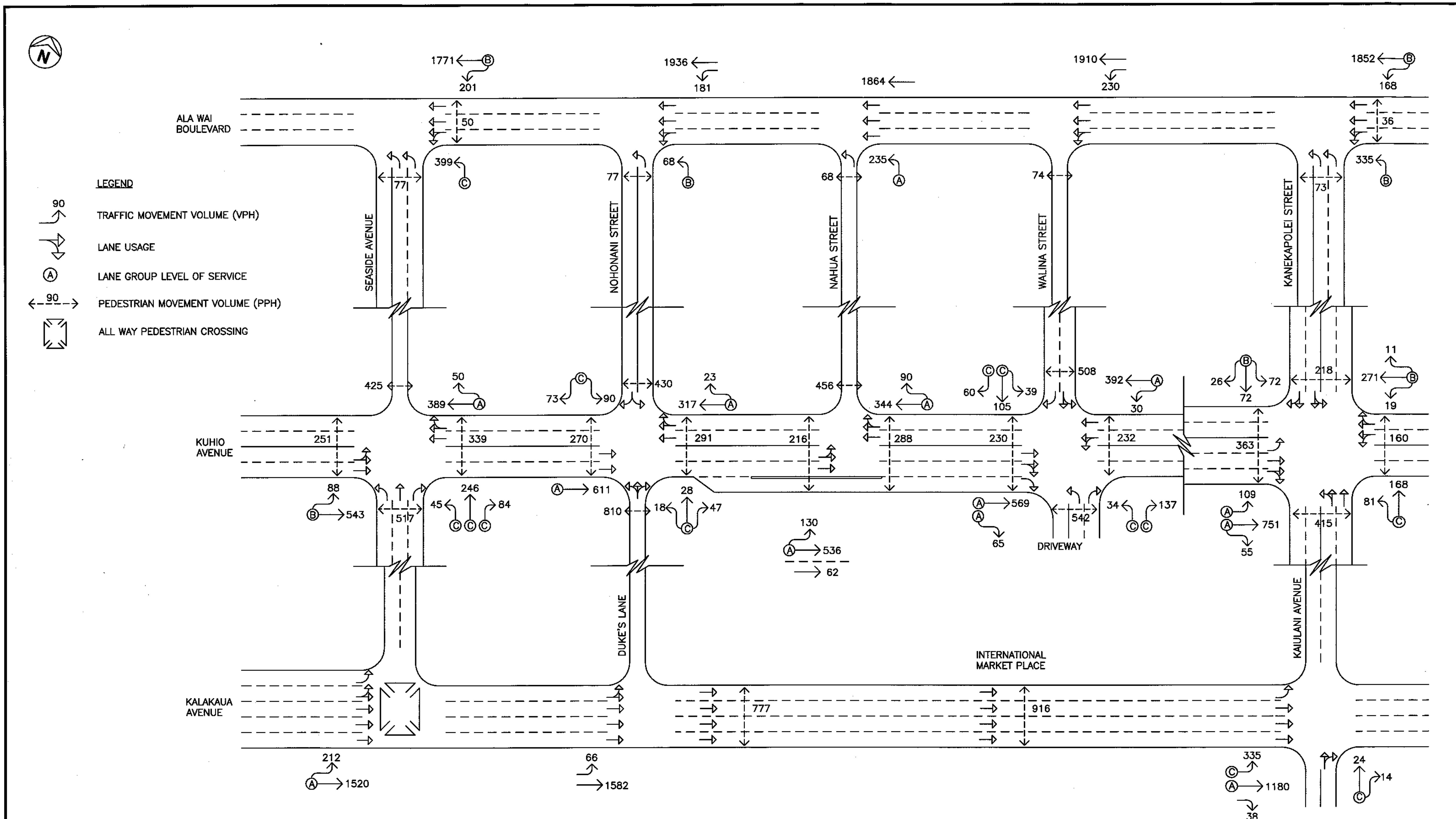
Under Year 2015 without project conditions, traffic operations are expected, in general, to remain similar to existing conditions. The westbound left-turn and through traffic movement at the intersection of Seaside Avenue with Ala Wai Boulevard is expected to operate at a slightly lower LOS "B" during the weekday PM peak period. The remaining critical traffic movements at this intersection, as well as, the other study intersection are expected to operate at levels of service similar to existing conditions during the weekday and Saturday PM peak periods with the exception of the Kalakaua Avenue and Kaiulani Avenue intersection. The traffic movements at this intersection are expected to operate at LOS "C" or better during both peak periods with the addition of the Diamond Head Tower development's driveway to that intersection.

E. Total Traffic Volumes With Project

Figures 9 and 10 show the Year 2015 cumulative weekday and Saturday PM peak hour traffic conditions with the proposed redevelopment of the International Market Place. The cumulative volumes consist of site- generated traffic superimposed over Year 2015 projected traffic demands. The traffic impacts resulting from the proposed project are addressed in the following section.

V. TRAFFIC IMPACT ANALYSIS

The Year 2015 cumulative weekday and Saturday PM peak hour traffic conditions with the proposed International Market Place revitalization project are summarized in Table 4. The intersection of Kuhio Avenue and Walina Street is assumed to be modified to include the new primary vehicular access for the proposed project, as well as, provide an exclusive eastbound right-turn lane. In addition, the traffic signal system at that intersection is assumed to be modified to accommodate the proposed lane use changes at that intersection. The existing and projected Year 2015 (Without Project) operating conditions are provided for comparison purposes. LOS calculations are included in Appendix E.



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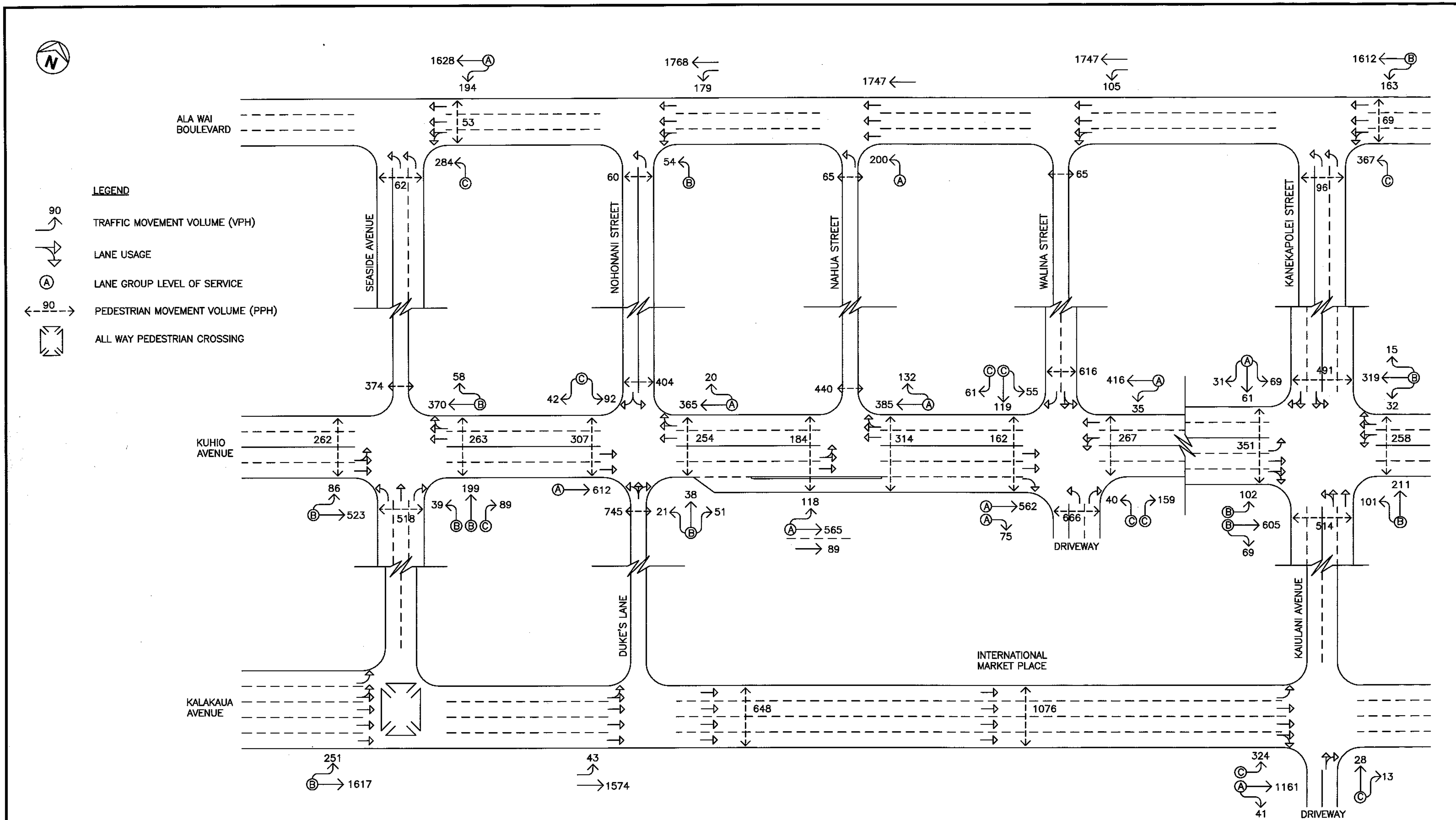
INTERNATIONAL MARKET PLACE

YEAR 2015 WEEKDAY PM PEAK HOUR OF TRAFFIC WITH PROJECT

FIGURE 9



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INTERNATIONAL MARKET PLACE

YEAR 2015 SATURDAY PM PEAK HOUR OF TRAFFIC WITH PROJECT

FIGURE 10

Table 4: Existing and Projected (Without and With Project) LOS Traffic Operating Conditions

Intersection	Critical Traffic Movement		Weekday PM Exist	Weekday PM Year 2015 w/out Proj	Weekday PM Year 2015 w/ Proj	Saturday PM Exist	Saturday PM Year 2015 w/out Proj	Saturday PM Year 2015 w/ Proj
Kalakaua Ave/ Seaside Ave	EB	LT-TH	A	A	A	B	B	B
Kalakaua Ave/ Kaiulani Ave	EB	LT	B	C	C	B	C	C
		TH	B	A	A	B	A	A
	NB	TH-RT	-	C	C	-	C	C
Kuhio Ave/ Seaside Ave	EB	LT-TH	B	B	B	B	B	B
	WB	TH-RT	A	A	A	B	B	B
	NB	LT	C	C	C	B	B	B
		TH	C	C	C	B	B	B
		RT	C	C	C	C	C	C
Kuhio Ave/ Nohonani St/ Duke's Ln	EB	TH	A	A	A	A	A	A
	WB	TH-RT	A	A	A	A	A	A
	NB	LT-TH-RT	C	C	C	B	B	B
	SB	LT-TH-RT	C	C	C	B	B	C
Kuhio Ave/ Nahua St	EB	LT-TH	A	A	A	A	A	A
	WB	TH-RT	B	B	A	B	B	A
Kuhio Ave/ Walina St	EB	TH	A	A	A	A	A	A
		RT			A			A
	WB	LT-TH	A	A	A	A	A	A
	NB	LT	-	-	C	-	-	C
		RT	-	-	C	-	-	C
	SB	LT-TH	C	C	C	C	C	C
		RT	D	D	C	C	C	C
Kuhio Ave/ Kanekapolei St	EB	LT	A	A	A	B	B	B
		TH-RT	A	A	A	B	B	B
	WB	LT-TH-RT	B	B	B	B	B	B
	NB	LT-TH	C	C	C	B	B	B
	SB	LT-TH-RT	B	B	B	A	A	A
Ala Wai Blvd/ Seaside Ave	WB	LT-TH	A	B	B	A	A	A
	NB	LT	C	C	C	C	C	C
Ala Wai Blvd/ Nohonani St	NB	LT	B	B	B	B	B	B

Table 4: Existing and Projected (Without and With Project) LOS Traffic Operating Conditions (Cont'd)

Intersection	Critical Traffic Movement		Weekday PM			Saturday PM		
			Exist	Year 2015		Exist	Year 2015	
				w/out Proj	w/ Proj		w/out Proj	w/ Proj
Ala Wai Blvd/ Nahua St	NB	LT	A	A	A	A	A	A
Ala Wai Blvd/ Kanekapolei St	WB	LT-TH	B	B	B	A	A	A
	NB	LT	B	B	B	B	B	C

Traffic operations under Year 2015 with project conditions are expected, in general, to remain similar to Year 2015 without project conditions during both peak periods. Along Kalakaua Avenue, the traffic movements at the intersection with Seaside Avenue are expected to continue operating at LOS "B" or better during both peak periods while those at the intersection with Kaiulani Avenue are expected to continue operating at LOS "C" or better during both peak periods. Along Kuhio Avenue, the traffic movements at the intersection with Seaside Avenue are expected to continue operating at LOS "C" or better during both peak periods while those at the intersection with Kanekapolei Street are expected to continue operating at LOS "C" or better during the weekday PM peak period and LOS "B" or better during the Saturday PM peak period. At the intersection with Nahua Street, the traffic movements are expected to operate at LOS "A" during both peak periods while those at the intersections with Nohonani Street/Duke's Lane and Walina Street are expected to operate at LOS "C" or better during both peak periods. Along Ala Wai Boulevard, the traffic movements at the intersections with Seaside Avenue and Kanekapolei Street are expected to continue operating at LOS "C" or better during both peak periods while those at the remaining study intersections along that roadway are expected to continue operating at LOS "B" or better during both peak periods.

Although Year 2015 with project conditions are expected to remain similar to without project conditions, the proposed project is located in a densely developed area with a high volume of pedestrian and vehicular traffic. As such, a traffic management plan is recommended for the International Market Place revitalization project to minimize conflicts with traffic associated with the development.

VI. RECOMMENDATIONS

Based on the analysis of the traffic data, the following are the recommendations associated with the proposed International Market Place revitalization project:

1. Provide sufficient sight distance for motorists to safely enter and exit all project driveways.

2. Provide adequate on-site loading and off-loading service areas and prohibit off-site loading operations.

3. Provide adequate turn-around area for service, delivery, and refuse collection vehicles to maneuver on the project site to avoid vehicle-reversing maneuvers onto adjacent public roadways.

4. Provide sufficient turning radii at all driveways to avoid or minimize vehicle encroachments to oncoming traffic lanes.

5. Align the primary vehicular access with Walina Street at the intersection with Kuhio Avenue to minimize conflicts between turning vehicles.

6. Modify the traffic signal phasing and timing at the intersection of Kuhio Avenue with Walina Street to accommodate the addition of the primary vehicular access for the proposed project to the intersection.

7. Align the primary pedestrian access along Kuhio Avenue with the intersection with Nahua Street.

8. Align the primary pedestrian access along Kalakaua Avenue with the existing signalized mid-block crosswalk.

9. Provide an additional eastbound lane along Kuhio Avenue between the proposed valet pull-out and the primary access at the intersection with Walina Street to minimize the impact of valet operations on Kuhio Avenue.

10. Provide a physical barrier between the eastbound through lanes of traffic along Kuhio Avenue and the auxiliary lane extending from the valet pull-out at the intersection with Nahua Street to eliminate vehicular conflicts with vehicles utilizing valet services.

11. Provide exclusive left-turn and right-turn lanes along the primary vehicular access at the intersection of Kuhio Avenue with Walina Street.

12. Ensure that queuing from the valet pull-out along Kuhio Avenue does not extend onto the adjacent public roadway.

13. Prepare a Traffic Management Plan (TMP) for the International Market Place that includes traffic demand management strategies, as well as, traffic circulation, parking and loading management strategies.

VII. CONCLUSION

The proposed project entails the replacement of the existing International Market Place adjacent to Kalakaua Avenue which houses a variety of shops, carts, restaurants, and hotel uses with a new retail complex. With the implementation of the aforementioned recommendations, the proposed International Market Place revitalization project is not expected to have a significant impact on traffic operations in the project vicinity. The traffic movements at the study intersections in the vicinity are expected to continue operating at levels of service similar to without project conditions. Although traffic conditions with the proposed redevelopment are expected to remain similar to without project conditions, the preparation of a Traffic Management Plan is recommended to further minimize the impact of the project on the surrounding roadways.

APPENDIX A

EXISTING TRAFFIC COUNT DATA

Wilson Okamoto Corporation

1907 S. Beretania Street, Suite 400
Honolulu, Hawaii

Counter:TU-0653, TU-0654
Counted By:RJ, DY
Weather:Clear

File Name : KalSea PM
Site Code : 00000001
Start Date : 8/30/2011
Page No : 1

Groups Printed- Unshifted

	Seaside Avenue Southbound					Kalakaua Avenue Westbound					Northbound	Kalakaua Avenue Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	0	0	0	159	159	0	0	0	149	149	0	63	257	0	63	383	691
03:15 PM	0	0	0	227	227	0	0	0	114	114	0	52	339	0	71	462	803
03:30 PM	0	0	0	226	226	0	0	0	137	137	0	58	390	0	53	501	864
03:45 PM	0	0	0	189	189	0	0	0	144	144	0	57	396	0	59	512	845
Total	0	0	0	801	801	0	0	0	544	544	0	230	1382	0	246	1858	3203
04:00 PM	0	0	0	167	167	0	0	0	127	127	0	57	373	0	79	509	803
04:15 PM	0	0	0	193	193	0	0	0	141	141	0	58	334	0	76	468	802
04:30 PM	0	0	0	197	197	0	0	0	110	110	0	50	333	0	65	448	755
04:45 PM	0	0	0	218	218	0	0	0	106	106	0	44	367	0	96	507	831
Total	0	0	0	775	775	0	0	0	484	484	0	209	1407	0	316	1932	3191
05:00 PM	0	0	0	265	265	0	0	0	177	177	0	56	381	0	75	512	954
05:15 PM	0	0	0	289	289	0	0	0	143	143	0	57	390	0	53	500	932
05:30 PM	0	0	0	268	268	0	0	0	128	128	0	43	386	0	66	495	891
05:45 PM	0	0	0	250	250	0	0	0	186	186	0	31	373	0	84	488	924
Total	0	0	0	1072	1072	0	0	0	634	634	0	187	1530	0	278	1995	3701
Grand Total	0	0	0	2648	2648	0	0	0	1662	1662	0	626	4319	0	840	5785	10095
Apprch %	0	0	0	100		0	0	0	100			10.8	74.7	0	14.5		
Total %	0	0	0	26.2	26.2	0	0	0	16.5	16.5	0	6.2	42.8	0	8.3	57.3	

	Seaside Avenue Southbound				Kalakaua Avenue Westbound				Northbound	Kalakaua Avenue Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 04:45 PM														
04:45 PM	0	0	0	0	0	0	0	0	0	44	367	0	411	411
05:00 PM	0	0	0	0	0	0	0	0	0	56	381	0	437	437
05:15 PM	0	0	0	0	0	0	0	0	0	**57**	**390**	0	**447**	**447**
05:30 PM	0	0	0	0	0	0	0	0	0	43	386	0	429	429
Total Volume	0	0	0	0	0	0	0	0	0	200	1524	0	1724	1724
% App. Total	0	0	0		0	0	0			11.6	88.4	0		
PHF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.877	.977	.000	.964	.964

Wilson Okamoto Corporation

1907 S. Beretania Street, Suite 400
Honolulu, Hawaii

Counter;TU-0650
Counted By:RF
Weather:Clear

File Name : KalDuke PM
Site Code : 00000000
Start Date : 8/30/2011
Page No : 1

Groups Printed- Unshifted

	Duke's Lane Southbound					Westbound	Northbound	Kalakaua Avenue Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	App. Total	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	0	0	0	228	228	0	0	16	252	0	128	396	624
03:15 PM	0	0	0	295	295	0	0	8	337	0	139	484	779
03:30 PM	0	0	0	339	339	0	0	16	393	0	118	527	866
03:45 PM	0	0	0	233	233	0	0	20	381	0	176	577	810
Total	0	0	0	1095	1095	0	0	60	1363	0	561	1984	3079
04:00 PM	0	0	0	251	251	0	0	19	362	0	170	551	802
04:15 PM	0	0	0	280	280	0	0	22	379	0	164	565	845
04:30 PM	0	0	0	268	268	0	0	9	339	0	182	530	798
04:45 PM	0	0	0	274	274	0	0	16	385	0	261	662	936
Total	0	0	0	1073	1073	0	0	66	1465	0	777	2308	3381
05:00 PM	0	0	0	465	465	0	0	15	388	0	189	592	1057
05:15 PM	0	0	0	342	342	0	0	9	384	0	218	611	953
05:30 PM	0	0	0	362	362	0	0	21	400	0	252	673	1035
05:45 PM	0	0	0	380	380	0	0	39	339	0	165	543	923
Total	0	0	0	1549	1549	0	0	84	1511	0	824	2419	3968
Grand Total	0	0	0	3717	3717	0	0	210	4339	0	2162	6711	10428
Apprch %	0	0	0	100				3.1	64.7	0	32.2		
Total %	0	0	0	35.6	35.6	0	0	2	41.6	0	20.7	64.4	

	Duke's Lane Southbound				Westbound	Northbound	Kalakaua Avenue Eastbound				
Start Time	Left	Thru	Right	App. Total	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1											
Peak Hour for Entire Intersection Begins at 04:45 PM											
04:45 PM	0	0	0	0	0	0	16	385	0	401	401
05:00 PM	0	0	0	0	0	0	15	388	0	403	403
05:15 PM	0	0	0	0	0	0	9	384	0	393	393
05:30 PM	0	0	0	0	0	0	**21**	**400**	0	**421**	**421**
Total Volume	0	0	0	0	0	0	61	1557	0	1618	1618
% App. Total	0	0	0				3.8	96.2	0		
PHF	.000	.000	.000	.000	.000	.000	.726	.973	.000	.961	.961

Wilson Okamoto Corporation

1907 S. Beretania Street, Suite 400
Honolulu, Hawaii

Counter:TU-0649
Counted By:PA
Weather:Clear

File Name : KalImp PM
Site Code : 00000000
Start Date : 8/30/2011
Page No : 1

Groups Printed- Unshifted

	Southbound	Westbound	Northbound	Kalakaua Avenue Eastbound					
Start Time	App. Total	App. Total	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	0	0	0	0	292	0	231	523	523
03:15 PM	0	0	0	0	374	0	176	550	550
03:30 PM	0	0	0	0	391	0	244	635	635
03:45 PM	0	0	0	0	352	0	195	547	547
Total	0	0	0	0	1409	0	846	2255	2255
04:00 PM	0	0	0	0	340	0	255	595	595
04:15 PM	0	0	0	0	403	0	201	604	604
04:30 PM	0	0	0	0	357	0	216	573	573
04:45 PM	0	0	0	0	365	0	244	609	609
Total	0	0	0	0	1465	0	916	2381	2381
05:00 PM	0	0	0	0	400	0	170	570	570
05:15 PM	0	0	0	0	439	0	245	684	684
05:30 PM	0	0	0	0	372	0	207	579	579
05:45 PM	0	0	0	0	370	0	198	568	568
Total	0	0	0	0	1581	0	820	2401	2401
Grand Total	0	0	0	0	4455	0	2582	7037	7037
Apprch %				0	63.3	0	36.7		
Total %	0	0	0	0	63.3	0	36.7	100	

	Southbound	Westbound	Northbound	Kalakaua Avenue Eastbound				
Start Time	App. Total	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1								
Peak Hour for Entire Intersection Begins at 05:00 PM								
05:00 PM	0	0	0	0	400	0	400	400
05:15 PM	0	0	0	0	**439**	0	**439**	**439**
05:30 PM	0	0	0	0	372	0	372	372
05:45 PM	0	0	0	0	370	0	370	370
Total Volume	0	0	0	0	1581	0	1581	1581
% App. Total				0	100	0		
PHF	.000	.000	.000	.000	.900	.000	.900	.900

Wilson Okamoto Corporation
1907 S. Beretania Street, Suite 400
Honolulu, Hawaii

Counter:D4-5673, TU-0651, TU-0652
Counted By:GC, EV,JY
Weather:Clear

File Name : KalKai PM
Site Code : 00000004
Start Date : 8/30/2011
Page No : 1

Groups Printed- Unshifted

	Kaiulani Avenue Southbound					Kalakaua Avenue (Numbers In Peds Column Indicates NB Ped Traffic From Moana Hotel Sidewalk To Hyatt Hotel Corner) Westbound					Moana Hotel Sidewalk Northbound					Kalakaua Avenue (Numbers In Peds Column Indicates NB Ped Traffic From Moana Hotel Sidewalk To Princess Kaiulani Corner) Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	0	0	0	214	214	0	0	0	24	24	0	0	0	275	275	75	166	0	64	305	818
03:15 PM	0	0	0	197	197	0	0	0	32	32	0	0	0	289	289	83	236	0	79	398	916
03:30 PM	0	0	0	156	156	0	0	0	75	75	0	0	0	333	333	115	319	0	88	522	1086
03:45 PM	0	0	0	177	177	0	0	0	66	66	0	0	0	329	329	94	271	0	80	445	1017
Total	0	0	0	744	744	0	0	0	197	197	0	0	0	1226	1226	367	992	0	311	1670	3837
04:00 PM	0	0	0	188	188	0	0	0	75	75	0	0	0	362	362	84	281	0	112	477	1102
04:15 PM	0	0	0	205	205	0	0	0	37	37	0	0	0	306	306	102	287	0	86	475	1023
04:30 PM	0	0	0	166	166	0	0	0	35	35	0	0	0	309	309	86	247	0	87	420	930
04:45 PM	0	0	0	224	224	0	0	0	49	49	0	0	0	372	372	79	286	0	88	453	1098
Total	0	0	0	783	783	0	0	0	196	196	0	0	0	1349	1349	351	1101	0	373	1825	4153
05:00 PM	0	0	0	207	207	0	0	0	66	66	0	0	0	332	332	80	308	0	97	485	1090
05:15 PM	0	0	0	224	224	0	0	0	89	89	0	0	0	371	371	74	304	0	88	466	1150
05:30 PM	0	0	0	206	206	0	0	0	81	81	0	0	0	352	352	86	295	0	75	456	1095
05:45 PM	0	0	0	275	275	0	0	0	80	80	0	0	0	411	411	84	265	0	84	433	1199
Total	0	0	0	912	912	0	0	0	316	316	0	0	0	1466	1466	324	1172	0	344	1840	4534
Grand Total	0	0	0	2439	2439	0	0	0	709	709	0	0	0	4041	4041	1042	3265	0	1028	5335	12524
Apprch %	0	0	0	100		0	0	0	100		0	0	0	100		19.5	61.2	0	19.3		
Total %	0	0	0	19.5	19.5	0	0	0	5.7	5.7	0	0	0	32.3	32.3	8.3	26.1	0	8.2	42.6	

	Kaiulani Avenue Southbound				Kalakaua Avenue (Numbers In Peds Column Indicates NB Ped Traffic From Moana Hotel Sidewalk To Hyatt Hotel Corner) Westbound				Moana Hotel Sidewalk Northbound				Kalakaua Avenue (Numbers In Peds Column Indicates NB Ped Traffic From Moana Hotel Sidewalk To Princess Kaiulani Corner) Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 03:30 PM																	
03:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	**115**	**319**	0	**434**	**434**
03:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	94	271	0	365	365
04:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	84	281	0	365	365
04:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	102	287	0	389	389
Total Volume	0	0	0	0	0	0	0	0	0	0	0	0	395	1158	0	1553	1553
% App. Total	0	0	0		0	0	0		0	0	0		25.4	74.6	0		
PHF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.859	.908	.000	.895	.895

Wilson Okamoto Corporation

1907 S. Beretania Street, Suite 400
Honolulu, HI 96826

Counter:D4-3889, D4-5677
Counted By: SF, RJ
Weather: Clear

File Name : KuhSea PM
Site Code : 00000001
Start Date : 8/31/2011
Page No : 1

Groups Printed- Unshifted

	Seaside Avenue Southbound					Kuhio Avenue Westbound					Seaside Avenue Northbound					Kuhio Avenue Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
03:00 PM	0	0	0	76	76	11	89	0	69	169	16	56	10	125	207	0	160	14	63	237	689
03:15 PM	0	0	0	80	80	13	72	0	56	141	26	60	8	153	247	0	184	11	65	260	728
03:30 PM	0	0	0	73	73	14	81	0	71	166	27	45	12	119	203	0	142	22	47	211	653
03:45 PM	0	0	0	98	98	22	85	0	70	177	15	52	9	130	206	0	141	25	69	235	716
Total	0	0	0	327	327	60	327	0	266	653	84	213	39	527	863	0	627	72	244	943	2786
04:00 PM	0	0	0	97	97	8	96	0	87	191	14	65	14	136	229	0	166	30	57	253	770
04:15 PM	0	0	0	111	111	19	73	0	79	171	24	66	9	161	260	0	156	16	71	243	785
04:30 PM	0	0	0	82	82	13	99	0	88	200	26	63	9	122	220	0	125	27	47	199	701
04:45 PM	0	0	0	135	135	10	81	0	85	176	17	52	13	98	180	0	138	15	76	229	720
Total	0	0	0	425	425	50	349	0	339	738	81	246	45	517	889	0	585	88	251	924	2976
05:00 PM	0	0	0	102	102	14	75	0	79	168	34	73	10	157	274	0	146	22	60	228	772
05:15 PM	0	0	0	86	86	11	96	0	89	196	29	72	7	134	242	0	166	17	42	225	749
05:30 PM	0	0	0	123	123	8	84	0	74	166	29	60	9	179	277	0	130	13	71	214	780
05:45 PM	0	0	0	137	137	13	90	0	93	196	21	57	8	156	242	0	139	14	57	210	785
Total	0	0	0	448	448	46	345	0	335	726	113	262	34	626	1035	0	581	66	230	877	3086
Grand Total	0	0	0	1200	1200	156	1021	0	940	2117	278	721	118	1670	2787	0	1793	226	725	2744	8848
Apprch %	0	0	0	100		7.4	48.2	0	44.4		10	25.9	4.2	59.9		0	65.3	8.2	26.4		
Total %	0	0	0	13.6	13.6	1.8	11.5	0	10.6	23.9	3.1	8.1	1.3	18.9	31.5	0	20.3	2.6	8.2	31	

	Seaside Avenue Southbound				Kuhio Avenue Westbound				Seaside Avenue Northbound				Kuhio Avenue Eastbound				
Start Time	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 03:45 PM																	
03:45 PM	0	0	0	0	**22**	85	0	107	15	52	9	76	0	141	25	166	349
04:00 PM	0	0	0	0	8	96	0	104	14	65	**14**	93	0	**166**	**30**	**196**	**393**
04:15 PM	0	0	0	0	19	73	0	92	24	**66**	9	**99**	0	156	16	172	363
04:30 PM	0	0	0	0	13	**99**	0	**112**	**26**	63	9	98	0	125	27	152	362
Total Volume	0	0	0	0	62	353	0	415	79	246	41	366	0	588	98	686	1467
% App. Total	0	0	0		14.9	85.1	0		21.6	67.2	11.2		0	85.7	14.3		
PHF	.000	.000	.000	.000	.705	.891	.000	.926	.760	.932	.732	.924	.000	.886	.817	.875	.933

Wilson Okamoto Corporation

1907 S. Beretania Street, Suite 400
Honolulu, HI 96826

Counter:D4-5672, D4-5676
Counted By:JY, RF
Weather: Clear

File Name : KuhNoh PM
Site Code : 00000000
Start Date : 8/31/2011
Page No : 1

Groups Printed- Unshifted

	Nohonani St. Southbound					Kuhio Avenue Westbound					Duke's Lane Northbound					Kuhio Avenue Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
03:00 PM	10	0	17	76	103	5	99	0	66	170	2	8	1	242	253	0	172	0	68	240	766
03:15 PM	9	0	18	91	118	5	78	0	57	140	6	6	1	155	168	0	195	2	76	273	699
03:30 PM	9	0	22	98	129	5	92	0	70	167	8	9	1	206	224	0	169	0	75	244	764
03:45 PM	17	0	16	100	133	7	83	0	71	161	3	5	7	221	236	0	149	0	70	219	749
Total	45	0	73	365	483	22	352	0	264	638	19	28	10	824	881	0	685	2	289	976	2978
04:00 PM	13	0	18	94	125	7	94	0	58	159	4	15	3	196	218	0	172	1	65	238	740
04:15 PM	18	0	22	101	141	7	72	0	78	157	4	2	8	242	256	0	175	0	80	255	809
04:30 PM	26	0	12	87	125	6	89	0	62	157	2	7	5	182	196	0	152	0	60	212	690
04:45 PM	16	0	14	148	178	3	70	0	93	166	5	4	2	190	201	0	151	0	65	216	761
Total	73	0	66	430	569	23	325	0	291	639	15	28	18	810	871	0	650	1	270	921	3000
05:00 PM	12	0	17	121	150	10	73	0	67	150	6	4	3	243	256	0	182	0	90	272	828
05:15 PM	13	0	23	111	147	7	91	0	85	183	3	7	3	266	279	0	201	0	104	305	914
05:30 PM	9	0	16	194	219	4	77	0	62	143	7	5	5	223	240	0	159	0	89	248	850
05:45 PM	8	0	20	139	167	9	86	0	61	156	5	2	4	228	239	0	152	0	87	239	801
Total	42	0	76	565	683	30	327	0	275	632	21	18	15	960	1014	0	694	0	370	1064	3393
Grand Total	160	0	215	1360	1735	75	1004	0	830	1909	55	74	43	2594	2766	0	2029	3	929	2961	9371
Apprch %	9.2	0	12.4	78.4		3.9	52.6	0	43.5		2	2.7	1.6	93.8		0	68.5	0.1	31.4		
Total %	1.7	0	2.3	14.5	18.5	0.8	10.7	0	8.9	20.4	0.6	0.8	0.5	27.7	29.5	0	21.7	0	9.9	31.6	

	Nohonani St. Southbound				Kuhio Avenue Westbound				Duke's Lane Northbound				Kuhio Avenue Eastbound				
Start Time	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 03:15 PM																	
03:15 PM	9	0	**18**	27	5	78	0	83	6	6	1	13	0	**195**	**2**	**197**	320
03:30 PM	9	0	**22**	31	5	92	0	97	**8**	9	1	18	0	169	0	169	315
03:45 PM	**17**	0	16	**33**	**7**	83	0	90	3	5	**7**	15	0	149	0	149	287
04:00 PM	13	0	18	31	7	**94**	0	**101**	4	**15**	3	**22**	0	172	1	173	**327**
Total Volume	48	0	74	122	24	347	0	371	21	35	12	68	0	685	3	688	1249
% App. Total	39.3	0	60.7		6.5	93.5	0		30.9	51.5	17.6		0	99.6	0.4		
PHF	.706	.000	.841	.924	.857	.923	.000	.918	.656	.583	.429	.773	.000	.878	.375	.873	.955

Wilson Okamoto Corporation

1907 S. Beretania Street, Suite 400
Honolulu, HI 96826

Counter: T-1839, D4-5674
Counted By: JI, BJ
Weather: Clear

File Name : KuhNah PM
Site Code : 00000003
Start Date : 8/31/2011
Page No : 1

Groups Printed- Unshifted

	Southbound	Kuhio Avenue Westbound					Northbound	Kuhio Avenue Eastbound					
Start Time	App. Total	Right	Thru	Left	Peds	App. Total	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
03:00 PM	0	13	100	0	88	201	0	0	162	28	62	252	453
03:15 PM	0	16	77	0	70	163	0	0	172	33	53	258	421
03:30 PM	0	21	86	0	54	161	0	0	186	23	43	252	413
03:45 PM	0	22	91	0	61	174	0	0	132	30	57	219	393
Total	0	72	354	0	273	699	0	0	652	114	215	981	1680
04:00 PM	0	18	94	0	73	185	0	0	150	34	44	228	413
04:15 PM	0	19	84	0	84	187	0	0	160	36	45	241	428
04:30 PM	0	10	93	0	48	151	0	0	121	27	59	207	358
04:45 PM	0	16	81	0	83	180	0	0	150	33	68	251	431
Total	0	63	352	0	288	703	0	0	581	130	216	927	1630
05:00 PM	0	8	82	0	76	166	0	0	165	36	47	248	414
05:15 PM	0	7	88	0	85	180	0	0	176	36	52	264	444
05:30 PM	0	17	79	0	83	179	0	0	163	26	64	253	432
05:45 PM	0	20	105	0	92	217	0	0	136	40	56	232	449
Total	0	52	354	0	336	742	0	0	640	138	219	997	1739
Grand Total	0	187	1060	0	897	2144	0	0	1873	382	650	2905	5049
Apprch %		8.7	49.4	0	41.8			0	64.5	13.1	22.4		
Total %	0	3.7	21	0	17.8	42.5	0	0	37.1	7.6	12.9	57.5	

	Southbound	Kuhio Avenue Westbound				Northbound	Kuhio Avenue Eastbound				
Start Time	App. Total	Right	Thru	Left	App. Total	App. Total	Right	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1											
Peak Hour for Entire Intersection Begins at 03:00 PM											
03:00 PM	0	13	**100**	0	**113**	0	0	162	28	190	303
03:15 PM	0	16	77	0	93	0	0	172	**33**	205	298
03:30 PM	0	21	86	0	107	0	0	**186**	23	**209**	**316**
03:45 PM	0	**22**	91	0	113	0	0	132	30	162	275
Total Volume	0	72	354	0	426	0	0	652	114	766	1192
% App. Total		16.9	83.1	0			0	85.1	14.9		
PHF	.000	.818	.885	.000	.942	.000	.000	.876	.864	.916	.943

Wilson Okamoto Corporation

1907 S. Beretania Street, Suite 400
Honolulu, HI 96826

Counter: D4-5675, D4-3888
Counted By: PA, CY
Weather: Clear

File Name : KuhWal PM
Site Code : 00000004
Start Date : 8/31/2011
Page No : 1

Groups Printed- Unshifted

	Walina Street Southbound					Kuhio Avenue Westbound					Walina Street Northbound					Kuhio Avenue Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
03:00 PM	16	3	7	152	178	0	100	4	47	151	0	0	0	145	145	8	148	0	42	198	672
03:15 PM	17	2	9	144	172	0	78	1	44	123	0	0	0	112	112	6	173	0	34	213	620
03:30 PM	17	4	8	112	141	0	91	1	58	150	0	0	0	123	123	11	181	0	39	231	645
03:45 PM	16	3	5	121	145	0	89	0	56	145	0	0	0	123	123	9	127	0	38	174	587
Total	66	12	29	529	636	0	358	6	205	569	0	0	0	503	503	34	629	0	153	816	2524
04:00 PM	16	3	10	64	93	0	85	0	79	164	0	0	0	86	86	11	155	0	49	215	558
04:15 PM	19	3	12	123	157	0	87	0	73	160	0	0	0	151	151	2	169	0	57	228	696
04:30 PM	16	4	11	138	169	0	69	0	52	121	0	0	0	148	148	3	131	0	64	198	636
04:45 PM	9	3	6	183	201	0	71	6	28	105	0	0	0	157	157	4	142	0	60	206	669
Total	60	13	39	508	620	0	312	6	232	550	0	0	0	542	542	20	597	0	230	847	2559
05:00 PM	11	2	12	143	168	0	67	0	59	126	0	0	0	185	185	3	152	0	49	204	683
05:15 PM	14	2	12	141	169	0	78	0	64	142	0	0	0	146	146	5	185	0	49	239	696
05:30 PM	15	1	14	211	241	0	72	3	61	136	0	0	0	140	140	4	161	0	49	214	731
05:45 PM	12	3	12	152	179	0	82	1	60	143	0	0	0	92	92	3	127	0	40	170	584
Total	52	8	50	647	757	0	299	4	244	547	0	0	0	563	563	15	625	0	187	827	2694
Grand Total	178	33	118	1684	2013	0	969	16	681	1666	0	0	0	1608	1608	69	1851	0	570	2490	7777
Apprch %	8.8	1.6	5.9	83.7		0	58.2	1	40.9		0	0	0	100		2.8	74.3	0	22.9		
Total %	2.3	0.4	1.5	21.7	25.9	0	12.5	0.2	8.8	21.4	0	0	0	20.7	20.7	0.9	23.8	0	7.3	32	

	Walina Street Southbound				Kuhio Avenue Westbound				Walina Street Northbound				Kuhio Avenue Eastbound				
Start Time	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 03:00 PM																	
03:00 PM	16	3	7	26	0	**100**	**4**	**104**	0	0	0	0	8	148	0	156	286
03:15 PM	**17**	2	**9**	28	0	78	1	79	0	0	0	0	6	173	0	179	286
03:30 PM	17	**4**	8	**29**	0	91	1	92	0	0	0	0	**11**	**181**	0	**192**	**313**
03:45 PM	16	3	5	24	0	89	0	89	0	0	0	0	9	127	0	136	249
Total Volume	66	12	29	107	0	358	6	364	0	0	0	0	34	629	0	663	1134
% App. Total	61.7	11.2	27.1		0	98.4	1.6		0	0	0		5.1	94.9	0		
PHF	.971	.750	.806	.922	.000	.895	.375	.875	.000	.000	.000	.000	.773	.869	.000	.863	.906

Wilson Okamoto Corporation

1907 S. Beretania Street, Suite 400
Honolulu, HI 96826

Counter: D4-5673, D4-5671
Counted By: DY, GC
Weather: Clear

File Name : KuhKan PM
Site Code : 00000005
Start Date : 8/31/2011
Page No : 1

Groups Printed- Unshifted

	Kanekapolei St. Southbound					Kuhio Avenue Westbound					Kanekapolei St. Northbound					Kuhio Avenue Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
03:00 PM	9	16	15	85	125	1	72	3	30	106	0	56	19	56	131	23	109	22	68	222	584
03:15 PM	5	22	17	90	134	0	55	6	45	106	0	54	17	71	142	21	139	21	101	282	664
03:30 PM	4	14	19	53	90	8	75	7	39	129	1	77	16	89	183	21	123	34	46	224	626
03:45 PM	6	22	16	56	100	4	67	6	45	122	0	72	24	93	189	13	107	24	53	197	608
Total	24	74	67	284	449	13	269	22	159	463	1	259	76	309	645	78	478	101	268	925	2482
04:00 PM	8	21	15	73	117	1	62	3	43	109	1	64	19	98	182	11	156	30	98	295	703
04:15 PM	6	22	18	69	115	4	74	5	52	135	0	52	23	109	184	16	183	33	102	334	768
04:30 PM	7	17	22	40	86	4	62	5	35	106	0	34	20	110	164	19	143	14	79	255	611
04:45 PM	5	12	17	36	70	2	61	6	30	99	0	35	22	98	155	9	166	26	84	285	609
Total	26	72	72	218	388	11	259	19	160	449	1	185	84	415	685	55	648	103	363	1169	2691
05:00 PM	4	17	20	68	109	5	57	3	26	91	1	66	19	86	172	9	165	36	103	313	685
05:15 PM	9	13	24	84	130	2	60	4	29	95	0	42	20	81	143	15	213	34	142	404	772
05:30 PM	1	13	20	115	149	4	58	3	25	90	3	34	20	92	149	17	154	22	77	270	658
05:45 PM	12	9	33	103	157	3	59	6	20	88	1	40	19	75	135	8	166	20	102	296	676
Total	26	52	97	370	545	14	234	16	100	364	5	182	78	334	599	49	698	112	424	1283	2791
Grand Total	76	198	236	872	1382	38	762	57	419	1276	7	626	238	1058	1929	182	1824	316	1055	3377	7964
Apprch %	5.5	14.3	17.1	63.1		3	59.7	4.5	32.8		0.4	32.5	12.3	54.8		5.4	54	9.4	31.2		
Total %	1	2.5	3	10.9	17.4	0.5	9.6	0.7	5.3	16	0.1	7.9	3	13.3	24.2	2.3	22.9	4	13.2	42.4	

	Kanekapolei St. Southbound				Kuhio Avenue Westbound				Kanekapolei St. Northbound				Kuhio Avenue Eastbound				
Start Time	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 03:30 PM																	
03:30 PM	4	14	**19**	37	**8**	**75**	**7**	**90**	**1**	**77**	16	94	**21**	123	**34**	178	399
03:45 PM	6	**22**	16	44	4	67	6	77	0	72	**24**	**96**	13	107	24	144	361
04:00 PM	**8**	21	15	44	1	62	3	66	1	64	19	84	11	156	30	197	391
04:15 PM	6	22	18	**46**	4	74	5	83	0	52	23	75	16	**183**	33	**232**	**436**
Total Volume	24	79	68	171	17	278	21	316	2	265	82	349	61	569	121	751	1587
% App. Total	14	46.2	39.8		5.4	88	6.6		0.6	75.9	23.5		8.1	75.8	16.1		
PHF	.750	.898	.895	.929	.531	.927	.750	.878	.500	.860	.854	.909	.726	.777	.890	.809	.910

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Counter: TU-0651, TU-0649
Counted By: JI, RJ
Weather: Clear

File Name : AlaSea PM
Site Code : 00000001
Start Date : 9/1/2011
Page No : 1

Groups Printed- Unshifted

	Southbound	Ala Wai Boulevard Westbound					Seaside Avenue Northbound					Eastbound	
Start Time	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	App. Total	Int. Total
03:00 PM	0	0	410	35	14	459	0	0	75	12	87	0	546
03:15 PM	0	0	379	59	18	456	0	0	83	7	90	0	546
03:30 PM	0	0	404	54	11	469	0	0	63	3	66	0	535
03:45 PM	0	0	396	55	21	472	0	0	70	9	79	0	551
Total	0	0	1589	203	64	1856	0	0	291	31	322	0	2178
04:00 PM	0	0	450	48	8	506	0	0	102	11	113	0	619
04:15 PM	0	0	389	52	16	457	0	0	114	15	129	0	586
04:30 PM	0	1	440	47	9	497	0	0	101	25	126	0	623
04:45 PM	0	0	400	54	17	471	0	0	82	26	108	0	579
Total	0	1	1679	201	50	1931	0	0	399	77	476	0	2407
05:00 PM	0	0	366	39	10	415	0	0	98	15	113	0	528
05:15 PM	0	0	418	44	28	490	0	0	98	19	117	0	607
05:30 PM	0	0	345	42	19	406	0	0	94	33	127	0	533
05:45 PM	0	0	362	39	13	414	0	0	66	7	73	0	487
Total	0	0	1491	164	70	1725	0	0	356	74	430	0	2155
Grand Total	0	1	4759	568	184	5512	0	0	1046	182	1228	0	6740
Apprch %		0	86.3	10.3	3.3		0	0	85.2	14.8			
Total %	0	0	70.6	8.4	2.7	81.8	0	0	15.5	2.7	18.2	0	

	Southbound	Ala Wai Boulevard Westbound				Seaside Avenue Northbound				Eastbound	
Start Time	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1											
Peak Hour for Entire Intersection Begins at 04:00 PM											
04:00 PM	0	0	**450**	48	**498**	0	0	102	102	0	**600**
04:15 PM	0	0	389	52	441	0	0	**114**	**114**	0	555
04:30 PM	0	**1**	440	47	488	0	0	101	101	0	589
04:45 PM	0	0	400	**54**	454	0	0	82	82	0	536
Total Volume	0	1	1679	201	1881	0	0	399	399	0	2280
% App. Total		0.1	89.3	10.7		0	0	100			
PHF	.000	.250	.933	.931	.944	.000	.000	.875	.875	.000	.950

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1907 S. Beretania Street, Suite 400
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Counter: D4-3890
Counted By: GC
Weather: Clear

File Name : AlaNoh PM
Site Code : 00000002
Start Date : 9/1/2011
Page No : 1

Groups Printed- Unshifted

	Southbound	Ala Wai Boulevard Westbound					Nohonani Street Northbound					Eastbound	
Start Time	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	App. Total	Int. Total
03:00 PM	0	0	428	39	0	467	0	0	17	16	33	0	500
03:15 PM	0	0	442	32	0	474	0	0	14	12	26	0	500
03:30 PM	0	0	427	35	0	462	0	0	19	8	27	0	489
03:45 PM	0	0	441	30	0	471	0	0	9	15	24	0	495
Total	0	0	1738	136	0	1874	0	0	59	51	110	0	1984
04:00 PM	0	0	488	40	0	528	0	0	16	7	23	0	551
04:15 PM	0	0	443	24	0	467	0	0	26	27	53	0	520
04:30 PM	0	0	464	42	0	506	0	0	14	22	36	0	542
04:45 PM	0	0	449	51	0	500	0	0	12	21	33	0	533
Total	0	0	1844	157	0	2001	0	0	68	77	145	0	2146
05:00 PM	0	0	394	40	0	434	0	0	21	18	39	0	473
05:15 PM	0	0	445	35	0	480	0	0	17	24	41	0	521
05:30 PM	0	0	376	39	0	415	0	0	12	22	34	0	449
05:45 PM	0	0	390	34	0	424	0	0	13	16	29	0	453
Total	0	0	1605	148	0	1753	0	0	63	80	143	0	1896
Grand Total	0	0	5187	441	0	5628	0	0	190	208	398	0	6026
Apprch %		0	92.2	7.8	0		0	0	47.7	52.3			
Total %	0	0	86.1	7.3	0	93.4	0	0	3.2	3.5	6.6	0	

	Southbound	Ala Wai Boulevard Westbound				Nohonani Street Northbound				Eastbound	
Start Time	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1											
Peak Hour for Entire Intersection Begins at 04:00 PM											
04:00 PM	0	0	**488**	40	**528**	0	0	16	16	0	**544**
04:15 PM	0	0	443	24	467	0	0	**26**	**26**	0	493
04:30 PM	0	0	464	42	506	0	0	14	14	0	520
04:45 PM	0	0	449	**51**	500	0	0	12	12	0	512
Total Volume	0	0	1844	157	2001	0	0	68	68	0	2069
% App. Total		0	92.2	7.8		0	0	100			
PHF	.000	.000	.945	.770	.947	.000	.000	.654	.654	.000	.951

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1907 S. Beretania Street, Suite 400
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Counter: TU-0654
Counted By: CY
Weather: Clear

File Name : AlaNah PM
Site Code : 00000003
Start Date : 9/1/2011
Page No : 1

Groups Printed- Unshifted

	Southbound	Ala Wai Boulevard Westbound					Nahua Street Northbound					Eastbound	
Start Time	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	App. Total	Int. Total
03:00 PM	0	0	431	0	0	431	0	0	50	19	69	0	500
03:15 PM	0	0	425	0	0	425	0	0	50	15	65	0	490
03:30 PM	0	0	441	0	0	441	0	0	48	5	53	0	494
03:45 PM	0	0	449	0	0	449	0	0	43	25	68	0	517
Total	0	0	1746	0	0	1746	0	0	191	64	255	0	2001
04:00 PM	0	0	475	0	0	475	0	0	69	9	78	0	553
04:15 PM	0	0	431	0	0	431	0	0	43	17	60	0	491
04:30 PM	0	0	440	0	0	440	0	0	45	25	70	0	510
04:45 PM	0	0	429	0	0	429	0	0	51	17	68	0	497
Total	0	0	1775	0	0	1775	0	0	208	68	276	0	2051
05:00 PM	0	0	384	0	0	384	0	0	58	15	73	0	457
05:15 PM	0	0	424	0	0	424	0	0	54	22	76	0	500
05:30 PM	0	0	378	0	0	378	0	0	45	26	71	0	449
05:45 PM	0	0	385	0	0	385	0	0	45	22	67	0	452
Total	0	0	1571	0	0	1571	0	0	202	85	287	0	1858
Grand Total	0	0	5092	0	0	5092	0	0	601	217	818	0	5910
Apprch %		0	100	0	0		0	0	73.5	26.5			
Total %	0	0	86.2	0	0	86.2	0	0	10.2	3.7	13.8	0	

	Southbound	Ala Wai Boulevard Westbound				Nahua Street Northbound				Eastbound	
Start Time	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1											
Peak Hour for Entire Intersection Begins at 03:15 PM											
03:15 PM	0	0	425	0	425	0	0	50	50	0	475
03:30 PM	0	0	441	0	441	0	0	48	48	0	489
03:45 PM	0	0	449	0	449	0	0	43	43	0	492
04:00 PM	0	0	**475**	0	**475**	0	0	**69**	**69**	0	**544**
Total Volume	0	0	1790	0	1790	0	0	210	210	0	2000
% App. Total		0	100	0		0	0	100			
PHF	.000	.000	.942	.000	.942	.000	.000	.761	.761	.000	.919

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1907 S. Beretania Street, Suite 400
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Counter: TU-0652
Counted By: RF
Weather: Clear

File Name : AlaWal PM
Site Code : 00000004
Start Date : 9/1/2011
Page No : 1

Groups Printed- Unshifted

	Southbound	Ala Wai Boulevard Westbound					Walina Street Northbound					Eastbound	
Start Time	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	App. Total	Int. Total
03:00 PM	0	0	445	25	0	470	0	0	0	9	9	0	479
03:15 PM	0	0	428	33	0	461	0	0	0	15	15	0	476
03:30 PM	0	0	428	30	0	458	0	0	0	13	13	0	471
03:45 PM	0	0	438	28	0	466	0	0	0	14	14	0	480
Total	0	0	1739	116	0	1855	0	0	0	51	51	0	1906
04:00 PM	0	0	482	45	0	527	0	0	0	15	15	0	542
04:15 PM	0	0	430	28	0	458	0	0	0	17	17	0	475
04:30 PM	0	0	464	28	0	492	0	0	0	17	17	0	509
04:45 PM	0	0	445	37	0	482	0	0	0	25	25	0	507
Total	0	0	1821	138	0	1959	0	0	0	74	74	0	2033
05:00 PM	0	0	381	36	0	417	0	0	0	17	17	0	434
05:15 PM	0	0	425	34	0	459	0	0	0	20	20	0	479
05:30 PM	0	0	370	41	0	411	0	0	0	22	22	0	433
05:45 PM	0	0	382	27	0	409	0	0	0	20	20	0	429
Total	0	0	1558	138	0	1696	0	0	0	79	79	0	1775
Grand Total	0	0	5118	392	0	5510	0	0	0	204	204	0	5714
Apprch %		0	92.9	7.1	0		0	0	0	100			
Total %	0	0	89.6	6.9	0	96.4	0	0	0	3.6	3.6	0	

	Southbound	Ala Wai Boulevard Westbound				Walina Street Northbound				Eastbound	
Start Time	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1											
Peak Hour for Entire Intersection Begins at 04:00 PM											
04:00 PM	0	0	**482**	**45**	**527**	0	0	0	0	0	**527**
04:15 PM	0	0	430	28	458	0	0	0	0	0	458
04:30 PM	0	0	464	28	492	0	0	0	0	0	492
04:45 PM	0	0	445	37	482	0	0	0	0	0	482
Total Volume	0	0	1821	138	1959	0	0	0	0	0	1959
% App. Total		0	93	7		0	0	0			
PHF	.000	.000	.945	.767	.929	.000	.000	.000	.000	.000	.929

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1907 S. Beretania Street, Suite 400
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Counter: TU-0650, TU-0653
Counted By: PA, DY
Weather: Clear

File Name : AlaKan PM
Site Code : 00000005
Start Date : 9/1/2011
Page No : 1

Groups Printed- Unshifted

	Southbound	Ala Wai Boulevard Westbound					Kanekapolei St. Northbound					Eastbound	
Start Time	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	App. Total	Int. Total
03:00 PM	0	0	374	39	12	425	0	0	98	16	114	0	539
03:15 PM	0	0	389	33	6	428	0	0	85	15	100	0	528
03:30 PM	0	0	386	30	10	426	0	0	95	18	113	0	539
03:45 PM	0	0	412	57	7	476	0	0	68	17	85	0	561
Total	0	0	1561	159	35	1755	0	0	346	66	412	0	2167
04:00 PM	0	0	437	36	10	483	0	0	98	16	114	0	597
04:15 PM	0	0	387	44	9	440	0	0	102	17	119	0	559
04:30 PM	0	0	430	41	4	475	0	0	70	15	85	0	560
04:45 PM	0	0	406	47	13	466	0	0	76	25	101	0	567
Total	0	0	1660	168	36	1864	0	0	346	73	419	0	2283
05:00 PM	0	0	337	49	10	396	0	0	88	21	109	0	505
05:15 PM	0	0	392	63	20	475	0	0	87	28	115	0	590
05:30 PM	0	0	340	74	14	428	0	0	97	22	119	0	547
05:45 PM	0	0	338	50	20	408	0	0	82	26	108	0	516
Total	0	0	1407	236	64	1707	0	0	354	97	451	0	2158
Grand Total	0	0	4628	563	135	5326	0	0	1046	236	1282	0	6608
Apprch %		0	86.9	10.6	2.5		0	0	81.6	18.4			
Total %	0	0	70	8.5	2	80.6	0	0	15.8	3.6	19.4	0	

	Southbound	Ala Wai Boulevard Westbound				Kanekapolei St. Northbound				Eastbound	
Start Time	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1											
Peak Hour for Entire Intersection Begins at 03:45 PM											
03:45 PM	0	0	412	**57**	469	0	0	68	68	0	537
04:00 PM	0	0	**437**	36	**473**	0	0	98	98	0	**571**
04:15 PM	0	0	387	44	431	0	0	**102**	**102**	0	533
04:30 PM	0	0	430	41	471	0	0	70	70	0	541
Total Volume	0	0	1666	178	1844	0	0	338	338	0	2182
% App. Total		0	90.3	9.7		0	0	100			
PHF	.000	.000	.953	.781	.975	.000	.000	.828	.828	.000	.955

APPENDIX B

LEVEL OF SERVICE DEFINITIONS

LEVEL OF SERVICE DEFINITIONS

LEVEL-OF-SERVICE CRITERIA FOR SIGNALIZED INTERSECTIONS

Level of Service (LOS) for signalized intersections is defined in terms of delay, which is a measure of driver discomfort, frustration, fuel consumption, and increased travel time. Specifically, level-of-service (LOS) criteria are stated in terms of the average control delay per vehicle, typically a 15-min analysis period. The criteria are given in the following table.

Table 1: Level-of-Service Criteria for Signalized Intersections

Level of Service	Control Delay per Vehicle (sec/veh)
A	≤10.0
B	>10.0 and ≤20.0
C	>20.0 and ≤35.0
D	>35.0 and ≤55.0
E	>55.0 and ≤80.0
F	>80.0

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 describes operations with low control delay, up to 10 sec per vehicle. This level of service 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 describes operations with control delay greater than 10 and up to 20 sec per vehicle. 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 describes operations with control delay greater than 20 and up to 35 sec per vehicle. 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 describes operations with control delay greater than 35 and up to 55 sec per vehicle. At level of service D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high v/c ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

"Highway Capacity Manual," Transportation Research Board, 2000.

Level of Service E describes operation with control delay greater than 55 and up to 80 sec per vehicle. 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 describes operations with control delay in excess of 80 sec per vehicle. This level, considered to be unacceptable to most drivers, often occurs with oversaturation, that is, when arrival flow rates exceed the capacity 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.

"Highway Capacity Manual," Transportation Research Board, 2000.

APPENDIX C

CAPACITY ANALYSIS CALCULATIONS
EXISTING PEAK HOUR TRAFFIC ANALYSIS

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations						
Volume (vph)	209	1407	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0				
Lane Util. Factor	0.81	0.81				
Frt	1.00	1.00				
Flt Protected	0.95	1.00				
Satd. Flow (prot)	1433	6031				
Flt Permitted	0.95	1.00				
Satd. Flow (perm)	1433	6031				
Peak-hour factor, PHF	0.94	0.94	0.92	0.92	0.92	0.92
Adj. Flow (vph)	222	1497	0	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	200	1519	0	0	0	0
Turn Type	Perm					
Protected Phases		4				
Permitted Phases	4					
Actuated Green, G (s)	55.0	55.0				
Effective Green, g (s)	55.0	55.0				
Actuated g/C Ratio	0.61	0.61				
Clearance Time (s)	5.0	5.0				
Lane Grp Cap (vph)	876	3686				
v/s Ratio Prot						
v/s Ratio Perm	0.14	0.25				
v/c Ratio	0.23	0.41				
Uniform Delay, d1	7.9	9.1				
Progression Factor	1.00	1.00				
Incremental Delay, d2	0.6	0.3				
Delay (s)	8.5	9.4				
Level of Service	A	A				
Approach Delay (s)		9.3	0.0		0.0	
Approach LOS		A	A		A	

Intersection Summary			
HCM Average Control Delay	9.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	35.0
Intersection Capacity Utilization	24.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations						
Volume (vph)	247	1474	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0				
Lane Util. Factor	0.81	0.81				
Frt	1.00	1.00				
Flt Protected	0.95	1.00				
Satd. Flow (prot)	1433	6030				
Flt Permitted	0.95	1.00				
Satd. Flow (perm)	1433	6030				
Peak-hour factor, PHF	0.94	0.94	0.92	0.92	0.92	0.92
Adj. Flow (vph)	263	1568	0	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	237	1594	0	0	0	0
Turn Type	Perm					
Protected Phases		4				
Permitted Phases	4					
Actuated Green, G (s)	45.0	45.0				
Effective Green, g (s)	45.0	45.0				
Actuated g/C Ratio	0.56	0.56				
Clearance Time (s)	5.0	5.0				
Lane Grp Cap (vph)	806	3392				
v/s Ratio Prot						
v/s Ratio Perm	0.17	0.26				
v/c Ratio	0.29	0.47				
Uniform Delay, d1	9.2	10.4				
Progression Factor	1.00	1.00				
Incremental Delay, d2	0.9	0.5				
Delay (s)	10.1	10.9				
Level of Service	B	B				
Approach Delay (s)		10.8	0.0		0.0	
Approach LOS		B	A		A	

Intersection Summary			
HCM Average Control Delay	10.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	35.0
Intersection Capacity Utilization	25.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations	↰	↑↑↑				
Volume (vph)	351	1101	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0				
Lane Util. Factor	1.00	0.91				
Frt	1.00	1.00				
Flt Protected	0.95	1.00				
Satd. Flow (prot)	1770	5085				
Flt Permitted	0.95	1.00				
Satd. Flow (perm)	1770	5085				
Peak-hour factor, PHF	0.93	0.93	0.92	0.92	0.92	0.92
Adj. Flow (vph)	377	1184	0	0	0	0
RTOR Reduction (vph)	168	0	0	0	0	0
Lane Group Flow (vph)	209	1184	0	0	0	0
Turn Type	Perm					
Protected Phases		6				
Permitted Phases	6					
Actuated Green, G (s)	50.0	50.0				
Effective Green, g (s)	50.0	50.0				
Actuated g/C Ratio	0.56	0.56				
Clearance Time (s)	5.0	5.0				
Lane Grp Cap (vph)	983	2825				
v/s Ratio Prot		c0.23				
v/s Ratio Perm	0.12					
v/c Ratio	0.21	0.42				
Uniform Delay, d1	10.1	11.6				
Progression Factor	1.11	0.96				
Incremental Delay, d2	0.5	0.4				
Delay (s)	11.7	11.6				
Level of Service	B	B				
Approach Delay (s)		11.6	0.0		0.0	
Approach LOS		B	A		A	

Intersection Summary			
HCM Average Control Delay	11.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	40.0
Intersection Capacity Utilization	25.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations	↰	↑↑↑				
Volume (vph)	337	1063	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0				
Lane Util. Factor	1.00	0.91				
Frt	1.00	1.00				
Flt Protected	0.95	1.00				
Satd. Flow (prot)	1770	5085				
Flt Permitted	0.95	1.00				
Satd. Flow (perm)	1770	5085				
Peak-hour factor, PHF	0.96	0.96	0.92	0.92	0.92	0.92
Adj. Flow (vph)	351	1107	0	0	0	0
RTOR Reduction (vph)	176	0	0	0	0	0
Lane Group Flow (vph)	176	1107	0	0	0	0
Turn Type	Perm					
Protected Phases		6				
Permitted Phases	6					
Actuated Green, G (s)	40.0	40.0				
Effective Green, g (s)	40.0	40.0				
Actuated g/C Ratio	0.50	0.50				
Clearance Time (s)	5.0	5.0				
Lane Grp Cap (vph)	885	2543				
v/s Ratio Prot		c0.22				
v/s Ratio Perm	0.10					
v/c Ratio	0.20	0.44				
Uniform Delay, d1	11.1	12.8				
Progression Factor	1.39	0.92				
Incremental Delay, d2	0.5	0.5				
Delay (s)	15.9	12.2				
Level of Service	B	B				
Approach Delay (s)		13.1	0.0		0.0	
Approach LOS		B	A		A	

Intersection Summary			
HCM Average Control Delay	13.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	40.0
Intersection Capacity Utilization	24.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↰↑			↑↱		↰	↑	↱			
Volume (vph)	88	585	0	0	349	50	45	246	81	0	0	0
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			
Lane Util. Factor		0.95			0.95		1.00	1.00	1.00			
Frpb, ped/bikes		1.00			0.95		1.00	1.00	0.64			
Flpb, ped/bikes		0.98			1.00		0.68	1.00	1.00			
Frt		1.00			0.98		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	1.00	1.00			
Satd. Flow (prot)		3457			3305		1195	1863	1014			
Flt Permitted		0.80			1.00		0.95	1.00	1.00			
Satd. Flow (perm)		2791			3305		1195	1863	1014			
Peak-hour factor, PHF	0.86	0.86	0.86	0.89	0.89	0.89	0.94	0.94	0.94	0.92	0.92	0.92
Adj. Flow (vph)	102	680	0	0	392	56	48	262	86	0	0	0
RTOR Reduction (vph)	0	0	0	0	13	0	0	0	62	0	0	0
Lane Group Flow (vph)	0	782	0	0	436	0	48	262	24	0	0	0
Confl. Peds. (#/hr)	425					425	251		339			
Turn Type	pm+pt						Perm		Perm			
Protected Phases	1	6			2			4				
Permitted Phases	6						4		4			
Actuated Green, G (s)		55.0			45.0		25.0	25.0	25.0			
Effective Green, g (s)		55.0			45.0		25.0	25.0	25.0			
Actuated g/C Ratio		0.61			0.50		0.28	0.28	0.28			
Clearance Time (s)		5.0			5.0		5.0	5.0	5.0			
Lane Grp Cap (vph)		1743			1653		332	518	282			
v/s Ratio Prot		c0.02			0.13			c0.14				
v/s Ratio Perm		c0.25					0.04		0.02			
v/c Ratio		0.45			0.26		0.14	0.51	0.08			
Uniform Delay, d1		9.4			13.0		24.5	27.3	24.0			
Progression Factor		1.00			0.56		0.86	0.89	1.27			
Incremental Delay, d2		0.8			0.4		0.9	3.5	0.6			
Delay (s)		10.2			7.7		22.0	27.7	31.0			
Level of Service		B			A		C	C	C			
Approach Delay (s)		10.2			7.7			27.8			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	13.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	57.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↰↑			↑↱		↰	↑	↱			
Volume (vph)	86	566	0	0	370	58	39	199	85	0	0	0
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			
Lane Util. Factor		0.95			0.95		1.00	1.00	1.00			
Frpb, ped/bikes		1.00			0.95		1.00	1.00	0.68			
Flpb, ped/bikes		0.99			1.00		0.68	1.00	1.00			
Frt		1.00			0.98		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	1.00	1.00			
Satd. Flow (prot)		3471			3299		1206	1863	1070			
Flt Permitted		0.79			1.00		0.95	1.00	1.00			
Satd. Flow (perm)		2749			3299		1206	1863	1070			
Peak-hour factor, PHF	0.94	0.94	0.94	0.82	0.82	0.82	0.87	0.87	0.87	0.92	0.92	0.92
Adj. Flow (vph)	91	602	0	0	451	71	45	229	98	0	0	0
RTOR Reduction (vph)	0	0	0	0	16	0	0	0	67	0	0	0
Lane Group Flow (vph)	0	693	0	0	506	0	45	229	31	0	0	0
Confl. Peds. (#/hr)	374					374	262		263			
Turn Type	pm+pt						Perm		Perm			
Protected Phases	1	6			2			4				
Permitted Phases	6						4		4			
Actuated Green, G (s)		45.0			35.0		25.0	25.0	25.0			
Effective Green, g (s)		45.0			35.0		25.0	25.0	25.0			
Actuated g/C Ratio		0.56			0.44		0.31	0.31	0.31			
Clearance Time (s)		5.0			5.0		5.0	5.0	5.0			
Lane Grp Cap (vph)		1591			1443		377	582	334			
v/s Ratio Prot		c0.03			0.15			c0.12				
v/s Ratio Perm		c0.22					0.04		0.03			
v/c Ratio		0.44			0.35		0.12	0.39	0.09			
Uniform Delay, d1		10.1			15.0		19.6	21.6	19.5			
Progression Factor		1.00			0.65		0.74	0.77	1.40			
Incremental Delay, d2		0.9			0.7		0.6	2.0	0.5			
Delay (s)		11.0			10.5		15.1	18.6	27.7			
Level of Service		B			B		B	B	C			
Approach Delay (s)		11.0			10.5			20.6			0.0	
Approach LOS		B			B			C			A	

Intersection Summary			
HCM Average Control Delay	13.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	57.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↑↑			↑↑>			✣			✣	
Volume (vph)	0	650	0	0	325	23	18	28	15	66	0	73
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	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frpb, ped/bikes		1.00			0.96			0.92			0.82	
Flpb, ped/bikes		1.00			1.00			0.93			0.86	
Frt		1.00			0.99			0.97			0.93	
Flt Protected		1.00			1.00			0.99			0.98	
Satd. Flow (prot)		3539			3352			1518			1203	
Flt Permitted		1.00			1.00			0.89			0.82	
Satd. Flow (perm)		3539			3352			1377			1009	
Peak-hour factor, PHF	0.93	0.93	0.93	0.86	0.86	0.86	0.69	0.69	0.69	0.87	0.87	0.87
Adj. Flow (vph)	0	699	0	0	378	27	26	41	22	76	0	84
RTOR Reduction (vph)	0	0	0	0	6	0	0	13	0	0	44	0
Lane Group Flow (vph)	0	699	0	0	399	0	0	76	0	0	116	0
Confl. Peds. (#/hr)						430	270		291	291		270
Turn Type							Perm			Perm		
Protected Phases		6			2			4			8	
Permitted Phases							4			8		
Actuated Green, G (s)		55.0			55.0			25.0			25.0	
Effective Green, g (s)		55.0			55.0			25.0			25.0	
Actuated g/C Ratio		0.61			0.61			0.28			0.28	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Lane Grp Cap (vph)		2163			2048			383			280	
v/s Ratio Prot		c0.20			0.12							
v/s Ratio Perm								0.06			c0.11	
v/c Ratio		0.32			0.19			0.20			0.41	
Uniform Delay, d1		8.5			7.7			24.8			26.5	
Progression Factor		0.30			0.03			0.88			0.79	
Incremental Delay, d2		0.4			0.2			1.1			3.9	
Delay (s)		2.9			0.4			23.0			25.0	
Level of Service		A			A			C			C	
Approach Delay (s)		2.9			0.4			23.0			25.0	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	6.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	44.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↑↑			↑↱			✥			✥	
Volume (vph)	0	651	0	0	365	20	21	38	14	64	0	42
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	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frpb, ped/bikes		1.00			0.97			0.94			0.87	
Flpb, ped/bikes		1.00			1.00			0.93			0.83	
Frt		1.00			0.99			0.97			0.95	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3539			3400			1557			1236	
Flt Permitted		1.00			1.00			0.91			0.78	
Satd. Flow (perm)		3539			3400			1433			1000	
Peak-hour factor, PHF	0.89	0.89	0.89	0.87	0.87	0.87	0.83	0.83	0.83	0.79	0.79	0.79
Adj. Flow (vph)	0	731	0	0	420	23	25	46	17	81	0	53
RTOR Reduction (vph)	0	0	0	0	5	0	0	11	0	0	31	0
Lane Group Flow (vph)	0	731	0	0	438	0	0	77	0	0	103	0
Confl. Peds. (#/hr)						404	307		254	254		307
Turn Type							Perm			Perm		
Protected Phases		6			2			4			8	
Permitted Phases							4			8		
Actuated Green, G (s)		45.0			45.0			25.0			25.0	
Effective Green, g (s)		45.0			45.0			25.0			25.0	
Actuated g/C Ratio		0.56			0.56			0.31			0.31	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Lane Grp Cap (vph)		1991			1913			448			313	
v/s Ratio Prot		c0.21			0.13							
v/s Ratio Perm								0.05			c0.10	
v/c Ratio		0.37			0.23			0.17			0.33	
Uniform Delay, d1		9.6			8.8			20.0			21.1	
Progression Factor		0.44			0.09			0.84			0.83	
Incremental Delay, d2		0.5			0.3			0.8			2.5	
Delay (s)		4.7			1.1			17.5			19.9	
Level of Service		A			A			B			B	
Approach Delay (s)		4.7			1.1			17.5			19.9	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM Average Control Delay	5.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	41.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations		↰↑	↑↱			
Volume (vph)	130	581	352	63	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0			
Lane Util. Factor		0.95	0.95			
Frpb, ped/bikes		1.00	0.90			
Flpb, ped/bikes		0.96	1.00			
Frt		1.00	0.98			
Flt Protected		0.99	1.00			
Satd. Flow (prot)		3379	3108			
Flt Permitted		0.73	1.00			
Satd. Flow (perm)		2491	3108			
Peak-hour factor, PHF	0.91	0.91	0.93	0.93	0.92	0.92
Adj. Flow (vph)	143	638	378	68	0	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	781	446	0	0	0
Confl. Peds. (#/hr)	456			456		
Turn Type	pm+pt					
Protected Phases	1	6	2			
Permitted Phases	6					
Actuated Green, G (s)		60.0	45.0			
Effective Green, g (s)		60.0	45.0			
Actuated g/C Ratio		0.67	0.50			
Clearance Time (s)		5.0	5.0			
Lane Grp Cap (vph)		1759	1554			
v/s Ratio Prot		c0.05	0.14			
v/s Ratio Perm		c0.25				
v/c Ratio		0.44	0.29			
Uniform Delay, d1		7.1	13.1			
Progression Factor		0.83	0.75			
Incremental Delay, d2		0.8	0.5			
Delay (s)		6.7	10.4			
Level of Service		A	B			
Approach Delay (s)		6.7	10.4		0.0	
Approach LOS		A	B		A	

Intersection Summary			
HCM Average Control Delay	8.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	30.0
Intersection Capacity Utilization	41.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations		↰↑	↑↱			
Volume (vph)	118	611	385	101	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0			
Lane Util. Factor		0.95	0.95			
Frpb, ped/bikes		1.00	0.87			
Flpb, ped/bikes		0.98	1.00			
Frt		1.00	0.97			
Flt Protected		0.99	1.00			
Satd. Flow (prot)		3425	2983			
Flt Permitted		0.71	1.00			
Satd. Flow (perm)		2449	2983			
Peak-hour factor, PHF	0.94	0.94	0.90	0.90	0.92	0.92
Adj. Flow (vph)	126	650	428	112	0	0
RTOR Reduction (vph)	0	0	29	0	0	0
Lane Group Flow (vph)	0	776	511	0	0	0
Confl. Peds. (#/hr)	440			440		
Turn Type	pm+pt					
Protected Phases	1	6	2			
Permitted Phases	6					
Actuated Green, G (s)		45.0	35.0			
Effective Green, g (s)		45.0	35.0			
Actuated g/C Ratio		0.56	0.44			
Clearance Time (s)		5.0	5.0			
Lane Grp Cap (vph)		1439	1305			
v/s Ratio Prot		c0.03	0.17			
v/s Ratio Perm		c0.27				
v/c Ratio		0.54	0.39			
Uniform Delay, d1		11.0	15.3			
Progression Factor		0.69	0.66			
Incremental Delay, d2		1.4	0.9			
Delay (s)		9.0	10.9			
Level of Service		A	B			
Approach Delay (s)		9.0	10.9		0.0	
Approach LOS		A	B		A	

Intersection Summary			
HCM Average Control Delay	9.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	35.0
Intersection Capacity Utilization	44.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↑↱			↰↑						↰	↱
Volume (vph)	0	597	20	6	359	0	0	0	0	39	13	60
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
Lane Util. Factor		0.95			0.95						1.00	1.00
Frpb, ped/bikes		0.98			1.00						1.00	0.68
Flpb, ped/bikes		1.00			1.00						0.76	1.00
Frt		1.00			1.00						1.00	0.85
Flt Protected		1.00			1.00						0.96	1.00
Satd. Flow (prot)		3442			3521						1367	1071
Flt Permitted		1.00			0.95						0.96	1.00
Satd. Flow (perm)		3442			3330						1367	1071
Peak-hour factor, PHF	0.90	0.90	0.90	0.91	0.91	0.91	0.92	0.92	0.92	0.82	0.82	0.82
Adj. Flow (vph)	0	663	22	7	395	0	0	0	0	48	16	73
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	0	0	0	57
Lane Group Flow (vph)	0	682	0	0	402	0	0	0	0	0	64	16
Confl. Peds. (#/hr)			542	542						232		230
Turn Type				Perm						Perm		Perm
Protected Phases		6			2						8	
Permitted Phases				2						8		8
Actuated Green, G (s)		60.0			60.0						20.0	20.0
Effective Green, g (s)		60.0			60.0						20.0	20.0
Actuated g/C Ratio		0.67			0.67						0.22	0.22
Clearance Time (s)		5.0			5.0						5.0	5.0
Lane Grp Cap (vph)		2295			2220						304	238
v/s Ratio Prot		c0.20										
v/s Ratio Perm					0.12						0.05	0.02
v/c Ratio		0.30			0.18						0.21	0.07
Uniform Delay, d1		6.2			5.7						28.6	27.6
Progression Factor		0.32			0.42						0.99	1.45
Incremental Delay, d2		0.3			0.2						1.3	0.5
Delay (s)		2.3			2.6						29.5	40.4
Level of Service		A			A						C	D
Approach Delay (s)		2.3			2.6			0.0			35.3	
Approach LOS		A			A			A			D	

Intersection Summary			
HCM Average Control Delay	6.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.28		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	39.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	0	592	19	4	425	0	0	0	0	55	14	61
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
Lane Util. Factor		0.95			0.95						1.00	1.00
Frpb, ped/bikes		1.00			1.00						1.00	0.75
Flpb, ped/bikes		1.00			1.00						0.74	1.00
Frt		1.00			1.00						1.00	0.85
Flt Protected		1.00			1.00						0.96	1.00
Satd. Flow (prot)		3523			3538						1332	1187
Flt Permitted		1.00			0.95						0.96	1.00
Satd. Flow (perm)		3523			3367						1332	1187
Peak-hour factor, PHF	0.94	0.94	0.94	0.90	0.90	0.90	0.92	0.92	0.92	0.86	0.86	0.86
Adj. Flow (vph)	0	630	20	4	472	0	0	0	0	64	16	71
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	0	0	0	53
Lane Group Flow (vph)	0	647	0	0	476	0	0	0	0	0	80	18
Confl. Peds. (#/hr)										267		162
Turn Type				Perm						Perm		Perm
Protected Phases		6			2						8	
Permitted Phases				2						8		8
Actuated Green, G (s)		50.0			50.0						20.0	20.0
Effective Green, g (s)		50.0			50.0						20.0	20.0
Actuated g/C Ratio		0.62			0.62						0.25	0.25
Clearance Time (s)		5.0			5.0						5.0	5.0
Lane Grp Cap (vph)		2202			2104						333	297
v/s Ratio Prot		c0.18										
v/s Ratio Perm					0.14						0.06	0.01
v/c Ratio		0.29			0.23						0.24	0.06
Uniform Delay, d1		6.9			6.6						23.9	22.8
Progression Factor		0.09			0.39						1.08	1.42
Incremental Delay, d2		0.3			0.2						1.5	0.3
Delay (s)		0.9			2.8						27.3	32.8
Level of Service		A			A						C	C
Approach Delay (s)		0.9			2.8			0.0			29.9	
Approach LOS		A			A			A			C	

Intersection Summary			
HCM Average Control Delay	5.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.28		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	38.6%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↱			↰↑↱			↰↑			↰↑↱	
Volume (vph)	103	648	55	19	259	11	84	185	0	72	72	26
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	
Lane Util. Factor	1.00	0.95			0.95			0.95			0.95	
Frpb, ped/bikes	1.00	0.95			0.99			1.00			0.94	
Flpb, ped/bikes	0.92	1.00			0.99			0.91			0.93	
Frt	1.00	0.99			0.99			1.00			0.98	
Flt Protected	0.95	1.00			1.00			0.98			0.98	
Satd. Flow (prot)	1637	3323			3416			3179			2979	
Flt Permitted	0.48	1.00			0.88			0.79			0.72	
Satd. Flow (perm)	835	3323			3022			2543			2190	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.80	0.80	0.80	0.92	0.92	0.92
Adj. Flow (vph)	118	745	63	22	298	13	105	231	0	78	78	28
RTOR Reduction (vph)	0	7	0	0	3	0	0	0	0	0	16	0
Lane Group Flow (vph)	118	801	0	0	330	0	0	336	0	0	168	0
Confl. Peds. (#/hr)	218		415	415		218	363			160		363
Turn Type	pm+pt			Perm			Perm			Perm		
Protected Phases	1	6			2			4			8	
Permitted Phases	6			2			4			8		
Actuated Green, G (s)	50.0	50.0			40.0			30.0			30.0	
Effective Green, g (s)	50.0	50.0			40.0			30.0			30.0	
Actuated g/C Ratio	0.56	0.56			0.44			0.33			0.33	
Clearance Time (s)	5.0	5.0			5.0			5.0			5.0	
Lane Grp Cap (vph)	508	1846			1343			848			730	
v/s Ratio Prot	0.01	c0.24										
v/s Ratio Perm	0.12				0.11			c0.13			0.08	
v/c Ratio	0.23	0.43			0.25			0.40			0.23	
Uniform Delay, d1	9.8	11.7			15.6			23.0			21.7	
Progression Factor	0.77	0.68			1.00			1.00			0.63	
Incremental Delay, d2	1.1	0.7			0.4			1.4			0.6	
Delay (s)	8.6	8.8			16.0			24.4			14.2	
Level of Service	A	A			B			C			B	
Approach Delay (s)		8.7			16.0			24.4			14.2	
Approach LOS		A			B			C			B	

Intersection Summary			
HCM Average Control Delay	13.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	71.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↱			↰↑↱			↰↑			↰↑↱	
Volume (vph)	95	483	69	32	296	15	102	228	0	69	61	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	
Lane Util. Factor	1.00	0.95			0.95			0.95			0.95	
Frpb, ped/bikes	1.00	0.92			0.98			1.00			0.93	
Flpb, ped/bikes	0.92	1.00			0.97			0.92			0.92	
Frt	1.00	0.98			0.99			1.00			0.97	
Flt Protected	0.95	1.00			1.00			0.98			0.98	
Satd. Flow (prot)	1631	3185			3347			3200			2894	
Flt Permitted	0.44	1.00			0.87			0.79			0.71	
Satd. Flow (perm)	760	3185			2912			2557			2108	
Peak-hour factor, PHF	0.93	0.93	0.93	0.94	0.94	0.94	0.88	0.88	0.88	0.84	0.84	0.84
Adj. Flow (vph)	102	519	74	34	315	16	116	259	0	82	73	37
RTOR Reduction (vph)	0	14	0	0	4	0	0	0	0	0	23	0
Lane Group Flow (vph)	102	579	0	0	361	0	0	375	0	0	169	0
Confl. Peds. (#/hr)	491		514	514		491	351			258		351
Turn Type	pm+pt			Perm			Perm			Perm		
Protected Phases	1	6			2			4			8	
Permitted Phases	6			2			4			8		
Actuated Green, G (s)	40.0	40.0			30.0			30.0			30.0	
Effective Green, g (s)	40.0	40.0			30.0			30.0			30.0	
Actuated g/C Ratio	0.50	0.50			0.38			0.38			0.38	
Clearance Time (s)	5.0	5.0			5.0			5.0			5.0	
Lane Grp Cap (vph)	434	1593			1092			959			791	
v/s Ratio Prot	0.01	c0.18										
v/s Ratio Perm	0.10				0.12			c0.15			0.08	
v/c Ratio	0.24	0.36			0.33			0.39			0.21	
Uniform Delay, d1	10.9	12.2			17.8			18.3			17.0	
Progression Factor	1.25	1.12			1.00			1.00			0.49	
Incremental Delay, d2	1.2	0.6			0.8			1.2			0.6	
Delay (s)	14.9	14.3			18.6			19.5			8.9	
Level of Service	B	B			B			B			A	
Approach Delay (s)		14.4			18.6			19.5			8.9	
Approach LOS		B			B			B			A	

Intersection Summary			
HCM Average Control Delay	15.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	69.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations						
Volume (vph)	0	0	201	1679	399	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	
Lane Util. Factor				0.91	0.97	
Frpb, ped/bikes				1.00	1.00	
Flpb, ped/bikes				0.98	1.00	
Frt				1.00	1.00	
Flt Protected				0.99	0.95	
Satd. Flow (prot)				4941	3433	
Flt Permitted				0.99	0.95	
Satd. Flow (perm)				4941	3433	
Peak-hour factor, PHF	0.92	0.92	0.94	0.94	0.88	0.88
Adj. Flow (vph)	0	0	214	1786	453	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	2000	453	0
Confl. Peds. (#/hr)			77			
Turn Type			Perm			
Protected Phases				2	4	
Permitted Phases			2			
Actuated Green, G (s)				55.0	25.0	
Effective Green, g (s)				55.0	25.0	
Actuated g/C Ratio				0.61	0.28	
Clearance Time (s)				5.0	5.0	
Lane Grp Cap (vph)				3020	954	
v/s Ratio Prot					c0.13	
v/s Ratio Perm				0.40		
v/c Ratio				0.66	0.47	
Uniform Delay, d1				11.4	27.0	
Progression Factor				0.76	1.00	
Incremental Delay, d2				1.0	1.7	
Delay (s)				9.8	28.7	
Level of Service				A	C	
Approach Delay (s)	0.0			9.8	28.7	
Approach LOS	A			A	C	

Intersection Summary			
HCM Average Control Delay	13.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	56.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations						
Volume (vph)	0	0	194	1519	284	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	
Lane Util. Factor				0.91	0.97	
Frpb, ped/bikes				1.00	1.00	
Flpb, ped/bikes				0.98	1.00	
Frt				1.00	1.00	
Flt Protected				0.99	0.95	
Satd. Flow (prot)				4968	3433	
Flt Permitted				0.99	0.95	
Satd. Flow (perm)				4968	3433	
Peak-hour factor, PHF	0.92	0.92	0.91	0.91	0.72	0.72
Adj. Flow (vph)	0	0	213	1669	394	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	1882	394	0
Confl. Peds. (#/hr)			62			
Turn Type			Perm			
Protected Phases				2	4	
Permitted Phases			2			
Actuated Green, G (s)				50.0	20.0	
Effective Green, g (s)				50.0	20.0	
Actuated g/C Ratio				0.62	0.25	
Clearance Time (s)				5.0	5.0	
Lane Grp Cap (vph)				3105	858	
v/s Ratio Prot					c0.11	
v/s Ratio Perm				0.38		
v/c Ratio				0.61	0.46	
Uniform Delay, d1				9.1	25.4	
Progression Factor				0.73	1.00	
Incremental Delay, d2				0.8	1.8	
Delay (s)				7.4	27.2	
Level of Service				A	C	
Approach Delay (s)	0.0			7.4	27.2	
Approach LOS	A			A	C	

Intersection Summary			
HCM Average Control Delay	10.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	49.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations						
Volume (veh/h)	0	0	157	1844	68	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.95	0.95	0.65	0.65
Hourly flow rate (vph)	0	0	165	1941	105	0
Pedestrians					77	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					6	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	321			924		
pX, platoon unblocked					0.85	
vC, conflicting volume			77		1055	77
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			77		448	77
tC, single (s)			4.1		*5.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		*2.5	3.3
p0 queue free %			88		82	100
cM capacity (veh/h)			1422		573	906

Direction, Lane #	NW 1	NW 2	NW 3	NE 1
Volume Total	553	776	776	105
Volume Left	165	0	0	105
Volume Right	0	0	0	0
cSH	1422	1700	1700	573
Volume to Capacity	0.12	0.46	0.46	0.18
Queue Length 95th (ft)	10	0	0	17
Control Delay (s)	3.2	0.0	0.0	12.7
Lane LOS	A			B
Approach Delay (s)	0.8			12.7
Approach LOS				B

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	49.2%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↰↑↑	↰	
Volume (veh/h)	0	0	151	1659	54	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.93	0.93	0.65	0.65
Hourly flow rate (vph)	0	0	162	1784	83	0
Pedestrians					60	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					5	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	321			924		
pX, platoon unblocked					0.91	
vC, conflicting volume			60		979	60
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			60		651	60
tC, single (s)			4.1		*5.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		*2.5	3.3
p0 queue free %			89		83	100
cM capacity (veh/h)			1465		485	943

Direction, Lane #	NW 1	NW 2	NW 3	NE 1
Volume Total	519	714	714	83
Volume Left	162	0	0	83
Volume Right	0	0	0	0
cSH	1465	1700	1700	485
Volume to Capacity	0.11	0.42	0.42	0.17
Queue Length 95th (ft)	9	0	0	15
Control Delay (s)	3.2	0.0	0.0	14.0
Lane LOS	A			B
Approach Delay (s)	0.8			14.0
Approach LOS				B

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	45.1%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↑↑↑	↰	
Volume (veh/h)	0	0	0	1775	208	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.93	0.93	0.75	0.75
Hourly flow rate (vph)	0	0	0	1909	277	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	640			605		
pX, platoon unblocked					0.81	
vC, conflicting volume			0		636	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			0		0	0
tC, single (s)			4.1		*5.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		*2.5	3.3
p0 queue free %			100		76	100
cM capacity (veh/h)			1622		1166	1084

Direction, Lane #	NW 1	NW 2	NW 3	NE 1
Volume Total	636	636	636	277
Volume Left	0	0	0	277
Volume Right	0	0	0	0
cSH	1700	1700	1700	1166
Volume to Capacity	0.37	0.37	0.37	0.24
Queue Length 95th (ft)	0	0	0	23
Control Delay (s)	0.0	0.0	0.0	9.1
Lane LOS				A
Approach Delay (s)	0.0			9.1
Approach LOS				A

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	52.5%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↑↑↑	↰	
Volume (veh/h)	0	0	0	1641	169	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.94	0.94	0.89	0.89
Hourly flow rate (vph)	0	0	0	1746	190	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	640			605		
pX, platoon unblocked					0.87	
vC, conflicting volume			0		582	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			0		19	0
tC, single (s)			4.1		*5.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		*2.5	3.3
p0 queue free %			100		85	100
cM capacity (veh/h)			1622		1230	1084

Direction, Lane #	NW 1	NW 2	NW 3	NE 1
Volume Total	582	582	582	190
Volume Left	0	0	0	190
Volume Right	0	0	0	0
cSH	1700	1700	1700	1230
Volume to Capacity	0.34	0.34	0.34	0.15
Queue Length 95th (ft)	0	0	0	14
Control Delay (s)	0.0	0.0	0.0	8.5
Lane LOS				A
Approach Delay (s)	0.0			8.5
Approach LOS				A

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	47.7%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↰↑↑	↰↰	
Volume (vph)	0	0	168	1660	313	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	
Lane Util. Factor				0.91	0.97	
Frpb, ped/bikes				1.00	1.00	
Flpb, ped/bikes				0.99	1.00	
Frt				1.00	1.00	
Flt Protected				1.00	0.95	
Satd. Flow (prot)				5005	3433	
Flt Permitted				1.00	0.95	
Satd. Flow (perm)				5005	3433	
Peak-hour factor, PHF	0.92	0.92	0.97	0.97	0.85	0.85
Adj. Flow (vph)	0	0	173	1711	368	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	1884	368	0
Confl. Peds. (#/hr)			73			
Turn Type			Perm			
Protected Phases				2	4	
Permitted Phases			2			
Actuated Green, G (s)				55.0	25.0	
Effective Green, g (s)				55.0	25.0	
Actuated g/C Ratio				0.61	0.28	
Clearance Time (s)				5.0	5.0	
Lane Grp Cap (vph)				3059	954	
v/s Ratio Prot					c0.11	
v/s Ratio Perm				0.38		
v/c Ratio				0.62	0.39	
Uniform Delay, d1				10.9	26.3	
Progression Factor				1.00	0.59	
Incremental Delay, d2				0.9	1.1	
Delay (s)				11.9	16.6	
Level of Service				B	B	
Approach Delay (s)	0.0			11.9	16.6	
Approach LOS	A			B	B	

Intersection Summary			
HCM Average Control Delay	12.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	52.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↰↑↑	↰↰	
Volume (vph)	0	0	163	1391	377	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	
Lane Util. Factor				0.91	0.97	
Frpb, ped/bikes				1.00	1.00	
Flpb, ped/bikes				0.98	1.00	
Frt				1.00	1.00	
Flt Protected				0.99	0.95	
Satd. Flow (prot)				4982	3433	
Flt Permitted				0.99	0.95	
Satd. Flow (perm)				4982	3433	
Peak-hour factor, PHF	0.92	0.92	0.95	0.95	0.89	0.89
Adj. Flow (vph)	0	0	172	1464	424	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	1636	424	0
Confl. Peds. (#/hr)			96			
Turn Type			Perm			
Protected Phases				2	4	
Permitted Phases			2			
Actuated Green, G (s)				50.0	20.0	
Effective Green, g (s)				50.0	20.0	
Actuated g/C Ratio				0.62	0.25	
Clearance Time (s)				5.0	5.0	
Lane Grp Cap (vph)				3114	858	
v/s Ratio Prot					c0.12	
v/s Ratio Perm				0.33		
v/c Ratio				0.53	0.49	
Uniform Delay, d1				8.4	25.7	
Progression Factor				1.00	0.68	
Incremental Delay, d2				0.6	2.0	
Delay (s)				9.0	19.3	
Level of Service				A	B	
Approach Delay (s)	0.0			9.0	19.3	
Approach LOS	A			A	B	

Intersection Summary			
HCM Average Control Delay	11.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	49.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX D

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2015 PEAK HOUR TRAFFIC
ANALYSIS WITHOUT PROJECT

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations						
Volume (vph)	209	1520	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0				
Lane Util. Factor	0.81	0.81				
Frt	1.00	1.00				
Flt Protected	0.95	1.00				
Satd. Flow (prot)	1433	6031				
Flt Permitted	0.95	1.00				
Satd. Flow (perm)	1433	6031				
Peak-hour factor, PHF	0.94	0.94	0.92	0.92	0.92	0.92
Adj. Flow (vph)	222	1617	0	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	200	1639	0	0	0	0
Turn Type	Perm					
Protected Phases		4				
Permitted Phases	4					
Actuated Green, G (s)	55.0	55.0				
Effective Green, g (s)	55.0	55.0				
Actuated g/C Ratio	0.61	0.61				
Clearance Time (s)	5.0	5.0				
Lane Grp Cap (vph)	876	3686				
v/s Ratio Prot						
v/s Ratio Perm	0.14	0.27				
v/c Ratio	0.23	0.44				
Uniform Delay, d1	7.9	9.3				
Progression Factor	1.00	1.00				
Incremental Delay, d2	0.6	0.4				
Delay (s)	8.5	9.7				
Level of Service	A	A				
Approach Delay (s)		9.6	0.0		0.0	
Approach LOS		A	A		A	

Intersection Summary			
HCM Average Control Delay	9.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	35.0
Intersection Capacity Utilization	26.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations	↰	↰↑↑↑				
Volume (vph)	247	1617	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0				
Lane Util. Factor	0.81	0.81				
Frt	1.00	1.00				
Flt Protected	0.95	1.00				
Satd. Flow (prot)	1433	6031				
Flt Permitted	0.95	1.00				
Satd. Flow (perm)	1433	6031				
Peak-hour factor, PHF	0.94	0.94	0.92	0.92	0.92	0.92
Adj. Flow (vph)	263	1720	0	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	237	1746	0	0	0	0
Turn Type	Perm					
Protected Phases		4				
Permitted Phases	4					
Actuated Green, G (s)	45.0	45.0				
Effective Green, g (s)	45.0	45.0				
Actuated g/C Ratio	0.56	0.56				
Clearance Time (s)	5.0	5.0				
Lane Grp Cap (vph)	806	3392				
v/s Ratio Prot						
v/s Ratio Perm	0.17	0.29				
v/c Ratio	0.29	0.51				
Uniform Delay, d1	9.2	10.8				
Progression Factor	1.00	1.00				
Incremental Delay, d2	0.9	0.6				
Delay (s)	10.1	11.3				
Level of Service	B	B				
Approach Delay (s)		11.2	0.0		0.0	
Approach LOS		B	A		A	

Intersection Summary			
HCM Average Control Delay	11.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	35.0
Intersection Capacity Utilization	27.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↑↱						↱				
Volume (vph)	335	1180	38	0	0	0	0	24	14	0	0	0
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				
Lane Util. Factor	1.00	0.91						1.00				
Frpb, ped/bikes	1.00	0.97						0.86				
Flpb, ped/bikes	0.50	1.00						1.00				
Frt	1.00	1.00						0.95				
Flt Protected	0.95	1.00						1.00				
Satd. Flow (prot)	877	4919						1527				
Flt Permitted	0.95	1.00						1.00				
Satd. Flow (perm)	877	4919						1527				
Peak-hour factor, PHF	0.93	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	360	1269	41	0	0	0	0	26	15	0	0	0
RTOR Reduction (vph)	120	4	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	240	1306	0	0	0	0	0	41	0	0	0	0
Confl. Peds. (#/hr)	783		1349						392			
Turn Type	Perm											
Protected Phases		6						4				
Permitted Phases	6											
Actuated Green, G (s)	60.0	60.0						20.0				
Effective Green, g (s)	60.0	60.0						20.0				
Actuated g/C Ratio	0.67	0.67						0.22				
Clearance Time (s)	5.0	5.0						5.0				
Lane Grp Cap (vph)	585	3279						339				
v/s Ratio Prot		0.27						c0.03				
v/s Ratio Perm	c0.27											
v/c Ratio	0.41	0.40						0.12				
Uniform Delay, d1	6.9	6.8						28.0				
Progression Factor	4.61	0.75						1.00				
Incremental Delay, d2	2.0	0.3						0.7				
Delay (s)	33.7	5.5						28.7				
Level of Service	C	A						C				
Approach Delay (s)		11.5			0.0			28.7			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	11.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.34		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↑↱						↱				
Volume (vph)	324	1161	41	0	0	0	0	28	13	0	0	0
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				
Lane Util. Factor	1.00	0.91						1.00				
Frpb, ped/bikes	1.00	0.97						0.89				
Flpb, ped/bikes	0.56	1.00						1.00				
Frt	1.00	0.99						0.96				
Flt Protected	0.95	1.00						1.00				
Satd. Flow (prot)	998	4902						1588				
Flt Permitted	0.95	1.00						1.00				
Satd. Flow (perm)	998	4902						1588				
Peak-hour factor, PHF	0.96	0.96	0.96	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	338	1209	43	0	0	0	0	30	14	0	0	0
RTOR Reduction (vph)	127	5	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	211	1248	0	0	0	0	0	44	0	0	0	0
Confl. Peds. (#/hr)	653		1289						327			
Turn Type	Perm											
Protected Phases		6						4				
Permitted Phases	6											
Actuated Green, G (s)	50.0	50.0						20.0				
Effective Green, g (s)	50.0	50.0						20.0				
Actuated g/C Ratio	0.62	0.62						0.25				
Clearance Time (s)	5.0	5.0						5.0				
Lane Grp Cap (vph)	624	3064						397				
v/s Ratio Prot		c0.25						c0.03				
v/s Ratio Perm	0.21											
v/c Ratio	0.34	0.41						0.11				
Uniform Delay, d1	7.1	7.5						23.1				
Progression Factor	3.46	0.77						1.00				
Incremental Delay, d2	1.3	0.4						0.6				
Delay (s)	26.0	6.2						23.7				
Level of Service	C	A						C				
Approach Delay (s)		10.4			0.0			23.7			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	10.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.32		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	45.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	88	633	0	0	382	50	45	246	81	0	0	0
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			
Lane Util. Factor		0.95			0.95		1.00	1.00	1.00			
Frpb, ped/bikes		1.00			0.96		1.00	1.00	0.64			
Flpb, ped/bikes		0.99			1.00		0.68	1.00	1.00			
Frt		1.00			0.98		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	1.00	1.00			
Satd. Flow (prot)		3467			3322		1195	1863	1014			
Flt Permitted		0.80			1.00		0.95	1.00	1.00			
Satd. Flow (perm)		2775			3322		1195	1863	1014			
Peak-hour factor, PHF	0.86	0.86	0.86	0.89	0.89	0.89	0.94	0.94	0.94	0.92	0.92	0.92
Adj. Flow (vph)	102	736	0	0	429	56	48	262	86	0	0	0
RTOR Reduction (vph)	0	0	0	0	12	0	0	0	62	0	0	0
Lane Group Flow (vph)	0	838	0	0	474	0	48	262	24	0	0	0
Confl. Peds. (#/hr)	425					425	251		339			
Turn Type	pm+pt						Perm		Perm			
Protected Phases	1	6			2			4				
Permitted Phases	6						4		4			
Actuated Green, G (s)		55.0			45.0		25.0	25.0	25.0			
Effective Green, g (s)		55.0			45.0		25.0	25.0	25.0			
Actuated g/C Ratio		0.61			0.50		0.28	0.28	0.28			
Clearance Time (s)		5.0			5.0		5.0	5.0	5.0			
Lane Grp Cap (vph)		1734			1661		332	518	282			
v/s Ratio Prot		c0.03			0.14			c0.14				
v/s Ratio Perm		c0.27					0.04		0.02			
v/c Ratio		0.48			0.29		0.14	0.51	0.08			
Uniform Delay, d1		9.7			13.1		24.5	27.3	24.0			
Progression Factor		1.00			0.55		0.86	0.89	1.26			
Incremental Delay, d2		1.0			0.4		0.9	3.5	0.6			
Delay (s)		10.6			7.6		22.0	27.8	31.0			
Level of Service		B			A		C	C	C			
Approach Delay (s)		10.6			7.6			27.8			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	13.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	59.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↰↑			↑↱		↰	↑	↱			
Volume (vph)	86	625	0	0	416	58	39	199	85	0	0	0
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			
Lane Util. Factor		0.95			0.95		1.00	1.00	1.00			
Frpb, ped/bikes		1.00			0.96		1.00	1.00	0.68			
Flpb, ped/bikes		0.99			1.00		0.68	1.00	1.00			
Frt		1.00			0.98		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	1.00	1.00			
Satd. Flow (prot)		3482			3322		1206	1863	1070			
Flt Permitted		0.77			1.00		0.95	1.00	1.00			
Satd. Flow (perm)		2713			3322		1206	1863	1070			
Peak-hour factor, PHF	0.94	0.94	0.94	0.82	0.82	0.82	0.87	0.87	0.87	0.92	0.92	0.92
Adj. Flow (vph)	91	665	0	0	507	71	45	229	98	0	0	0
RTOR Reduction (vph)	0	0	0	0	14	0	0	0	67	0	0	0
Lane Group Flow (vph)	0	756	0	0	565	0	45	229	31	0	0	0
Confl. Peds. (#/hr)	374					374	262		263			
Turn Type	pm+pt						Perm		Perm			
Protected Phases	1	6			2			4				
Permitted Phases	6						4		4			
Actuated Green, G (s)		45.0			35.0		25.0	25.0	25.0			
Effective Green, g (s)		45.0			35.0		25.0	25.0	25.0			
Actuated g/C Ratio		0.56			0.44		0.31	0.31	0.31			
Clearance Time (s)		5.0			5.0		5.0	5.0	5.0			
Lane Grp Cap (vph)		1574			1453		377	582	334			
v/s Ratio Prot		c0.03			0.17			c0.12				
v/s Ratio Perm		c0.24					0.04		0.03			
v/c Ratio		0.48			0.39		0.12	0.39	0.09			
Uniform Delay, d1		10.5			15.2		19.6	21.6	19.5			
Progression Factor		1.00			0.69		0.73	0.77	1.39			
Incremental Delay, d2		1.1			0.8		0.6	2.0	0.5			
Delay (s)		11.5			11.3		15.0	18.6	27.6			
Level of Service		B			B		B	B	C			
Approach Delay (s)		11.5			11.3			20.5			0.0	
Approach LOS		B			B			C			A	

Intersection Summary			
HCM Average Control Delay	13.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	60.1%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↑↑			↑↑>			✥			✥	
Volume (vph)	0	698	0	0	358	23	18	28	15	66	0	73
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	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frpb, ped/bikes		1.00			0.96			0.92			0.82	
Flpb, ped/bikes		1.00			1.00			0.93			0.86	
Frt		1.00			0.99			0.97			0.93	
Flt Protected		1.00			1.00			0.99			0.98	
Satd. Flow (prot)		3539			3368			1518			1203	
Flt Permitted		1.00			1.00			0.89			0.82	
Satd. Flow (perm)		3539			3368			1377			1009	
Peak-hour factor, PHF	0.93	0.93	0.93	0.86	0.86	0.86	0.69	0.69	0.69	0.87	0.87	0.87
Adj. Flow (vph)	0	751	0	0	416	27	26	41	22	76	0	84
RTOR Reduction (vph)	0	0	0	0	5	0	0	13	0	0	44	0
Lane Group Flow (vph)	0	751	0	0	438	0	0	76	0	0	116	0
Confl. Peds. (#/hr)						430	270		291	291		270
Turn Type							Perm			Perm		
Protected Phases		6			2			4			8	
Permitted Phases							4			8		
Actuated Green, G (s)		55.0			55.0			25.0			25.0	
Effective Green, g (s)		55.0			55.0			25.0			25.0	
Actuated g/C Ratio		0.61			0.61			0.28			0.28	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Lane Grp Cap (vph)		2163			2058			383			280	
v/s Ratio Prot		c0.21			0.13							
v/s Ratio Perm								0.06			c0.11	
v/c Ratio		0.35			0.21			0.20			0.41	
Uniform Delay, d1		8.6			7.8			24.8			26.5	
Progression Factor		0.28			0.03			0.87			0.77	
Incremental Delay, d2		0.4			0.2			1.1			3.8	
Delay (s)		2.8			0.5			22.8			24.1	
Level of Service		A			A			C			C	
Approach Delay (s)		2.8			0.5			22.8			24.1	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	5.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	45.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↑↑			↑↱			✥			✥	
Volume (vph)	0	710	0	0	411	20	21	38	14	64	0	42
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	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frpb, ped/bikes		1.00			0.97			0.94			0.87	
Flpb, ped/bikes		1.00			1.00			0.93			0.83	
Frt		1.00			0.99			0.97			0.95	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3539			3415			1557			1236	
Flt Permitted		1.00			1.00			0.91			0.78	
Satd. Flow (perm)		3539			3415			1433			1000	
Peak-hour factor, PHF	0.89	0.89	0.89	0.87	0.87	0.87	0.83	0.83	0.83	0.79	0.79	0.79
Adj. Flow (vph)	0	798	0	0	472	23	25	46	17	81	0	53
RTOR Reduction (vph)	0	0	0	0	4	0	0	11	0	0	30	0
Lane Group Flow (vph)	0	798	0	0	491	0	0	77	0	0	104	0
Confl. Peds. (#/hr)						404	307		254	254		307
Turn Type							Perm			Perm		
Protected Phases		6			2			4			8	
Permitted Phases							4			8		
Actuated Green, G (s)		45.0			45.0			25.0			25.0	
Effective Green, g (s)		45.0			45.0			25.0			25.0	
Actuated g/C Ratio		0.56			0.56			0.31			0.31	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Lane Grp Cap (vph)		1991			1921			448			313	
v/s Ratio Prot		c0.23			0.14							
v/s Ratio Perm								0.05			c0.10	
v/c Ratio		0.40			0.26			0.17			0.33	
Uniform Delay, d1		9.9			8.9			20.0			21.1	
Progression Factor		0.41			0.07			0.82			0.78	
Incremental Delay, d2		0.6			0.3			0.8			2.5	
Delay (s)		4.6			1.0			17.3			19.0	
Level of Service		A			A			B			B	
Approach Delay (s)		4.6			1.0			17.3			19.0	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM Average Control Delay	5.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	43.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations		↰↑	↑↱			
Volume (vph)	130	629	385	63	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0			
Lane Util. Factor		0.95	0.95			
Frpb, ped/bikes		1.00	0.91			
Flpb, ped/bikes		0.97	1.00			
Frt		1.00	0.98			
Flt Protected		0.99	1.00			
Satd. Flow (prot)		3399	3140			
Flt Permitted		0.72	1.00			
Satd. Flow (perm)		2481	3140			
Peak-hour factor, PHF	0.91	0.91	0.93	0.93	0.92	0.92
Adj. Flow (vph)	143	691	414	68	0	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	834	482	0	0	0
Confl. Peds. (#/hr)	456			456		
Turn Type	pm+pt					
Protected Phases	1	6	2			
Permitted Phases	6					
Actuated Green, G (s)		60.0	45.0			
Effective Green, g (s)		60.0	45.0			
Actuated g/C Ratio		0.67	0.50			
Clearance Time (s)		5.0	5.0			
Lane Grp Cap (vph)		1756	1570			
v/s Ratio Prot		c0.05	0.15			
v/s Ratio Perm		c0.26				
v/c Ratio		0.47	0.31			
Uniform Delay, d1		7.3	13.3			
Progression Factor		0.84	0.72			
Incremental Delay, d2		0.9	0.5			
Delay (s)		7.0	10.1			
Level of Service		A	B			
Approach Delay (s)		7.0	10.1		0.0	
Approach LOS		A	B		A	

Intersection Summary			
HCM Average Control Delay	8.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	30.0
Intersection Capacity Utilization	43.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations		↰↑	↑↱			
Volume (vph)	118	670	431	101	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0			
Lane Util. Factor		0.95	0.95			
Frpb, ped/bikes		1.00	0.88			
Flpb, ped/bikes		0.98	1.00			
Frt		1.00	0.97			
Flt Protected		0.99	1.00			
Satd. Flow (prot)		3444	3030			
Flt Permitted		0.70	1.00			
Satd. Flow (perm)		2421	3030			
Peak-hour factor, PHF	0.94	0.94	0.90	0.90	0.92	0.92
Adj. Flow (vph)	126	713	479	112	0	0
RTOR Reduction (vph)	0	0	25	0	0	0
Lane Group Flow (vph)	0	839	566	0	0	0
Confl. Peds. (#/hr)	440			440		
Turn Type	pm+pt					
Protected Phases	1	6	2			
Permitted Phases	6					
Actuated Green, G (s)		45.0	35.0			
Effective Green, g (s)		45.0	35.0			
Actuated g/C Ratio		0.56	0.44			
Clearance Time (s)		5.0	5.0			
Lane Grp Cap (vph)		1426	1326			
v/s Ratio Prot		c0.04	0.19			
v/s Ratio Perm		c0.29				
v/c Ratio		0.59	0.43			
Uniform Delay, d1		11.4	15.6			
Progression Factor		0.69	0.62			
Incremental Delay, d2		1.7	1.0			
Delay (s)		9.6	10.7			
Level of Service		A	B			
Approach Delay (s)		9.6	10.7		0.0	
Approach LOS		A	B		A	

Intersection Summary			
HCM Average Control Delay	10.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	35.0
Intersection Capacity Utilization	47.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↑↱			↰↑						↰	↱
Volume (vph)	0	645	20	6	392	0	0	0	0	39	13	60
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
Lane Util. Factor		0.95			0.95						1.00	1.00
Frpb, ped/bikes		0.98			1.00						1.00	0.68
Flpb, ped/bikes		1.00			1.00						0.76	1.00
Frt		1.00			1.00						1.00	0.85
Flt Protected		1.00			1.00						0.96	1.00
Satd. Flow (prot)		3449			3524						1367	1071
Flt Permitted		1.00			0.95						0.96	1.00
Satd. Flow (perm)		3449			3333						1367	1071
Peak-hour factor, PHF	0.90	0.90	0.90	0.91	0.91	0.91	0.92	0.92	0.92	0.82	0.82	0.82
Adj. Flow (vph)	0	717	22	7	431	0	0	0	0	48	16	73
RTOR Reduction (vph)	0	2	0	0	0	0	0	0	0	0	0	57
Lane Group Flow (vph)	0	737	0	0	438	0	0	0	0	0	64	16
Confl. Peds. (#/hr)			542	542						232		230
Turn Type				Perm						Perm		Perm
Protected Phases		6			2						8	
Permitted Phases				2						8		8
Actuated Green, G (s)		60.0			60.0						20.0	20.0
Effective Green, g (s)		60.0			60.0						20.0	20.0
Actuated g/C Ratio		0.67			0.67						0.22	0.22
Clearance Time (s)		5.0			5.0						5.0	5.0
Lane Grp Cap (vph)		2299			2222						304	238
v/s Ratio Prot		c0.21										
v/s Ratio Perm					0.13						0.05	0.02
v/c Ratio		0.32			0.20						0.21	0.07
Uniform Delay, d1		6.4			5.8						28.6	27.6
Progression Factor		0.30			0.38						0.99	1.39
Incremental Delay, d2		0.3			0.2						1.2	0.4
Delay (s)		2.3			2.4						29.4	38.9
Level of Service		A			A						C	D
Approach Delay (s)		2.3			2.4			0.0			34.4	
Approach LOS		A			A			A			C	

Intersection Summary			
HCM Average Control Delay	5.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.29		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	40.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↑↱			↰↑						↰	↱
Volume (vph)	0	651	19	4	471	0	0	0	0	55	14	61
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
Lane Util. Factor		0.95			0.95						1.00	1.00
Frpb, ped/bikes		1.00			1.00						1.00	0.75
Flpb, ped/bikes		1.00			1.00						0.74	1.00
Frt		1.00			1.00						1.00	0.85
Flt Protected		1.00			1.00						0.96	1.00
Satd. Flow (prot)		3524			3538						1332	1187
Flt Permitted		1.00			0.95						0.96	1.00
Satd. Flow (perm)		3524			3367						1332	1187
Peak-hour factor, PHF	0.94	0.94	0.94	0.90	0.90	0.90	0.92	0.92	0.92	0.86	0.86	0.86
Adj. Flow (vph)	0	693	20	4	523	0	0	0	0	64	16	71
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	0	0	0	53
Lane Group Flow (vph)	0	710	0	0	527	0	0	0	0	0	80	18
Confl. Peds. (#/hr)										267		162
Turn Type				Perm						Perm		Perm
Protected Phases		6			2						8	
Permitted Phases				2						8		8
Actuated Green, G (s)		50.0			50.0						20.0	20.0
Effective Green, g (s)		50.0			50.0						20.0	20.0
Actuated g/C Ratio		0.62			0.62						0.25	0.25
Clearance Time (s)		5.0			5.0						5.0	5.0
Lane Grp Cap (vph)		2203			2104						333	297
v/s Ratio Prot		c0.20										
v/s Ratio Perm					0.16						0.06	0.01
v/c Ratio		0.32			0.25						0.24	0.06
Uniform Delay, d1		7.0			6.7						23.9	22.8
Progression Factor		0.08			0.38						1.04	1.31
Incremental Delay, d2		0.3			0.3						1.5	0.3
Delay (s)		0.9			2.8						26.3	30.2
Level of Service		A			A						C	C
Approach Delay (s)		0.9			2.8			0.0			28.2	
Approach LOS		A			A			A			C	

Intersection Summary			
HCM Average Control Delay	4.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.30		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	40.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↱			↰↑↱			↰↑			↰↑↱	
Volume (vph)	103	696	55	19	287	11	84	185	0	72	72	26
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	
Lane Util. Factor	1.00	0.95			0.95			0.95			0.95	
Frpb, ped/bikes	1.00	0.95			0.99			1.00			0.94	
Flpb, ped/bikes	0.93	1.00			0.99			0.91			0.93	
Frt	1.00	0.99			0.99			1.00			0.98	
Flt Protected	0.95	1.00			1.00			0.98			0.98	
Satd. Flow (prot)	1651	3337			3430			3179			2979	
Flt Permitted	0.46	1.00			0.88			0.79			0.72	
Satd. Flow (perm)	805	3337			3034			2543			2190	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.80	0.80	0.80	0.92	0.92	0.92
Adj. Flow (vph)	118	800	63	22	330	13	105	231	0	78	78	28
RTOR Reduction (vph)	0	7	0	0	3	0	0	0	0	0	16	0
Lane Group Flow (vph)	118	856	0	0	362	0	0	336	0	0	168	0
Confl. Peds. (#/hr)	218		415	415		218	363			160		363
Turn Type	pm+pt			Perm			Perm			Perm		
Protected Phases	1	6			2			4			8	
Permitted Phases	6			2			4			8		
Actuated Green, G (s)	50.0	50.0			40.0			30.0			30.0	
Effective Green, g (s)	50.0	50.0			40.0			30.0			30.0	
Actuated g/C Ratio	0.56	0.56			0.44			0.33			0.33	
Clearance Time (s)	5.0	5.0			5.0			5.0			5.0	
Lane Grp Cap (vph)	494	1854			1348			848			730	
v/s Ratio Prot	0.01	c0.26										
v/s Ratio Perm	0.12				0.12			c0.13			0.08	
v/c Ratio	0.24	0.46			0.27			0.40			0.23	
Uniform Delay, d1	9.8	12.0			15.8			23.0			21.7	
Progression Factor	0.82	0.71			1.00			1.00			0.60	
Incremental Delay, d2	1.1	0.8			0.5			1.4			0.6	
Delay (s)	9.1	9.3			16.3			24.4			13.6	
Level of Service	A	A			B			C			B	
Approach Delay (s)		9.2			16.3			24.4			13.6	
Approach LOS		A			B			C			B	

Intersection Summary			
HCM Average Control Delay	13.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↱			↰↑↱			↰↑			↰↑↱	
Volume (vph)	95	542	69	32	335	15	109	229	0	69	61	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	
Lane Util. Factor	1.00	0.95			0.95			0.95			0.95	
Frpb, ped/bikes	1.00	0.93			0.98			1.00			0.93	
Flpb, ped/bikes	0.93	1.00			0.98			0.91			0.92	
Frt	1.00	0.98			0.99			1.00			0.97	
Flt Protected	0.95	1.00			1.00			0.98			0.98	
Satd. Flow (prot)	1651	3219			3373			3186			2899	
Flt Permitted	0.41	1.00			0.87			0.78			0.71	
Satd. Flow (perm)	721	3219			2931			2525			2104	
Peak-hour factor, PHF	0.93	0.93	0.93	0.94	0.94	0.94	0.88	0.88	0.88	0.84	0.84	0.84
Adj. Flow (vph)	102	583	74	34	356	16	124	260	0	82	73	37
RTOR Reduction (vph)	0	12	0	0	4	0	0	0	0	0	23	0
Lane Group Flow (vph)	102	645	0	0	402	0	0	384	0	0	169	0
Confl. Peds. (#/hr)	491		514	514		491	351			258		351
Turn Type	pm+pt			Perm			Perm			Perm		
Protected Phases	1	6			2			4			8	
Permitted Phases	6			2			4			8		
Actuated Green, G (s)	40.0	40.0			30.0			30.0			30.0	
Effective Green, g (s)	40.0	40.0			30.0			30.0			30.0	
Actuated g/C Ratio	0.50	0.50			0.38			0.38			0.38	
Clearance Time (s)	5.0	5.0			5.0			5.0			5.0	
Lane Grp Cap (vph)	419	1610			1099			947			789	
v/s Ratio Prot	0.02	c0.20										
v/s Ratio Perm	0.11				0.14			c0.15			0.08	
v/c Ratio	0.24	0.40			0.37			0.41			0.21	
Uniform Delay, d1	11.0	12.5			18.1			18.4			17.0	
Progression Factor	1.33	1.20			1.00			1.00			0.46	
Incremental Delay, d2	1.3	0.7			0.9			1.3			0.5	
Delay (s)	16.0	15.7			19.1			19.7			8.3	
Level of Service	B	B			B			B			A	
Approach Delay (s)		15.7			19.1			19.7			8.3	
Approach LOS		B			B			B			A	

Intersection Summary			
HCM Average Control Delay	16.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	71.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations						
Volume (vph)	0	0	201	1821	399	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	
Lane Util. Factor				0.91	0.97	
Frpb, ped/bikes				1.00	1.00	
Flpb, ped/bikes				0.98	1.00	
Frt				1.00	1.00	
Flt Protected				1.00	0.95	
Satd. Flow (prot)				4951	3433	
Flt Permitted				1.00	0.95	
Satd. Flow (perm)				4951	3433	
Peak-hour factor, PHF	0.92	0.92	0.94	0.94	0.88	0.88
Adj. Flow (vph)	0	0	214	1937	453	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	2151	453	0
Confl. Peds. (#/hr)			77			
Turn Type			Perm			
Protected Phases				2	4	
Permitted Phases			2			
Actuated Green, G (s)				55.0	25.0	
Effective Green, g (s)				55.0	25.0	
Actuated g/C Ratio				0.61	0.28	
Clearance Time (s)				5.0	5.0	
Lane Grp Cap (vph)				3026	954	
v/s Ratio Prot					c0.13	
v/s Ratio Perm				0.43		
v/c Ratio				0.71	0.47	
Uniform Delay, d1				12.0	27.0	
Progression Factor				0.77	1.00	
Incremental Delay, d2				1.2	1.7	
Delay (s)				10.5	28.7	
Level of Service				B	C	
Approach Delay (s)	0.0			10.5	28.7	
Approach LOS	A			B	C	

Intersection Summary			
HCM Average Control Delay	13.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↰↑↑	↰↰	
Volume (vph)	0	0	194	1684	284	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	
Lane Util. Factor				0.91	0.97	
Frpb, ped/bikes				1.00	1.00	
Flpb, ped/bikes				0.98	1.00	
Frt				1.00	1.00	
Flt Protected				0.99	0.95	
Satd. Flow (prot)				4978	3433	
Flt Permitted				0.99	0.95	
Satd. Flow (perm)				4978	3433	
Peak-hour factor, PHF	0.92	0.92	0.91	0.91	0.72	0.72
Adj. Flow (vph)	0	0	213	1851	394	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	2064	394	0
Confl. Peds. (#/hr)			62			
Turn Type			Perm			
Protected Phases				2	4	
Permitted Phases			2			
Actuated Green, G (s)				50.0	20.0	
Effective Green, g (s)				50.0	20.0	
Actuated g/C Ratio				0.62	0.25	
Clearance Time (s)				5.0	5.0	
Lane Grp Cap (vph)				3111	858	
v/s Ratio Prot					c0.11	
v/s Ratio Perm				0.41		
v/c Ratio				0.66	0.46	
Uniform Delay, d1				9.6	25.4	
Progression Factor				0.74	1.00	
Incremental Delay, d2				1.0	1.8	
Delay (s)				8.1	27.2	
Level of Service				A	C	
Approach Delay (s)	0.0			8.1	27.2	
Approach LOS	A			A	C	

Intersection Summary			
HCM Average Control Delay	11.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	52.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↰↑↑	↰	
Volume (veh/h)	0	0	157	1986	53	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.95	0.95	0.65	0.65
Hourly flow rate (vph)	0	0	165	2091	82	0
Pedestrians					77	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					6	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	321			924		
pX, platoon unblocked					0.81	
vC, conflicting volume			77		1104	77
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			77		306	77
tC, single (s)			4.1		*5.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		*2.5	3.3
p0 queue free %			88		88	100
cM capacity (veh/h)			1422		654	906

Direction, Lane #	NW 1	NW 2	NW 3	NE 1
Volume Total	583	836	836	82
Volume Left	165	0	0	82
Volume Right	0	0	0	0
cSH	1422	1700	1700	654
Volume to Capacity	0.12	0.49	0.49	0.12
Queue Length 95th (ft)	10	0	0	11
Control Delay (s)	3.1	0.0	0.0	11.3
Lane LOS	A			B
Approach Delay (s)	0.8			11.3
Approach LOS				B

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	51.6%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↰↑↑	↰	
Volume (veh/h)	0	0	151	1824	54	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.93	0.93	0.65	0.65
Hourly flow rate (vph)	0	0	162	1961	83	0
Pedestrians					60	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					5	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	321			924		
pX, platoon unblocked					0.87	
vC, conflicting volume			60		1038	60
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			60		513	60
tC, single (s)			4.1		*5.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		*2.5	3.3
p0 queue free %			89		85	100
cM capacity (veh/h)			1465		549	943

Direction, Lane #	NW 1	NW 2	NW 3	NE 1
Volume Total	555	785	785	83
Volume Left	162	0	0	83
Volume Right	0	0	0	0
cSH	1465	1700	1700	549
Volume to Capacity	0.11	0.46	0.46	0.15
Queue Length 95th (ft)	9	0	0	13
Control Delay (s)	3.1	0.0	0.0	12.7
Lane LOS	A			B
Approach Delay (s)	0.8			12.7
Approach LOS				B

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	48.3%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↑↑↑	↰	
Volume (veh/h)	0	0	0	1917	208	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.93	0.93	0.75	0.75
Hourly flow rate (vph)	0	0	0	2061	277	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	640			605		
pX, platoon unblocked					0.77	
vC, conflicting volume			0		687	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			0		0	0
tC, single (s)			4.1		*5.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		*2.5	3.3
p0 queue free %			100		75	100
cM capacity (veh/h)			1622		1114	1084

Direction, Lane #	NW 1	NW 2	NW 3	NE 1
Volume Total	687	687	687	277
Volume Left	0	0	0	277
Volume Right	0	0	0	0
cSH	1700	1700	1700	1114
Volume to Capacity	0.40	0.40	0.40	0.25
Queue Length 95th (ft)	0	0	0	25
Control Delay (s)	0.0	0.0	0.0	9.3
Lane LOS				A
Approach Delay (s)	0.0			9.3
Approach LOS				A

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	55.2%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↑↑↑	↰	
Volume (veh/h)	0	0	0	1806	169	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.94	0.94	0.89	0.89
Hourly flow rate (vph)	0	0	0	1921	190	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	640			605		
pX, platoon unblocked					0.84	
vC, conflicting volume			0		640	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			0		0	0
tC, single (s)			4.1		*5.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		*2.5	3.3
p0 queue free %			100		84	100
cM capacity (veh/h)			1622		1203	1084

Direction, Lane #	NW 1	NW 2	NW 3	NE 1
Volume Total	640	640	640	190
Volume Left	0	0	0	190
Volume Right	0	0	0	0
cSH	1700	1700	1700	1203
Volume to Capacity	0.38	0.38	0.38	0.16
Queue Length 95th (ft)	0	0	0	14
Control Delay (s)	0.0	0.0	0.0	8.6
Lane LOS				A
Approach Delay (s)	0.0			8.6
Approach LOS				A

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	50.9%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↰↑↑	↰↰	
Volume (vph)	0	0	168	1802	346	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	
Lane Util. Factor				0.91	0.97	
Frpb, ped/bikes				1.00	1.00	
Flpb, ped/bikes				0.99	1.00	
Frt				1.00	1.00	
Flt Protected				1.00	0.95	
Satd. Flow (prot)				5011	3433	
Flt Permitted				1.00	0.95	
Satd. Flow (perm)				5011	3433	
Peak-hour factor, PHF	0.92	0.92	0.97	0.97	0.85	0.85
Adj. Flow (vph)	0	0	173	1858	407	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	2031	407	0
Confl. Peds. (#/hr)			73			
Turn Type			Perm			
Protected Phases				2	4	
Permitted Phases			2			
Actuated Green, G (s)				55.0	25.0	
Effective Green, g (s)				55.0	25.0	
Actuated g/C Ratio				0.61	0.28	
Clearance Time (s)				5.0	5.0	
Lane Grp Cap (vph)				3062	954	
v/s Ratio Prot					c0.12	
v/s Ratio Perm				0.41		
v/c Ratio				0.66	0.43	
Uniform Delay, d1				11.4	26.6	
Progression Factor				1.00	0.63	
Incremental Delay, d2				1.1	1.4	
Delay (s)				12.6	18.1	
Level of Service				B	B	
Approach Delay (s)	0.0			12.6	18.1	
Approach LOS	A			B	B	

Intersection Summary			
HCM Average Control Delay	13.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	56.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↰↑↑	↰↰	
Volume (vph)	0	0	163	1555	378	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	
Lane Util. Factor				0.91	0.97	
Frpb, ped/bikes				1.00	1.00	
Flpb, ped/bikes				0.99	1.00	
Frt				1.00	1.00	
Flt Protected				1.00	0.95	
Satd. Flow (prot)				4992	3433	
Flt Permitted				1.00	0.95	
Satd. Flow (perm)				4992	3433	
Peak-hour factor, PHF	0.92	0.92	0.95	0.95	0.89	0.89
Adj. Flow (vph)	0	0	172	1637	425	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	1809	425	0
Confl. Peds. (#/hr)			96			
Turn Type			Perm			
Protected Phases				2	4	
Permitted Phases			2			
Actuated Green, G (s)				50.0	20.0	
Effective Green, g (s)				50.0	20.0	
Actuated g/C Ratio				0.62	0.25	
Clearance Time (s)				5.0	5.0	
Lane Grp Cap (vph)				3120	858	
v/s Ratio Prot					c0.12	
v/s Ratio Perm				0.36		
v/c Ratio				0.58	0.50	
Uniform Delay, d1				8.8	25.7	
Progression Factor				1.00	0.68	
Incremental Delay, d2				0.8	2.0	
Delay (s)				9.6	19.4	
Level of Service				A	B	
Approach Delay (s)	0.0			9.6	19.4	
Approach LOS	A			A	B	

Intersection Summary			
HCM Average Control Delay	11.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	52.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX E

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2015 PEAK HOUR TRAFFIC
ANALYSIS WITH PROJECT

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations	↰	↰↑↑↑				
Volume (vph)	212	1520	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0				
Lane Util. Factor	0.81	0.81				
Frt	1.00	1.00				
Flt Protected	0.95	1.00				
Satd. Flow (prot)	1433	6031				
Flt Permitted	0.95	1.00				
Satd. Flow (perm)	1433	6031				
Peak-hour factor, PHF	0.94	0.94	0.92	0.92	0.92	0.92
Adj. Flow (vph)	226	1617	0	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	203	1640	0	0	0	0
Turn Type	Perm					
Protected Phases		4				
Permitted Phases	4					
Actuated Green, G (s)	55.0	55.0				
Effective Green, g (s)	55.0	55.0				
Actuated g/C Ratio	0.61	0.61				
Clearance Time (s)	5.0	5.0				
Lane Grp Cap (vph)	876	3686				
v/s Ratio Prot						
v/s Ratio Perm	0.14	0.27				
v/c Ratio	0.23	0.44				
Uniform Delay, d1	7.9	9.3				
Progression Factor	1.00	1.00				
Incremental Delay, d2	0.6	0.4				
Delay (s)	8.5	9.7				
Level of Service	A	A				
Approach Delay (s)		9.6	0.0		0.0	
Approach LOS		A	A		A	

Intersection Summary			
HCM Average Control Delay	9.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	35.0
Intersection Capacity Utilization	26.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations						
Volume (vph)	251	1617	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0				
Lane Util. Factor	0.81	0.81				
Frt	1.00	1.00				
Flt Protected	0.95	1.00				
Satd. Flow (prot)	1433	6031				
Flt Permitted	0.95	1.00				
Satd. Flow (perm)	1433	6031				
Peak-hour factor, PHF	0.94	0.94	0.92	0.92	0.92	0.92
Adj. Flow (vph)	267	1720	0	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	240	1747	0	0	0	0
Turn Type	Perm					
Protected Phases		4				
Permitted Phases	4					
Actuated Green, G (s)	45.0	45.0				
Effective Green, g (s)	45.0	45.0				
Actuated g/C Ratio	0.56	0.56				
Clearance Time (s)	5.0	5.0				
Lane Grp Cap (vph)	806	3392				
v/s Ratio Prot						
v/s Ratio Perm	0.17	0.29				
v/c Ratio	0.30	0.52				
Uniform Delay, d1	9.2	10.8				
Progression Factor	1.00	1.00				
Incremental Delay, d2	0.9	0.6				
Delay (s)	10.1	11.3				
Level of Service	B	B				
Approach Delay (s)		11.2	0.0		0.0	
Approach LOS		B	A		A	

Intersection Summary			
HCM Average Control Delay	11.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	35.0
Intersection Capacity Utilization	27.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↑↑↱						↱				
Volume (vph)	335	1180	38	0	0	0	0	24	14	0	0	0
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				
Lane Util. Factor	1.00	0.91						1.00				
Frpb, ped/bikes	1.00	0.97						0.86				
Flpb, ped/bikes	0.50	1.00						1.00				
Frt	1.00	1.00						0.95				
Flt Protected	0.95	1.00						1.00				
Satd. Flow (prot)	877	4919						1527				
Flt Permitted	0.95	1.00						1.00				
Satd. Flow (perm)	877	4919						1527				
Peak-hour factor, PHF	0.93	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	360	1269	41	0	0	0	0	26	15	0	0	0
RTOR Reduction (vph)	120	4	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	240	1306	0	0	0	0	0	41	0	0	0	0
Confl. Peds. (#/hr)	783		1349						392			
Turn Type	Perm											
Protected Phases		6						4				
Permitted Phases	6											
Actuated Green, G (s)	60.0	60.0						20.0				
Effective Green, g (s)	60.0	60.0						20.0				
Actuated g/C Ratio	0.67	0.67						0.22				
Clearance Time (s)	5.0	5.0						5.0				
Lane Grp Cap (vph)	585	3279						339				
v/s Ratio Prot		0.27						c0.03				
v/s Ratio Perm	c0.27											
v/c Ratio	0.41	0.40						0.12				
Uniform Delay, d1	6.9	6.8						28.0				
Progression Factor	4.75	0.77						1.00				
Incremental Delay, d2	2.0	0.3						0.7				
Delay (s)	34.6	5.6						28.7				
Level of Service	C	A						C				
Approach Delay (s)		11.9			0.0			28.7			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	12.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.34		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
18: Kalakaua Ave. & Kaiulani Ave.

10/12/2011

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↑↑↱						↑↱				
Volume (vph)	324	1161	41	0	0	0	0	28	13	0	0	0
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				
Lane Util. Factor	1.00	0.91						1.00				
Frpb, ped/bikes	1.00	0.97						0.89				
Flpb, ped/bikes	0.56	1.00						1.00				
Frt	1.00	0.99						0.96				
Flt Protected	0.95	1.00						1.00				
Satd. Flow (prot)	998	4902						1588				
Flt Permitted	0.95	1.00						1.00				
Satd. Flow (perm)	998	4902						1588				
Peak-hour factor, PHF	0.96	0.96	0.96	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	338	1209	43	0	0	0	0	30	14	0	0	0
RTOR Reduction (vph)	127	5	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	211	1248	0	0	0	0	0	44	0	0	0	0
Confl. Peds. (#/hr)	653		1289						327			
Turn Type	Perm											
Protected Phases		6						4				
Permitted Phases	6											
Actuated Green, G (s)	50.0	50.0						20.0				
Effective Green, g (s)	50.0	50.0						20.0				
Actuated g/C Ratio	0.62	0.62						0.25				
Clearance Time (s)	5.0	5.0						5.0				
Lane Grp Cap (vph)	624	3064						397				
v/s Ratio Prot		c0.25						c0.03				
v/s Ratio Perm	0.21											
v/c Ratio	0.34	0.41						0.11				
Uniform Delay, d1	7.1	7.5						23.1				
Progression Factor	3.46	0.77						1.00				
Incremental Delay, d2	1.3	0.4						0.6				
Delay (s)	26.0	6.2						23.7				
Level of Service	C	A						C				
Approach Delay (s)		10.4			0.0			23.7			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	10.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.32		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	45.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↰↑			↑↱		↰	↑	↱			
Volume (vph)	88	543	0	0	389	50	45	246	84	0	0	0
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			
Lane Util. Factor		0.95			0.95		1.00	1.00	1.00			
Frpb, ped/bikes		1.00			0.96		1.00	1.00	0.64			
Flpb, ped/bikes		0.98			1.00		0.68	1.00	1.00			
Frt		1.00			0.98		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	1.00	1.00			
Satd. Flow (prot)		3459			3326		1195	1863	1014			
Flt Permitted		0.78			1.00		0.95	1.00	1.00			
Satd. Flow (perm)		2717			3326		1195	1863	1014			
Peak-hour factor, PHF	0.86	0.86	0.86	0.89	0.89	0.89	0.94	0.94	0.94	0.92	0.92	0.92
Adj. Flow (vph)	102	631	0	0	437	56	48	262	89	0	0	0
RTOR Reduction (vph)	0	0	0	0	11	0	0	0	64	0	0	0
Lane Group Flow (vph)	0	733	0	0	482	0	48	262	25	0	0	0
Confl. Peds. (#/hr)	425					425	251		339			
Turn Type	pm+pt						Perm		Perm			
Protected Phases	1	6			2			4				
Permitted Phases	6						4		4			
Actuated Green, G (s)		55.0			45.0		25.0	25.0	25.0			
Effective Green, g (s)		55.0			45.0		25.0	25.0	25.0			
Actuated g/C Ratio		0.61			0.50		0.28	0.28	0.28			
Clearance Time (s)		5.0			5.0		5.0	5.0	5.0			
Lane Grp Cap (vph)		1702			1663		332	518	282			
v/s Ratio Prot		c0.02			0.14			c0.14				
v/s Ratio Perm		c0.24					0.04		0.02			
v/c Ratio		0.43			0.29		0.14	0.51	0.09			
Uniform Delay, d1		9.2			13.2		24.5	27.3	24.1			
Progression Factor		1.00			0.55		0.86	0.89	1.30			
Incremental Delay, d2		0.8			0.4		0.9	3.5	0.6			
Delay (s)		10.0			7.6		22.1	27.7	31.8			
Level of Service		B			A		C	C	C			
Approach Delay (s)		10.0			7.6			28.0			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	13.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	56.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
20: Kuhio Ave. & Seaside

10/12/2011

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↰↑↑			↑↑↱		↰	↑	↱			
Volume (vph)	86	523	0	0	370	58	39	199	89	0	0	0
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			
Lane Util. Factor		0.95			0.95		1.00	1.00	1.00			
Frpb, ped/bikes		1.00			0.95		1.00	1.00	0.68			
Flpb, ped/bikes		0.99			1.00		0.68	1.00	1.00			
Frt		1.00			0.98		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	1.00	1.00			
Satd. Flow (prot)		3466			3299		1206	1863	1070			
Flt Permitted		0.78			1.00		0.95	1.00	1.00			
Satd. Flow (perm)		2725			3299		1206	1863	1070			
Peak-hour factor, PHF	0.94	0.94	0.94	0.82	0.82	0.82	0.87	0.87	0.87	0.92	0.92	0.92
Adj. Flow (vph)	91	556	0	0	451	71	45	229	102	0	0	0
RTOR Reduction (vph)	0	0	0	0	16	0	0	0	70	0	0	0
Lane Group Flow (vph)	0	647	0	0	506	0	45	229	32	0	0	0
Confl. Peds. (#/hr)	374					374	262		263			
Turn Type	pm+pt						Perm		Perm			
Protected Phases	1	6			2			4				
Permitted Phases	6						4		4			
Actuated Green, G (s)		45.0			35.0		25.0	25.0	25.0			
Effective Green, g (s)		45.0			35.0		25.0	25.0	25.0			
Actuated g/C Ratio		0.56			0.44		0.31	0.31	0.31			
Clearance Time (s)		5.0			5.0		5.0	5.0	5.0			
Lane Grp Cap (vph)		1579			1443		377	582	334			
v/s Ratio Prot		c0.03			0.15			c0.12				
v/s Ratio Perm		c0.20					0.04		0.03			
v/c Ratio		0.41			0.35		0.12	0.39	0.10			
Uniform Delay, d1		9.9			15.0		19.6	21.6	19.5			
Progression Factor		1.00			0.65		0.73	0.77	1.41			
Incremental Delay, d2		0.8			0.7		0.6	2.0	0.6			
Delay (s)		10.7			10.4		15.0	18.6	28.1			
Level of Service		B			B		B	B	C			
Approach Delay (s)		10.7			10.4			20.7			0.0	
Approach LOS		B			B			C			A	

Intersection Summary			
HCM Average Control Delay	13.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	56.1%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↑↑			↑↱			✣			✣	
Volume (vph)	0	611	0	0	317	23	18	28	47	90	0	73
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	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frpb, ped/bikes		1.00			0.96			0.83			0.85	
Flpb, ped/bikes		1.00			1.00			0.96			0.86	
Frt		1.00			0.99			0.93			0.94	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3539			3348			1366			1249	
Flt Permitted		1.00			1.00			0.92			0.76	
Satd. Flow (perm)		3539			3348			1271			969	
Peak-hour factor, PHF	0.93	0.93	0.93	0.86	0.86	0.86	0.69	0.69	0.69	0.87	0.87	0.87
Adj. Flow (vph)	0	657	0	0	369	27	26	41	68	103	0	84
RTOR Reduction (vph)	0	0	0	0	6	0	0	40	0	0	33	0
Lane Group Flow (vph)	0	657	0	0	390	0	0	95	0	0	155	0
Confl. Peds. (#/hr)						430	270		291	291		270
Turn Type							Perm			Perm		
Protected Phases		6			2			4			8	
Permitted Phases							4			8		
Actuated Green, G (s)		55.0			55.0			25.0			25.0	
Effective Green, g (s)		55.0			55.0			25.0			25.0	
Actuated g/C Ratio		0.61			0.61			0.28			0.28	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Lane Grp Cap (vph)		2163			2046			353			269	
v/s Ratio Prot		c0.19			0.12							
v/s Ratio Perm								0.07			c0.16	
v/c Ratio		0.30			0.19			0.27			0.57	
Uniform Delay, d1		8.4			7.7			25.4			27.9	
Progression Factor		0.33			0.03			0.91			0.79	
Incremental Delay, d2		0.3			0.2			1.8			7.3	
Delay (s)		3.1			0.4			24.9			29.3	
Level of Service		A			A			C			C	
Approach Delay (s)		3.1			0.4			24.9			29.3	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	8.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	45.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↑↑			↑↑>			✥			✥	
Volume (vph)	0	612	0	0	365	20	21	38	51	92	0	42
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	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frpb, ped/bikes		1.00			0.97			0.85			0.89	
Flpb, ped/bikes		1.00			1.00			0.96			0.83	
Frt		1.00			0.99			0.94			0.96	
Flt Protected		1.00			1.00			0.99			0.97	
Satd. Flow (prot)		3539			3400			1409			1286	
Flt Permitted		1.00			1.00			0.93			0.74	
Satd. Flow (perm)		3539			3400			1322			979	
Peak-hour factor, PHF	0.89	0.89	0.89	0.87	0.87	0.87	0.83	0.83	0.83	0.79	0.79	0.79
Adj. Flow (vph)	0	688	0	0	420	23	25	46	61	116	0	53
RTOR Reduction (vph)	0	0	0	0	5	0	0	39	0	0	21	0
Lane Group Flow (vph)	0	688	0	0	438	0	0	94	0	0	148	0
Confl. Peds. (#/hr)						404	307		254	254		307
Turn Type							Perm			Perm		
Protected Phases		6			2			4			8	
Permitted Phases							4			8		
Actuated Green, G (s)		45.0			45.0			25.0			25.0	
Effective Green, g (s)		45.0			45.0			25.0			25.0	
Actuated g/C Ratio		0.56			0.56			0.31			0.31	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Lane Grp Cap (vph)		1991			1913			413			306	
v/s Ratio Prot		c0.19			0.13							
v/s Ratio Perm								0.07			c0.15	
v/c Ratio		0.35			0.23			0.23			0.48	
Uniform Delay, d1		9.5			8.8			20.3			22.3	
Progression Factor		0.47			0.12			0.85			0.80	
Incremental Delay, d2		0.5			0.3			1.3			4.7	
Delay (s)		4.9			1.3			18.5			22.6	
Level of Service		A			A			B			C	
Approach Delay (s)		4.9			1.3			18.5			22.6	
Approach LOS		A			A			B			C	

Intersection Summary			
HCM Average Control Delay	7.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	42.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
29: Kuhio & Nahua St.

10/12/2011

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations		↰↑	↑↱			
Volume (vph)	130	536	344	90	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0			
Lane Util. Factor		0.95	0.95			
Frpb, ped/bikes		1.00	0.86			
Flpb, ped/bikes		0.96	1.00			
Frt		1.00	0.97			
Flt Protected		0.99	1.00			
Satd. Flow (prot)		3377	2956			
Flt Permitted		0.72	1.00			
Satd. Flow (perm)		2441	2956			
Peak-hour factor, PHF	0.91	0.91	0.93	0.93	0.92	0.92
Adj. Flow (vph)	143	589	370	97	0	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	732	467	0	0	0
Confl. Peds. (#/hr)	456			456		
Turn Type	pm+pt					
Protected Phases	1	6	2			
Permitted Phases	6					
Actuated Green, G (s)		60.0	45.0			
Effective Green, g (s)		60.0	45.0			
Actuated g/C Ratio		0.67	0.50			
Clearance Time (s)		5.0	5.0			
Lane Grp Cap (vph)		1731	1478			
v/s Ratio Prot		c0.05	0.16			
v/s Ratio Perm		c0.23				
v/c Ratio		0.42	0.32			
Uniform Delay, d1		7.0	13.4			
Progression Factor		0.78	0.64			
Incremental Delay, d2		0.7	0.6			
Delay (s)		6.2	9.0			
Level of Service		A	A			
Approach Delay (s)		6.2	9.0		0.0	
Approach LOS		A	A		A	

Intersection Summary			
HCM Average Control Delay	7.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	30.0
Intersection Capacity Utilization	41.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	NWT	NWR	SWL	SWR
Lane Configurations		↰↑	↑↱			
Volume (vph)	118	565	385	132	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0			
Lane Util. Factor		0.95	0.95			
Frpb, ped/bikes		1.00	0.84			
Flpb, ped/bikes		0.98	1.00			
Frt		1.00	0.96			
Flt Protected		0.99	1.00			
Satd. Flow (prot)		3427	2857			
Flt Permitted		0.69	1.00			
Satd. Flow (perm)		2385	2857			
Peak-hour factor, PHF	0.94	0.94	0.90	0.90	0.92	0.92
Adj. Flow (vph)	126	601	428	147	0	0
RTOR Reduction (vph)	0	0	42	0	0	0
Lane Group Flow (vph)	0	727	533	0	0	0
Confl. Peds. (#/hr)	440			440		
Turn Type	pm+pt					
Protected Phases	1	6	2			
Permitted Phases	6					
Actuated Green, G (s)		45.0	35.0			
Effective Green, g (s)		45.0	35.0			
Actuated g/C Ratio		0.56	0.44			
Clearance Time (s)		5.0	5.0			
Lane Grp Cap (vph)		1407	1250			
v/s Ratio Prot		c0.03	0.19			
v/s Ratio Perm		c0.26				
v/c Ratio		0.52	0.43			
Uniform Delay, d1		10.8	15.6			
Progression Factor		0.69	0.53			
Incremental Delay, d2		1.3	1.0			
Delay (s)		8.8	9.3			
Level of Service		A	A			
Approach Delay (s)		8.8	9.3		0.0	
Approach LOS		A	A		A	

Intersection Summary			
HCM Average Control Delay	9.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	35.0
Intersection Capacity Utilization	44.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↑↑	↱		←↑↑		↰		↱		←↑	↱
Volume (vph)	0	569	65	30	392	0	34	0	137	35	105	60
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		0.95	1.00		0.95		1.00		1.00		1.00	1.00
Frpb, ped/bikes		1.00	0.29		1.00		1.00		1.00		1.00	0.68
Flpb, ped/bikes		1.00	1.00		0.98		1.00		1.00		0.92	1.00
Frt		1.00	0.85		1.00		1.00		0.85		1.00	0.85
Flt Protected		1.00	1.00		1.00		0.95		1.00		0.99	1.00
Satd. Flow (prot)		3539	458		3460		1770		1583		1692	1071
Flt Permitted		1.00	1.00		0.88		0.60		1.00		0.99	1.00
Satd. Flow (perm)		3539	458		3065		1121		1583		1692	1071
Peak-hour factor, PHF	0.90	0.90	0.90	0.91	0.91	0.91	0.92	0.92	0.92	0.82	0.82	0.82
Adj. Flow (vph)	0	632	72	33	431	0	37	0	149	43	128	73
RTOR Reduction (vph)	0	0	25	0	0	0	0	0	17	0	0	53
Lane Group Flow (vph)	0	632	47	0	464	0	37	0	132	0	171	20
Confl. Peds. (#/hr)			542	542						232		230
Turn Type			Perm	Perm			custom		custom	Perm		Perm
Protected Phases		6			2						8	
Permitted Phases			6	2			4		4	8		8
Actuated Green, G (s)		55.0	55.0		55.0		25.0		25.0		25.0	25.0
Effective Green, g (s)		55.0	55.0		55.0		25.0		25.0		25.0	25.0
Actuated g/C Ratio		0.61	0.61		0.61		0.28		0.28		0.28	0.28
Clearance Time (s)		5.0	5.0		5.0		5.0		5.0		5.0	5.0
Lane Grp Cap (vph)		2163	280		1873		311		440		470	298
v/s Ratio Prot		c0.18										
v/s Ratio Perm			0.10		0.15		0.03		0.08		0.10	0.02
v/c Ratio		0.29	0.17		0.25		0.12		0.30		0.36	0.07
Uniform Delay, d1		8.3	7.6		8.0		24.3		25.6		26.1	23.9
Progression Factor		0.36	0.51		0.70		1.00		1.00		0.96	1.35
Incremental Delay, d2		0.3	1.2		0.3		0.8		1.7		1.7	0.3
Delay (s)		3.4	5.0		5.9		25.1		27.3		26.7	32.6
Level of Service		A	A		A		C		C		C	C
Approach Delay (s)		3.5			5.9			26.9			28.5	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	10.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.31		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	54.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		↑↑	↱		↰↑		↰		↱		↰	↱
Volume (vph)	0	562	75	35	416	0	40	0	159	55	119	61
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		0.95	1.00		0.95		1.00		1.00		1.00	1.00
Frpb, ped/bikes		1.00	1.00		1.00		1.00		1.00		1.00	0.75
Flpb, ped/bikes		1.00	1.00		1.00		1.00		1.00		0.90	1.00
Frt		1.00	0.85		1.00		1.00		0.85		1.00	0.85
Flt Protected		1.00	1.00		1.00		0.95		1.00		0.98	1.00
Satd. Flow (prot)		3539	1583		3525		1770		1583		1648	1187
Flt Permitted		1.00	1.00		0.88		0.58		1.00		0.98	1.00
Satd. Flow (perm)		3539	1583		3105		1084		1583		1648	1187
Peak-hour factor, PHF	0.94	0.94	0.94	0.90	0.90	0.90	0.92	0.92	0.92	0.86	0.86	0.86
Adj. Flow (vph)	0	598	80	39	462	0	43	0	173	64	138	71
RTOR Reduction (vph)	0	0	35	0	0	0	0	0	119	0	0	49
Lane Group Flow (vph)	0	598	45	0	501	0	43	0	54	0	202	22
Confl. Peds. (#/hr)										267		162
Turn Type			Perm	Perm			custom		custom	Perm		Perm
Protected Phases		6			2						8	
Permitted Phases			6	2			4		4	8		8
Actuated Green, G (s)		45.0	45.0		45.0		25.0		25.0		25.0	25.0
Effective Green, g (s)		45.0	45.0		45.0		25.0		25.0		25.0	25.0
Actuated g/C Ratio		0.56	0.56		0.56		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
Lane Grp Cap (vph)		1991	890		1747		339		495		515	371
v/s Ratio Prot		c0.17										
v/s Ratio Perm			0.03		0.16		0.04		0.03		0.12	0.02
v/c Ratio		0.30	0.05		0.29		0.13		0.11		0.39	0.06
Uniform Delay, d1		9.2	7.9		9.1		19.7		19.6		21.5	19.3
Progression Factor		0.18	0.09		0.62		1.00		1.00		1.01	1.06
Incremental Delay, d2		0.3	0.1		0.4		0.8		0.4		2.2	0.3
Delay (s)		2.0	0.8		6.0		20.5		20.0		24.0	20.8
Level of Service		A	A		A		C		C		C	C
Approach Delay (s)		1.8			6.0			20.1			23.2	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM Average Control Delay	9.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.33		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	56.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↱			↰↑↱			↰↑			↰↑↱	
Volume (vph)	109	751	55	19	271	11	81	168	0	72	72	26
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	
Lane Util. Factor	1.00	0.95			0.95			0.95			0.95	
Frpb, ped/bikes	1.00	0.96			0.99			1.00			0.94	
Flpb, ped/bikes	0.93	1.00			0.99			0.91			0.93	
Frt	1.00	0.99			0.99			1.00			0.98	
Flt Protected	0.95	1.00			1.00			0.98			0.98	
Satd. Flow (prot)	1643	3350			3427			3165			2967	
Flt Permitted	0.48	1.00			0.87			0.79			0.73	
Satd. Flow (perm)	823	3350			3003			2526			2204	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.80	0.80	0.80	0.92	0.92	0.92
Adj. Flow (vph)	125	863	63	22	311	13	101	210	0	78	78	28
RTOR Reduction (vph)	0	6	0	0	3	0	0	0	0	0	16	0
Lane Group Flow (vph)	125	920	0	0	343	0	0	311	0	0	168	0
Confl. Peds. (#/hr)	218		415	415		218	363			160		363
Turn Type	pm+pt			Perm			Perm			Perm		
Protected Phases	1	6			2			4			8	
Permitted Phases	6			2			4			8		
Actuated Green, G (s)	50.0	50.0			40.0			30.0			30.0	
Effective Green, g (s)	50.0	50.0			40.0			30.0			30.0	
Actuated g/C Ratio	0.56	0.56			0.44			0.33			0.33	
Clearance Time (s)	5.0	5.0			5.0			5.0			5.0	
Lane Grp Cap (vph)	503	1861			1335			842			735	
v/s Ratio Prot	0.01	c0.27										
v/s Ratio Perm	0.12				0.11			c0.12			0.08	
v/c Ratio	0.25	0.49			0.26			0.37			0.23	
Uniform Delay, d1	9.8	12.3			15.7			22.8			21.6	
Progression Factor	0.75	0.70			1.00			1.00			0.59	
Incremental Delay, d2	1.2	0.9			0.5			1.2			0.6	
Delay (s)	8.5	9.5			16.1			24.1			13.3	
Level of Service	A	A			B			C			B	
Approach Delay (s)		9.4			16.1			24.1			13.3	
Approach LOS		A			B			C			B	

Intersection Summary			
HCM Average Control Delay	13.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	90.0	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			

HCM Signalized Intersection Capacity Analysis
24: Kuhio & Kanekapolei St.

10/12/2011

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	↰	↑↱			↰↑↱			↰↑			↰↑↱	
Volume (vph)	102	605	69	32	319	15	101	211	0	69	61	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	
Lane Util. Factor	1.00	0.95			0.95			0.95			0.95	
Frpb, ped/bikes	1.00	0.93			0.98			1.00			0.93	
Flpb, ped/bikes	0.93	1.00			0.98			0.91			0.92	
Frt	1.00	0.98			0.99			1.00			0.97	
Flt Protected	0.95	1.00			1.00			0.98			0.98	
Satd. Flow (prot)	1643	3249			3373			3184			2884	
Flt Permitted	0.43	1.00			0.85			0.78			0.72	
Satd. Flow (perm)	737	3249			2893			2531			2117	
Peak-hour factor, PHF	0.93	0.93	0.93	0.94	0.94	0.94	0.88	0.88	0.88	0.84	0.84	0.84
Adj. Flow (vph)	110	651	74	34	339	16	115	240	0	82	73	37
RTOR Reduction (vph)	0	11	0	0	4	0	0	0	0	0	23	0
Lane Group Flow (vph)	110	714	0	0	385	0	0	355	0	0	169	0
Confl. Peds. (#/hr)	491		514	514		491	351			258		351
Turn Type	pm+pt			Perm			Perm			Perm		
Protected Phases	1	6			2			4			8	
Permitted Phases	6			2			4			8		
Actuated Green, G (s)	40.0	40.0			30.0			30.0			30.0	
Effective Green, g (s)	40.0	40.0			30.0			30.0			30.0	
Actuated g/C Ratio	0.50	0.50			0.38			0.38			0.38	
Clearance Time (s)	5.0	5.0			5.0			5.0			5.0	
Lane Grp Cap (vph)	425	1625			1085			949			794	
v/s Ratio Prot	0.02	c0.22										
v/s Ratio Perm	0.11				0.13			c0.14			0.08	
v/c Ratio	0.26	0.44			0.36			0.37			0.21	
Uniform Delay, d1	11.0	12.8			18.0			18.2			17.0	
Progression Factor	1.01	0.90			1.00			1.00			0.45	
Incremental Delay, d2	1.4	0.8			0.9			1.1			0.5	
Delay (s)	12.6	12.3			18.9			19.3			8.1	
Level of Service	B	B			B			B			A	
Approach Delay (s)		12.4			18.9			19.3			8.1	
Approach LOS		B			B			B			A	

Intersection Summary			
HCM Average Control Delay	14.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↰↑↑	↰↰	
Volume (vph)	0	0	201	1771	399	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	
Lane Util. Factor				0.91	0.97	
Frpb, ped/bikes				1.00	1.00	
Flpb, ped/bikes				0.98	1.00	
Frt				1.00	1.00	
Flt Protected				0.99	0.95	
Satd. Flow (prot)				4948	3433	
Flt Permitted				0.99	0.95	
Satd. Flow (perm)				4948	3433	
Peak-hour factor, PHF	0.92	0.92	0.94	0.94	0.88	0.88
Adj. Flow (vph)	0	0	214	1884	453	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	2098	453	0
Confl. Peds. (#/hr)			77			
Turn Type			Perm			
Protected Phases				2	4	
Permitted Phases			2			
Actuated Green, G (s)				55.0	25.0	
Effective Green, g (s)				55.0	25.0	
Actuated g/C Ratio				0.61	0.28	
Clearance Time (s)				5.0	5.0	
Lane Grp Cap (vph)				3024	954	
v/s Ratio Prot					c0.13	
v/s Ratio Perm				0.42		
v/c Ratio				0.69	0.47	
Uniform Delay, d1				11.8	27.0	
Progression Factor				0.80	1.00	
Incremental Delay, d2				1.2	1.7	
Delay (s)				10.7	28.7	
Level of Service				B	C	
Approach Delay (s)	0.0			10.7	28.7	
Approach LOS	A			B	C	

Intersection Summary			
HCM Average Control Delay	13.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	58.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↰↑↑	↰↰	
Volume (vph)	0	0	194	1628	284	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	
Lane Util. Factor				0.91	0.97	
Frpb, ped/bikes				1.00	1.00	
Flpb, ped/bikes				0.98	1.00	
Frt				1.00	1.00	
Flt Protected				0.99	0.95	
Satd. Flow (prot)				4975	3433	
Flt Permitted				0.99	0.95	
Satd. Flow (perm)				4975	3433	
Peak-hour factor, PHF	0.92	0.92	0.91	0.91	0.72	0.72
Adj. Flow (vph)	0	0	213	1789	394	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	2002	394	0
Confl. Peds. (#/hr)			62			
Turn Type			Perm			
Protected Phases				2	4	
Permitted Phases			2			
Actuated Green, G (s)				50.0	20.0	
Effective Green, g (s)				50.0	20.0	
Actuated g/C Ratio				0.62	0.25	
Clearance Time (s)				5.0	5.0	
Lane Grp Cap (vph)				3109	858	
v/s Ratio Prot					c0.11	
v/s Ratio Perm				0.40		
v/c Ratio				0.64	0.46	
Uniform Delay, d1				9.4	25.4	
Progression Factor				0.77	1.00	
Incremental Delay, d2				0.9	1.8	
Delay (s)				8.2	27.2	
Level of Service				A	C	
Approach Delay (s)	0.0			8.2	27.2	
Approach LOS	A			A	C	

Intersection Summary			
HCM Average Control Delay	11.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	51.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↰↑↑	↰	
Volume (veh/h)	0	0	181	1936	53	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.95	0.95	0.65	0.65
Hourly flow rate (vph)	0	0	191	2038	82	0
Pedestrians					77	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					6	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	321			924		
pX, platoon unblocked					0.82	
vC, conflicting volume			77		1137	77
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			77		383	77
tC, single (s)			4.1		*5.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		*2.5	3.3
p0 queue free %			87		86	100
cM capacity (veh/h)			1422		586	906

Direction, Lane #	NW 1	NW 2	NW 3	NE 1
Volume Total	598	815	815	82
Volume Left	191	0	0	82
Volume Right	0	0	0	0
cSH	1422	1700	1700	586
Volume to Capacity	0.13	0.48	0.48	0.14
Queue Length 95th (ft)	12	0	0	12
Control Delay (s)	3.5	0.0	0.0	12.1
Lane LOS	A			B
Approach Delay (s)	0.9			12.1
Approach LOS				B

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	51.1%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↰↑↑	↰	
Volume (veh/h)	0	0	179	1768	54	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.93	0.93	0.65	0.65
Hourly flow rate (vph)	0	0	192	1901	83	0
Pedestrians					60	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					5	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	321			924		
pX, platoon unblocked					0.87	
vC, conflicting volume			60		1079	60
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			60		582	60
tC, single (s)			4.1		*5.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		*2.5	3.3
p0 queue free %			87		83	100
cM capacity (veh/h)			1465		494	943

Direction, Lane #	NW 1	NW 2	NW 3	NE 1
Volume Total	573	760	760	83
Volume Left	192	0	0	83
Volume Right	0	0	0	0
cSH	1465	1700	1700	494
Volume to Capacity	0.13	0.45	0.45	0.17
Queue Length 95th (ft)	11	0	0	15
Control Delay (s)	3.5	0.0	0.0	13.8
Lane LOS	A			B
Approach Delay (s)	1.0			13.8
Approach LOS				B

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	47.8%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

HCM Unsignalized Intersection Capacity Analysis
30: Ala Wai & Nahua St.

10/12/2011

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↑↑↑	↰	
Volume (veh/h)	0	0	0	1864	235	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.93	0.93	0.75	0.75
Hourly flow rate (vph)	0	0	0	2004	313	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	640			605		
pX, platoon unblocked					0.77	
vC, conflicting volume			0		668	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			0		0	0
tC, single (s)			4.1		*5.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		*2.5	3.3
p0 queue free %			100		72	100
cM capacity (veh/h)			1622		1114	1084

Direction, Lane #	NW 1	NW 2	NW 3	NE 1
Volume Total	668	668	668	313
Volume Left	0	0	0	313
Volume Right	0	0	0	0
cSH	1700	1700	1700	1114
Volume to Capacity	0.39	0.39	0.39	0.28
Queue Length 95th (ft)	0	0	0	29
Control Delay (s)	0.0	0.0	0.0	9.5
Lane LOS				A
Approach Delay (s)	0.0			9.5
Approach LOS				A

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	55.7%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↑↑↑	↰	
Volume (veh/h)	0	0	0	1747	199	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.94	0.94	0.89	0.89
Hourly flow rate (vph)	0	0	0	1859	224	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	640			605		
pX, platoon unblocked					0.84	
vC, conflicting volume			0		620	0
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			0		0	0
tC, single (s)			4.1		*5.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		*2.5	3.3
p0 queue free %			100		81	100
cM capacity (veh/h)			1622		1204	1084

Direction, Lane #	NW 1	NW 2	NW 3	NE 1
Volume Total	620	620	620	224
Volume Left	0	0	0	224
Volume Right	0	0	0	0
cSH	1700	1700	1700	1204
Volume to Capacity	0.36	0.36	0.36	0.19
Queue Length 95th (ft)	0	0	0	17
Control Delay (s)	0.0	0.0	0.0	8.7
Lane LOS				A
Approach Delay (s)	0.0			8.7
Approach LOS				A

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	51.4%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations						
Volume (vph)	0	0	168	1852	335	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	
Lane Util. Factor				0.91	0.97	
Frpb, ped/bikes				1.00	1.00	
Flpb, ped/bikes				0.99	1.00	
Frt				1.00	1.00	
Flt Protected				1.00	0.95	
Satd. Flow (prot)				5012	3433	
Flt Permitted				1.00	0.95	
Satd. Flow (perm)				5012	3433	
Peak-hour factor, PHF	0.92	0.92	0.97	0.97	0.85	0.85
Adj. Flow (vph)	0	0	173	1909	394	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	2082	394	0
Confl. Peds. (#/hr)			73			
Turn Type			Perm			
Protected Phases				2	4	
Permitted Phases			2			
Actuated Green, G (s)				55.0	25.0	
Effective Green, g (s)				55.0	25.0	
Actuated g/C Ratio				0.61	0.28	
Clearance Time (s)				5.0	5.0	
Lane Grp Cap (vph)				3063	954	
v/s Ratio Prot					c0.11	
v/s Ratio Perm				0.42		
v/c Ratio				0.68	0.41	
Uniform Delay, d1				11.6	26.5	
Progression Factor				1.00	0.72	
Incremental Delay, d2				1.2	1.3	
Delay (s)				12.9	20.3	
Level of Service				B	C	
Approach Delay (s)	0.0			12.9	20.3	
Approach LOS	A			B	C	

Intersection Summary			
HCM Average Control Delay	14.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	57.1%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations				↰↑↑	↰↰	
Volume (vph)	0	0	163	1612	367	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)				5.0	5.0	
Lane Util. Factor				0.91	0.97	
Frpb, ped/bikes				1.00	1.00	
Flpb, ped/bikes				0.99	1.00	
Frt				1.00	1.00	
Flt Protected				1.00	0.95	
Satd. Flow (prot)				4995	3433	
Flt Permitted				1.00	0.95	
Satd. Flow (perm)				4995	3433	
Peak-hour factor, PHF	0.92	0.92	0.95	0.95	0.89	0.89
Adj. Flow (vph)	0	0	172	1697	412	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	1869	412	0
Confl. Peds. (#/hr)			96			
Turn Type			Perm			
Protected Phases				2	4	
Permitted Phases			2			
Actuated Green, G (s)				50.0	20.0	
Effective Green, g (s)				50.0	20.0	
Actuated g/C Ratio				0.62	0.25	
Clearance Time (s)				5.0	5.0	
Lane Grp Cap (vph)				3122	858	
v/s Ratio Prot					c0.12	
v/s Ratio Perm				0.37		
v/c Ratio				0.60	0.48	
Uniform Delay, d1				9.0	25.6	
Progression Factor				1.00	0.72	
Incremental Delay, d2				0.9	1.9	
Delay (s)				9.8	20.2	
Level of Service				A	C	
Approach Delay (s)	0.0			9.8	20.2	
Approach LOS	A			A	C	

Intersection Summary			
HCM Average Control Delay	11.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	53.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Final Archaeological Inventory Survey Plan for the International Market Place Re-Development Project, Waikīkī Ahupua‘a, Honolulu (Kona) District, Island of O‘ahu

TMK: [1]-2-6-022: 036, 037, 038, 039 & 043

Prepared for the

The Queen Emma Land Company

and

The Taubman Company

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Management Summary

Reference	Archaeological Inventory Survey Plan for the International Market Place Re-Development Project, Waikīkī Ahupuaʻa, Honolulu (Kona) District, Island of Oʻahu TMK: [1]-2-6-022: 036, 037, 038, 039 & 043 (Hammatt and Shideler 2011).
Date	June 2011
Project Number (s)	Cultural Surveys Hawaiʻi Inc. (CSH) Project No. WAIKIKI 57
Investigation Permit Number	The fieldwork for the planned archaeological inventory survey investigation will likely be carried out under archaeological permit number 11-17 issued by the Hawaiʻi State Historic Preservation Division/Department of Land and Natural Resources (SHPD/DLNR), per Hawaiʻi Administrative Rules (HAR) Chapter 13-282.
Project Location	The International Market Place Re-Development Project is located in central Waikīkī, east Honolulu, *ahupuaʻa* of Waikīkī, District of Kona, Island of Oʻahu. The project area comprises TMK 2-6-022: parcels 036, 037, 038, 039 & 043 bounded by Kūhiō Ave to the northeast, the Ohana East Hotel and Princess Kaʻiulani Hotels to the southeast, by Kalākaua Avenue to the southwest and by the Aqua Waikiki Wave Hotel, Duke's Lane, and the Waikiki Beachcomber Hotel to the northwest.
Land Jurisdiction	The Queen Emma Land Company
Project Description	The proposed re-development includes a variety of shops and restaurants in a new retail experience.
Project Acreage	The International Market land area comprises TMK 2-6-022: parcels 036 (7,120 sq ft.), 037 (7,120 sq ft.), 038 (124,917 sq ft.), and 043 (71,111 sq ft.) equaling 210,268 square feet or 4.827 acres. The vicinity of one exceptional and two significant existing trees to be retained in the re-development will not be part of the sub-surface investigative process. The non-development area for these three trees is estimated at 12,874 square feet or 0.295 acres. The Miramar Hotel Parcel (039) is 50,329 square feet or 1.16 acres

Historic Preservation Regulatory Context	This plan was revised to address comments in a Chapter 6E-42 Historic Preservation Review (dated May 23, 2011; Log No 2010.3950, Doc No. 1105MV26) addressing a December 2010 draft. The proposed project is subject to Hawaiʻi State environmental and historic preservation review legislation [Hawaiʻi Revised Statutes (HRS) Chapter 343 and HRS 6E-42/Hawaiʻi Administrative Rules (HAR) Chapter 13-284, respectively]. This current archaeological inventory survey plan was prepared in advance of a planned archaeological inventory survey of the proposed project area. To better define the scope of work for the archaeological inventory survey, this plan was prepared in accordance with the requirements for an archaeological inventory survey plan as stated in Hawaiʻi Administrative Rules (HAR) 13-284-5(c). The plan details the proposed methods of the inventory survey, per the requirements of Hawaiʻi Administrative Rules (HAR) Chapter 13-276
Summary of the Planned Inventory Survey Research Design	The research design for the planned archaeological inventory survey includes a 100% pedestrian inspection of the project area and a program of subsurface testing with a combination of backhoe and hand excavated trenching. The sub-surface testing program will consist of the excavation of approximately 60 backhoe assisted test trenches for a total sample size of approximately 288 m^2, representing a sample size of approximately 1.2 % of the project area, and 1.25% of the proposed development areas. Trenches will be distributed throughout the proposed development areas to provide representative coverage and assess the stratigraphy and potential for subsurface cultural resources. Trench excavation methodology will initially consist of saw cutting of the asphalt and concrete surfaces and removal by backhoe of the overlying fill deposits. If undisturbed, in situ sand deposits are encountered, excavation will be conducted by hand. This hand excavation in sand deposits will be specifically undertaken to identify potential burial deposits prior to sand excavation with the backhoe. The sand will be carefully scraped off in thin layers in order to minimize any possible burial disturbance. Only once the hand excavation through the sand deposit is completed will the backhoe's bladed bucket be used to further excavate to the water table.

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Section 1 Introduction

1.1 Project Background

This Archaeological Inventory Survey Plan was revised to address comments in a Chapter 6E-42 Historic Preservation Review (dated May 23, 2011; Log No 2010.3950, Doc No. 1105MV26) addressing a December 2010 draft.

At the request of Taubman, Cultural Surveys Hawai‘i (CSH) has prepared this archaeological inventory survey plan for the Queen Emma Land company lands comprised of the International Market Place, the Waikiki Town Center, and the Miramar Hotel in Waikīkī, Waikīkī Ahupua‘a, Kona District, Island of O‘ahu (TMK 2-6-22: 036, 037, 038, 039 and 043) (Figure 1 to Figure 3). The lands are bounded by Kūhiō Ave to the northeast, the Ohana East Hotel and Princess Ka‘iulani Hotels are to the southeast, Kalākaua Avenue is to the southwest and the Aqua Waikiki Wave Hotel, Duke’s Lane, and the Waikiki Beachcomber Hotel lie to the northwest. the Waikiki Beachcomber Hotel are adjacent to the northwest. The International Market Place lands including the Miramar Hotel are proposed for renovation.

The International Market Place Re-development land area comprises TMK 2-6-022: parcels 036 (7,120 sq ft.), 037 (7,120 sq ft.), 038 (124,917 sq ft.), and 043 (71,111 sq ft.) equaling 210,268 square feet or 4.827 acres. The vicinity of one exceptional and two significant trees will not be developed. The non-development area for these three trees is estimated at 12,874 square feet or 0.295 acres. The Miramar Hotel Parcel (039) is 50,329 square feet or 1.16 acres

The research design for the planned archaeological inventory survey includes a 100% pedestrian inspection of the project area and a program of subsurface testing with a combination of backhoe assisted and hand excavated trenching. The sub-surface testing program will consist of the excavation of approximately 60 backhoe assisted test trenches for a total excavation of approximately 288 m^2, representing a sample size of approximately 1.2% of the project area, and 1.25% of proposed development areas. Trenches will be distributed throughout the proposed development areas to provide representative coverage and assess the stratigraphy and potential for subsurface cultural resources.

The proposed project is subject to Hawai‘i State environmental and historic preservation review legislation [Hawai‘i Revised Statutes (HRS) Chapter 343 and HRS 6E-42/Hawai‘i Administrative Rules (HAR) Chapter 13-284, respectively]. The current archaeological inventory survey plan was prepared in advance of a planned archaeological inventory survey of the proposed project area. To better define the scope of work for the archaeological inventory survey, this plan was prepared in accordance with the requirements for an archaeological inventory survey plan as stated in Hawai‘i Administrative Rules (HAR) 13-284-5(c). The plan details the proposed methods of the inventory survey, per the requirements of Hawai‘i Administrative Rules (HAR) Chapter 13-276.

The fieldwork for the planned archaeological inventory survey investigation will likely be carried out under archaeological permit number 11-17 issued by the Hawai‘i State Historic Preservation Division/Department of Land and Natural Resources (SHPD/DLNR), per Hawai‘i Administrative Rules (HAR) Chapter 13-282.

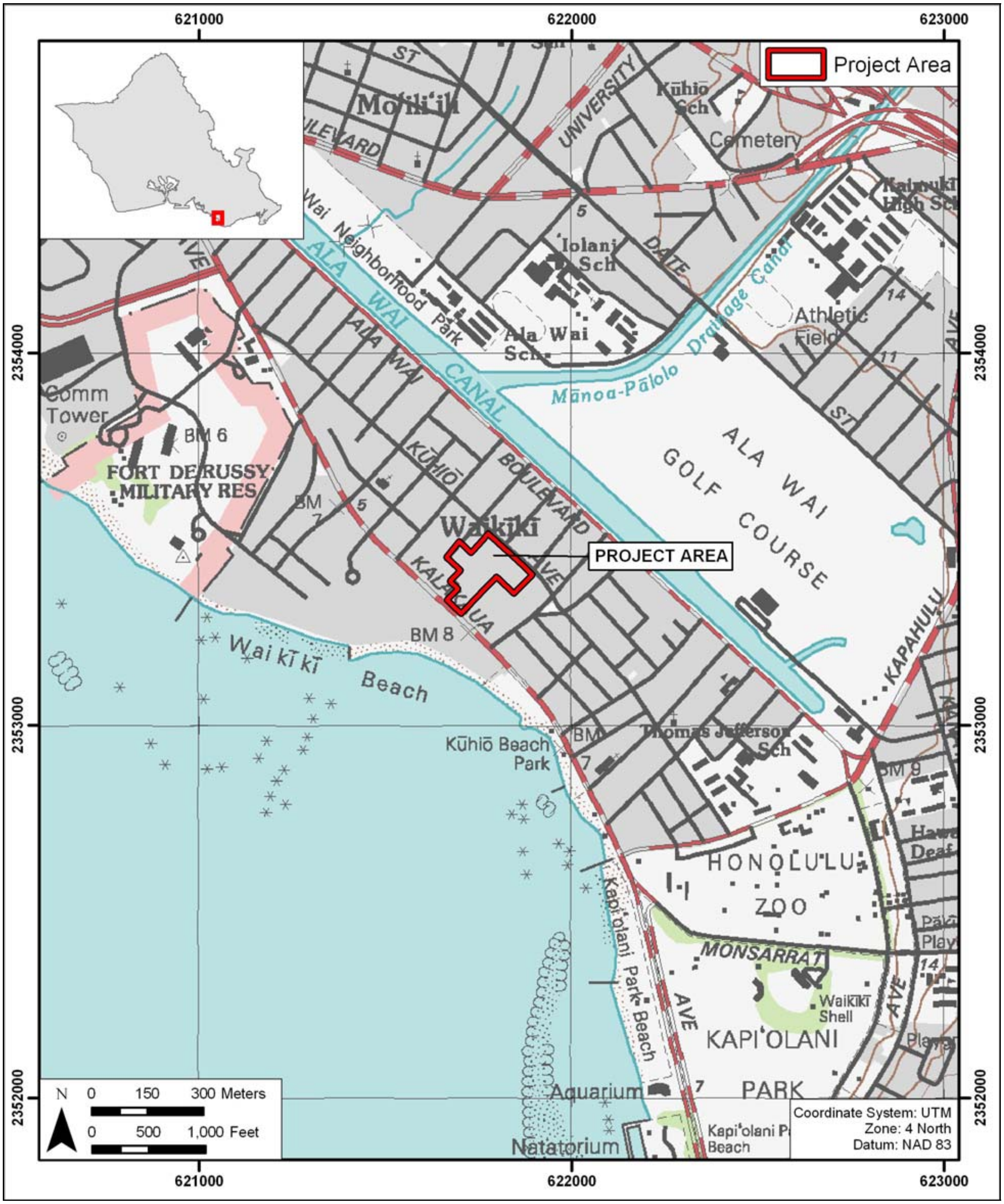

Figure 1. Portion of 1998 U. S. Geological Survey Topographic Map, Honolulu Quadrangle, showing location of project area

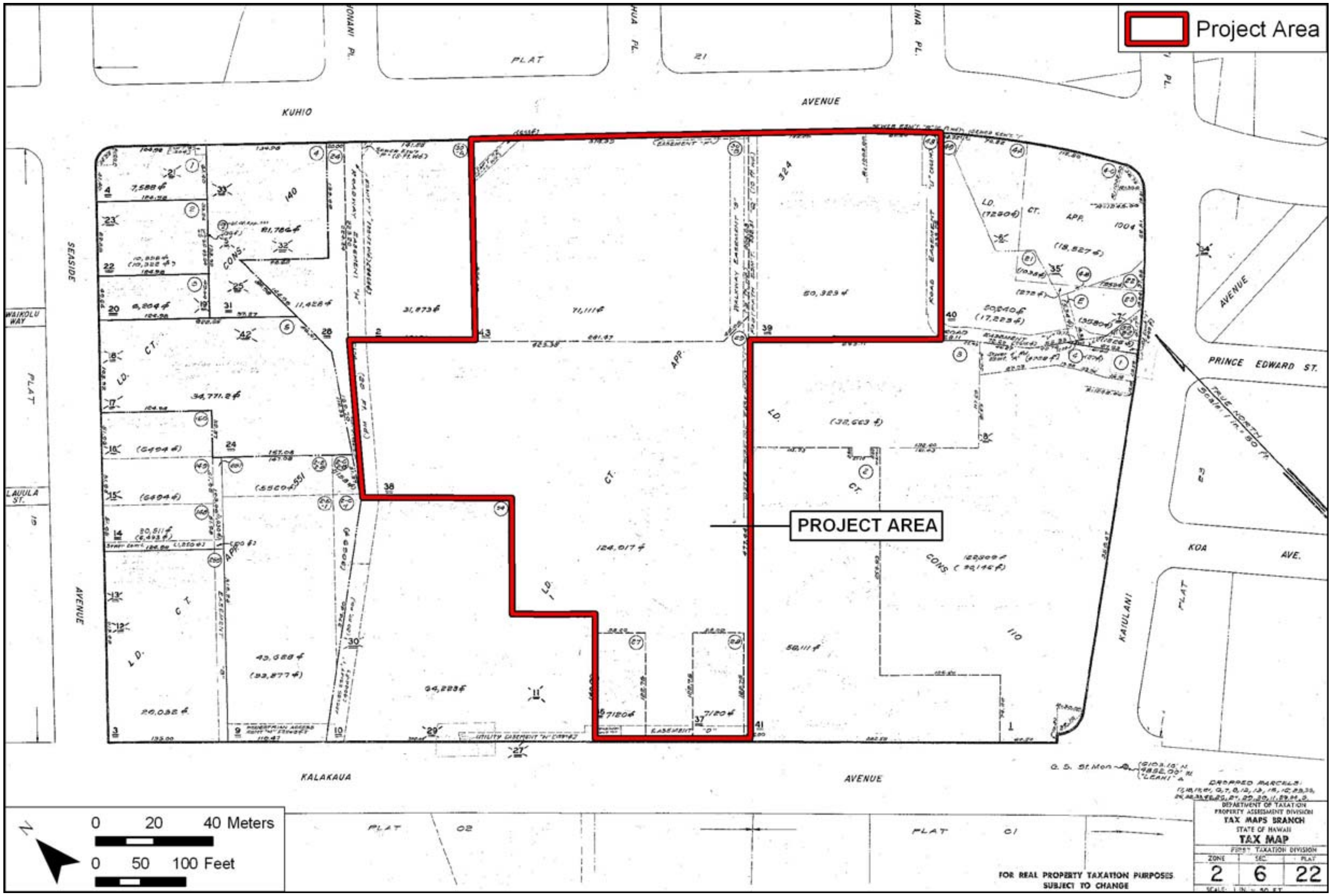

Figure 2. Tax Map Key (TMK) plat: 2-6-022, showing project area in lots 22, 36, 37, 39 and 43 (Hawai‘i TMK Service)

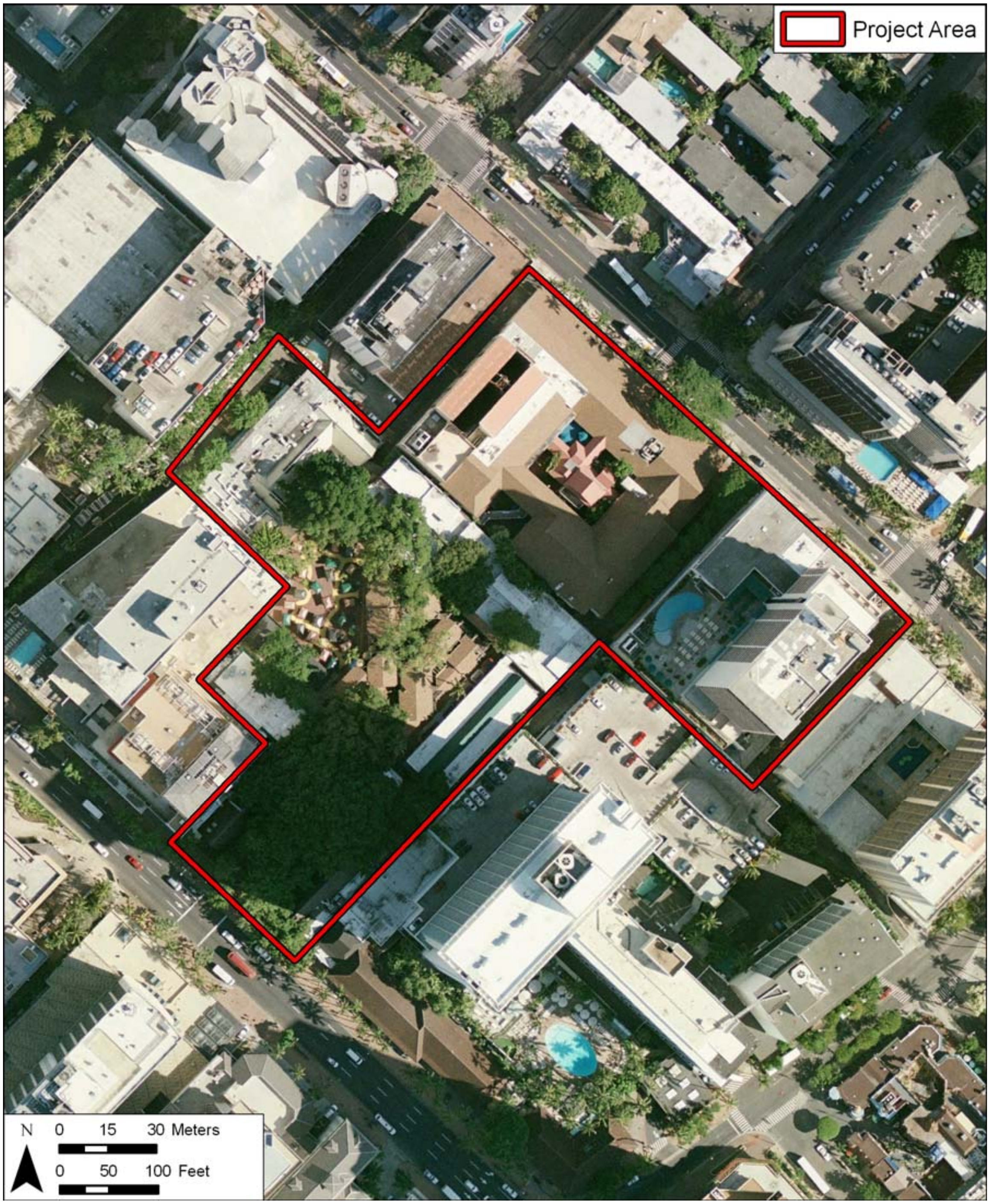

Figure 3. Aerial photograph showing location of project area, including the International Market Place (lower), the Waikīkī Town Center (upper left) and the Miramar Hotel (upper right) (Google Earth)

1.2 Environmental Setting

1.2.1 Natural Environment

The ancient land division of Waikīkī included all the valleys “from the west side of Makiki Valley away to the east side of Wailupe” (Lyons 1874:2). On modern maps, the western boundary of Waikīkī Ahupua‘a would extend from Pi‘ikoi and Sheridan Streets, and the *mauka* (mountain) border would extend from Tantalus to the peak of Kōnāhuanui, along the crest of the Ko‘olau Range to the border with Maunalua. The ocean constitutes the *makai* (seaward) border.

One section of this *ahupua‘a* was the coastal area, backed by a large marshland. The marshland extended from the volcanic craters of Lē‘ahi (Diamond Head) and the Kaimukī dome (where the present day Kaimukī fire station is built) on the east. The *mauka* boundary of the marshland is where Kapahulu Park is located today, which then runs along the foot of Mānoa Valley into the districts of Kamō‘ili‘ili and Makiki, ending at the junction of Wilder and Pi‘ikoi Streets, then turning again to the sea. This marshy area was about 3 miles long and 1 mile wide, enclosing approximately 2,000 acres (Kanahele 1995:5-6). A major feature of the immediate project area, until it was filled in c. 1922, was the outlet of ‘Āpuakēhau Stream. This stream used to pass through the southeastern corner of the project area.

The plain of Waikīkī is flat and, generally, less than 4.5 m (15 feet) above sea level (Davis 1989:5). Soils in the area are composed solely of Jaucus Sand with 0-15% slopes (JaC) (Figure 4), which are characterized as well-drained calcareous soils developed from coral and seashells found on coastal plains near the ocean (Foote et al.1972). Rainfall averages between 20-30 inches per year (Armstrong 1983:62). Northeasterly tradewinds prevail throughout the year, although their frequency varies from more than 90% during the summer months to 50% in January; the average annual wind velocity is approximately 10 miles per hour. Currently, vegetation in the general area includes introduced exotics, such as MacArthur Palm, and Coconut, and a variety of grasses.

1.2.2 Built Environment

The International Market Place is a complex of mostly 1- to 2- story shops and restaurants located within urban Waikīkī in the central portion of the Waikīkī resort area. The Miramar at Waikiki Hotel (TMK parcel :39; 357 hotel rooms and 22 floors) is located in the northeast corner of the Queen Emma lands, The Queen Emma lands are surrounded by modern urban developments including high-rise hotels, streets, sidewalks, and utility infrastructure (refer to Figure 3). Kalākaua Avenue, the main thoroughfare for coastal Waikīkī, bounds the International Market Place to the southwest separating the International Market Place from Kūhiō Beach. The specific proposed project areas are relatively level

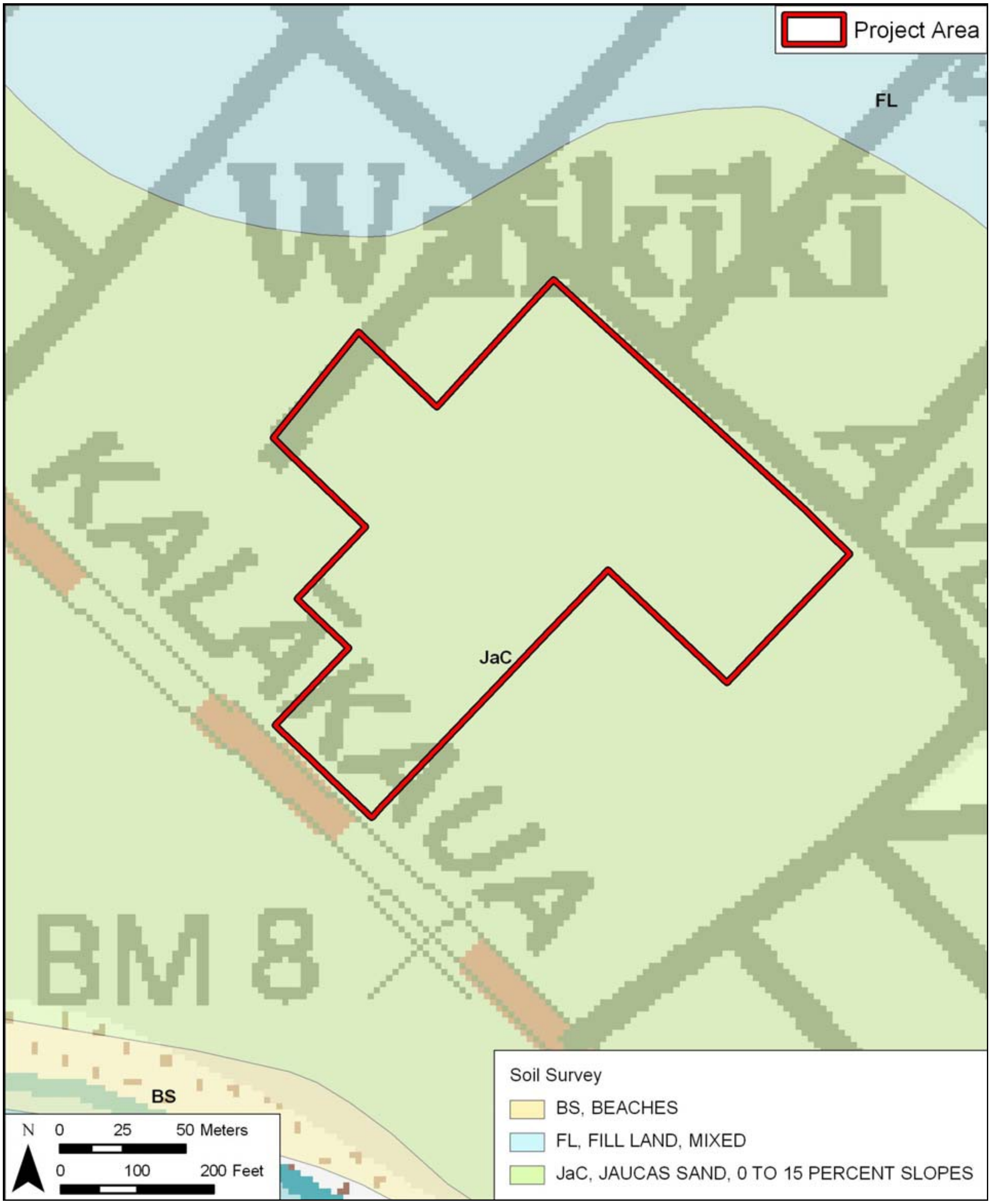

Figure 4. Overlay of Soil Survey of the State of Hawaiʻi (Foote et al. 1972), showing the sediment type within the project area (entirely Jaucas Sand).

Section 2 Background Research

Waikīkī had a previous life, long before the first tourist arrived or the first hotel was built. A brief review of the history of Waikīkī focused on the present International Market Place project area follows.

2.1 Pre-Contact to Early 1800s

The marshland of Waikīkī was watered from streams in the Makiki, Mānoa, and Pālolo Valleys and from springs in Mānoa (Punahou and Kānewai). The name Waikīkī, which means "water spurting from many sources," was well adapted to the character of the swampy land of ancient Waikīkī, where water from the upland valleys would gush forth from underground. Before the construction of the Ala Wai Canal, the Mānoa and Pālolo Streams did not merge until deep within Waikīkī. As they entered the flat Waikīkī Plain, the names of the streams changed; the Mānoa became the Kālia and the Pālolo became the Pāhoa. They joined near Hamohamo (now an area *mauka* of the Kapahulu Library) and then divided into three new streams, the Kuekaunahi, ‘Āpuakēhau, and Pi‘inaio. The Kuekaunahi once emptied into the sea at Hamohamo (near the intersection of ‘Ōhua and Kalākaua Avenues), the ‘Āpuakēhau, also called the *Muliwai o Kawehewehe*, or "the stream that opens the way" (Kanahele 1995:7) on some maps, emptied in the ocean at Helumoa (between the Royal Hawaiian and Moana Hotels), and the Pi‘inaio entered the sea at Kālia as a wide delta. The land between these three streams was called Waikolu, meaning "three waters" (Kanahele 1995:7-8).

Waikīkī, by the time of the arrival of Europeans in the Hawaiian Islands during the late eighteenth century, had long been a center of population and political power on O‘ahu. According to Martha Beckwith (1940), by the end of the fourteenth century, Waikīkī had become "the ruling seat of the chiefs of O‘ahu." George Kanahele (1995:62) relates that the ruling chief Ma‘ilikūkāhi made the decision:

> ..to move his capital from ‘Ewa to Waikīkī around 1400. As a result, for the next 400 years – and until Honolulu became the trading center of the Kingdom of Hawai‘i in the early 1800s – Waikīkī remained one of the main political and economic centers of O‘ahu.

Ma‘ilikūkāhi was known as a kind chief and was greatly loved by his subjects who enjoyed prosperity and peace under his reign (Kamakau 1964:223). Ma‘ilikūkāhi won the respect and loyalty of his people: "Because of his exceedingly great concern for the prosperity of the kingdom…". (Kamakau 1991:55).

Kanahele (1995:134) notes the continuity in the royal residences: "The royal residences were generally located in the same areas that all of Waikīkī's ancient chiefs had located their residences for hundreds of years." Kanahele (1995:134-1345) goes on to explain that, "Three features were common to royal locations in Waikīkī. They were situated 1) near the beach, 2) next to a stream or *‘auwai* (canal), and 3) among a grove of cocoanut or *kou* trees."

Hibbard and Franzen (1986:2) note that:

> When old Hawaiians refer to O‘ahu they recall, ‘ke one ‘ai ali‘i o Kākuhihewa’, or the chief-consuming sands of Kakuhikewa. Kakuhihewa was a famous ali‘i (chief) who ruled O‘ahu during the late 1500s. He lived at Ulukou, Waikiki on the spot now occupied by the Moana Hotel. His reign was marked by great prosperity during which all the invading chiefs from other islands were defeated. The sands at Ulukou were known as chief-eating sands because of the strength of this great chief. Kakuhikewa’s Waikiki came to epitomize the golden era of aboriginal Hawaiian history and is mentioned frequently in traditional Hawaiian chants as well as contemporary song. Five generations before Kakuhihewa’s birth, circa 1450, Ma‘ilikukahi first established Waikiki as the government center for the island of O‘ahu. From this time until 1809, when Kamehameha I moved his court to Honolulu, Waikiki was the seat of power for O‘ahu. Originally Waikiki encompassed a larger area than the section we are familiar with today.

The preeminence of Waikīkī continued into the eighteenth century and is betokened by Kamehameha’s decision to reside there upon wresting control of O‘ahu by defeating the island’s chief, Kalanikūpule. The 19th-century Hawaiian historian John Papa ‘Ī‘ī (1959:17), himself a member of the *ali‘i* (chiefly class), described the king’s Waikīkī residence:

> Kamehameha’s houses were at Puaaliilii, makai of the old road [now Kalakaua Avenue], and extended as far as the west side of the sands of ‘Apuakehau [Stream]. Within it was Helumoa where Ka‘ahumanu mā [Ka‘ahumanu’s people] went to while away the time. The king built a stone house there, enclosed by a fence . . . . (‘Ī‘ī 1959:17)

‘Ī‘ī further noted that the “place had long been a residence of chiefs. It is said that it had been Kekuapoi's home, through her husband Kahahana, since the time of Kahekili” (‘Ī‘ī 1959:17).

Chiefly residences, however, were only one element of a complex of features – that characterized Waikīkī up to pre-contact times. Beginning in the fifteenth century, a vast system of irrigated taro fields was constructed, extending across the littoral plain from Waikīkī to lower Mānoa and Pālolo valleys. This field system – an impressive feat of engineering the design of which is traditionally attributed to the chief Kalamakua – took advantage of streams descending from Makiki, Mānoa and Pālolo valleys which also provided ample fresh water for the Hawaiians living in the *ahupua‘a.* Water was also available from springs in nearby Mō‘ili‘ili and Punahou. Closer to the Waikīkī shoreline, coconut groves and fishponds dotted the landscape, as shown on early historic maps (Figure 5 and Figure 6). A sizeable population developed amidst this Hawaiian-engineered abundance. Captain George Vancouver (1798:161-164), arriving at “Whyteete” in 1792, captured something of this profusion in his journals:

> On shores, the villages appeared numerous, large, and in good repair; and the surrounding country pleasingly interspersed with deep, though not extensive valleys; which, with the plains near the sea-side, presented a high degree of cultivation and fertility.
>
> [Our] guides led us to the northward through the village, to an exceedingly well-made causeway, about twelve feet broad, with a ditch on each side.

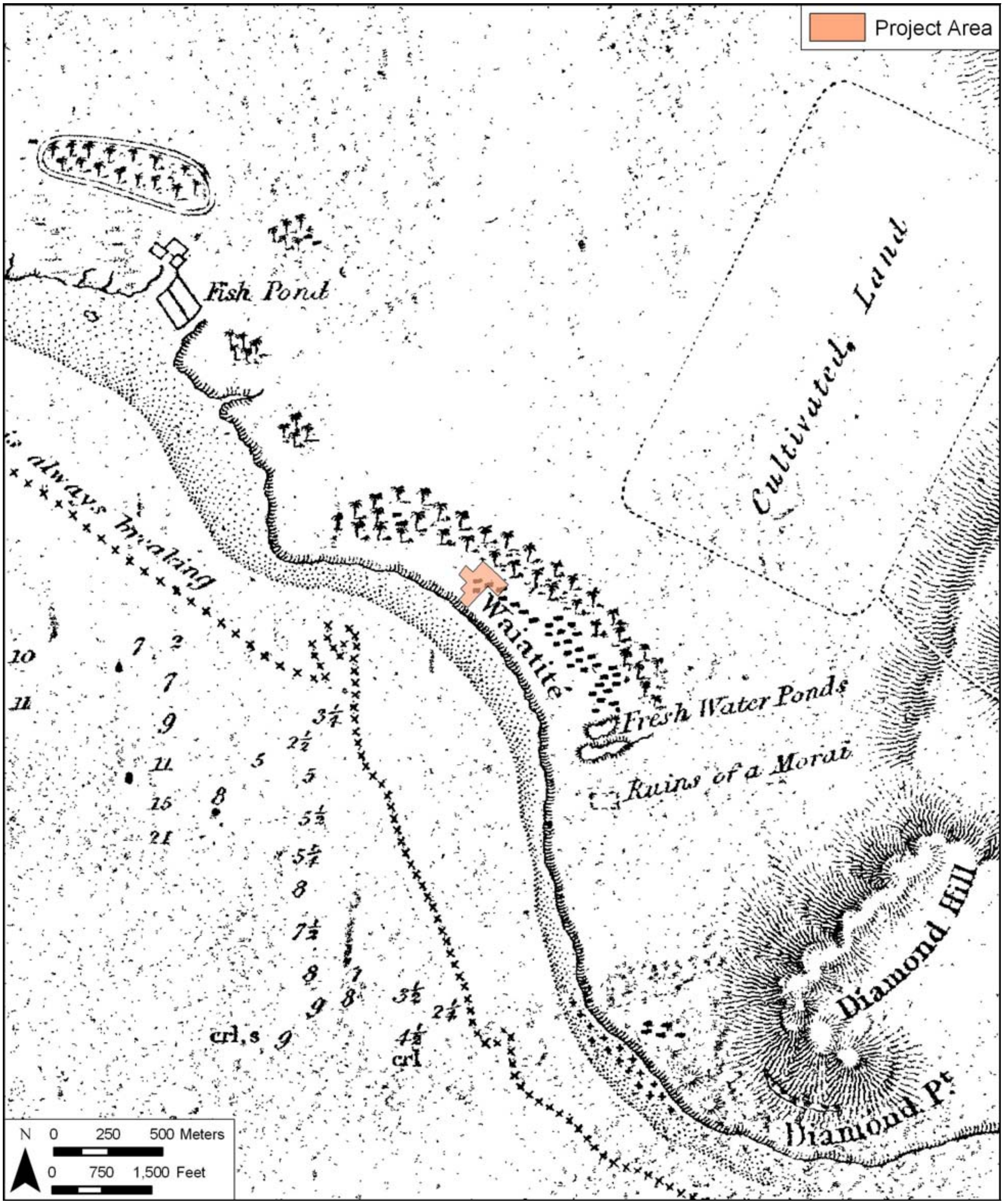

Figure 5. 1825 map of the "South Coast of Woahoo and Honorurou Harbour," by Lt. Charles R. Malden from the British ship *Blonde*, showing the project area in the village of "Waitite" [Waikīkī] (Registered Map No 431, Hawai'i Land Survey Division)

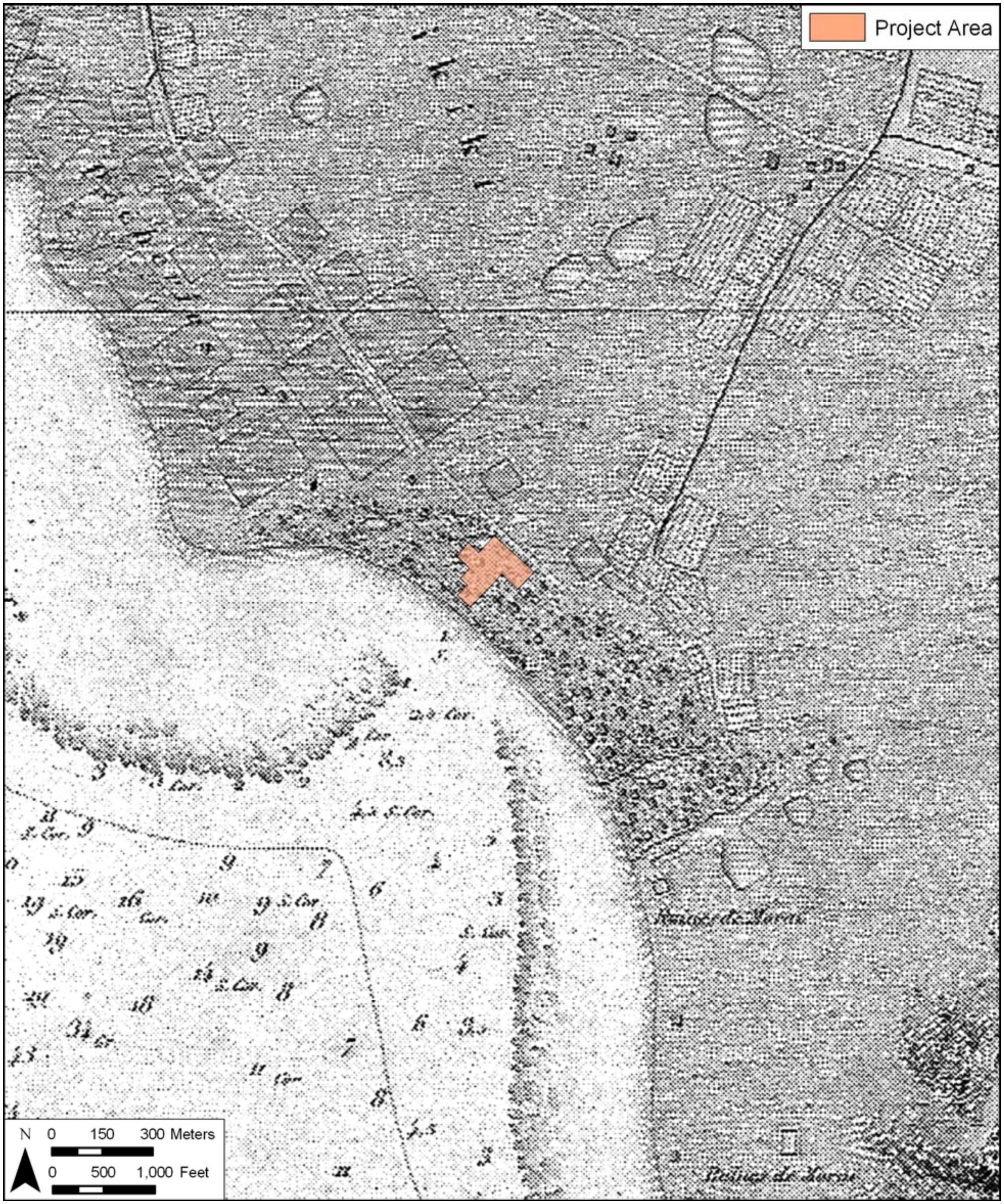

Figure 6. 1855 map of southeastern O‘ahu by Joseph Marie Henri de LaPasse, of the French ship *Eurydice* (map reprinted in Fitzpatrick 1986:82-83), showing study parcel surrounded by the taro fields (rectangles) around Waikīkī

> This opened our view to a spacious plain, which, in the immediate vicinity of the village, had the appearance of the open common fields in England; but, on advancing, the major part appeared to be divided into fields of irregular shape and figure, which were separated from each other by low stone walls, and were in a very high state of cultivation. These several portions of land were planted with the eddo or taro root, in different stages of inundation; none being perfectly dry, and some from three to six or seven inches under water. The causeway led us near a mile from the beach, at the end of which was the water we were in quest of. It was a rivulet five or six feet wide, and about two or three feet deep, well banked up, and nearly motionless; some small rills only, finding a passage through the dams that checked the sluggish stream, by which a constant supply was afforded to the taro plantations.
>
> [We] found the plain in a high state of cultivation, mostly under immediate crops of taro; and abounding with a variety of wild fowl, chiefly of the duck kind . . . The sides of the hills, which were at some distance, seemed rocky and barren; the intermediate vallies, which were all inhabited, produced some large trees, and made a pleasing appearance. The plain, however, if we may judge from the labour bestowed on their cultivation, seemed to afford the principal proportion of the different vegetable productions on which the inhabitants depend for their subsistence.

Further details of the exuberant life that must have characterized the Hawaiians use of the lands that included the *ahupua‘a* of Waikīkī are given by Archibald Menzies (1920:23-24), a naturalist accompanying Vancouver's expedition:

> The verge of the shore was planted with a large grove of cocoanut palms, affording a delightful shade to the scattered habitations of the natives. Some of those near the beach were raised a few feet from the ground upon a kind of stage, so as to admit the surf to wash underneath them. We pursued a pleasing path back to the plantation, which was nearly level and very extensive, and laid out with great neatness into little fields planted with taro, yams, sweet potatoes and the cloth plant. These, in many cases, were divided by little banks on which grew the sugar cane and a species of Draecena without the aid of much cultivation, and the whole was watered in a most ingenious manner by dividing the general stream into little aqueducts leading in various directions so as to be able to supply the most distant fields at pleasure, and the soil seemed to repay the labour and industry of these people by the luxuriancy of its productions. Here and there we met with ponds of considerable size, and besides being well stocked with fish, they swarmed with water fowl of various kinds such as ducks, coots, water hens, bitterns, plovers and curlews.

However, the traditional Hawaiian focus on Waikīkī as a center of chiefly and agricultural activities on southeastern O‘ahu was soon to change – disrupted by the same Euro-American contact which produced the first documentation (including the records cited above) of that traditional life. The *ahupua‘a* of Honolulu - with the only sheltered harbor on O‘ahu - became the center for trade with visiting foreign vessels, drawing increasing numbers of Hawaiians away from their traditional environments. Kamehameha himself moved his residence from Waikīkī to the coast near Honolulu harbor, likely in order to maintain his control of the lucrative trade in sandalwood that had developed. By 1828, the missionary Levi Chamberlain (1957:26), describing a journey into Waikīkī, would note:

> Our path led us along the borders of extensive plats of marshy ground, having raised banks on one or more sides, and which were once filled with water, and replenished abundantly with esculent fish; but now overgrown with tall rushes waving in the wind. The land all around for several miles has the appearance of having once been under cultivation. I entered into conversation with the natives respecting this present neglected state. They ascribed it to the decrease of population. (Chamberlain 1957:26)

Tragically, the depopulation of Waikīkī was not simply a result of the attractions of Honolulu (where, by the 1820's, the population was estimated at 6,000 to 7,000) but also of the European diseases that had devastating effects upon the Hawaiian population.

While the abundance of fishponds and streams suggest a potentially quite large pre-Contact population the demographics of pre-contact Waikīkī remain uncertain (see Kanahele 1995:32-33). The missionary census of 1831/1832 lists a relatively large population for "Waikiki" of 2,571 (Schmitt 1973:19) but this appears to include all land between Honolulu and Waimanalo (including for example Mānoa and Pālolo) and the population of Kaluaokau and vicinity remains uncertain.

2.2 Mid-Nineteenth Century and the Māhele

The depopulation of Waikīkī, however, was not total and the *ahupuaʻa* continued to sustain Hawaiians living traditionally into the mid-19th century. The Organic Acts of 1845 and 1846 initiated the process of the Māhele (the division of Hawaiian lands) which introduced private property into Hawaiian society. In 1848, the crown (Hawaiian government) and the *aliʻi* (royalty) and their land managers (*konohiki*) received their land titles. Subsequently in the Māhele, Land Commission Awards (LCAs) for *kuleana* parcels were awarded to commoners and others who could prove residency on and use of the parcels they claimed. Land Commission Award records document awardees continuing to maintain fishponds and irrigated and dry-land agricultural plots, though on a greatly reduced scale than had been previously possible with adequate manpower.

At the Māhele, the *ʻili* of Kaluaokau, including the present project area, was granted to William Lunalilo (1835-1874) – the future King Lunalilo – as part of LCA 8559 as a *konohiki* award. The *aliʻi* and their *konohiki* were not required to record the use of their large land awards, so it is to the surrounding smaller *kuleana* awards to commoners that we must look to understand the land use of this area of Waikīkī. Table 1 presents a summary of Land Commission Awards surrounding the project area. The full text of each award, including LCA 8559-B, is presented in Appendix A.

The LCA testimony indicates that the awards usually included several *loʻi* (irrigated taro patches) near streams and *muliwai* (lagoons or stream mouths) and *ʻauwai* (irrigation ditches) and at least one houselot near the beach. Important resources, such as coconut, *hau, lauhala* trees and bulrush areas were also individually claimed. One claim also included fishponds and two claims had a small pond, probably on the banks of a stream, where small fish fry were kept. Several claimed *kula* lands, which were lands used for pasture and dry-land agriculture. In one instance, a claimant specified that he grew sweet potatoes and gourds on his *kula*. Some of the awards were to the *ali‘i* and could be quite large; most to the common people consisted of one or two lots under an acre in size.

Table 1. Land Commission Awards near the project area

LCA	Claimant	*‘Ili*	Ac.	Description
104-FL	Kekuanaoa	Kālia, Kapuni, Uluniu, Piinaoi	112.9	2 *lo‘i* and 5 fishponds in Kālia, 1 *muliwai* in Piinaoi, a houselot in a coconut grove
1506	Waikiki	Ulukou	16.0	One row of taro, 1 *kula*, and 1 houselot
2006	Male	Kalokoeli	27.0	5 *lo‘i* by two ‘*auwai*, a pool for fish fry in the stream, a house lot with coconut trees
2027	Palaualelo	Mo‘okahi, Hamohamo	0.55	3 taro *lo‘i,* four bulrush *lo‘i* by two ‘*auwai*; one houselot and one *hau* tree
2079	Kauhola, wahine	Kiki, Mo‘okahi, Kawalaala	7.25	13 taro *lo‘i*; 1 ‘*auwai*, 2 *kula* lands, a pond for fish fry, *lauhala* trees, a house lot
2082	Kuene	Mo‘okahi	0.9	4 *lo‘i* at an ‘*auwai*; one houselot with two houses and 4 coconut trees
2084	Keohoka-hina	Kalokoeli, Uluko	0.53	2 *lo‘i* near ‘*auwai*; one houselot
2843	Kaanaana	Hamohamo	0.73	1 *lo‘i* and one houselot
6324	Kameheu	‘Au‘aukai	0.72	3 taro *lo‘i*; one *kula* planted in sweet potato and gourds
8452	Keohok-alolo	Hamohamo	101.92	7 lo‘i
10677	Pupuka	Mo‘okahi, Hamohamo	0.43	3 lo‘i and 3 ‘auwai

2.3 Mid to Late 1800s

As the 19th century progressed, Waikīkī was becoming a popular site among foreigners – mostly American – who had settled on O‘ahu. An 1865 article in the *Pacific Commercial Advertiser* mentioned a small community that had developed along the beach. The area continued to be popular with the *ali‘i* – the Hawaiian royalty – and several notables had residences there. A visitor to O‘ahu in 1873 described Waikīkī as “a hamlet of plain cottages, whither the people of Honolulu go to revel in bathing clothes, mosquitoes, and solitude, at odd times of the year” (Bliss 1873:195-196).

Other developments during the second half of the 19th century a prelude of changes that would dramatically alter the landscape of Waikīkī during the 20th century – include the improvement of the road connecting Waikīkī to Honolulu (the route of the present Kalākaua Ave.), the building of a tram line between the two areas, and the opening of Kapi‘olani Park on June 11, 1877. Traditional land-uses in Waikīkī were abandoned or modified. By the end of the 19th century most of the fishponds that had previously proliferated had been neglected and allowed to deteriorate. The remaining taro fields were planted in rice to supply the growing numbers of immigrant laborers imported from China and Japan, and for shipment to the west coast of the United States.

As the sugar industry throughout the Hawaiian kingdom expanded in the second half of the 19th century, the need for increased numbers of field laborers prompted passage of contract labor laws. In 1852, the first Chinese contract laborers arrived in the islands. Contracts were for five years, and pay was $3 a month plus room and board. Upon completion of their contracts, a number of the immigrants remained in the islands, many becoming merchants or rice farmers. As was happening in other locales, in the 1880’s, groups of Chinese began leasing and buying (from the Hawaiians of Waikīkī) former taro lands for conversion to rice farming. The taro lands’ availability throughout the islands in the late 1800's reflected the declining demand for taro as the native Hawaiian population diminished.

The Hawaiian Islands were well positioned for rice cultivation. A market for rice in California had developed as increasing numbers of Chinese laborers immigrated there since the mid-19th century. Similarly, as Chinese immigration to the islands also accelerated, a domestic market opened.

> The primary market for both husked rice and paddy raised in all parts of the Hawaiian Islands was in Honolulu. The number of Chinese in the islands created a large home demand.
>
> In 1880 the home market was made more secure by an increase in the duty on rice imported into Hawai‘i to 1½ cents on paddy and 2½ cents on hulled rice. It resulted in further checking the importation of foreign rice and giving an immense impetus to the home product. (Coulter and Chun 1937:130

By 1892, Waikīkī had 542 acres planted in rice, representing almost 12% of the total 4,659 acres planted in rice on O‘ahu. Most of the former taro *lo‘i* converted to rice fields were located mauka of the present Ala Wai Boulevard.

2.4 1900 to 1920

During the first decade of the 20th century, the U.S. War Department acquired more than 70 acres in the Kālia portion of Waikīkī for the establishment of a military reservation called Fort De Russy, named in honor of Brig. Gen. R.E. De Russy of the Army Corps of Engineers.

> On 12 November 1908, a detachment of the 1st Battalion of Engineers from Fort Mason, California, occupied the new post...
>
> Between 1909 and 1911 the engineers were primarily occupied with mapping the island of O‘ahu. At DeRussy other activities also had to be attended to -

> especially the filling of a portion of the fishponds which covered most of the Fort. This task fell to the Quartermaster Corps, and they accomplished it through the use of an hydraulic dredger which pumped fill from the ocean continuously for nearly a year in order to build up an area on which permanent structures could be built. Thus the Army began the transformation of Waikīkī from wetlands to solid ground. (Hibbard and Franzen 1986:79)

All the fishponds were filled by 1928.

2.5 1920s to 1930s

During the 1920's, the Waikīkī landscape would be transformed when the construction of the Ala Wai Drainage Canal, begun in 1921 and completed in 1928, resulted in the draining and filling in of the remaining ponds and irrigated fields of Waikīkī. The canal was one element of a plan to urbanize Waikīkī and the surrounding districts:

> The [Honolulu city] planning commission began by submitting street layout plans for a Waikīkī reclamation district. In January 1922 a Waikīkī improvement commission resubmitted these plans to the board of supervisors, which, in turn, approved them a year later. From this grew a wider plan that eventually reached the Kapahulu, Mō'ili'ili, and McCully districts, as well as lower Makiki and Mānoa...
>
> The standard plan for new neighborhoods, with allowances for local terrain, was to be that of a grid, with 80-foot-wide streets crossing 70-foot-wide avenues at right angles so as to leave blocks of house lots about 260 by 620 feet. Allowing for a 10-foot-wide sidewalk and a 10-foot right-of-way [alley] down the center of each block, there would be twenty house lots, each about 60 by 120 feet, in each block. (Johnson 1991:311)

During the course of the Ala Wai Canal's construction, the banana patches and ponds between the canal and the mauka side of Kalākaua Avenue were filled and the present grid of streets was laid out. These newly created land tracts spurred a rush to development in the 1930's. An article in the *Honolulu Star-Bulletin* in 1938 extolled the area's progress:

> The expansion of apartment and private residence construction is no secret. Examination of building permits will show that more projects have been completed during the past year, and more are now underway in this area, than in any other section of the territory. (Newton 1938:10)
>
> These developments are being made by island residents who have recognized the fact that Waikīkī presents the unparalleled possibility for safe investment with excellent return. (Newton 1938: 10)

The writer (Newton 1938:10) speculated that the "future of Waikīkī is assured."

2.6 1940s

The entrance of the United States into World War II following the Japanese bombing of Pearl Harbor on December 7, 1941 put on hold plans for the development of Waikīkī as a tourist destination. Until the war’s end in 1945, the tourist trade was non-existent “...since the Navy controlled travel to and from Hawai‘i and did not allow pleasure trips” (Brown 1989: 141). For the duration of the war, Waikīkī was transformed into a recreation area for military personnel.

> It was not the same Waikīkī as before the war, though; barbed wire barricades now lined its sands, and there were other changes too. Fort DeRussy became a huge recreation center, with a dance hall called Maluhia that attracted thousands of men at a time. The Moana Hotel continued to function, but many other establishments and private homes in the area were taken over by the military. (Brown 1989:141)

Nearing the war’s end, concerns began arising over the future of Waikīkī. An article in the *Honolulu Advertiser* of July 16, 1945 decried “honky-tonks” that had sprung up in Waikīkī during the course of the war, and asked: “Can anyone look at present-day Kalākaua Ave. – lined with makeshift curio shops, noisy ‘recreation’ centers, eyesores that pass under the name of lunchrooms and miscellany of ‘joints’ – and hope that Waikīkī can stage a comeback [as a tourist destination]?”

2.7 1950s

By the mid-1950’s there were more than fifty hotels and apartments from the Kālia area to the Diamond Head end of Kapi‘olani Park. The Waikīkī population, by the mid-1950’s, was not limited to transient tourists but included 11,000 permanent residents living in 4,000 single dwellings and apartments in stucco or frame buildings.

2.8 Historic Documentation of the Project Area

2.8.1 Kaluaokau

As indicated on an 1881 map of Waikīkī (Figure 7), the present International Market Place project area is situated within the *‘ili* of Kaluaokau in the *ahupua‘a* of Waikīkī. The ‘Āpuakēhau Stream extended through the southeast corner. This stream would have provided the water for the adjoining irrigated taro fields of the occupants.

In the definitive book on Hawaiian place names by Mary Pukui and others, *Place Names of Hawai‘i* (Pukui et al. 1974), no meaning is given for this place name Kaluaokau. In a pamphlet on the history of the International Market Place, the place name is spelled Ka-lua-o-kau, with “*ka”* translated as “the” and “*lua”* translated as “pit.” The pamphlet suggests two possible meanings for the word *kau*. “Kau” is a star in the northern sky that served as a guide for sea travelers, and as such this area may have been a location of celestial observation. The word “*kau*” also means “to discuss” and may have served to describe “a pit where discussions took place” (Queen Emma Foundation n.d.). Others have interpreted “*kau*” as “place”, thus Kaluaokau is “the place of the pit” (Acson 2003: 46).

These suggestions are based on the idea that the pronunciation of the name is Ka-lua-o-kau; however, a Hawaiian ethnologist, Henry Kekahuna spelled the place name as Ka-lu‘a-o-ka‘u. The term *lu‘a* can mean “heap, pile, or grave.” Ka‘u is usually a proper noun. Using this pronunciation, Thrum (1922:641) translated this place name as “the grave” (*lu‘a*) of Ka‘u,” possibly referring to a person named Ka‘u. In summary, the ancient meaning of Kaluaokau is unknown. There are numerous possible meanings for the words *lua*, *luʻa*, *kau*, and *kaʻu,* and depending on the pronunciation, several possible combinations of the root words.

2.8.2 Royal Residence, Pre-Contact to 1885

Laʻie-lohelohe, the daughter of noted Waikiki chief Kalamakua, was raised within the bounds of Kaluaokau. She was betrothed to a Maui chief and later gave birth to Kiha-a-Piʻilani, the great Maui leader. He was born at ʻĀpuakēhau, a *heiau* (ceremonial structure) once on the beach near Kaluaokau (Kamakau 1991:49).

The 1881 map (Figure 7) identifies the *ʻili* of Helumoa just *makai* of Kaluaokau. Both are on the major cross-*ahupuaʻa* trail that once extended along the southern Oʻahu coast. The present-day alignment of Kalākaua Avenue covers the eastern portion of this trail through Waikīkī, passing through Helumoa and crossing the ʻĀpuakēhau Stream.

In *Fragments of Hawaiian History* John Papa ʻĪʻī described the "Honolulu trails of about 1810" (ʻĪʻī 1959: 89), including the trail from Honolulu to Waikīkī, which ran just south of the proposed project area (Figure 8):

> The trail from Kawaiahao which led to lower Waikiki went along Kaananiau, into the coconut grove at Pawaa, the coconut grove of Kuakuaka, then down to Piinaio; along the upper side of Kahanaumaikai's coconut grove, along the border of Kaihikapu pond, into Kawehewehe; then through the center of Helumoa of Puaaliilii, down to the mouth of the Apuakehau stream; along the sandy beach of Ulukou to Kapuni, where the surfs roll in; thence to the stream of Kuekaunahi; to Waiaula . . . (ʻĪʻī 1959:92)

Helumoa was the site of Kamehameha I's residence in Waikīkī following his conquest of Oʻahu Island. Mid-nineteenth century Māhele documents confirm the significance of this portion of Waikīkī – including Helumoa, Kaluaokau, and adjacent *ʻili* – in the lives of the Hawaiian *aliʻi*. For example, in the vicinity the present Royal Hawaiian Hotel were portions of at least two *kuleana* LCAs: 228 to Kaleiheana and 1445 to Kanemakua. Land use data for LCAs 228 and 1445 document multiple *ʻāpana* (lots). Testifying on December 11, 1848, Kanemakua reported that he had lived there since the time of Kamehameha II. He also claimed seven houses, three irrigation ditches and three streams all belonging to him. According to testimony his "House lot, [was] situated in Helumoa, Waititi and bounded: *Mauka* by Kekuanaoa's land, Waialae by an arm of the sea, *Makai*, the sea, Honolulu by Kaluahinenui's" (Waihona ʻAina 2000).

LCA 228 was granted to Kaleiheana in 1847. John ʻĪʻī stated in testimony regarding the property:

> . . . I have seen this land and these names which are written in this claim document are the attendants of Kamehameha 1. Their work was taking care of the house and preparing the food. These people were in constant contact with the chiefs and were close to each and every chief. When Kamehameha I died, they continued to live on the property and when the chief returned from Hawaii Kalaiheana went to live there. These people have lived there since Kamehameha II to Kaahumanu's reign, and to the year 1846 when Kuluwailehua had raised objections.

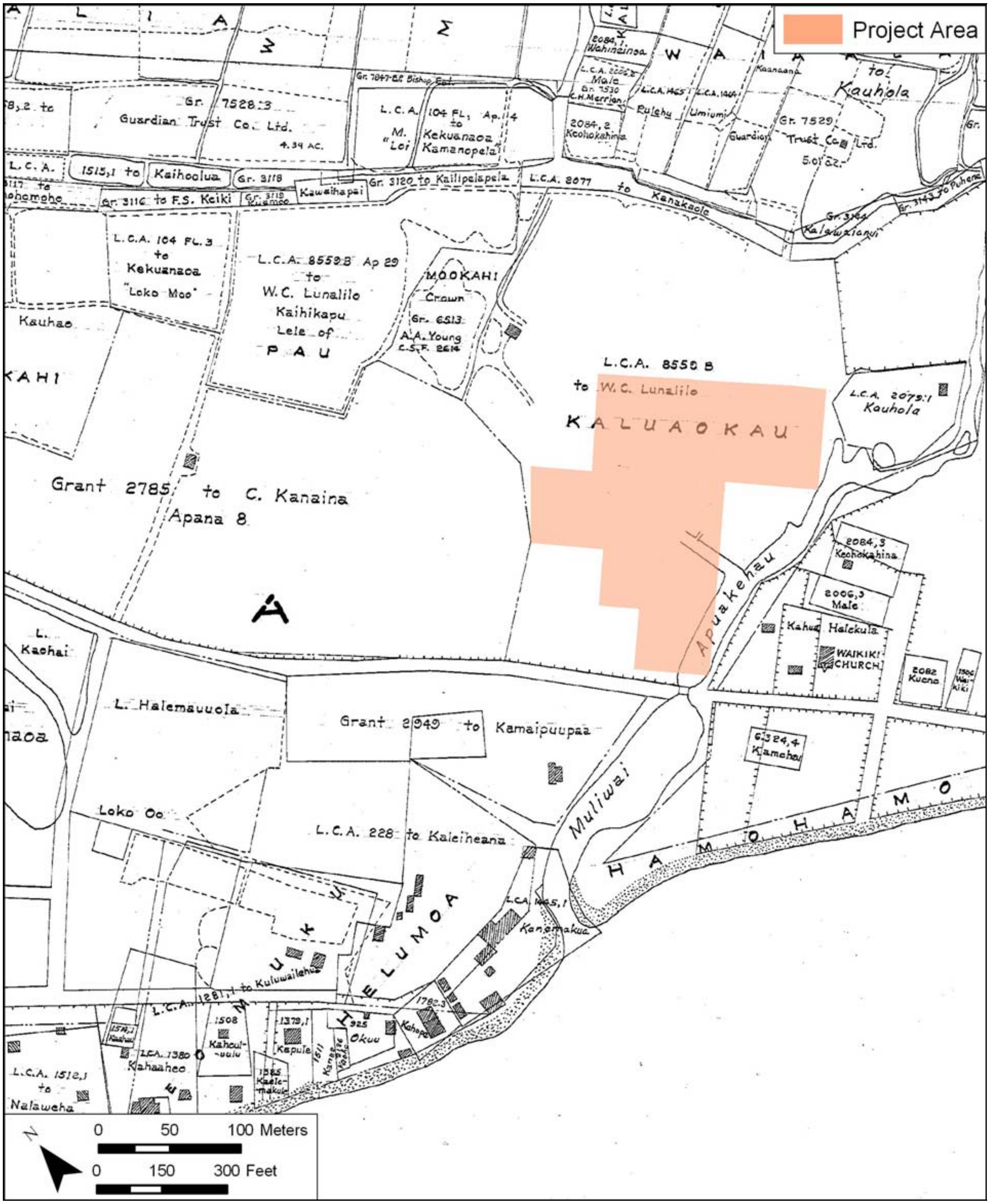

Figure 7. 1881 map of Waikīkī by S.E. Bishop showing location of Kaluaokau, Helumoa and the ʻĀpuakēhau Stream (Registered Map No. 1090. On file at the Hawai'i Land Survey Division)

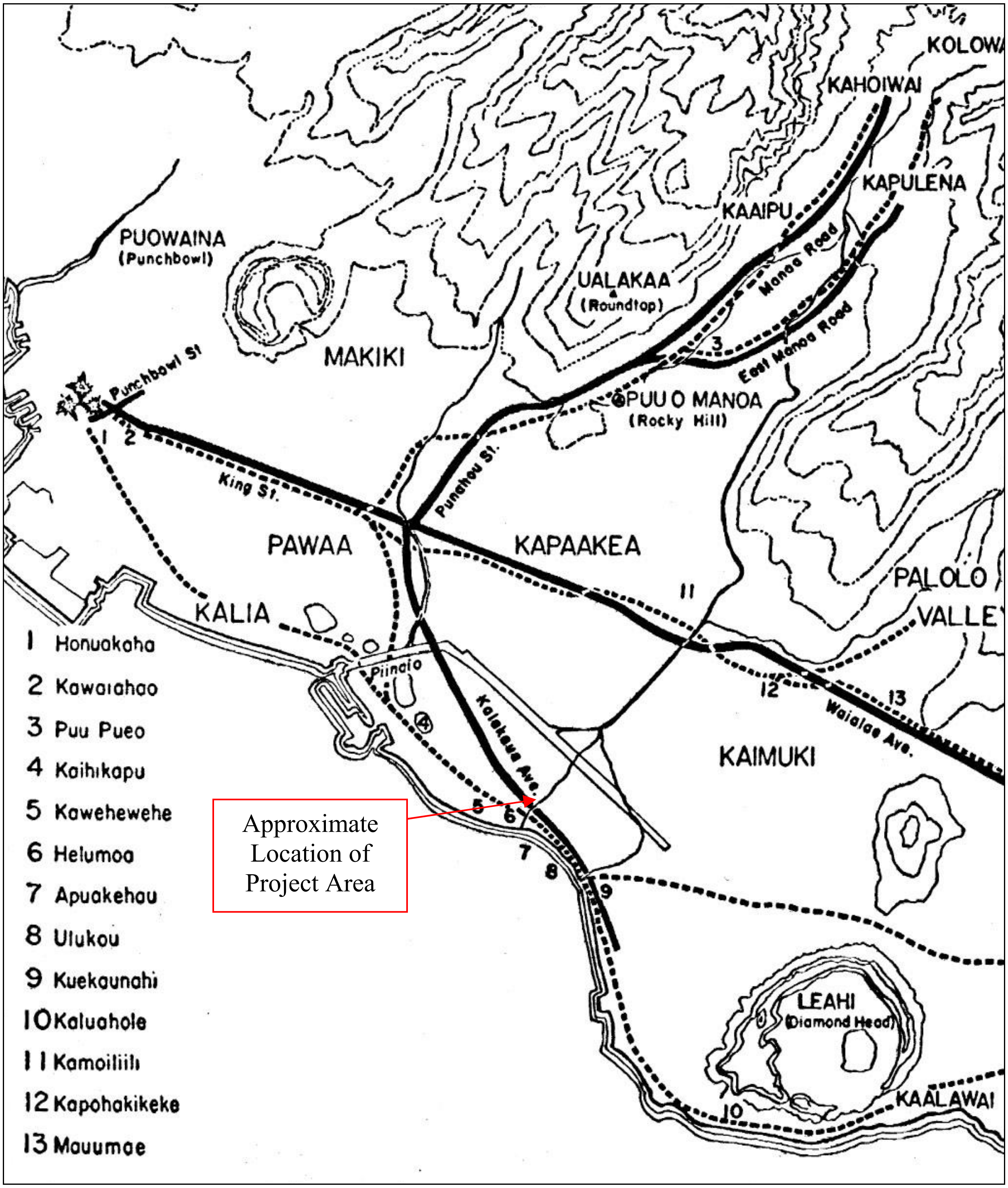

Figure 8. Early nineteenth century trails on the southwest coast of O'ahu (illustration from 'Ī'ī 1959:93), showing locations of some place names in Waikīkī and approximate location of the project area

It is further stated that Kamehameha I lived on this land until his death and subsequently the land has been the resting place for the chiefs down to Kamehameha V.

Regarding the neighboring *‘ili* of Kaluaokau, it appears that Kaluaokau was purchased sometime in the mid-nineteenth century by Henry Macfarlane, an entrepreneur from New Zealand who had settled on O‘ahu. It was Macfarlane and his wife who planted the banyan tree currently growing in the center of the International Market Place. They lived on this property for a while, eventually raising six children, some of who became financiers for sugar plantations and for the early tourist industry in Waikīkī (Hibbard and Franzen 1986: 66-67).

Subsequently, at the Māhele, the *‘ili* of Kaluaokau was granted to William Lunalilo (1835-1874) – the future King Lunalilo – as part of LCA 8559-. Lunalilo was the son of Charles Kana‘āina, and the grandson of Kalaimamahu, who was Kamehameha I's half-brother. Lunalilo was known as the "People's King"; he was democratically elected in 1873 defeating Kalākaua.

Lunalilo enjoyed "the quiet life of Waikīkī", and living "on fish and *poi* with his native friends," while visiting his residence at Kaluaokau.

Lunalilo used his beach cottage to recover from the effects of tuberculosis. Queen Emma visited him during one of his periods of convalescence. She noted in a letter to her cousin:

> One night he (Lunalilo) he slept out on the grass in front of his house [at] Waikiki where he is now and took cold in his injured lungs. [This] brought on another attack of pleurisy . . . Then an intermittent feaver [*sic*] came on every day in the afternoon. . . . .
>
> I went Sunday noon [for] the first time since his illness. He talked with me incessantly for 2 hours or more and did not wish me to leave so soon. When I returned to his bed and wished him goodbye, he said, "Oh, that is too long—as if you will not come again—say good day instead. Poor man, he was very weak . . . and appeared extremely ill. (letter cited in Korn 1976:84-85)

Following Lunalilo's death in 1874, his Kaluaokau home and land were bequeathed to Queen Emma, the widow of King Kamehameha IV, Alexander Liholiho, who had died in 1863. Queen Emma is known to have resided occasionally on the Waikīkī property before her death in 1885. An old photograph (Figure 9), taken sometime during her residence (1874-1885) shows the simple beach cottage. An 1880 (Figure 10) photograph shows the *makai* portion of the estate, the portion from Beach Road to the coast, with a long wall adjacent to ‘Āpuakēhau Stream. Queen Emma had Papa‘ena‘ena Heiau on the slopes of Diamond Head dismantled, and she used the rocks to build a fence to surround her Waikīkī estate (Kanahele 1995:136).

In 1878, Queen Emma sued the Lunalilo Trust, as she believed her bequest from Lunalilo should have included the entire 29-acre Kaluaokau parcel, not just the 4-acres of land immediately around the house lot. From this suit, a little information on the land is presented. The testimony states that the land was referred to as the "Marine Residence" by King Lunalilo and it consisted of a residence, a detached cottage, and outbuildings, surrounded by a fence to keep out straying animals. Queen Emma wanted the entire parcel, including access to the water (Āpuakēhau Stream) and the taro growing on the property. The suit mentions that the first structure on the property was a simple grass hut. Queen Emma won her suit, as the court determined that the term "Marine Residence" used in Lunalilo's will, although ambiguous,

Figure 9. Photograph (taken between 1874 and 1885) of the Waikīkī cottage at Kaluaokau, owned by King Lunalilo and bequeathed to Queen Emma (Bishop Museum Archives; reprinted in Grant 1996:22-23)

Figure 10. 1880 photograph of the *makai* portion of the King Lunalilo / Queen Emma estate at Kaluaokau, view from the Beach Road / Kalākaua Avenue (on right) towards the mouth of ʻĀpuakēhau Stream (Hawaiʻi State Archives, reprinted in Kapono 2009:19)

probably referred to the entire Kaluaokau (spelled Kaluakau in the testimony) parcel (Hawaiian Reports 1883:82-88). A 1915 Land Court Application map (Figure 11) shows the extent of this estate, including a small section that extends *makai* to the sea, and includes several small outbuildings ("lanai") and a canoe shed.

In the 1885 will of Queen Emma, her lands were put in trust, the proceeds to benefit the Queen's Hospital in Honolulu, who Queen Emma, along with her husband, Kamehameha IV, had helped to found.

2.8.1 Late Nineteenth and Twentieth Century Residential and Tourist Area

An 1875-1877 "working map," by C. J. Lyons of the surveyor's triangulation points for Waikīkī (Figure 12) shows the position of the Kamehameha V cottage at Helumoa and the position of the Lunalilo cottage in Kaluaokau, adjacent to the ʻĀpuakēhau Stream. This working map was later used to create several finished maps of the *ʻili* of Waikīkī, but on those maps the locations of the two cottages were not marked. The location of King Lunalilo's cottage seems to be outside the southwest of the current project area. This accords well with a description of the Royal Hawaiian Hotel in a 1930 tour guide, which states; "Near where the tennis-courts are now used to be the home of King Lunalilo" (Griffis 1930:61). On the 1915 Land Court Application map (see Figure 11), the tennis courts are southwest of the border of the current project area.

An 1893 map (Figure 13) shows the project area in an uncultivated area surrounded by swampland, probably still used to grow taro, with rice fields *mauka* of the property. Although no houses are shown in the project area on this map, this does not mean that there was not a cottage on the property. Early surveyors only mapped what they considered substantial "permanent" structures, but did not map grass houses or "beach cottages." An 1897 map by M. D. Monsarrat (Figure 14) shows that the present project area parcel *makai* of the Beach Road (the future Kalākaua Avenue) to the southwest, with ʻĀpuakēhau Stream coursing through the southeastern section. The 1897 map shows one large house, perpendicular to the orientation of the stream, south of an inlet, labeled "Queen Emma." This label probably refers to the property, owned by the Queen Emma trust, as the map post-dates Queen Emma's death in 1885. Whether this structure was a building which dates to the time of Queen Emma's residence is unknown. It does not seem to be in the same area as the Lunalilo cottage, which was in the tennis court area southwest and outside of the project area.

In the late nineteenth century, the Waikīkī beach area in Ulukou and Kahaloa was dotted with small cottages and some bathing houses. These "bathing houses," placed strategically near the beach, were places where people could change into their bathing suits, rent towels, and walk directly into the ocean. One of the first of these bathhouses was the "Long Branch Baths," named after a popular New Jersey resort. This long wooden shed was built near the edge of ʻĀpuakēhau Stream by James Dodd in 1881 at the former residence of Kākuhihewa.

W. C. Peacock, a wealthy Honolulu landowner, had a seaside cottage in Waikīkī east of ʻĀpuakēhau Stream. He tore down his cottage and built the Moana Hotel, which opened March 11, 1901. The first hotel building had 75 rooms, each with its own private bath and telephone, an unheard of luxury. In 1905, Peacock sold the hotel to Alexander Young, who had an interest in several other Hawaiian hotels. Young's estate managed the hotel until 1928, when it was

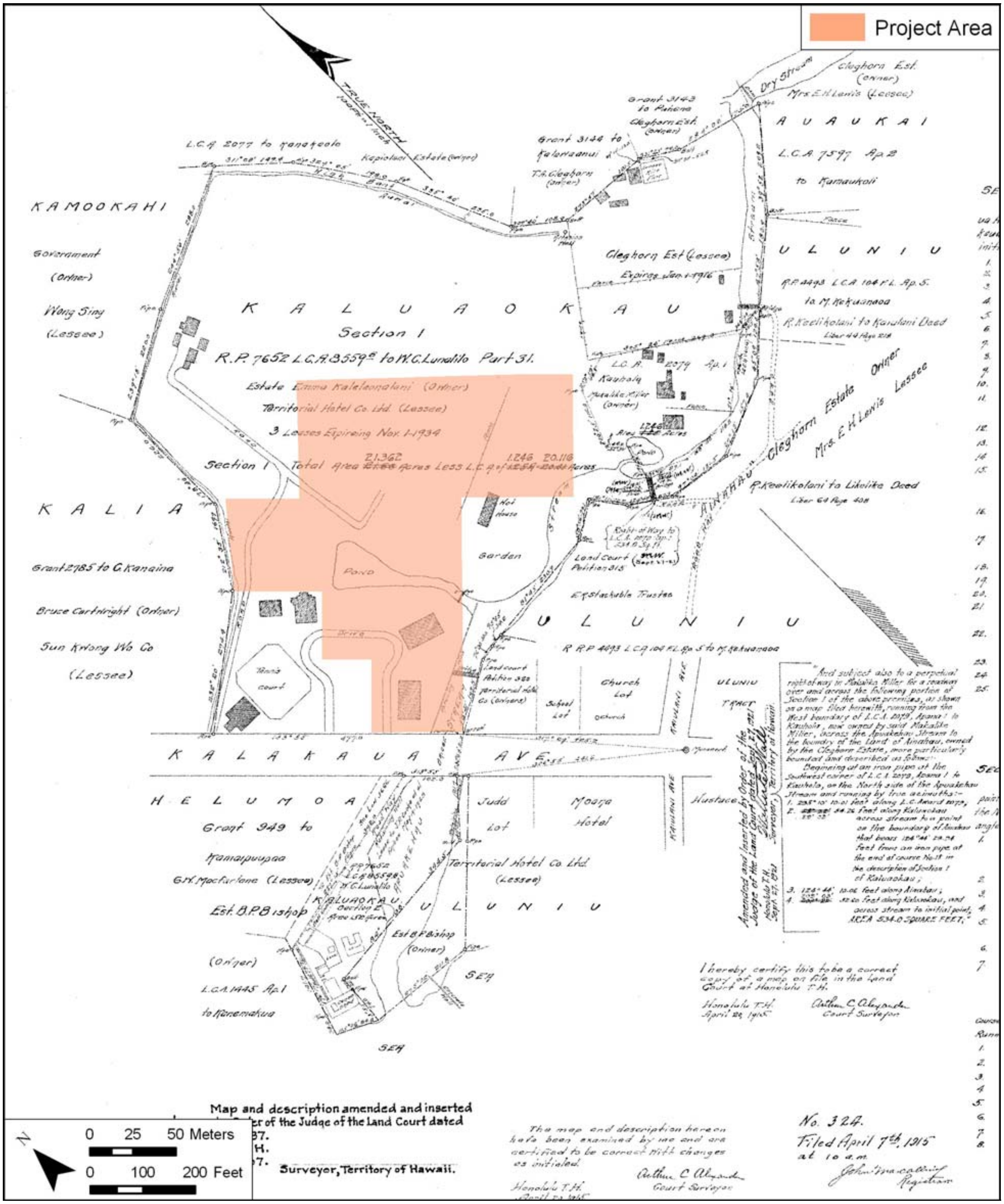

Figure 11. 1915 map of Kaluaokau showing the extent of the land bequeathed by King Lunalilo to Queen Emma in relation to the project area (Hawai'i Land Survey Division, Land Court Application Map No. 324)

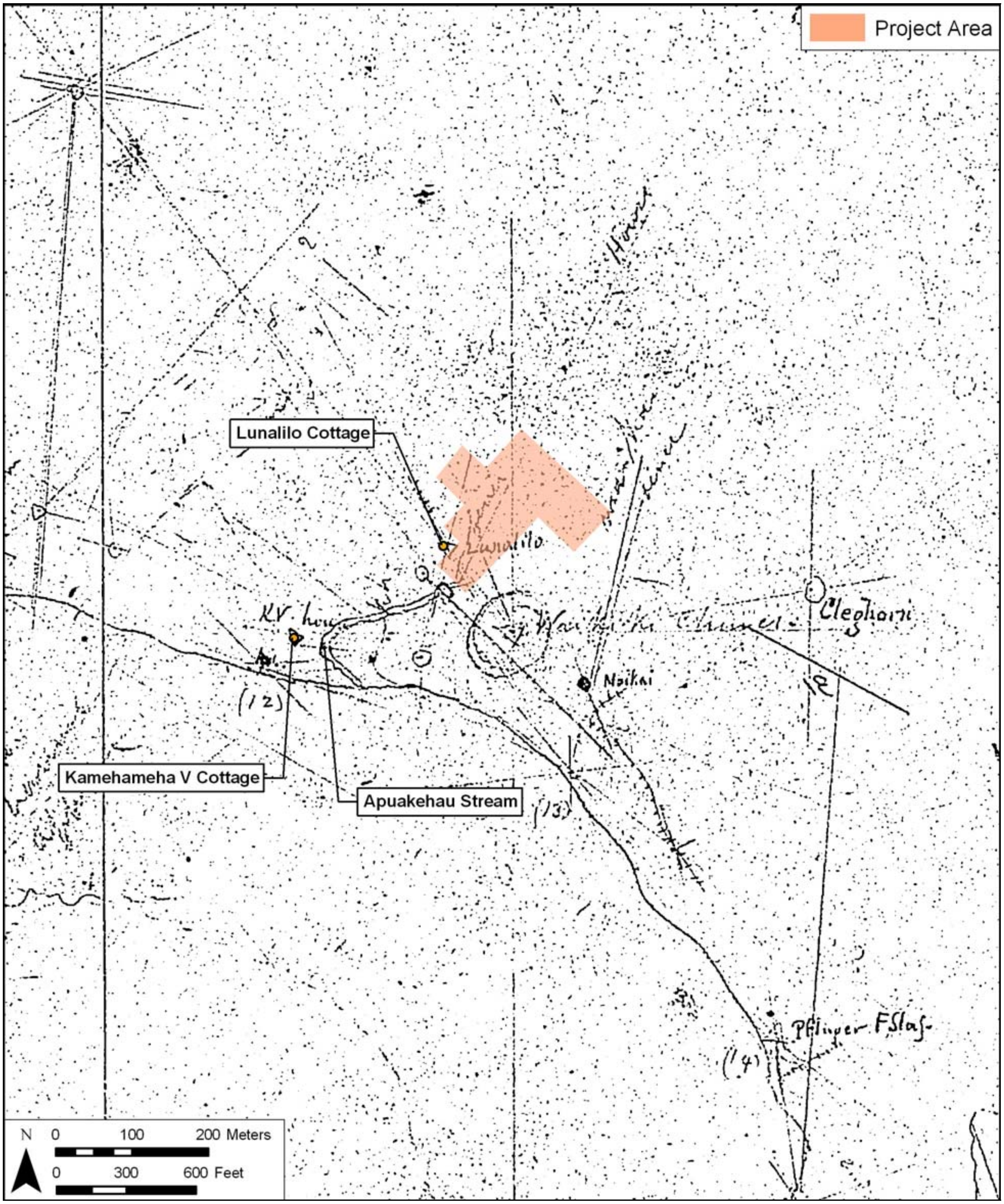

Figure 12. 1875-1877 working map of Waikīkī triangulation points, by C. J. Lyons, depicting the locations of the Kamehameha V cottage at Helumoa and the Lunalilo Cottage at Kaluaokau, in relation to the 'Apuakēhau Stream

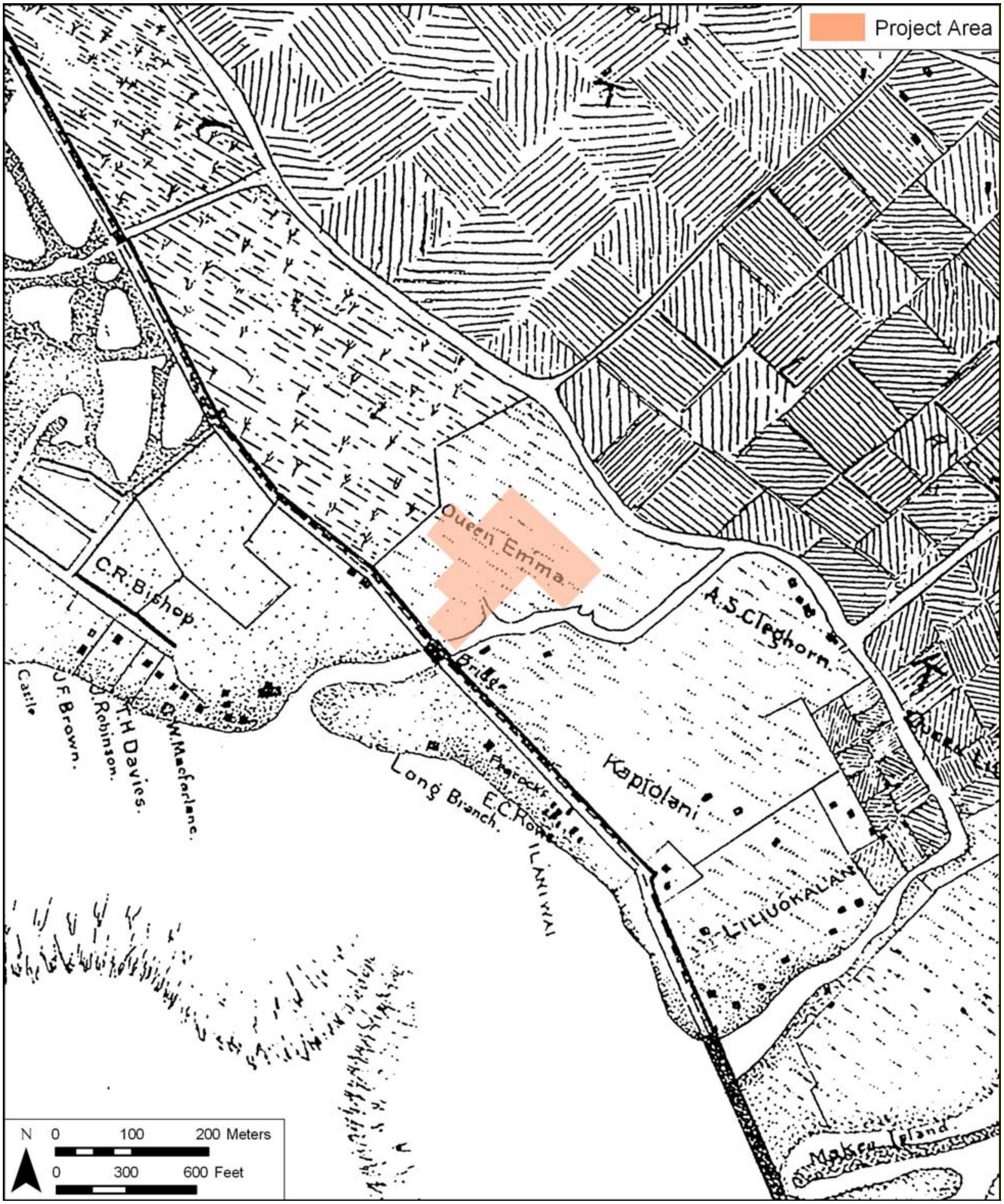

Figure 13. 1893 map of Honolulu and Vicinity by W. A. Wall, showing project area on land owned by the Queen Emma estate (Registered Map No. 1690, Hawai'i Land Survey Division)

purchased by the Matson Navigation Company for $1.6 million. Matson purchased the hotel to cater to the new steamship tourists that were flocking to Hawaii as a vacation spot. Under the title of the Territorial Hotel Co., Ltd., Matson operated a number of hotels in Hawai‘i, including the Moana, the Royal Hawaiian, and its predecessor the Seaside Hotel.

The Seaside Hotel was built in 1906, and consisted of a ten-acre parcel west of ‘Āpuakēhau Stream, and west of the Moana Hotel. Scattered on the grounds were bungalows and tent houses for guests who liked a “folksy, family-style living” (Scott 1968:623). Many famous people came to stay at the hotel, including Alice Roosevelt Longworth, the daughter of the Theodore Roosevelt, and Jack London, who wrote several of his South Pacific stories at the hotel during his stay.

A 1910-1917 U.S. Engineers map (Figure 15) shows the project area in the taro area, with rice fields *mauka* marked by earthen berms. On this map, two large rectangular structures are shown, a structure oriented “diagonal” to ‘Āpuakēhau Stream, and a structure south and oriented parallel to the stream. These structures also appear on a 1927-28 U.S. Geological survey map (Figure 16) and a 1943 U.S. War Department map (Figure 17).

A 1914 Sanborn Fire Insurance map (Figure 18) shows the diagonal and parallel structures labeled as “Moana Hot’l Rooms” of the Moana Hotel. It also shows several smaller structures labeled “Moana Hot’l Cottages.” The structures are also shown on the 1915 Land Application map (see Figure 11). These structures can be clearly seen on a 1920 photograph (Figure 19) just northwest of the H-shaped Moana Hotel. On a 1929 photograph (Figure 20), the parallel structure can still be seen, but the diagonal structure is probably hidden by the trees.

The original construction date of these hotel rooms and cottages is unknown, although they must predate 1914, the date of the Land Court Application map. The size and roof lines of the two larger structures are identical, indicating that they were built at the same time and for the same function. The two large rectangular structures were probably built by the Moana Hotel as auxiliary Hotel Rooms sometime between the Moana Hotel’s opening in 1901 and the date of the Sanborn Fire Insurance and Land Court Application maps of 1914-1915.

A 1927 Sanborn Fire Insurance map (Figure 21) shows the Moana Rooms and Cottages, the tennis courts, and a horse-shoe shaped drive surrounding a “pavilion” in area labeled as the “Seaside Hotel.” This is probably the horseshoe-shaped drive of the Seaside Hotel mentioned by Scott (1969:623) as “in the lattice-front entrance, on the *mauka* side, were the hotel offices facing a horseshoe driveway that entered from a connecting roadway off Waikiki Road.” The map also shows two long strips used for automobile parking (labeled “A”). The Outrigger Canoe Club, then located across Kalākaua Avenue on the site of the present Outrigger Hotel, leased parking space in this area in the 1920s. East of the project area, the Moana also built a power plant and hotel garage.

Sadao Hikida (born 1914), an interviewee for the *Oral History Project* conducted by the Social Science Research Institute, University of Hawaii, sheds further light on the early years of the Moana Hotel:

> The Moana Hotel in those early years, 1920-30s, was self-supporting; they had their own facilities. They had their own power plant to supply hot water, steam and cold drinking water from their own well, electric plan and shop, paint shop,

Figure 14. 1897 map of Honolulu, Hawaiian Islands, by M.D. Monsarrat map, showing proposed project area; one structure in the project area is labeled “Queen Emma” (Registered Map No. 1910, Hawai‘i Land Survey Division)

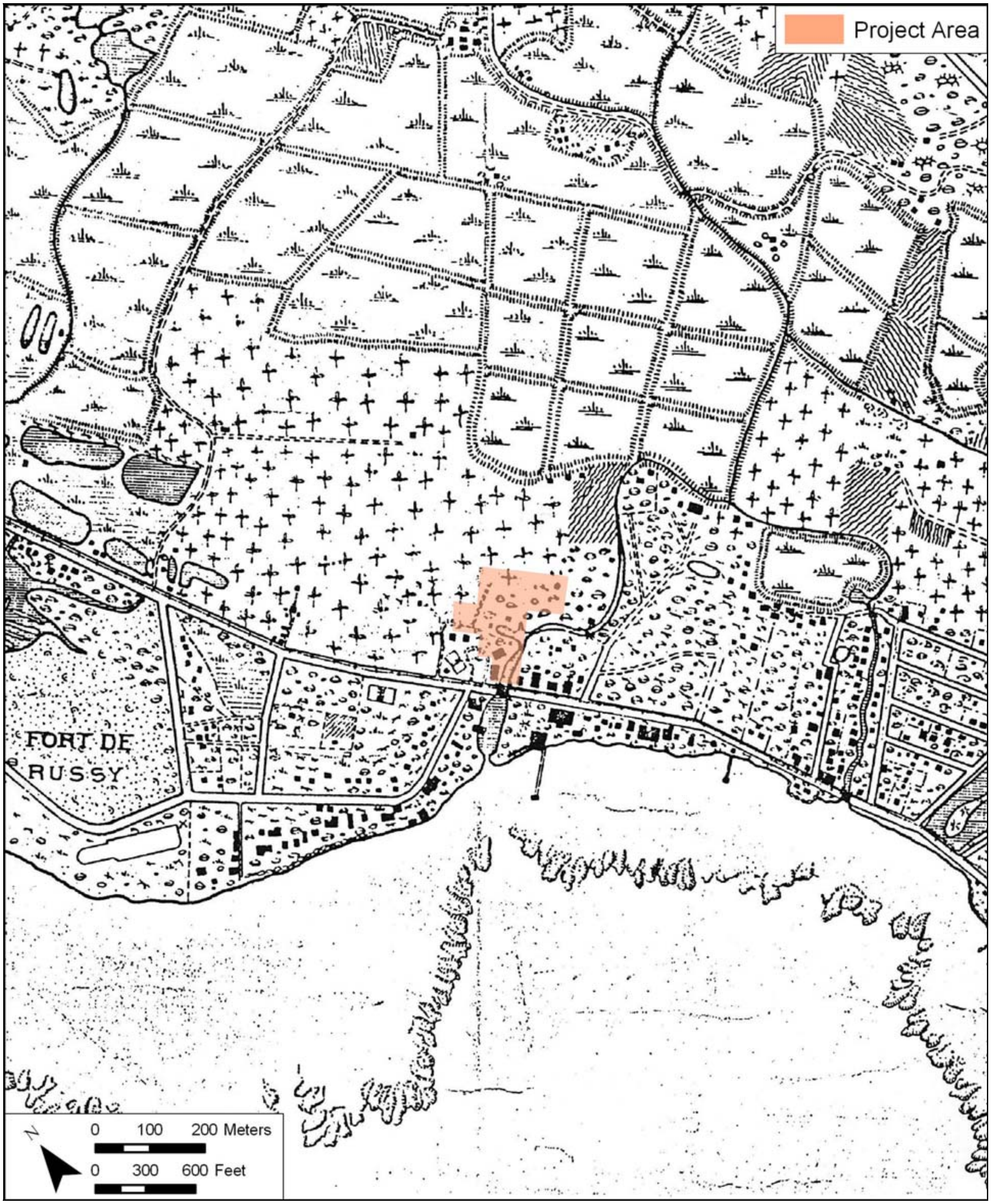

Figure 15. 1910-1917 U.S. Engineers map with the approximate location of the project area indicated (Copy of map at Cultural Surveys Hawai'i Library)

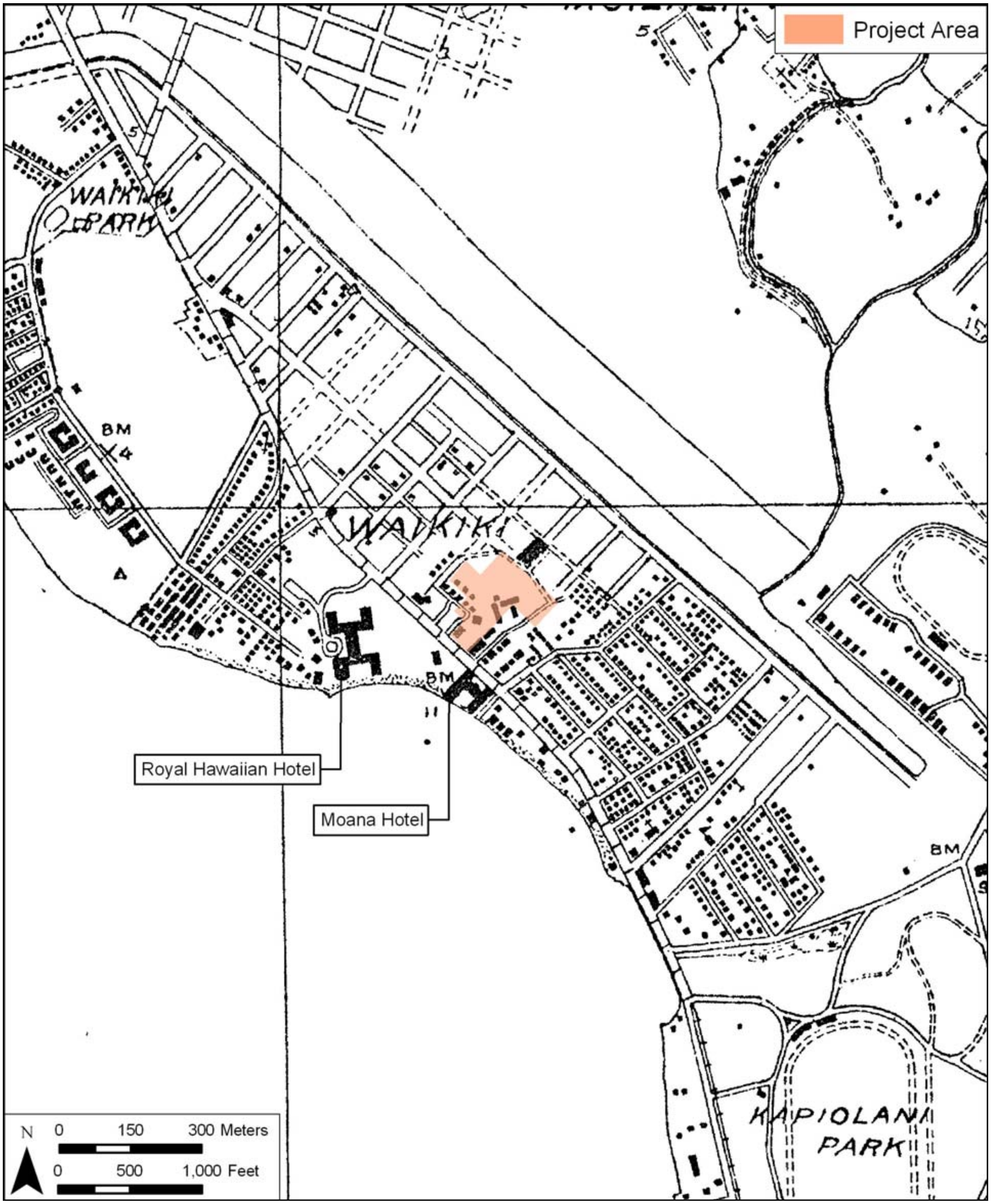

Figure 16. 1927 U.S. Geological Survey map, Honolulu Quadrangle, showing the project area northwest of the Moana Hotel and northeast of the Royal Hawaiian Hotel

Figure 17. 1943 U. S. War Department map, Diamond Head quadrangle, showing the proposed project area

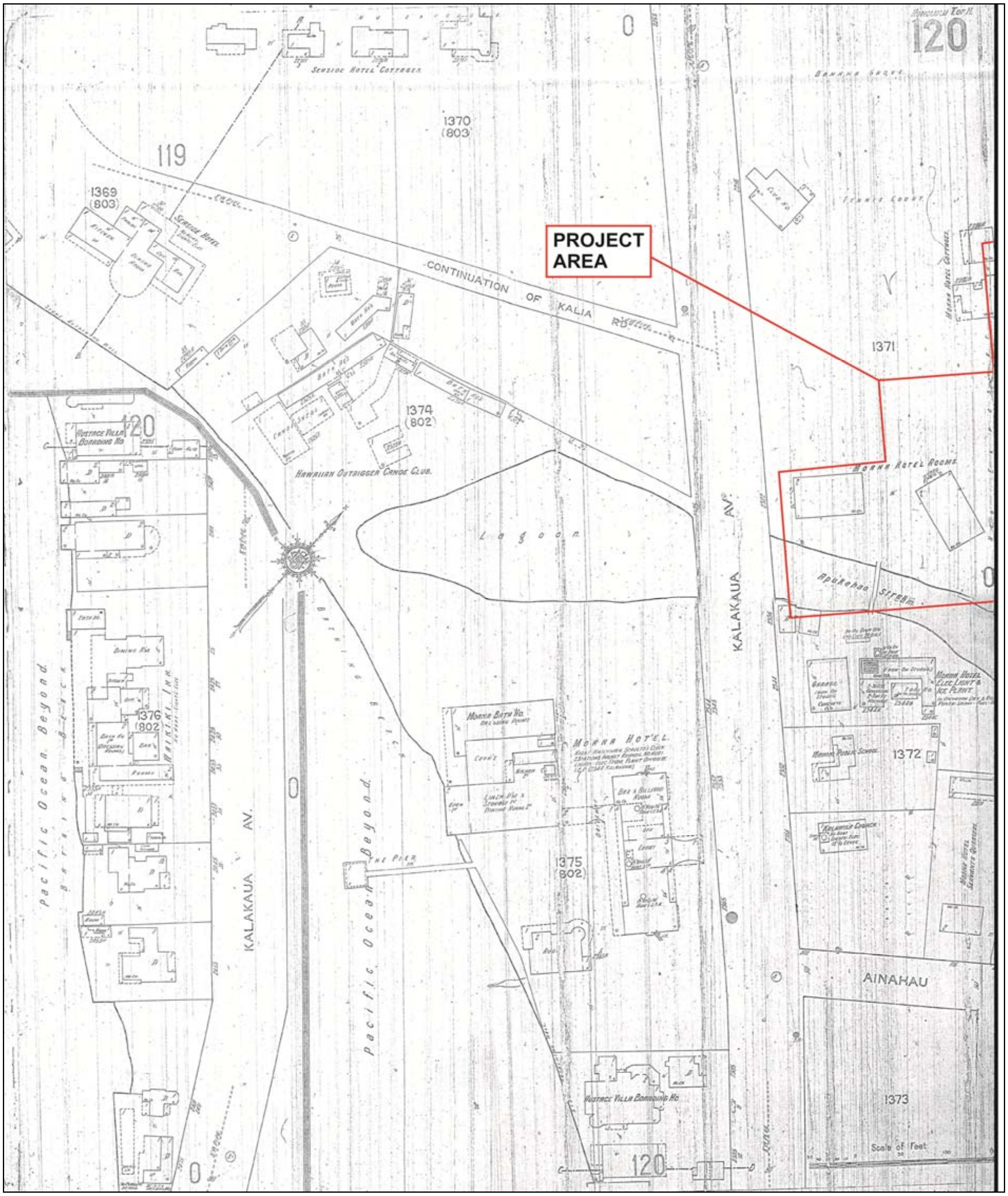

Figure 18. 1914 Sanborn Fire Insurance map with seaward portion of the project location (note: the “0” on the right edge of the map indicates that there is no adjoining map); the two structures in the southern portion of the project area are labeled “Moana Hot’l Rooms”; two smaller structures on the west side are labeled “Moana Hot’l Cottages” (Sanborn Fire Insurance Co. 1914)

Figure 19. 1920 aerial photograph of the Moana Hotel coastal area, showing general project area; the two structures (diagonal and parallel to the stream) shown on earlier maps are still present (U.S. Army Air Service, reprinted in Cohen 1995:59)

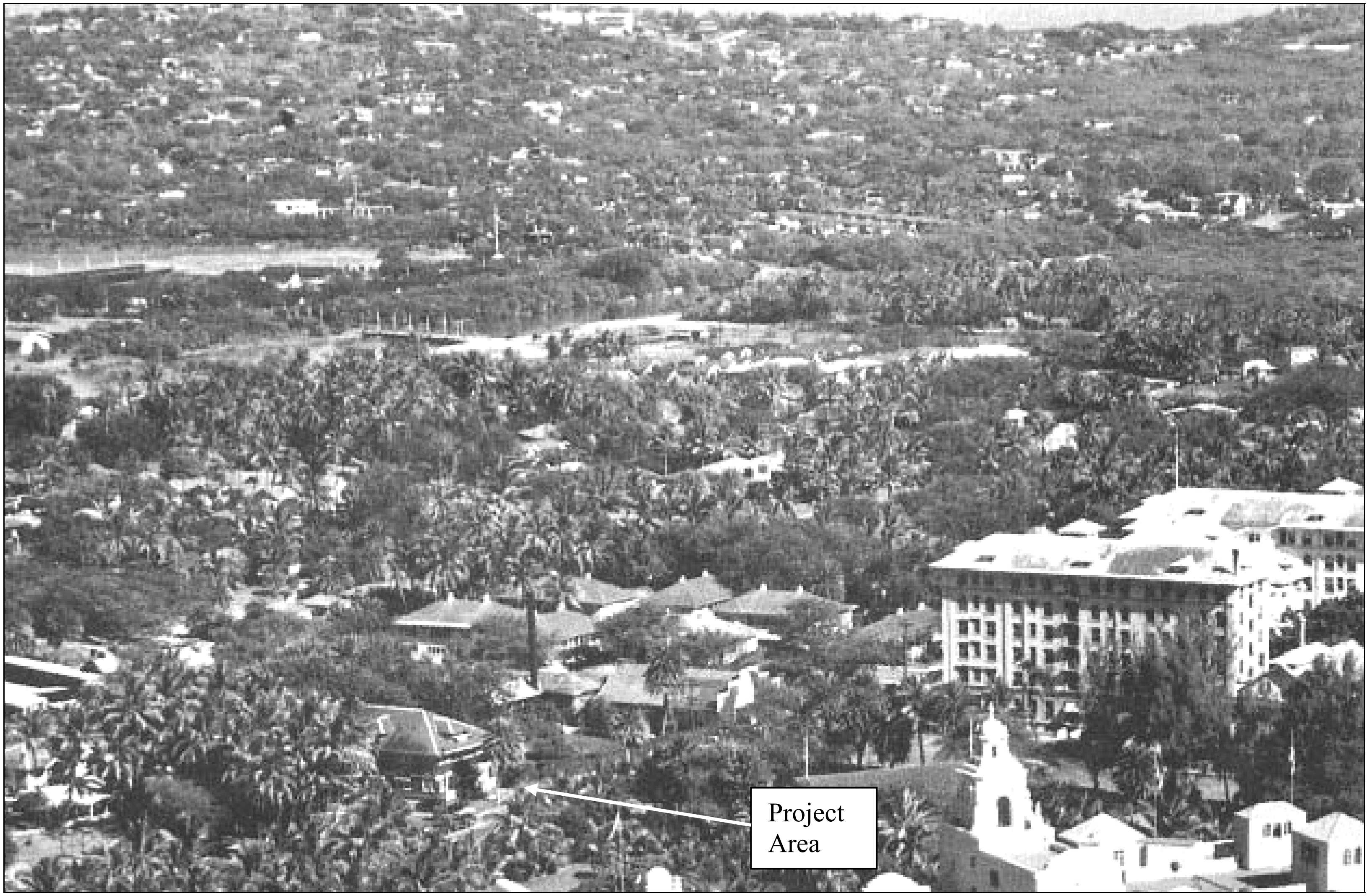

Figure 20. 1929 aerial photograph of Waikīkī, showing numerous cottages behind the Moana Hotel (Hawai'i State Archives, reprinted in Brown 1985:40); one of the older structures is still present, but the original Queen Emma Trust house is hidden

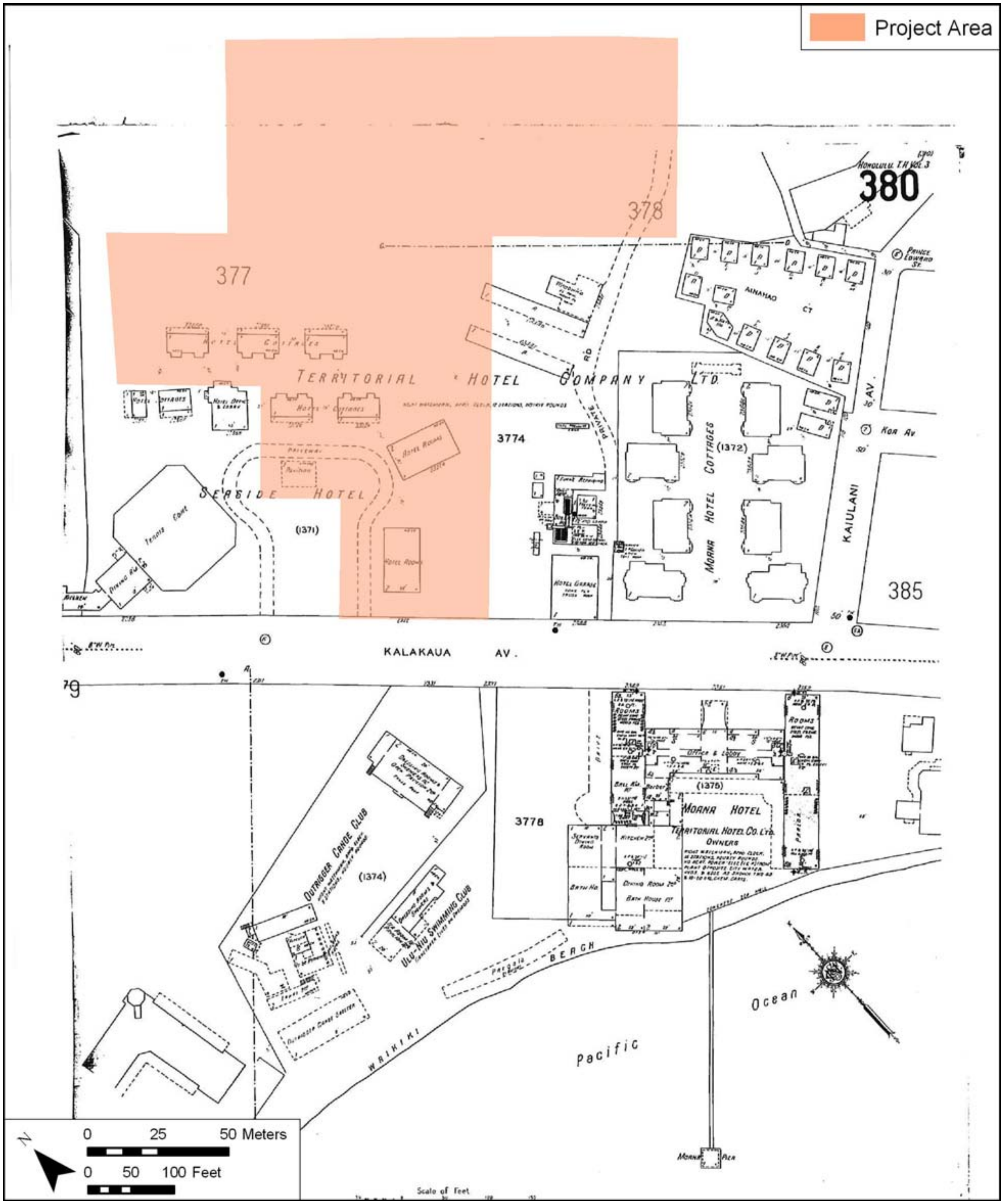

Figure 21. 1927 Sanborn Fire Insurance Map (Sheet 380), showing the project area with structure labeled for the Seaside Hotel and the Moana Hotel, both owned by the Territorial Hotel Company

> ice plant, carpenter shop, machine shop, upholstery shed, disposal yard, drying room, garden (flower and vegetable), fish pond, garage, plumbing shop, and living quarters for the single and married employees of the Moana, Seaside, and Royal Hawaiian Hotels. (Social Science Research Institute 1985:973)

By the 1920s, the Territorial Hotel Company owned the Moana Hotel and held the lease for the Seaside Hotel. In 1925, they began to move many of the bungalows and cottages on the Seaside Hotel beach area to the *mauka* side of Kalākaua Avenue to clear the ground for the construction of the new Royal Hawaiian Hotel. An oral history interviewee, Beatrice Tominagam, who lived in the Moana Hotel employee housing area east of Ka‘iuilani Street from 1919 to 1925, has memories of life in this area when she was just a young girl:

> Oh, when we were there when I was a little girl, this was an empty lot. Just empty, nothing was on it. When I was living there, we watched them build these four big beautiful buildings (and a small two-bedroom cottage). They were beautiful (and painted white). They were two stories and they had a chimney on each one of them, and a big yard. The hotel called it the Moana Hotel Annex. And then, this part, ‘Ainahau Court, had many two-bedroom cottages and lot of date trees over here. We used to pick dates when they fell on the ground. (Beatrice Tominagam, in University of Hawai‘i 1985:1986).

The four buildings referred to are probably four of the eight structures labeled “Moana Hotel Cottages” on the west side of Ka‘iuilani Avenue, east of the project area on the 1927 Sanborn map (see Figure 21). The ‘Āinahau Court is *mauka* of these structures.

> The Moana Hotel Annex, were (for) hotel guests. (A) lot of them were from Australia, New Zealand and Canada. Some from Europe, of course, and some from the United States. Mostly White, of course. (Beatrice Tominagam, in University of Hawai‘i 1985:1986-1987).

Mrs. Tominagam remembers that many of the buildings on the *mauka* side of Kalakaua Avenue were used for hotel guests; not all the buildings were used for hotel employees. The small cottages *mauka* of the Moana Annex, in the ‘Āinahau Court, were also for visitors. She noted: “Ainahau Court, were (for) Mainland people who rented those cottages and they lived there for many years.” In the current project area:

> Oh, this area right here where the International Market [Place] is now was the Seaside Hotel cottages that they moved from Kālia Road to make room for the Royal Hawaiian Hotel. They moved them here and they were over here. They were cottages, you see. After the war [World War II] they got rid of those cottages. And in the middle 1950s they built the International Market Place. (Beatrice Tominagam, in University of Hawai‘i 1985:1986-1987).

Stan Cohen (1997:42), in his book on the Princess Ka‘iulani Hotel, recounts “In 1920 cottages and an expansive lawn were built across Kalākaua Avenue at the former site of ‘Āinahau.” These generally refer to a number of small rectangular cottages directly opposite the Moana Hotel on the *mauka* side of Kalākaua Avenue, east of Ka‘iulani Avenue and east of the current project area. These neatly aligned cottages can be seen on the 1929 aerial photograph (see Figure 20) directly across Kalākaua Avenue from the main entrance of the Moana Hotel.

On a 1950 Sanborn map (Figure 22), the two large rectangular structures in the project area are still labeled as “Hotel Rooms,” and a series of smaller cottages, the former beachside Seaside bungalows, are labeled as “Hotel Cottages.” The area within the horseshoe drive has a number of kitchen and dining facilities. In the northeastern section of the project area, the Miramar Hotel parcel, the Moana built a series of interconnecting structures for hotel maintenance, including shops for pipes, woodworking, furniture, and pillows and mattresses.

On the 1956 Sanborn map (Figure 23), all of the hotel rooms and cottages are gone, and most of the land is labeled as “Parking.” The only remaining hotel structures are the kitchen and dining facilities in the horseshoe-shaped driveway area.

By the mid-1950s, there were more than fifty hotels and apartments from the Kālia area to the Diamond Head end of Kapi‘olani Park. The Waikīkī population, by the mid-1950s, was not limited to transient tourists but included 11,000 permanent residents living in 4,000 single-dwellings and apartments in stucco or frame buildings. By the late 1950s, a row of retail shops had been constructed along Kalākaua Avenue. In 1952, Matson built a new hotel adjacent to the Moana on the east side, called the Surfrider Hotel. The 1953 U.S. War Department map of O‘ahu (Figure 24) shows this addition, and significant development in Waikīkī. Matson sold all of its Waikīkī hotel properties to the Sheraton Company in 1959 and no longer required housing for its hotel staff. Additionally, properties were likely cleared in anticipation of the extensive development that occurred throughout Waikīkī in the 1960s and 1970s.

The International Market Place (Figure 25) was built in 1957, as described in the market’s history:

> On January 16, 1955, entrepreneur Donn Beach (Don the Beachcomber) announced plans for a “Waikiki Village” that was to be called “The International Market Place”. Designed originally to encompass 14 acres between the Waikiki Theater and the Princess Ka‘iulani, extending from Kalakaua Avenue halfway to Kuhio Avenue, the International Market Place was to be a “casual, tropical village with arts, crafts, entertainment, and foods of Hawai‘i’s truly diverse people...including Hawaiian, South Sea islander, Japanese, Chinese, Indian, and Filipino...” (Queen Emma Foundation n.d.)

In the same timeframe the present Miramar Hotel parcel was being re-developed. Circa 1950 (Figure 22) there was a mattress and awning shop on the parcel understood as a “back-of-house” portion of the Matson Navigation Hawaiian Hotels Division. This was largely cleared out by 1956 (Figure 23). In 1961 a four-story “Waikiki International Terminal Parking Garage and Transportation Center” was developed including a service station and restaurant fronting Kūhiō Avenue and with a large covered terminal loading area on the *makai* side. The 349-room, 22-floor Miramar Hotel (see Figure 26) was constructed almost immediately thereafter in 1962 incorporating the recent construction. It started as a sister hotel to the Miramar Hotel in Hong Kong and it is decorated in a predominantly Chinese motif. The Miramar Hotel was purchased in 1976 by the Milford (International) Investment Co., Ltd. (Young 2010).

2.8.2 Summary of Land Use in the Project Area

In the pre-contact period, the project area, within the *‘ili* of Kaluaokau, was the home of the Hawaiian *ali‘i*, including La‘ielohelohe, the daughter of noted Waikīkī chief Kalamakua. In the

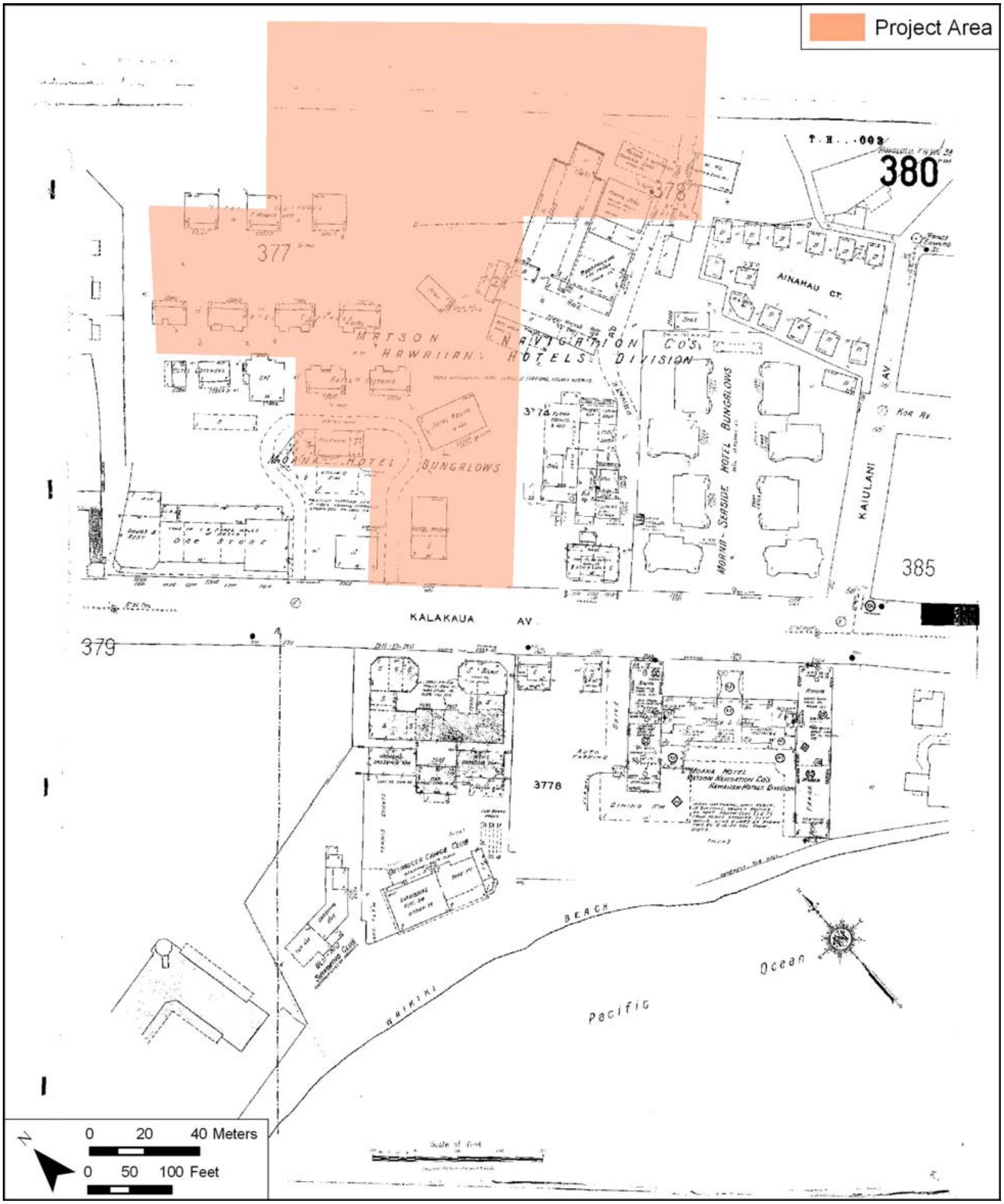

Figure 22. 1950 Sanborn Fire insurance map showing structures in project area during early 1950s (Sanborn Fire Insurance Co. 1927)

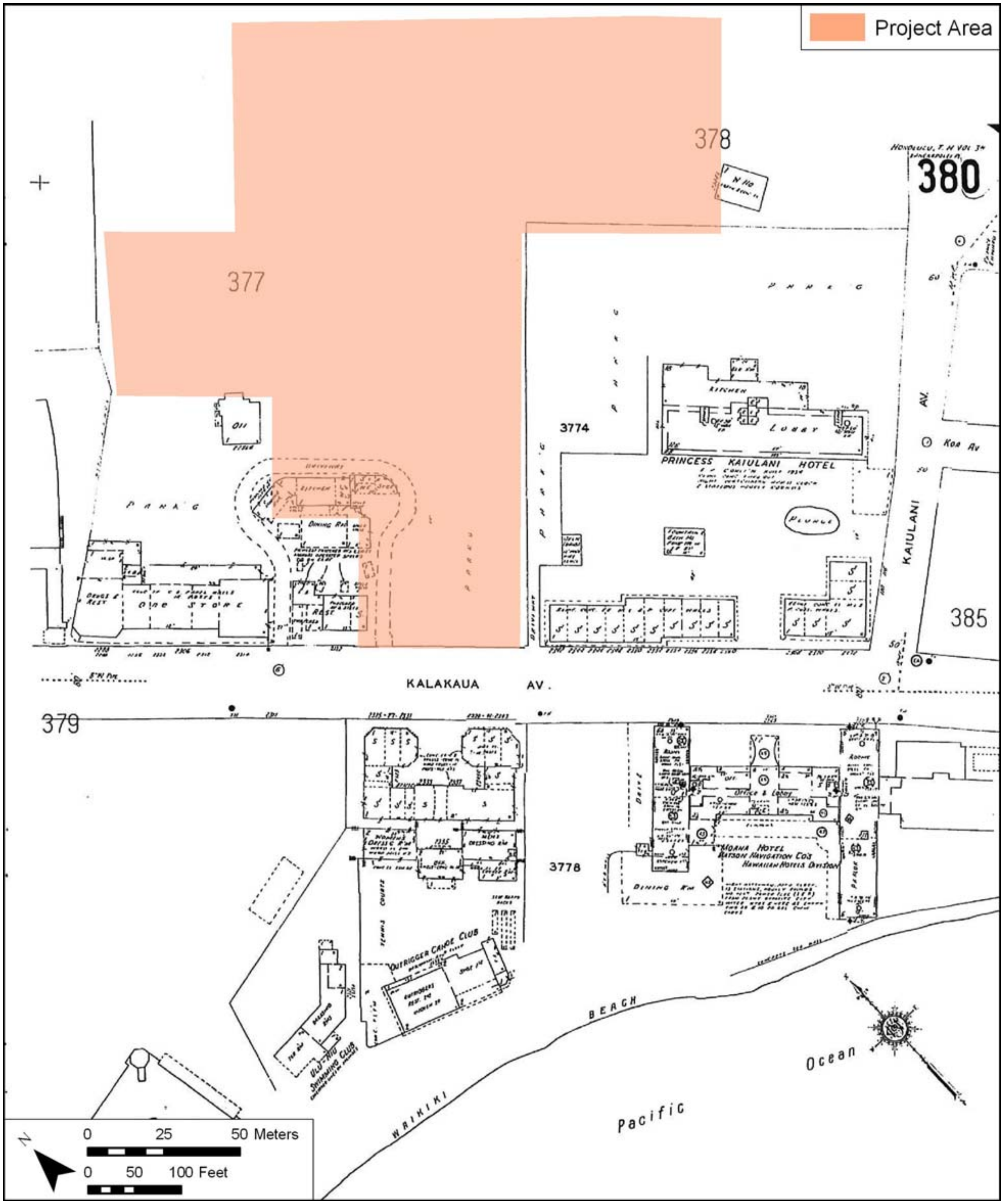

Figure 23. 1956 Sanborn Fire Insurance Map, showing the removal of most of the Moana Hotel structures in the project area

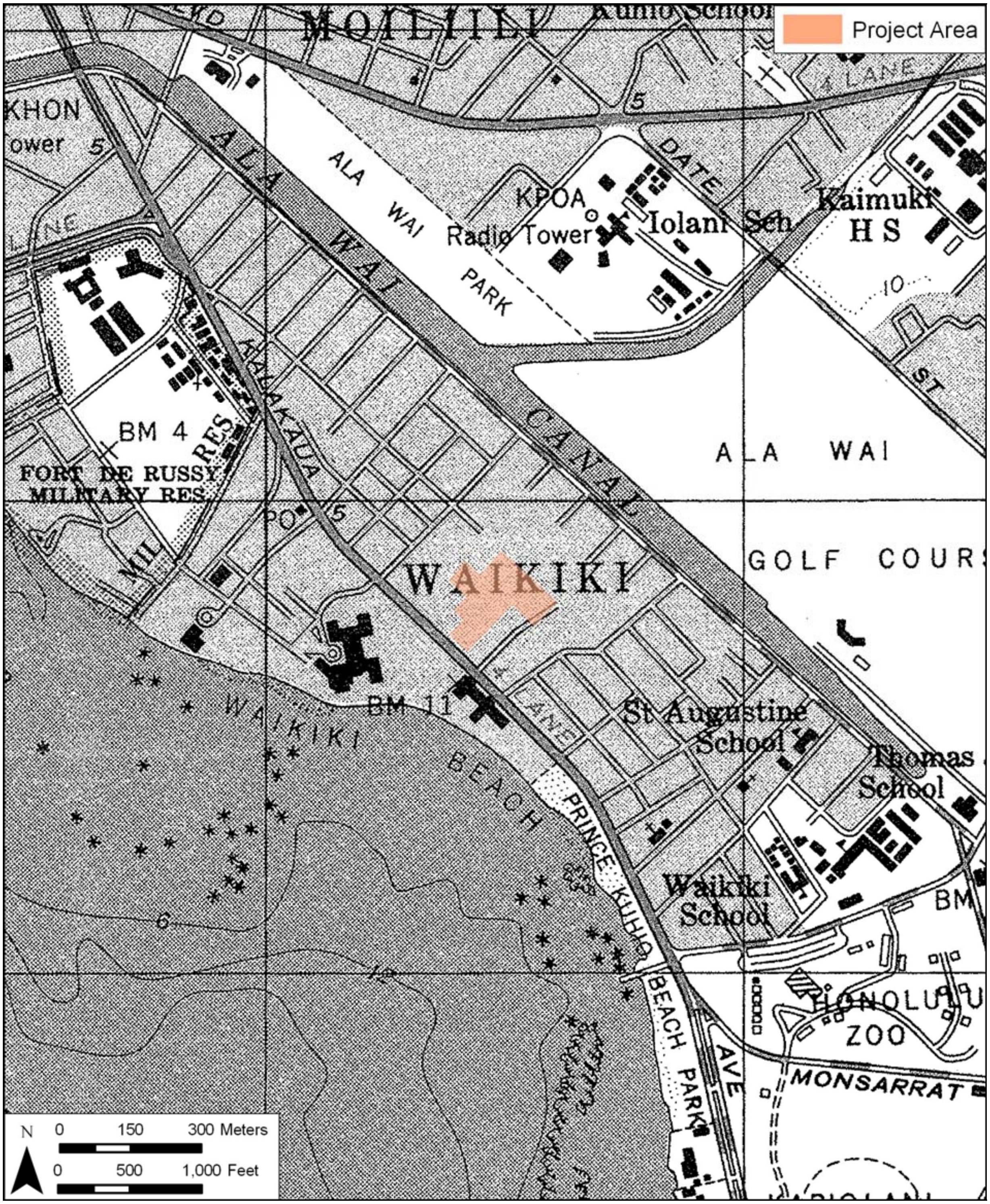

Figure 24. 1953 U. S. Geological Survey map, Honolulu Quadrangle, showing project area

Figure 25. International Market Place, entrance on Kalākaua Avenue, view *mauka* (Cultural Surveys Hawai‘i photograph, November 12, 2008)

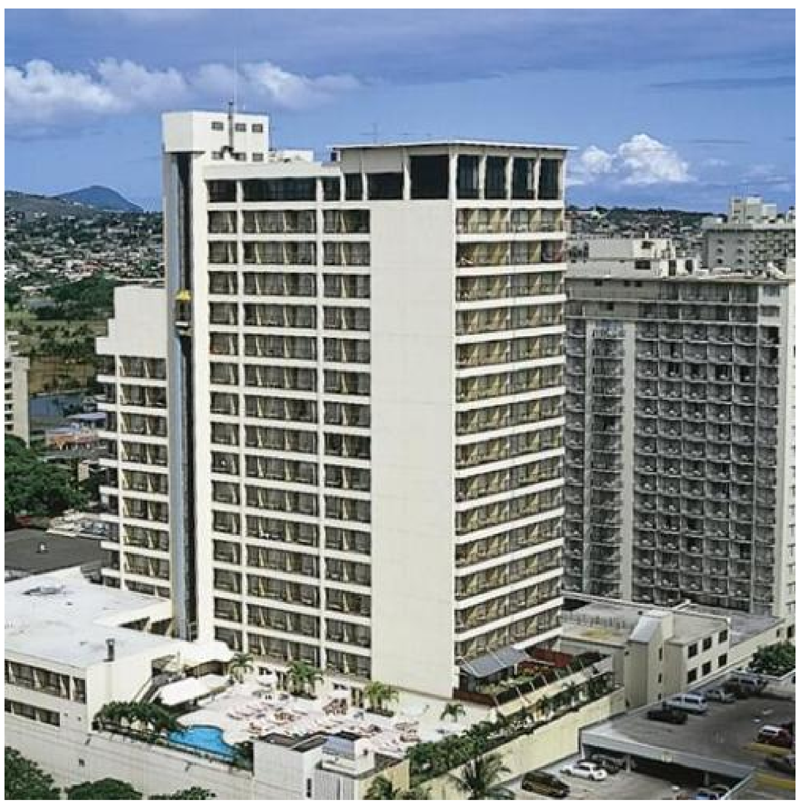

Figure 26. Miramar Hotel 2010 (photograph from Young 2010)

mid-nineteenth century, the parcel was acquired by the businessman William Macfarlane, who planted one of the large banyan trees on the property. The Macfarlane family's primary Waikīkī residence was a cottage on the beach. It is unclear how the Macfarlanes used the project area parcel, which was *mauka* of Waikīkī Road (now Kalākaua Avenue).

In the Māhele, the *ʻili* of Kaluaokau was awarded to Lunalilo, later King of Hawaiʻi. He built a modest cottage on the land, using it as a retreat and a place to recover from illness. His cottage was located in the area of the Moana Hotel tennis courts, southwest of the current project area. At his death in 1874, the land was bequeathed to Queen Emma, who occupied the land for visits until her death in 1885. She may have moved or improved the Lunalilo cottage, and she may have built outbuildings. The land then became part of the Queen Emma Trust; the money gained from leases was used to support the Queen's Medical Center in Honolulu. At some point in the early twentieth century, between the construction of the Moana Hotel in 1901 and the date of a 1915 map (see Figure 11), the Moana Hotel leased a portion of the land. By 1914, there were two large rectangular structures labeled as "Moana Hot'l Rooms" in the project area. These were used for guests of the hotel.

One area inside a horseshoe-shaped driveway was used as a pavilion and later as a dining room with kitchens. This facility was first used by the Seaside Hotel, built in 1906, and then by the Territorial Hotel Company, which owned the Moana Hotel and later took over the lease of the Seaside Hotel. In the early 1920s, several of the smaller beachside cottages of the Seaside Hotel were moved on the *mauka* side of Kalākaua Street, including within the project area, for rent by island residents or visitors. This was to make way for the construction of the new Royal Hawaiian Hotel on the former grounds of the Seaside Hotel. The Moana Hotel also built cottages for employees, but these seem to have been initially restricted to the area east of Kaʻiulani Street and east of the project area. By 1956, only the kitchen and dining facilities of the Moana Hotel remained in the project area. Most of the land at this time was used for parking. In 1955, the land was cleared to build the International Market Place, and in 1962, the Miramar Hotel was built on the northeastern section of the project area.

2.9 Consultation

Consultation is on-going. Concerned families that include members previously recognized as cultural descendants of Waikīkī were invited to an informal introduction to the proposed re-development project held at the Outrigger Reef Hotel on November 9, 2010. In attendance, in addition to the re-development team, were:

- Ms. Kaʻanohi Paulette Kaleikini and family including Ms. Moani Soares and Mr. Kala Keliinoi,
- Mr. and Ms. A. Van Horn Diamond,
- Mr. Thomas Shirai
- Mr. and Ms. Adrian Kealoha Keohokalole,
- Mr. and Ms. Kanaloa Koko

Many memories of the International Market Place in the 1950s through 1970s were shared and ideas for re-development were explored. No one expressed any particular knowledge regarding previous finds or the likelihood of *iwi kūpuna* being found.

It is anticipated that there will be presentations of this proposed International Market Place re-development project to the Oʻahu Island Burial Council at the January 2011 OIBC meeting.

Section 3 Previous Archaeological Research

3.1 Overview of Waikīkī Archaeology

The *ahupuaʻa* of Waikīkī, in the centuries before the arrival of Europeans, was an intensely utilized area, with abundant natural and cultivated resources, that supported a large population. In the nineteenth and early twentieth centuries, after a period of depopulation, Waikīkī was reanimated by Hawaiians and foreigners residing there, and by farmers continuing to work the irrigated field system, which had been converted from taro to rice. Farming continued up to the first decades of the twentieth century until the Ala Wai Canal drained the remaining ponds and irrigated fields. Remnants of the pre-contact and historical occupation of Waikīkī have been discovered and recorded in archaeological reports, usually in connection with construction activities related to urban development, or infrastructural improvements. These discoveries, which have occurred throughout Waikīkī, have included many human burials, traditional Hawaiian and historic, as well as pre-contact Hawaiian and historic cultural deposits. As previously stated, the project area, and most of coastal Waikīkī, is underlain by Jaucus Sands (JaC) (Foote et al. 1972). On several Hawaiian islands, and indeed throughout Waikīkī, Jaucas sands have been documented to contain traditional Hawaiian burials. A list of projects conducted in the Waikīkī area is presented in Table 2. The projects are listed in date order, from oldest to the most recent, and show the author, type of study, and the findings. A supplementary listing of Waikīkī burial finds held in the osteological collections of the Bernice Pauahi Bishop Museum is presented in Table 3. The table lists the year of the find, the number of burials found, and the source of the information. A discussion of projects, focusing on burials (Figure 27) follows.

N.B. Emerson reported on the uncovering of human burials during the summer of 1901 on the property of James B. Castle, the site of the present Elks Club, in Waikīkī during excavations for the laying of sewer pipes (Emerson 1902:18-20). Emerson noted:

> The soil was white coral sand mixed with coarse coral debris and sea-shells together with a slight admixture of red earth and perhaps an occasional trace of charcoal. The ground had been trenched to a depth of five or six feet, at about which level a large number of human bones were met with, mostly placed in separate groups apart from each other, as if each group formed the bones of a single skeleton. Many of the skulls and larger bones had been removed by the workmen before my arrival, especially the more perfect ones. (Emerson 1902:18)

Emerson's report on the find describes the remains of at least four individuals, all presumed to be Hawaiian. Associated burial goods were also exposed during excavation; these included "a number of conical beads of whale-teeth such as the Hawaiians formerly made" and "a number of round glass beads of large size". The glass beads "can be assigned with certainty to some date subsequent to the arrival of the white man" (Emerson 1902:19). Also located with the beads was "a small sized *niho-palaoa*, such as was generally appropriated to the use of the chiefs" which had been "carved from the tooth of the sperm-whale" and which was "evidently of great age" (Emerson 1902:19).

Table 2. Previous Archaeological Investigations in Waikīkī Ahupua‘a

Reference	Type of Investigation	General Location	Findings
Emerson 1902	Burial recovery account	Present Elks Club	At least four individuals, all presumed to be Hawaiian and associated burial goods
McAllister 1933	Island-wide survey	All of O‘ahu	Waikīkī listed as Site 60.
1963 Bishop Museum (cited in Neller 1984)	Bishop Museum burial recovery	2431 Prince Edward Street	Two + individuals from a construction trench
Honolulu Star-Bulletin; 1963; Yost 1971	Burial recovery account	Present Outrigger Canoe Club	27 Burials
1964 Bishop Museum Site Files	Burial recovery account	Fronting the Surfrider Hotel	4 burials?
1976 Bishop Museum Site Files	Burial recovery account	Hale Koa Hotel	Six burials
Sinoto 1977	Archaeological Reconnaissance Survey	Grounds of Hilton Hawaiian Village Hotel, Waikīkī	No surface features noted; recommends monitoring
Nakamura 1979	History Graduate Thesis	Waikīkī	History of Waikīkī with focus on the radical changes in land use that occurred in the early 20th century.
Neller 1980	Monitoring Report	Kālia Burial Site: Hilton Hawaiian Village	Brief field inspection: partial recovery of 3 historic Hawaiian burials, trash pit from 1890's, no prehistoric Hawaiian sites.
Bishop Museum 1981	Testing, Excavations, & Monitoring	Halekūlani Hotel	Intact cultural deposits found.
Neller 1981	Reconnaissance Survey	Halekūlani Hotel	Limited background research on area
Acson 1983	Historical Research	‘Ewa to Diamond Head	Nine walks through Waikīkī, photos, maps and historical info.
Bishop Museum 1984	Burial Remains List	Waikīkī Ahupua‘a	Listing of burial remains found in Waikīkī Ahupua‘a at the Bishop Museum

Reference	Type of Investigation	General Location	Findings
Davis 1984	Archaeological and Historical Investigation	Halekūlani Hotel	48 historic and prehistoric features excavated with six human burials reported.
Neller 1984	Informal Narrative Report	Paoakalani Street	Recovery of seven human skeletons at construction site
Center for Oral History 1985	Oral Histories, Volumes I-IV	Waikīkī	Oral Histories of Waikīkī, 1900-1985, Volumes I-IV
Griffin 1987	Burial Recovery Report	Along Kalākaua Ave. near corner of Ka‘iulani St.	Bones removed and bagged by construction crew, burial found in makai wall of gas pipe excavation.
SHPD 1987	Burial, Recovery Report	Kalākaua Ave. and Ka‘iulani Street	From excavation adjacent to Moana Hotel (site -9901).
Bath and Kawachi 1989	Burial, Recovery Report	Ala Wai golf Course	2 burials
Davis 1989	Reconnaissance Survey & Historical Research	Fort DeRussy	Fishponds and other features are buried in this area. Sites -4573 thru -4577 are fishponds, 4570 is a remnant cultural deposit.
Riford 1989	Background Literature Search	TMK: 2-6-014:039	List of literature pertaining to Waikīkī area.
Rosendahl 1989	Inventory Survey, Prelim. Report	Fort DeRussy	Historic artifacts, no human remains
Athens 1990	Letter	TMK: 2-6-023:025	Letter to SHPD listing human remains at IARII lab from Pacific Beach Hotel, and Barbers Point Generating Station.
Hurst 1990	Historical Literature Search	Waikikian Hotel	Background and planning document. No fieldwork was done.
Chigioji 1991	Assessment	2 parcels, TMK 2-6-24:65-68 and 80-83, TMK 2-6-24:34-40 & 42-45	Formerly a corner of the ‘Āinahau estate; remainder of parcels, former ‘auwai, kalo and rice fields; test excavations and specific sampling strategy recommended.

Reference	Type of Investigation	General Location	Findings
Davis 1991	Monitoring Report	Fort DeRussy	See also Davis 1989. Subsurface features and material remains date to early post-contact times (c. 1780s to 1790s) through the mid-19th century.
Kennedy 1991	Monitoring Report	TMK: 2-6-022:014 IMAX theatre location	Pollen and bulk-sediment 14C samples from ponded sediments were recovered. The three 14C dates and pollen sequence were inverted.
SHPD 1991	Public Inquiry	TMK: 2-6-024:036	Bones were determined to be non-human and part of the extensive fill material present
Simons et al. 1991	Interim Field Study, Monitoring & Data Recovery	Moana Hotel Area	8 burials, preliminary osteological analysis indicates pre-contact type; pre- and post artifactual material recovered.
Hurlbett and Carter 1992	Monitoring Report	TMK: 2-6-008:001	Site -2870 (3 burials) found by Neller in 1980. This report is on testing and monitoring in same area.
Pietru-sewsky 1992a	PA Report	Moana Hotel	Right half of human mandible found by hotel guest.
Pietru-sewsky 1992b	PA Report	Liliʻuokalani Gardens Site, Hamohamo	Human Remains from the Liliʻuokalani Gardens Site, Hamohamo, Waikīkī, Oʻahu
Rosendahl 1992	Monitoring Report	Hilton Hawaiian Village	Identified12 historic refuse pits, 3 historic to modern trenches.
Streck 1992	Memorandum for Record	Fort DeRussy	Human burial discovery (believed to be late prehistoric Hawaiian) during data recovery excavations, May, 20, 1992.
Cleghorn 1993	Inadvertent Discovery of Human Remains	Waikīkī Aquarium	Remains of one human individual, mandible identified.
Dagher 1993	Inadvertent Discovery of Human Remains	Waikīkī Aquarium	Human remains of at least one person identified, excavation recommended.
Dega and Kennedy 1993	Inadvertent Discovery of Remains	Waikīkī Aquarium	Discovery of unidentified bone fragments, all remains turned over to SHPD.

Reference	Type of Investigation	General Location	Findings
Hammatt and Chiogioji 1993	Archaeological Assessment	16-Acre Portion of the Ala Wai Golf Course	Not associated with any known surface archaeological site, however prehistoric and early historic occupation layers associated with loʻi system remain intact below modern fill. Specific sampling strategy and potential burial testing recommended.
Carlson et al. 1994	Report of Human Remains	Realignment of Kālia Road, Fort DeRussy	Approximately 40 human burials (the majority were recovered in a large communal burial feature & a cultural enriched layer that contained postholes.
Maly et al. 1994	Archaeological and Historical Assessment Study	Convention Center Project Area	Recommend subsurface testing to determine presence or absence of cultural deposits and features.
McMahon 1994	SHPD Burial Report	Intersection of Kalākaua and Kuamoʻo Streets	Inadvertent Burial Discovery: misc. bones uncovered in back dirt pile during construction. Follow up by CSH.
Hammatt and Shideler 1995	Sub-surface Inventory Surface	Hawaiʻi Convention Center Site, 1777 Kalākaua Ave.	No further work recommended.
Jourdane 1995	Inadvertent Discovery of Human Remains	Paoakalani Avenue	Human skeletal remains discovered in planted strip between street and sidewalk fronting hotel.
Simons et al. 1995	Data Recovery Excavations	Fort DeRussy	Historic and prehistoric artifacts, and midden materials collected from 7 occupation layers. 6 prehistoric cultural features recorded: ʻauwai bunds and channels, fishpond walls and sediments, a possible loʻi, and hearths.
Cleghorn 1996	Inventory Survey	TMK: 2-6-016:23, 25, 26, 28, 61, 69	7 backhoe trenches excavated, no sites located.
Grant 1996	Historical Reference	Waikīkī	Historical information about Waikīkī prior to 1900.
Hammatt and Shideler 1996	Data Recovery	Hawaiʻi Convention Center Site	No clear evidence that Kuwili Pond sediments present in project area; no further work recommended.
McDermott et al. 1996	Inventory Survey	ʻĀinahau Estate	Buried remnants of ʻauwai and loʻi and human burial found. 14C dates

Reference	Type of Investigation	General Location	Findings
Denham et al. 1997	Data Recovery Report	Fort DeRussy	Excavations conducted at fishponds,14C dates mid-17th C.
Denham and Pantaleo 1997	Monitoring and Excavations Report	Fort DeRussy	Final Report does not include SHPD recommendations. 10 subsurface features and 9 burial locations found. 14C dates
Beardsley and Kaschko 1997	Monitoring and Data Recovery Report	Pacific Beach Hotel Office Annex	Traditional Hawaiian cultural deposits and 2 human burials. 3 14C dates
Hammatt and Chiogioji 1998	Assessment	King Kalākaua Plaza Phase II	No surface archaeological sites, documented human burials, presence of subsurface cultural deposits (both of pre-contact Hawaiian and historic provenance).
Hammatt and McDermott 1999	Burial Disinterment Plan and Report	Kalākaua Avenue	Two human burials found
Perzinski et al. 1999	Monitoring Report	Along Ala Wai Blvd., Kalākaua Ave., Ala Moana Blvd., & ‘Ena Rd.	Two human burials found (1 preceding monitoring); pockets of undisturbed layers still exist. Burial #2 previously disturbed.
Rosendahl 1999	Interim Report: Inventory Survey	Fort DeRussy	This area is part of the old shoreline.
Hammatt and Chiogioji 2000	Archaeological Assessment	Honolulu Zoo Parcel	Majority of zoo parcel unlikely to yield significant cultural deposits. However, strong possibility of significant subsurface cultural deposits in the SW portion. Monitoring is recommended in this area.
LeSuer et al. 2000	Inventory Survey	King Kalākaua Plaza Phase II	Site -5796 has been adversely affected by land alteration of the project area. Site -4970, has been adequately documented.
Perzinski et al. 2000	Burial Findings	Kalākaua Ave. between Ka‘iulani & Monsarrat Avenues	44 sets of human remains; 37 disinterred, 7 left in place; believed to be Native Hawaiian, interred prior to 1820.
Cleghorn 2001 a & b	Mitigation	Burger King Construction Site	Concerning three incidents of uncovered human remains while locating a buried sewer-line for the ABC’s store.

Reference	Type of Investigation	General Location	Findings
Corbin 2001	Inventory Survey	Hilton Waikikian Property	No arch. sites were found during excavations of the area
Elmore and Kennedy 2001	Burial Report	Royal Hawaiian Hotel	Human remains found during trench excavations for conduit. The in situ remains were left in place, while the disturbed remains were re-interred with the others.
McGuire and Hammatt 2001	Cultural Assessment for Waikīkī Beach Walk Project	Along Lewers St., Beach Walk, Kālia Rd. & Saratoga Rd.	Primary cultural concern identified as inadvertent burial discovery. Cultural monitoring recommended for all subsurface work within project area.
Perzinski and Hammatt 2001a	Monitoring Report	Kapi‘olani Bandstand	A charcoal layer was observed, concentrated on the SW side of the bandstand; recovered indigenous basalt lamp with a handle, from the SE end of the bandstand.
Perzinski and Hammatt 2001b	Monitoring Report	Kapi‘olani Park	No cultural layer, artifacts, midden or human burials were encountered during the excavations.
Perzinski and Hammatt 2001c	Monitoring Report	Kalākaua Avenue from the Natatorium to Poni Mō‘ī Road	No cultural layer, artifacts, midden or human burials were encountered during the excavations.
Rosendahl 2001	Assessment Study	Outrigger Beach Walk	Assessment of previous archaeology and historical literature.
Winieski and Hammatt 2001	Monitoring Report	TMK: 1-2-6-025:000	There is a possibility that Hawaiian or Historic materials as well as human burials may still be present within the project area.
Borthwick, et al. 2002	Inventory Survey	71,000 sq. ft. parcel, TMK: 2-6-016:002	No burials were found during testing; absence of dry Jaucas sand deposits indicate that burial finds are unlikely in project area.
Bush and Hammatt 2002	Monitoring Report	Kalākaua Avenue, between Ala Moana Blvd. and Kapahulu Ave.	Encountered 4 human burials, probably pre-contact Native Hawaiians; several historic trash pits; entire pig within an imu pit (estimated date, A.D. 1641-1671); gleyed muck associated with former ponds.
Calis 2002	Monitoring Report	Lemon Road	No historic deposits, major previous disturbance

Reference	Type of Investigation	General Location	Findings
Elmore and Kennedy 2002	Monitoring Report	Fort DeRussy	No findings.
Mann and Hammatt 2002	Monitoring Report	Lili‘uokalani Avenue and Uluniu Avenue	5 burial finds of 6 individuals; two historic trash pits.
Putzi and Cleghorn 2002	Monitoring Report	Hilton Hawaiian Village	No findings during monitoring of trench excavations for sewer connections.
Winieski, Perzinski, Shideler, and Hammatt 2002	Monitoring Report	Kalākaua Ave. between Ka‘iulani and Monsarrat Avenues.	44 human burials encountered, 37 disinterred; buried habitation layer identified, with traditional Hawaiian artifacts, midden, firepits, & charcoal; fragment of light gauge rail, remnant of Honolulu Transit trolley system, observed; low energy alluvial sediments associated with the now channelized muliwai Kukaunahi also observed.
Winieski Perzinski, Souza, and Hammatt 2002	Monitoring Report	Kūhiō Beach	Skeletal remains of 10 individuals, six disinterred, only 2 in situ. 4 indigenous artifacts, none in situ. Discontinuous cultural layer, historic seawall.
Bush et al. 2003	Monitoring Report	International Marketplace	Historic trash found.
Kailihiwa and Cleghorn 2003	Monitoring Report	Waikīkī Water System Improvements on Portions of Lau‘ula Street, Waikolu Way and Royal Hawaiian Avenue	No significant finds
Tome and Dega 2003	Monitoring Report	Waikīkī Marriot	One isolated not in situ possible human bone fragment found. Recommends monitoring during future work.
Tulchin and Hammatt 2003	Archaeological & Cultural Impact Assessment	2284 Kalākaua Ave.	Notes possibility of burials in the project area; recommends an inventory survey with subsurface testing.

Reference	Type of Investigation	General Location	Findings
Chiogioji et al. 2004	Archaeological Inventory Survey	Tusitala Vista Elderly Apartment	SIHP sites -6682, -6705, -6706, and –6707 including human remains, remnants of the ‘Āinahau Estate and agricultural sites
Havel, and Spear 2004	Monitoring Report	ABC Store No. 21, Kanekapolei Street	No significant finds
Jones and Hammatt 2004	Archaeological Monitoring Report	for the Anti-Crime Street Lighting Improvements Project (Part III) Along the Mauka Side of Kalākaua Avenue from Ala Wai Boulevard to Pau Street, TMK 2-6-7 & 13)	Some pond or lo‘i sediments noted near intersection of McCully and Kalākaua.
McIntosh, and Cleghorn 2004	Archaeological Inventory Survey	For Urban Loft Development at Launiu Street, (TMK: 2-6-17; 68, 70, 71, 72, 73)	SIHP 50-80-14-6680 ponded field sediments documented. Anomalous date reported
Tulchin et al. 2004	Archaeological Data Recovery Report	For SIHP # 50-80-14-6407 Feature A; an approximately 71,000-Sq. Ft. parcel in Waikīkī Ahupua‘a, (TMK 2-6-16: 2, 4, 6, 7, 8, 12-19, 62, 64, 70, 75, 76, & 77	Pollen and carbon dating results and the Hawaiian use of Kuāuna and Paukū features are discussed
Freeman et al. 2005	Archaeological Inventory Survey	Hobron Lane	Four sites identified during subsurface testing; 1 disturbed burial; 1 coffin burial with two individuals; 1 cultural deposit; and, 1 fishpond sediment
O’Hare et al. 2005	Archaeological Inventory Survey	Kaio‘o Drive	Site 50-80-14-6848, a pre-contact fire pit radiocarbon dated to AD 1470-1660, was recorded.

Reference	Type of Investigation	General Location	Findings
O’Leary, Chiogioji, Borthwick, and Hammatt 2005	Archaeological Inventory Survey	1-Acre Parcel, 2284 Kalākaua Avenue (former Waikiki 3 Theater)	1 burial encountered
O’Leary, Chiogioji, Bush, Borthwick & Hammatt 2005	Archaeological Assessment	0.5-Acre Royal Kāhili Condo	No significant finds
Bell and McDermott 2006	Archaeological Inventory Survey	Allure Waikīkī Development (former Wave Waikiki location),	2 human burials and a cultural deposit
Esh and Hammatt 2006	Archaeological Monitoring Report	For Kūhiō Avenue (Ka‘iulani to Kapahulu), TMK [1] 2-6-Plats 23 to 28)	No significant finds
Hammatt and Shideler 2006a	Archaeological Assessment	Two Parcels at the Corner of Kūhiō and Kapahulu Avenues	No significant finds, study area abuts former Ku‘ekaunahi Stream (now overlain by Kapahulu Avenue)
Hammatt and Shideler 2006b	Archaeological Assessment	0.015-Acre Parcel at the Corner of Kūhiō and Kapahulu TMK: 2-6-027:052	No significant finds, study area abuts former Ku‘ekaunahi Stream (now overlain by Kapahulu Avenue)
O’Hare et al. 2006	Archaeological Inventory Survey	Kaio‘o Drive	Site 50-80-14-6848, a pre-contact fire pit radiocarbon dated to AD 1470-1660, was recorded.
Dye 2007	Archaeological Inventory Survey	For New Utility Connections, Waikiki Beach Walk Project, TMK 2-6-002, 003, 004)	No significant finds

Reference	Type of Investigation	General Location	Findings
Hammatt and Shideler 2007	Archaeological Monitoring Report	For a Grease Interceptor at the Sheraton Moana Surfrider Hotel, TMK: [1] 2-6-001:012	No significant finds
Pammer and Hammatt 2007	Archaeological Monitoring Report	Perry's Smorgy Restaurant Project TMK: [1] 2-6-021:114	No significant finds
Tulchin, J. and Hammatt 2007	Archaeological Data Recovery Report	Tusitala Vista Elderly Apartments, TMK: [1] 2-6-024: 070, 071, & 89	Presents palynological and radiocarbon analysis tracing the paleo-environmental change and man-made alterations of the landscape at SIHP No. 50-80-09-6707,
Hazlett, Chiogioji, Borthwick and Hammatt 2008	Archaeological Monitoring Report	Report for a 1-Acre Parcel, 2284 Kalākaua Avenue, TMK: [1]- 2-6-22:009	No significant finds
Hazlett, Esh and Hammatt 2008	Archaeological Monitoring Report	Royal Hawaiian Shopping Center Parcel, TMK: [1] 2-6-002:018	No significant finds
Runyon et al. 2008	Archaeological Assessment	Improvements to the Royal Hawaiian and Sheraton Hotels TMK: [1] 2-6-002: 005 & 006	Isolated human remains were identified. No sites were designated
Thurman and Hammatt 2008	Archaeological Monitoring Report	For Geotechnical Testing at the Royal Hawaiian and Sheraton Waikiki Hotels TMK: [1] 2-6-002:005, 006 & 026	No significant finds

Reference	Type of Investigation	General Location	Findings
Tulchin, J. and Hammatt 2008	Archaeological Assessment	1944 Kalākaua Project TMK: [1] 2-6-014: 004, 006, 007, 008, 010, 019 & 058	No significant finds
Petrey et al. 2008	Monitoring Report	City and County of Honolulu’s Emergency Temporary Beach Walk Sewer Bypass Project, TMK: [1] 2-3-034, -036, 037; 2-6-017, -018; 2-7-036	No findings; a section of wall at Ala Moana Park Drive at Ala Moana Beach Park (SIHP #50-80-14-1388) was cut and replaced during the project.
Whitman et al. 2008	Archaeological Monitoring Report	for a 12-inch Water Main Installation Project along a Portion of Kalākaua Avenue and Poni Mō‘ī Road, TMK: [1] 3-1-032 & 043	One inadvertent human burial was discovered during monitoring. The remains were fully articulated and the burial is likely to be Native Hawaiian. It was designated SIHP #50-80-14-6946
Kahahane and Cleghorn 2009	Archaeological Monitoring Report	for the Waikīkī Water System Improvements, Part V on Nohonani Street, Nāhua Street, Walina Street, and Lili‘uokalani Avenue [TMK (1) 2-6-021 and 2-6-024]	Modest finds (15 mundane post-Contact artifacts), no human remains

Reference	Type of Investigation	General Location	Findings
Mooney., Fechner, and Cleghorn 2009	Archaeological Monitoring Report	For the Hilton Hawaiian Village Grand Waikīkīan Development Project, [TMK (1) 2-6-8: 1-3, 5, 7, 12, 19-21, 23, 24, 27, 31, 34, 37, 38, and (1) 2-6-9: 1-3, 7, 9, 10-13],	Two sites identified: 50-80-14-7086 a Historic trash feature complex and -7087 a previously disturbed human burial
Thurman et al. 2009	Archaeological Inventory Survey	Diamond Head Tower Redevelopment Project, TMK: [1] 2-6-001:012	Two historic properties were identified: SIHP 50-80-14-7068 an intact cultural layer, with a calibrated radiocarbon date to AD 1801 - AD 1939 (66.1% probability), and SIHP 50-80-14-7069 a historic trash pit dated to the late nineteenth through early twentieth century
Yucha et al. 2009	Archaeological Inventory Survey	Waikīkī Shopping Plaza Redevelopment Project, TMK: [1] 2-6-019:056, 061	One previously recorded historic property was identified within the current project area. SIHP# 50-80-14-5796, a culturally modified wetland ground surface that extends throughout portions of Waikīkī
Park, and Collins 2010	Archaeological Monitoring Report	in Support of the Ala Wai Garden Plaza Project, TMKs (1) 2-6-016: 056-060	No historic properties or human remains observed
Runyon et al. 2010	Princess Ka‘iulani Hotel	Monitoring Report	Three historic properties recorded: the remains the Waikiki Church and Cemetery (Site 70605), a pre-contact cultural layer (Site 7066), and a human burial (7067)

Table 3. References to Burial Finds in Waikīkī from the Bishop Museum NAGPRA Inventory

Date	Account	Source
1913	…two individuals from Waikīkī…	FR* page 1; BPBM records indicate this was ID No OA0002 & 0003 from the Sacred Hearts Convent, Waikīkī
1916	…one individual from Waikīkī…	FR* page 2; BPBM records indicate this was ID No OA009 a “sand burial”
1917	“from unknown location in Waikiki”	BPBM records indicate this was ID No OA0012 (no details)
1923	…one individual from the ‘Āinahau district, Waikīkī…	FR* page 2; BPBM records indicate this was ID No OA0018 “found by Hawaiian Dredging Company by dredge Kewalo”
1923	…five individuals from Helumoa, Waikīkī, O‘ahu were collected by Kenneth P. Emory. Museum information indicates they were victims of the 1853 smallpox epidemic…	FR* page 2; BPBM records indicate this was ID Nos OA0019 – OA0023 logged in on October 1923
1926	…one individual from Waikīkī…found during house construction	FR* page 3; BPBM records indicate this was ID No OA0087 from a residence in Waikīkī
1927	…one individual from Waikīkī…	FR* page 3
1950	3207 Noela Drive “Found at rear of donor’s property during excavation	BPBM records indicate this was ID No OA0211 and OA0212
1955	…two individuals from Waikīkī…	FR* page 7; BPBM records indicate this was ID No OA 0315 discovered at the Reef Hotel Waikiki
1957	…nine individuals from Waikīkī…	FR* page 8; BPBM records indicate this was ID Nos OA0391 to OA0402 from Dad Center located along Kalākaua Avenue
1961	…one individual from Waikīkī…	FR* page 8; BPBM records indicate this was ID No OA0419 from 331 Saratoga Avenue
1962	…one individual from Waikīkī…	FR* page 9; BPBM records indicate this was ID No OA0421 “from sand burial near Reef Hotel”
1963	…five individuals from Waikīkī…	FR* page 9; BPBM records indicate this was ID No OA0424 “found on Edgewater Drive near Reef Hotel” [it would be atypical for the BPBM to assign one ID No. to 5 burials]

Date	Account	Source
1963	…96 individuals from Waikīkī…[donated by Bowen]	FR* page 9; BPBM records indicate this was ID Nos OA0425 to OA0455 “from Old Outrigger Canoe Club Premises” Note: Bishop Museum records from 1963 specify the finds donated by Robert N. Bowen on January 22, 1963 were from “the Old Outrigger Canoe Club Premises” However the 1/24/63 *Honolulu Advertiser* article concerns burial finds at the present club location by the Elk’s Club.
1964	…four individuals from Waikīkī…	FR* page 9; BPBM records indicate this was ID No OA0464 “from site on beach in front of old Outrigger Canoe Club” [it would be atypical for the BPBM to assign one ID No. to 4 burials]
1965	“Human remains collected from San Souci Beach, Waikiki”	BPBM records indicate this was ID No OA0633
1966	Two accessions from 2431 Prince Edward Street	BPBM records indicate this was ID No OA0462 & OA0467 from *ʻewa* side of lot *makai* of Prince Edward Street
1967	…one individual from Waikīkī…	FR* page 11; BPBM records indicate this was ID No OA0516 from the “Tahiti by Six” at the International Market Place – in the present study area
1970	…eight individuals from Waikīkī…[donated] by the Sheraton Hawaiʻi Corp….recovered during excavations for tank construction…	FR* page 11; BPBM records indicate this was ID No OA0522 on Sheraton Hawaiʻi Corp Property logged in on 3/6/1970
1981	…eight individuals from Waikīkī…[donated] by Bertell Davis	FR* page 12; BPBM records indicate this was ID Nos OA0565 to OA0571 “from unknown location in Waikiki; also OA0572 “recovered through archaeological excavation at the Halekūlani hotel, Waikiki
1996	…one individual from Waikīkī…acquired during the early 1900s	FR* page 14

FR* = Federal Register January 28, 1998 (Volume 63, Number 18)

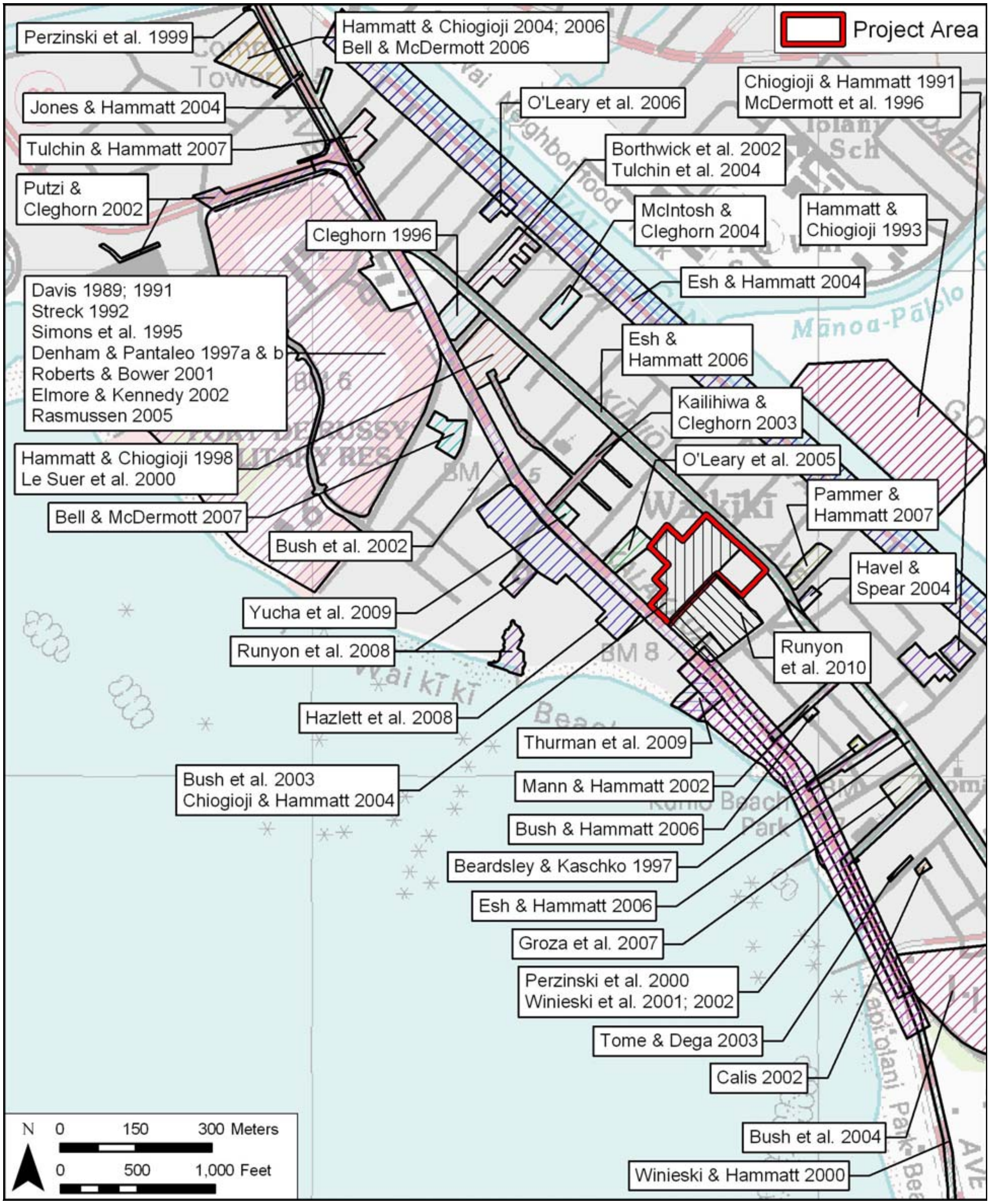

Figure 27. 1998 U.S. Geological Survey map, Honolulu Quadrangle, showing locations of previous archaeological studies near the project area

It is widely assumed that at the time of the construction of the Royal Hawaiian Hotel that many human burials and other archaeological finds were encountered. Kanahele (1995:99) writes of an "*ʻulu maika* course was part of the royal sports complex of Kahuamokomoko in Helumoa" and states that: "When excavations for the Royal Hawaiian Hotel were made in the early 1920s many *ʻulu maika* discs were found." It seems highly probable that the "five individuals from Helumoa, Waikīkī, Oʻahu" that were collected by Kenneth P. Emory of the Bishop Museum in October of 1923 and reported as "victims of the 1853 smallpox epidemic" came from construction related to the Royal Hawaiian Hotel. (*Federal Register* January 28, 1998 Volume 63, Number 18 page 2; BPBM records indicate this was ID Nos OA0019 – OA0023).

In the 1920s and 30s the first systematic archaeological survey of Oʻahu was conducted by J. C. McAllister (1933). He recorded four *heiau* (temples), three of which were located at the *mauka* reaches of Waikīkī Ahupuaʻa in lower Mānoa Valley. The fourth *heiau* – Papaʻenaʻena - was located at the foot of Diamond Head crater in the environs of the present Hawaiʻi School for Girls. Papaʻenaʻena Heiau is traditionally associated with Kamehameha I, who was said to have visited the *heiau* before setting off to battle for Niʻihau and Kauaʻi in 1804. Five years later, according to John Papa ʻĪʻī, Kamehameha placed at Papaʻenaʻena the remains of an adulterer – "all prepared in the customary manner of that time" (ʻĪʻī 1959:50-51).

In 1963, two human skulls and other human remains were discovered in a construction trench at 2431 Prince Edward St. (Bishop Museum site Oa-A4-23, cited in Neller 1984).

Multiple burials were encountered in 1963 during excavation for the construction of the present Outrigger Canoe Club at the Diamond Head end of Kalākaua Avenue. As reported in a newspaper article on Jan. 24, 1963:

> The Outrigger Canoe Club yesterday dedicated its new site [on land adjacent to and leased from the Elks Club], an ancient Hawaiian burial ground in Waikīkī. . .
>
> Robert Bowen of the Bishop Museum has been working closely with Ernest Souza, Hawaiian Dredging superintendent, on the removal of skeletons unearthed on the site, between the Colony Surf and the Elks Club. . . .
>
> Most of the bodies were buried in the traditional hoolewa position, with the legs bound tightly against the chest.
>
> One of the skeletons, Bowen said, shows evidence of a successful amputation of the lower forearm, indicating that the Hawaiians knew this kind of operation before the arrival of Europeans.
>
> The ages of the skeletons ranged from children to 40-year-old men and women. The average life span of the Hawaiians at the time was about 32 years. (*Honolulu Star-Bulletin;* Jan. 24, 1963: 1A)

A total of 27 burials were encountered according to Yost (1971:121-122). Apparently, no formal archaeological report on the burials was produced.

Bishop Museum records show 31 accessions of human remains (ID Nos OA0425 to OA0455) donated by Robert N. Bowen on January 22, 1963 stating that they were all from "the <u>Old</u> Outrigger Canoe Cub Premises" which suggests the former location by the Royal Hawaiian Hotel. However the 1/24/63 *Honolulu Advertiser* article concerns burial finds at the present club location by the Elk's Club. The *Federal Register* of January 28, 1998 (Volume 63, Number 18 page 4281) asserts that: "In 1963, human remains representing 96 individuals from Waikiki Oʻahu were collected and donated to the Bishop Museum by Robert N. Bowen." There is a mystery here. The *Honolulu Star-Bulletin* and Yost accounts speak only of mass burials at the present Outrigger Canoe Club Premises (by the Elks Club) while the Bishop Museum records speak only of mass burials at the old Outrigger Canoe Club Premises (by the Royal Hawaiian) and the Federal Register provides no locational data within Waikīkī but gives a significantly greater number of individuals (96) than suggested in the Yost history of the Outrigger (which specifies 27 burials). Given the close relationships of the dates of the report of Bowen's work on multiple burials at the present Outrigger Canoe Club (Jan. 24, 1963) and the date of accession of remains at Bishop Museum (Jan. 22, 1963), and noting that there is no account in the Bishop museum records of remains from the "new" Outrigger Canoe Club location, it appears most likely to us that all of the burials reported were actually from the present "new" Outrigger Canoe Club location. This remains uncertain.

In 1964, sand dune burials, a traditional Hawaiian mortuary practice, were revealed as beach sand eroded fronting the Surfrider Hotel (Bishop Museum Site Files).

It seems highly probable that "…eight individuals from Waikīkī…[donated] by the Sheraton Hawaiʻi Corp….recovered during excavations for tank construction… in March 1970" were indeed associated with the initial construction of the hotel (*Federal Register* January 28, 1998 Volume 63, Number 18 page 11; BPBM records indicate this was ID No OA0522 found on Sheraton Hawaiʻi Corp Property logged in on 3/6/1970)

In 1976, during construction of the Hale Koa Hotel, adjacent to the Hilton Hawaiian Village Hotel, six burials were unearthed, five of apparent prehistoric or early historic age, and one of more recent date (Bishop Museum Site Files).

In 1980, three burials were exposed at the Hilton Hawaiian Village during construction of the hotel's Tapa Tower. Earl Neller of the (then named) State Historic Preservation Program was called in upon discovery of the burials and conducted fieldwork limited to three brief inspection of the project area. Neller's (1980) report noted:

> The bones from three Hawaiian burials were partially recovered; one belonged to a young adult male, one a young adult female, and one was represented by a single bone. An old map showed that rapid shoreline accretion had occurred in the area during the 1800s, and that the beach in the construction area was not very old. It is possible the burials date back to the smallpox epidemic of 1853. It is likely that burials will continue to be found in the area. It is also possible that early Hawaiian sites exist farther inland, beneath Mōʻiliʻili, adjacent to where the shoreline would have been 1000 years ago. (Neller 1980:5)

Neller also documented the presence of trash pits, including one from the 1890s, which contained "a large percentage of luxury items, including porcelain tableware imported from China, Japan, the United States, and Europe" (Neller 1980:5). He further notes:

> It is suspected that other important historic archaeological sites exist in the highly developed concrete jungle of Waikīkī, with discrete, dateable trash deposits

> related to the different ethnic and social groups that occupied Waikīkī over the last 200 years. (Neller 1980:5)

Between December 1981 and February 1982, archaeologists from the Bishop Museum led by Bertell Davis conducted a program of excavations and monitoring during construction of the new Halekūlani Hotel (Davis 1984). Six human burials were recovered along with “animal burials [and] cultural refuse from prehistoric Hawaiian firepits, and a large collection of bottles, ceramics, and other materials from trash pits and privies dating to the late 19th century” (Davis 1984:i). Age analysis of volcanic glass recovered from the site led Davis to conclude: “For the first time we can now empirically date . . . settlement in Waikīkī to no later than the mid-1600s” (Neller 1980:5). Just as significant to Davis was the collection of historic era material at the Halekūlani site; he states:

> [The] Halekūlani excavations clearly demonstrate...that there is a definite need to consider historic-period archaeology as a legitimate avenue of inquiry in Hawaiian research. Furthermore, archaeology in the urban context can yield results every bit as significant as in less developed areas. Development in the 19th and early 20th centuries clearly has not destroyed all archaeological resources in Waikīkī, Honolulu, or in any of the other urbanized areas of Hawai‘i. (Neller 1980:5)

In 1983, at the Lili‘uokalani Gardens condominium construction site, seven traditional Hawaiian burials were recovered (Neller 1984). This had been the site of a bungalow owned by Queen Lili‘uokalani at the end of the nineteenth century. In addition to the burials, the site contained plentiful historic artifacts, and a pre-historic cultural layer pre-dating the burials.

In 1985, International Archaeological Research Institute, Inc. performed archaeological monitoring and data recovery at the Pacific Beach Hotel Office Annex, approximately 100 meters east of the current project area (Beardsley and Kaschko 1997). Two traditional Hawaiian burials were discovered and removed. Intact buried traditional Hawaiian cultural deposits, including a late pre-contact habitation layer, contained pits, firepits, post molds, artifacts, and food debris. The artifacts included basalt and volcanic glass flakes and cores, a basalt adze and adze fragments, worked pearl shells, a coral file and abraders, and a pearl shell fishhook fragment. Additionally, a late nineteenth century trash pit was discovered, which contained a variety of ceramics, bottles, and other materials.

During 1985 and 1986, archaeologists from Paul H. Rosendahl, Ph.D. Inc. conducted archaeological monitoring at the site of the Mechanical Loop Project at the Hilton Hawaiian Village, Waikīkī. Much of this project area was disturbed by historic and modern construction and modification. Fifteen subsurface features were uncovered during the monitoring, all of which were determined to be historic trash pits or trenches. The dating of these features was based on dating the artifactual material they contained. All 15 features are thought to post-date 1881 based on this artifact analysis. Three partial burials were reported by Neller (1980) (see above). No additional burials were encountered during the PHRI field work (Hurlbett et. al. 1992).

In 1987, a human burial was discovered and removed at the intersection of Kalākaua Avenue and Ka‘iulani Street during excavations for a gas pipe fronting the Moana Hotel (Griffin 1987).

In 1989, skeletal remains were unearthed on the grounds of the Ala Wai Golf Course during digging of an electrical line trench for a new sprinkler system. The trench had exposed a pit containing two burials (Bath and Kawachi 1989: 2). The report suggests that one of the burials may have been disturbed earlier during grading for the Territorial Fair Grounds. The osteological analysis included in the report concludes that both sets of remains "appear ancient" (Bath and Kawachi 1989: 2)

Davis’ (1989, 1991) excavation and monitoring work at Fort DeRussy documented substantial subsurface archaeological deposits, prehistoric, historic, and modern. These deposits included buried fishpond sediments, ‘*auwai* [irrigation ditch] sediments, midden and artifact enriched sediments, structural remains such as post holes and fire pits, historic trash pits, and a human burial. Davis’ (1991) report documents human activity in the Fort DeRussy beachfront area from the sixteenth century to the present.

The work at Fort DeRussy continued in 1992 when BioSystems researchers built upon Davis’ work (Simons et al. 1995). BioSystems research documents the development and expansion of the fishpond and ‘*auwai* system in this area. The ‘*auwai* system was entered on the State Inventory of Historic Places (SIHP) as State Site 50-80-14-4970. Remains of the fishpond and ‘*auwai* deposits, as well as habitation deposits, were documented below modern fill deposits. This research, along with that of Davis (1991), clearly demonstrates that historical document research can be an effective guide to locating late prehistoric/early historic subsurface deposits, even amidst the development of Waikīkī.

In 1992, Hurlbett et al. (1992) conducted additional monitoring and testing in this same area as Neller (1980). The state site -2870 was given to the three burials first found by Neller. Additional subsurface features, postdating 1881, were found during trenching operations.

The realignment of Kālia Road at Fort DeRussy in 1993 uncovered approximately 40 human burials. A large majority of these remains were recovered in a large communal burial feature (Carlson et al. 1994). The monitoring and excavations associated with this realignment uncovered a cultural enriched layer that contained post holes.

In 1993, during construction activities at the Waikīkī Aquarium, human remains were discovered scattered in a back dirt pile, although no burial pit was identified (Dega and Kennedy 1993).

On April 28, 1994, an inadvertent burial discovery was made during excavation for a water line at the intersection of Kalākaua Avenue and Kuamo‘o Street (just *mauka* of Fort DeRussy). These remains represented a single individual (McMahon 1994).

In 1995, the remains of one individual were discovered *in situ* during construction activities on Paoakalani Street, fronting the Waikīkī Sunset Hotel (Jourdane 1995).

In 1996, Pacific Legacy, Inc. conducted an archaeological inventory survey of the block bounded by Kalākaua Avenue, Kūhiō Avenue, ‘Olohana Street, and Kālaimoku Street (Cleghorn 1996). The survey included excavation of seven backhoe trenches. The subsurface testing indicated that

> . . . this area was extremely wet and probably marshy. This type of environment was not conducive for traditional economic practices. . . . The current project area

> appears to have been unused because it was too wet and marshy. Several peat deposits, containing the preserved remains of organic plant materials were discovered and sampled. These deposits have the potential to add to our knowledge of the paleoenvironment of the area. (Cleghorn 1996:15)

The report concluded that no further archaeological investigations of the parcel were warranted since “no potentially significant traditional sites or deposits were found”, but cautioned of the “possibility, however remote in this instance, that human burials may be encountered during large scale excavations” (Cleghorn 1996:15).

In 1996, a traditional Hawaiian burial was discovered and left in place during test excavations on two lots at Lili‘uokalani Avenue and Tusitala Street (McDermott et al. 1996). Indigenous Hawaiian artifacts and historic artifacts were also found within that project area.

From September 1997 to September 1998, archaeological monitoring was conducted by CSH for the Waikīkī Force Main Replacement project that extended along Kalākaua Ave. from the existing pump station near the Waikiki Aquarium, to ‘Ōhua Ave., and *mauka* on ‘Ōhua Ave. to Kūhiō Ave. Findings included a dog burial and scattered human remains on ‘Ōhua Ave; a pit feature on Kalākaua Ave.; a discontinuous old “A” horizon on Kalākaua Avenue; and an old asphalt road surface at the intersection of Kalākaua, Kapahulu, and Monsarrat Avenues (Winieski and Hammatt 2000). The human remains included the proximal end and mid-shaft of a human tibia, a patella, and the distal end and mid-shaft of a femur. These remains occurred within a coralline sand matrix that had been heavily disturbed by previous construction, and by the on-going construction project. No precise location for the original burial site was identified, however, the partial remains were found just *makai* of Kūhiō Ave. and adjacent to the current project area. The dog burial was determined to be historic.

In April 1999, two human burials were inadvertently encountered near the intersection of Ena Road and Kalākaua Avenue during excavation activities for the first phase of the Waikīkī Anti-Crime Lighting Improvements Project (Perzinski et al. 1999).

From November, 1999, to May, 2000, 44 human burials, with associated cultural deposits, were encountered during excavation for a waterline project on Kalākaua Avenue between the Ka‘iulani and ‘Ōhua Avenues (Winieski et al. 2002). Except for previously disturbed partial burials in fill, most of the burials were encountered within a coralline sand matrix. Additionally, a major cultural layer was found and documented. Twenty of the burials were found on Kealohilani Ave. near the intersection of Kalākaua Ave. (State Site Number 50-80-14-5860), and five burials were found on ‘Ōhua Ave. near the intersection of Kalākaua Ave. (State Site Number 50-80-14-5861). Both locations are *makai* of the current project area.

From July 1999 to October 2000, four sets of human remains were inadvertently encountered during excavation activities relating to the Waikīkī Anti-Crime Street Lighting Improvement project along portions of Kalākaua Avenue (Bush and Hammatt 2002). The first burial was encountered on Kalākaua Avenue, just before Dukes Lane and assigned State Site 50-80-14-5864. The burial was left in place however, and the light post was repositioned. The second burial was encountered at the intersection of Kalākaua Avenue and Ka‘iulani Avenue. Earlier, during archaeological monitoring for the water mains project, two burials were encountered in the immediate area of the second burial find; they were assigned state site 50-80-14-5856 features A and B. Due to the close proximity to the previously encountered burials, the second burial was assigned the same State Site 50-80-14-5856, and designated feature C. Burials 3 and 4 were recovered at the intersection of Kalākaua Avenue and Kealohilani, near an area of concentrated burials assigned State Site 50-80-14-5860 during monitoring for the water mains project. Consequently, burials 3 and 4 were also assigned State Site 50-80-14-5860, features U and V. In addition to human remains, pre-contact deposits, historic and modern rubbish concentrations, and pond sediments were also encountered *makai* of the current project area.

CSH monitored the Waikīkī anticrime lighting improvement project from July 1999 to October 2000; the project extended along Kalākaua Avenue between Ala Moana Boulevard and Kapahulu Avenue. Two more burials were found and identified as features of Site 50-80-14-5860 (see above); both burials were located at the diamond head side of the intersection of Kealohilani Ave. and Kalākaua Ave., approximately 100 meters *makai* of the current project area (Bush et al. 2002).

In April 2001 human remains were inadvertently disturbed during excavations associated with the construction of a spa at the Royal Hawaiian Hotel (Elmore et al. 2001). Archaeological Consultants of the Pacific, Inc was responsible for the documentation of the remainder of the burial and carrying out the instruction of DLNR/ SHPD. The burial and its location were assigned State Site # 50-80-14-5937. The partially disturbed burial was encountered on the North side of the hotel in the spa garden. The remains, disturbed through the thoracic region and anatomical left side, were wrapped in muslin cloth and placed with the in situ remains and reburied. The burial was recorded as a post contact burial based on artifacts associated with it. The associated artifacts included one shell button found in situ and three more shell buttons found in the disturbed material. A single drilled dog tooth was found also during excavation but could not be positively associated with the site.

On May 2nd and June 14th, 2001, two in situ and two previously disturbed human burials were encountered at the site of a new Burger King (Cleghorn 2001a) and an adjoining ABC Store (Cleghorn 2001b). The finds were located at the intersection of ʻŌhua Street and Kalākaua Avenue (Cleghorn 2001a and 2001b). Because of their proximity to five burials encountered during the Kalākaua 16" Water Main Installation (Winieski et al. 2002a), they were included in the previously assigned SIHP # 50-80-14-5861. Three of these burials were recovered, and one was left in place. Volcanic glass fragments were found in association with one of the burials. A cultural layer was also observed which contained moderate to heavy concentrations of charcoal and fragments of volcanic glass. Historic era artifacts, including a bottle fragment, plastic and glass buttons, a ceramic fragment, and metal fragments were also encountered within fill materials.

In 2001 and 2002, CSH (Mann and Hammatt 2002) performed archaeological monitoring for the installation of 8- and 12-inch water mains on Uluniu Avenue and Liliʻuokalani Avenue During the course of monitoring, five burials finds, consisting of six individuals, were recorded within the project area, approximately 200 meters *makai* of the current project area. Four burial finds were recorded on Uluniu Avenue; three of these inadvertent finds were found in fill sediment. Due to the nature of the three burial finds in fill, it was concluded that no State Site number(s) be assigned to these three previously disturbed burials. The only primary *in situ* burial encountered on Uluniu Avenue was assigned State Site #50-80-14-6369. The fifth burial, consisting of two individuals in fill material, was recorded from Lili‘uokalani Avenue. Since three burials had been found in the immediate vicinity during a previous project (Winieski, Perzinski, Souza and Hammatt 2002) and had been assigned to Site #50-80-14-5859, the two new individuals were recorded as Feature H of the previously recorded site.

In 2004, Cultural Surveys Hawai‘i conducted an archaeological inventory survey and cultural impact evaluation for the Ala Wai Gateway project site (Freeman et al. 2005). The project site comprised TMK 2-6-011:001, 002, 004, 32, 37, and 40, which are bounded by Ala Wai and Ala Moana boulevards, Hobron Lane, and Līpe‘epe‘e Street. Four historic properties were documented in the survey including human remains, a cultural layer, and a fishpond remnant.

In 2005 Cultural Surveys Hawai‘i conducted an archaeological inventory survey of a 72,135 square foot (1.67 acre) project area on Kaio‘o Drive (TMK: [1] 2-6-012: 37, 38, 39, 40, 41, 42, 43, 44, 55, 56, 57) (O’Hare et al. 2006). Site 50-80-14-6848, a pre-contact firepit radiocarbon dated to AD 1470-1660, was recorded.

In 2005 CSH conducted an archaeological inventory survey at the Allure Waikīkī Development, (site of the former Wave Waikīkī) on Kalākaua Avenue at Ena Road (TMK: [1] 2-6-13: 1, 3, 4, 7, 8, 9, 11 and 12) (Bell and McDermott 2005). Two burials, SIHP 50-80-14-6875, were encountered in the eastern corner of the project area.

In 2006 CSH (Hammatt & Shideler 2006a and 2006b) conducted an archaeological inventory survey (called an assessment in the absence of finds) of three parcels at the corner of Kūhiō and Kapahulu Avenues. There were no significant finds but sediments relating to the former Ku‘ekaunahi Stream (now overlain by Kapahulu Avenue) were documented.

In 2007 CSH (Hammatt & Shideler 2007) conducted archaeological monitoring of a grease interceptor at the Sheraton Moana Surfrider Hotel. There were no significant finds but a thick disturbed layer was documented nearly to the water table.

In 2007 CSH (Pammer, and Hammatt 2007) conducted archaeological monitoring of a grease interceptor at Perry’s Smorgy restaurant but there were no significant finds.

In 2008 CSH (Hazlett, Chigioji, Borthwick and Hammatt 2008) conducted archaeological monitoring of re-development of the former Waikiki 3 Theater parcel but there were no significant finds.

In 2008 CSH (Hazlett, Esh and Hammatt 2008) concluded an archaeological monitoring report of re-development of the Waikiki Shopping Center but there were no significant finds.

In 2008 CSH (Petrey, Borthwick and Hammatt 2008) concluded an archaeological monitoring report for a City and County of Honolulu’s emergency temporary Beach Walk Sewer Bypass project but there were no significant finds.

In 2008 CSH carried out a number of studies (Runyon, et al. 2008; Thurman and Hammatt 2008) relating to re-development of the Royal Hawaiian Hotel and Sheraton Waikiki Resort. Isolated, disarticulated human skeletal elements were recovered from disturbed sand contexts.

In 2008 CSH (Tulchin, J. and Hammatt 2008) conducted an archaeological inventory survey (called an assessment in the absence of finds) of a 1944 Kalākaua Avenue project but there were no significant finds.

In 2008 CSH (Tulchin T. and Hammatt 2008) completed an Archaeological Data Recovery Report for the Tusitala Vista Elderly Apartments, that presents palynological and radiocarbon analysis tracing the paleo-environmental change and man-made alterations of the landscape at SIHP No. 50-80-09-6707.

In 2008 CSH (Whitman et al. 2008) completed an Archaeological Monitoring Report for a 12-inch water main installation project along a Portion of Kalākaua Avenue and Poni Mō'ī Road. One inadvertent human burial was discovered during monitoring. The remains were fully articulated and was designated SIHP # 50-80-14-6946.

In 2009 Cultural Surveys Hawai'i conducted an archaeological inventory survey for the proposed Waikīkī Shopping Plaza redevelopment project (Yucha et al. 2009). This investigation found that subsurface deposits consisted of several strata of early 20th century land-reclamation and hydraulic fill overlying a culturally modified wetland ground surface, SIHP# 50-80-14-5796, at a depth in excess of 1.5 m below surface. SIHP # 50-80-14-5796 was documented with a detailed written description, photographed in profile, analyzed, and radiocarbon dated. Jaucas sand deposits were absent within the project area. A monitoring program was recommended.

3.2 Previous Burial Finds in the Vicinity of the Project Area

Several isolated burials have been previously found within one or two blocks of the project area, as shown in Figure 28. In addition, human remains representing at least 17 individuals have been identified during excavation of the basement and Banyan Court of the Moana Hotel.

The Bernice Pauahi Bishop NAGPRA records (see Table 3) relate that skeletal reamians from one individual were recovered from the vicinity of the "Tahiti By Six" bar (west central portion of the present project area) in 1967. No details are available.

In 1987, a human burial was discovered and removed at the intersection of Kalākaua Avenue and Ka'iulani Street during excavations for a gas pipe fronting the Moana Hotel (Griffin 1987). The remains were from a pit in a matrix of dark gray, silty sand approximately 96 cm below surface (Griffin 1987:1-2). The remains were reinterred with other burials recovered during the 1988 Moana Rehabilitation Project (see below) and identified as Individual 12 at that time (Simons et al. 1991:10). The burial was later given its own site designation as SIHP # 50-80-14-3745.

In1988, the Moana Hotel Historical Rehabilitation Project (Simons et. al. 1991) encountered human remains that amounted to at least 8 individuals under the basement floor or the Diamond Head Makai Wing. Based on stratigraphic association these burials were interred over time as the land form at the site changed. The sediment surrounding these burials yielded traditional midden and artifact assemblages.

The final report (Simons et al. 1991) documents the monitoring of approximately 1489 square meters of the Banyan Court and the basements and the recovery of the remains of 17 individuals, including the eight individuals reported in the interim report, and one that was recovered by SHPD in 1987 (Burial 12, see Griffin 1987 above). However, "so many burials were scattered that the true population of human burials on the site property will never be known" (Simons et al. 1991:106). It should also be noted that the number of burials sets reported in the text varies from 24 to 27. Set 18-24 (or set 18-27) consists of scattered human remains found during screening of

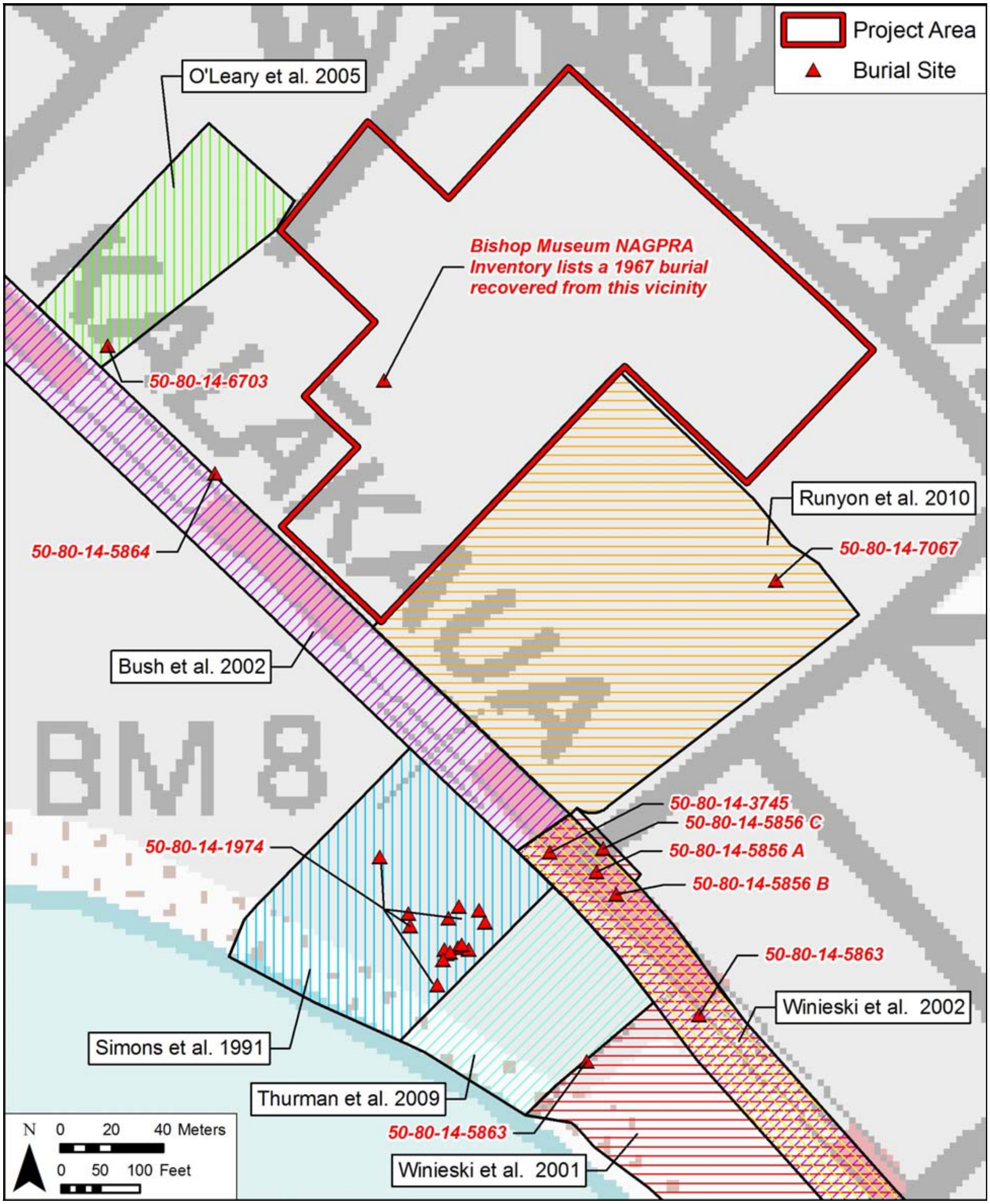

Figure 28. Previous Archaeological studies and burial locations near the International Market Place (1998 U.S. Geological Survey topographic map, Honolulu Quadrangle) (Note 1967 Bishop Museum NAGPRA Inventory burial location is approximate)

backhoe dump piles in the Banyan Court; these did not contribute to the 17 individual burials noted in the report. The recovered remains were reinterred in a "cement cyst on the *mauka* side of the sea wall in the Banyan Court. A metal tag that identified the contents is on top the cyst" (Simons et al. 1991:127). All of the burials were considered part of site SIHP # 50-80-14-1974.

CSH monitored the installation of a 16" water main within an approximately 915 meter (3,000 ft.) long portion of Kalākaua Avenue between Kaʻiulani Avenue and Monsarrat Avenue from November 1999 to October 2000 (Winieski et al. 2002). A total of forty-four human burials (SIHP 50-80-14-5856 thru -5862) were encountered, thirty-seven of which were disinterred. Most relevant to the proposed project is SIHP 50-80-14-5856, consisting of two burials (Features A and B), located on Kalākaua at Kaʻiulani, and fronting the Moana.

SIHP # 50-80-14-5856 Burial-A was located on the *makai* portion of Kalākaua Avenue approximately 5 m *mauka* of the *makai* curb and approximately 20 m east (Diamond Head) of Kaʻiulani Avenue. The burial was *mauka* from the annex of the Moana Hotel. The remains recovered were at a depth of 1.35 m below the asphalt road surface. A concentration of bones had been gathered and left in the southeast end of the waterline trench (trenching had stopped as the remains were encountered). Although burial recovery excavation by trowel commenced, no in situ remains and no trace of a burial pit were observed. The remains recovered were in a stratum designated IIIB which consisted of a 10YR 8/4 very pale brown, medium calcareous beach sand. The remains recovered were quite fragmented and far from complete. Some of the remains were much whiter than the rest suggesting the possibility of surface exposure or differential weathering. The find appeared to be that of a single adult. It was concluded in the field that the burial was most likely disturbed by trenching for an adjacent gas line that ran along the *makai* side of the trench.

SIHP # 50-80-14-5856 Burial-B was located 5 m inland of the *makai* curb of Kalākaua Avenue directly *makai* of the east (Diamond Head) side of Kaʻiulani Avenue approximately 15 m east (Diamond Head) of Burial 1. The burial was located in the northeast-central portion of the trench at a depth of 185 cm to 2 m below the road surface. The burial appeared to be bundled or tightly flexed in a stratum designated IIIB, which consisted of a 10YR 8/4 very pale brown medium calcareous beach sand. Stratigraphic nomenclature was consistent with that for Burial #1 (Strata II and IIIA were not present at the location of Burial #2). The head was to the northwest facing northeast (*mauka*) and the burial was lying on its left side. Relatively few bones were recovered away from the in situ remains.

The remains recovered were typically quite fragmented with the in situ remains showing numerous old (post-mortem) breaks. The entire cranium and mandible were recovered intact with the exception of three incisors in the mandible and three corresponding incisors in the maxilla. There appeared to be some absorption of the maxilla indicating tooth loss during life but this was not clear in the mandible. Portions of all long bones appeared to be accounted for, but no intact long bones were recovered. No portion of the pelvis or the balls of the femurs were recovered. Two small unmodified *Nerita polita* (*kupeʻe*) shells were found in the course of screening and may have been associated with the burial (no other midden or cultural remains were observed). The absence of historic artifacts associated with the burial indicates traditional Hawaiian burial practices.

Between July 1999 and October 2000, four sets of human remains were inadvertently encountered during excavation activities relating to the Waikīkī Anti-Crime Street Lighting Improvement project along portions of Kalākaua Avenue (Bush et al. 2002). The first burial was encountered on Kalākaua Avenue, just before Duke's Lane and assigned SIHP # 50-80-14-5864. It was within a well-defined burial pit, 110 to 150 cm below surface. The burial was left in place, and the light post was repositioned. Site 5864 is approximately 25 meters west of the current project area

The second burial was encountered at the intersection of Kalākaua Avenue and Ka‘iulani Avenue. Due to the close proximity of this burial found to the two burials during the Force Main Project (Winieski et al. 2002), the second burial was assigned the same SIHP # 50-80-14-5856, and designated Burial C. Burials 3 and 4 were recovered at the intersection of Kalākaua Avenue and Kealohilani, near an area of concentrated burials assigned SIHP # 50-80-14-5860 during monitoring for the water mains project. Consequently, burials 3 and 4 were also assigned SIHP # 50-80-14-5860, features U and V. In addition to human remains, pre-contact deposits, historic and modern rubbish concentrations, and pond sediments were also encountered.

SIHP 50-80-14-5856 Burial C, was found within the Stratum I brown silt loam rather than the Stratum II light brown sand that most burials in this area have been found. Fire-cracked basalt and coral cobbles, and charcoal were observed directly below the remains. Hand probing of the area did not reveal an in situ location for the burial, and it is unclear whether the complete set of remains was located in this vicinity. Inventory of the remains collected revealed an incomplete, single adult individual of indeterminable sex and ethnicity. Due to left and right remains being present, it is possible that this burial was previously disturbed. The burial location strongly suggests Hawaiian ancestry.

From January 2000, to October 2000, 10 human burials were encountered during archaeological monitoring of the Kūhiō Beach Extension/Kalākaua Promenade project (Winieski, Perzinski, Souza, et al. 2002). Six of these were located within a coralline sand matrix. The four others were partial and previously disturbed within fill. Additionally, a major cultural layer was found and documented, and was apparently part of the same major cultural layer associated with the waterline project between Ka‘iulani and ‘Ōhua Avenues. The burials were later given the designations of sites SIHP 50-80-14-5863, 5857 to -5862. SIHP # 50-80-14-Site 5863 consisted of two finds. The first was a disturbed burial *makai* of Kalākaua Avenue near the police substation, east of Uluniu Street. The second was a single human bone found in the same area nearer the road; the bone was a proximal end of a femur, possibly waste material from the manufacture of a fish hook. These two burials are within two blocks of the current project area.

In 2005, CSH (O'Leary et al. 2005a), conducted an archaeological inventory survey of the approximately 1-acre former Waikiki 3 Theatre parcel (TMK: 1-2-6-022:009) on Kalākaua Avenue, adjacent to the west side of International Market, one of the current study areas. Twelve trenches were excavated. Subsurface testing revealed that the majority of the strata within the project area are the result of the infilling of the marshland that once comprised most of Waikīkī during the early part of the 20th century. The uppermost layers (Ia-Ie) are the materials that were removed from the Ala Wai Canal during dredging and dumped as a fill layer(s) for future construction in Waikīkī. These layers were a coarse sandy loam mixed with primarily crushed coral inclusions. Some construction debris was also found in them. Beneath the dry fill layers were pumped fine sands, silts, and clays that were also deposited from the dredging of the canal. These fine-grained sands, silts, and clays differ from the overlying layers in that, instead of being dumped, they were pumped into the various low-lying areas of Waikīkī. The middle layers (IIa-b), are sediments that originally comprised the agricultural wetland soils. Stratum II contained a high level organic material and large quantities of land snails. The excellent preservation of the organic materials and shells indicates that the area was covered rapidly with materials pumped from the canal. The lowest stratigraphic layer, III, was marine deposited sterile sand mixed with coral fragments. An articulated human burial was found during the excavation of Trench 2, SIHP # 50-80-14-6819. The burial was left in place and the trench was refilled. As the burial was within Stratum II, the wetland layer present during the pre-contact and early post-contact periods in Waikīkī, the burial was assumed to be that of a native Hawaiian.

In 2010 (Runyon et al. 2010), 22 backhoe test trenches were excavated in the Princess Ka'iulani Hotel area. Three historic properties were identified during subsurface testing (SHIP # 50-80-14-7065, -7066, and -7067). Site -7605 represents the remains of the late nineteenth/early twentieth century Kawaiaha'o Church Branch and Cemetery. Excavations within this area produced five locations containing disarticulated human skeletal elements in a disturbed context. A cultural layer, SIHP # 50-80-14-7066, was observed in the southern portion of the project area, with the majority of the site being located within the Kawaiaha'o Waikīkī Branch Church and Cemetery parcel (SIHP # 50-80-14-7065). A sediment sample from Feature 2 was sent to Beta Analytic, Inc. for radiocarbon dating. The sample yielded a calibrated 2-sigma date range of AD 1725 to AD 1815 (46.4%). During excavation of a trench located within the existing hotel loading zone near the eastern corner of the project area, one in situ fully extended human burial was encountered at a depth of approximately 150 cm below the surface. The in situ burial was assigned SIHP # 50-80-14-7067. Glass beads were found in the burial pit, indicating that the burial was most likely that of a early post-contact Hawaiian (Runyon 2010:79).

In 2009 Cultural Surveys Hawai'i conducted an archaeological inventory survey for proposed redevelopment of the Diamond Head Tower of the Moana Hotel (Thurman et al. 2009). One isolated human skeletal fragment consisting of one tarsal phalange was discovered on the *makai* side of the Diamond Head Tower. The human remain was found within a disturbed sand stratum. Two sites were identified consisting of a trash pit (-7069) containing bottles and ceramics dating from the late nineteenth through early twentieth centuries and an intact cultural layer (-7068) radiocarbon dated to AD 1801 – AD 1939. The cultural layer was documented between the hotel and the *makai* side of Kalākaua Avenue.

3.3 Background Summary and Predictive Model

The *ahupua'a* of Waikīkī, in the centuries before the arrival of Europeans, was a well-used locale with abundant natural and cultivated resources – including an expansive system of irrigated taro fields and numerous fishponds – supporting a large population that included the highest-ranking *ali'i* (Hawaiian royalty). In the second half of the nineteenth century, after a period of depopulation and desuetude, Waikīkī was reanimated by the Hawaiian *ali'i* and the foreigners residing there, and by farmers continuing to work the irrigated field system that had been converted from taro to rice. This farming continued up to the first decades of the twentieth century when the newly-constructed Ala Wai Canal drained the remaining ponds and irrigated fields of Waikīkī.

The present project area is located in central Waikīkī that, in traditional Hawaiian times and before the massive drainage accomplished by the Ala Wai Canal, comprised a complex of *lo‘i* (taro) and banana agricultural fields. Land Commission Award documents from the mid-nineteenth century record *ali‘i* land owner, continuing Native Hawaiian habitation, and taro cultivation in parcels adjacent to the present project area. Subsequent nineteenth and twentieth century documents – including historic maps and photographs – indicate that the project area from traditional Hawaiian times to the modern era comprised agricultural fields. In traditional Hawaiian times, such an environment would have provided a base for habitation, work, and recreational activities of the population. From at least the mid-nineteenth century, the project area in Kaluaokau was the home of the high *ali‘i* and of the monarchy. King Lunalilo built a small cottage on this property and used it as a health retreat in the 1860s and 1870s. In 1874, at his death, he bequeathed the property to Queen Emma, who also occasionally occupied the property until her death in 1885. The Queen Emma Trust leased the land in the early twentieth century to the Moana Hotel and later the Matson Navigation Company for additional hotel rooms and cottages for workers. In 1957, the International Market Place was constructed in the project area.

The substantial history of archaeological work in Waikīkī has indicated a relatively high density of burials within Jaucus sand deposits such as constitute the soils in the proposed project area. Much of Waikīkī was formerly quite low-lying, at or close to the water table. Lands that were slightly higher, such as the present proposed project area were preferentially chosen for interment of the dead.

Three areas of very high densities of burials have been previously reported from Waikīkī: in 1963 from the present Outrigger Canoe Club (apparently 96 burials – but see discussions above), in 1993 in a large communal burial feature uncovered during the realignment of Kālia Road at Fort DeRussy (approximately 40 human burials, Carlson et. al. 1994) and during a Kalākaua Avenue water line project near the intersection with Kealohilani Avenue (18 burials; Perzinski et al. 2000). It seems probable that additional areas with a high density of burials will be encountered in the future.

Especially relevant to the present project area are the scattered burial sites found within one to two blocks of the current project area, including: remains (of one individual) recovered near the “Tahiti By Six” Bar in 1967 (Bishop Museum NAGPRA records), during gas repair work in front of the Moana Hotel (1 burial), during road/sewer work along Kalākaua Avenue (six burials), at the Waikīkī Theater (one burial), and at the Ka‘iulani Hotel (one burial). In addition, human bones representing at least 17 individuals were discovered and reinterred at the Moana Hotel basement and grounds.

Several archaeological studies have recorded the presence within Waikīkī of subsurface cultural deposits of both pre-contact Hawaiian and historic provenance. These deposits were intact despite years of construction activity that have altered the entire Waikīkī area. The authors of these studies emphasize the potential for discovering similar intact deposits elsewhere in Waikīkī.

Section 4 Inventory Survey Methodology

This section details the methods to be used by CSH personnel during fieldwork, laboratory analysis, and the preparation of the archaeological inventory survey report for the International Market Place project, shown on Figures 1-4. This research design is intended to meet the specifications for an inventory survey plan outlined in the Hawaii Administrative Rules 13-275-5.

4.1 Personnel

Fieldwork for the Archaeological Inventory Survey will be carried out under the supervision of principal investigator Hallett H. Hammatt, Ph.D. It is anticipated that the field crew will consist of three archeologists and field work will take approximately 45 work shifts, for a total of 135 archaeologist-days.

4.2 Field Methods

The research design for the planned archaeological inventory survey includes a 100% pedestrian inspection of the project area to ascertain the age of standing architecture and whether there are surface historic properties. Following the pedestrian inspection, the archaeological fieldwork will focus on a program of subsurface testing with a combination of backhoe and hand excavated trenching to locate any buried cultural deposits, which based on the results of background research, CSH expects to find beneath a layer of historic era (e.g. Ala Wai Canal fill) and modern fill. Historic era is defined as anything older than 50 years and modern is defined as anything younger than 50 years.

4.2.1 Sample Size

The International Market land area comprises TMK 2-6-022: parcels 036 (7,120 sq ft.), 037 (7,120 sq ft.), 038 (124,917 sq ft.), and 043 (71,111 sq ft.) equaling 210,268 sq ft. or 4.827 acres. The Miramar Hotel (TMK: 2-6-022:039 is 50,329 sq ft. or 1.16 acres. The vicinity of three existing trees to be retained in the development will not be part of the subsurface investigative process. The non-development areas for these three trees are estimated at 12,874 sq ft. There are two substantial areas of existing subsurface excavations: the semi-subterranean Lava Rock Bar (4,000 sq ft.) and a back-of-house vehicle maintenance pit (2,000 square feet). The estimated developable area that has not undergone significant excavation previously is estimated at 191,394 sq ft. or 17,781 sq m.

The sub-surface testing program will consist of the excavation of approximately 60 backhoe-assisted test trench excavations (each typically being 6m long by 0.8 m wide = 4.8 m^2) for a total surface excavation of approximately 288 m^2, representing a sample size of approximately 1.2% of the project area, and 1.25% of proposed development areas (Figure 29, Figure 30 and Figure 75). Trenches will be distributed throughout the proposed development areas to provide representative coverage and assess the stratigraphy and potential for subsurface cultural resources (Figure 29 Figure 88).

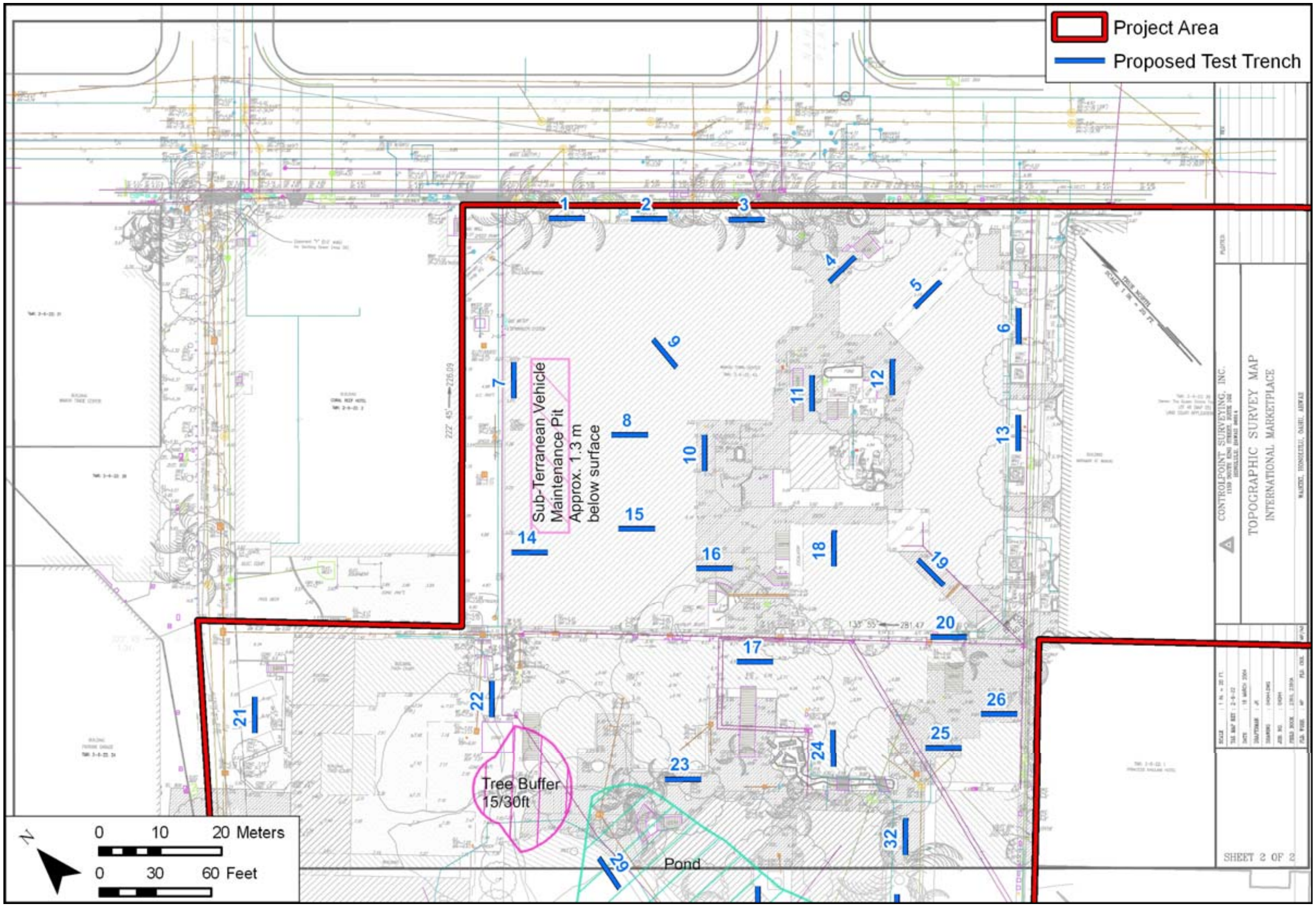

Figure 29. Plan of the International Market Place (*mauka* portion) showing the project area outlined in red and the proposed test trench locations in blue

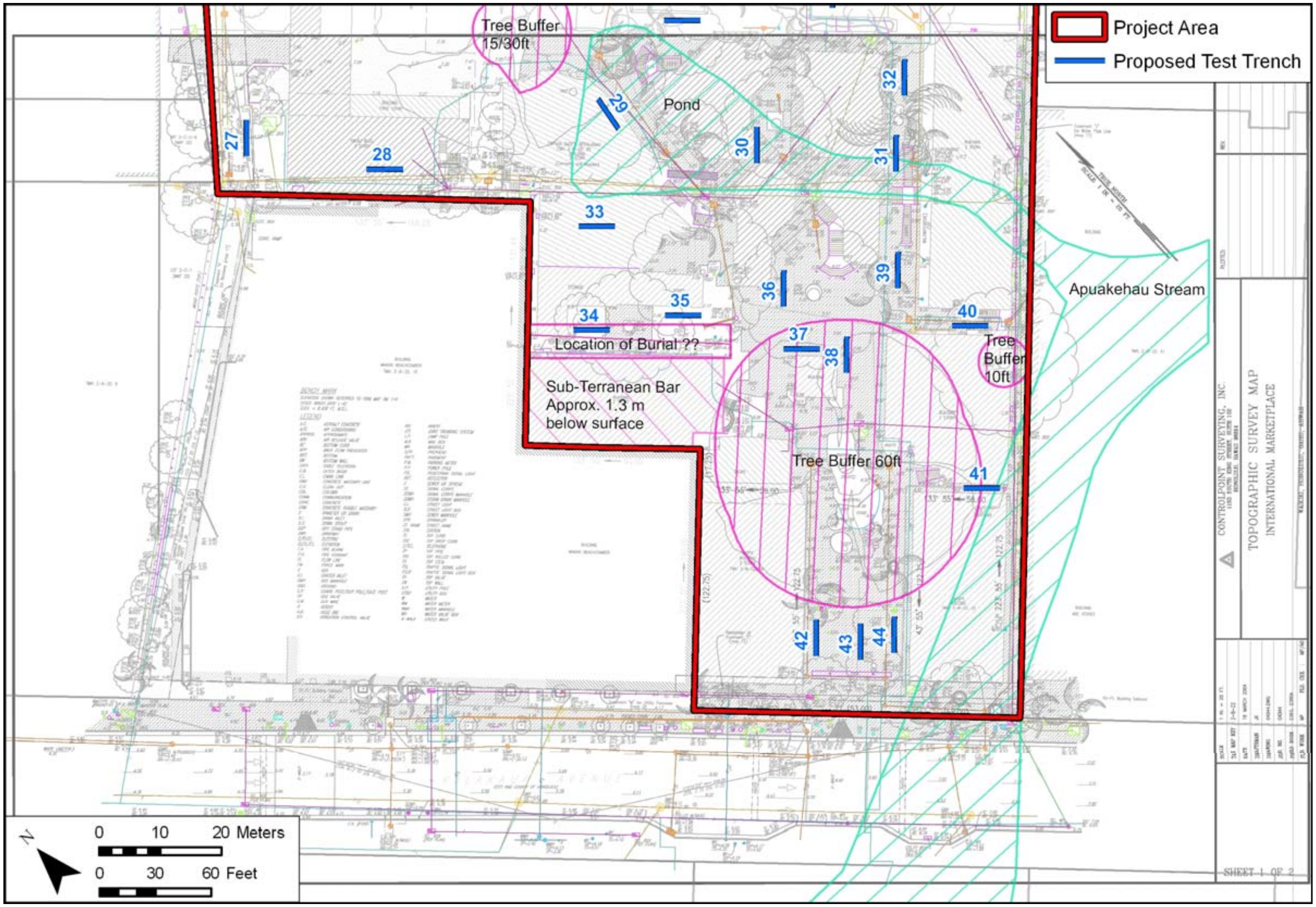

Figure 30. Plan of the International Market Place (*makai* portion) showing the project area outlined in red and the proposed test trench locations in blue

Figure 31. Trench 1, north corner of campus (Kūhiō Ave. at right) view to northwest *(‘ewa*)

Figure 32. Trench 2, north corner of campus (Kūhiō Ave. at right and Lotus Soundbar at left), view to northwest *(‘ewa*)

Figure 33. Trench 3, central northeast edge of campus (Kūhiō Ave. at right and Hoku Wireless at left), view to northwest *(‘ewa*)

Figure 34. Trench 4, northeast side of campus, central walkway by stairwell, view to west (*makai/‘ewa*)

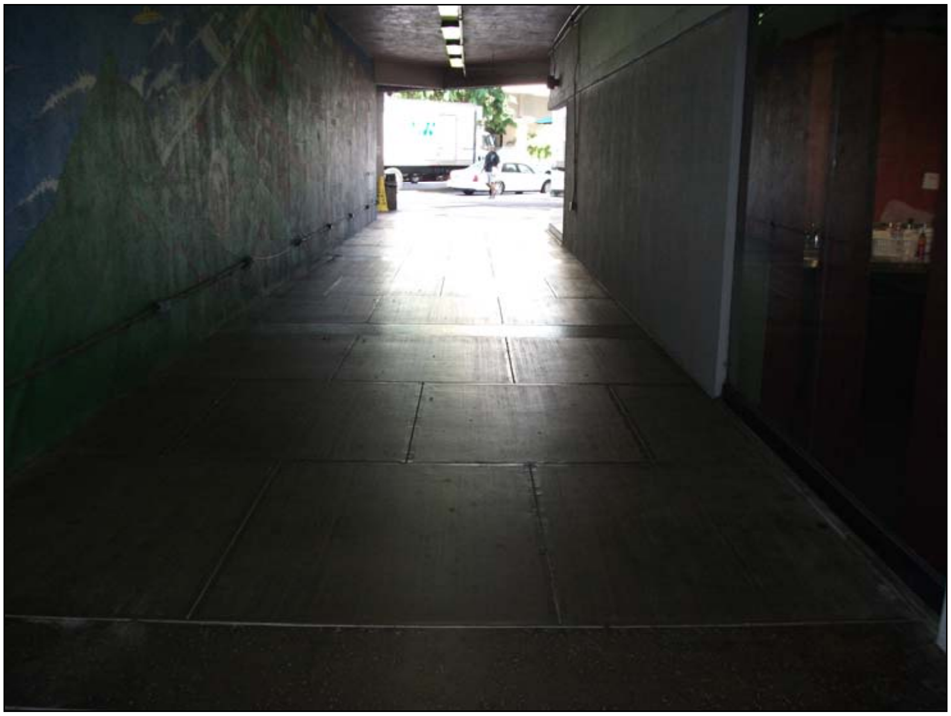

Figure 35. Trench 5, east corner hall way, view to east (*mauka*/Diamond Head)

Figure 36. Trench 6, east corner of campus Diamond Head walkway (Miramar at left), view to southwest (*makai*)

Figure 37. Trench 7, northwest edge of north corner of campus, at vehicle maintenance area, view to southeast (Diamond Head)

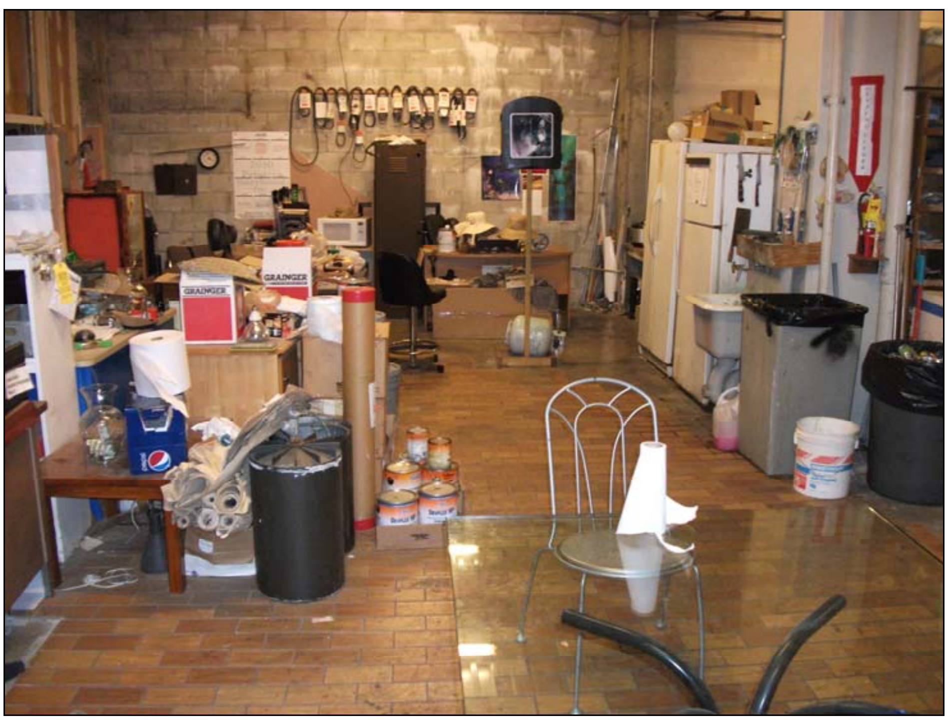

Figure 38. Trench 8, north portion of campus, maintenance shop interior, view to northwest (*'ewa*)

Figure 39. Trench 9, north corner of campus, interior hallway, view to north (*mauka/‘ewa*)

Figure 40. Trench 10, north central portion of campus, northwest side of central walkway, view to southwest (*makai*)

Figure 41. Trench 11, north side of campus, central walkway by escalator, view to southwest (*makai*)

Figure 42. Trench 12, east corner courtyard by elevator, view to southwest (*makai*)

Figure 43. Trench 13, east corner of campus Diamond Head walkway (Miramar at left), view to southwest (*makai*)

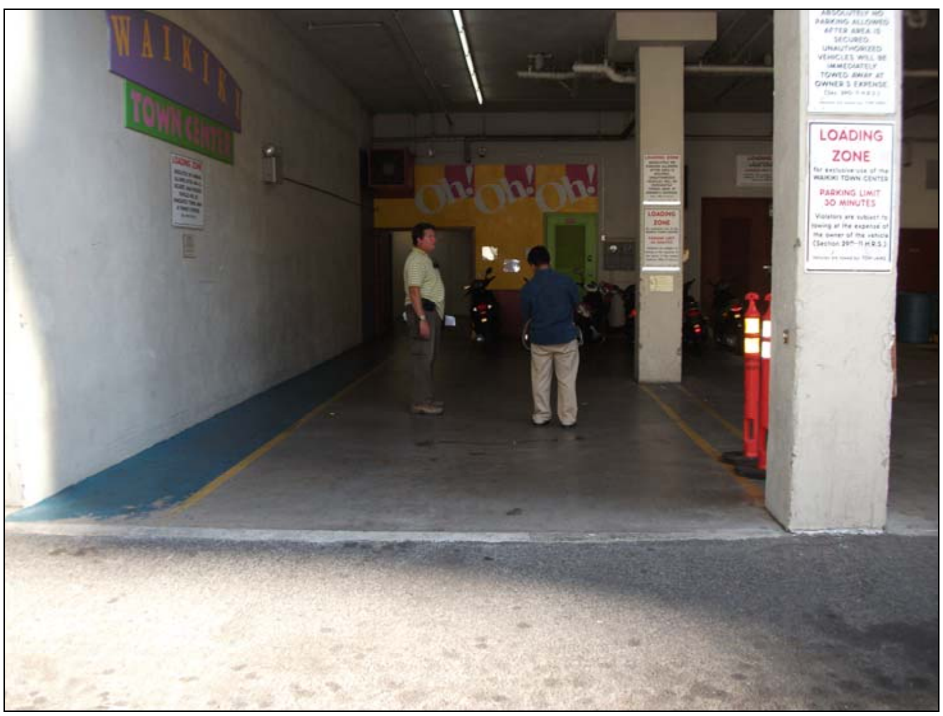

Figure 44. Trench 14, northwest edge of north portion of campus at loading zone, view to southeast (Diamond Head)

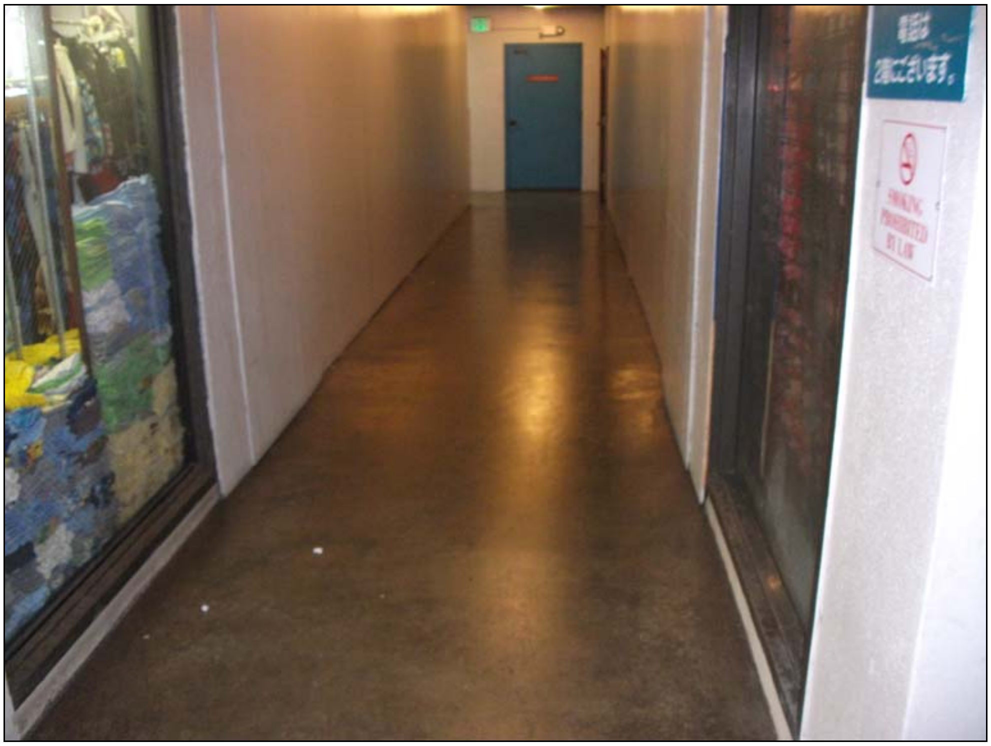

Figure 45. Trench 15, north central portion of campus, interior hallway, view to northwest *('ewa*)

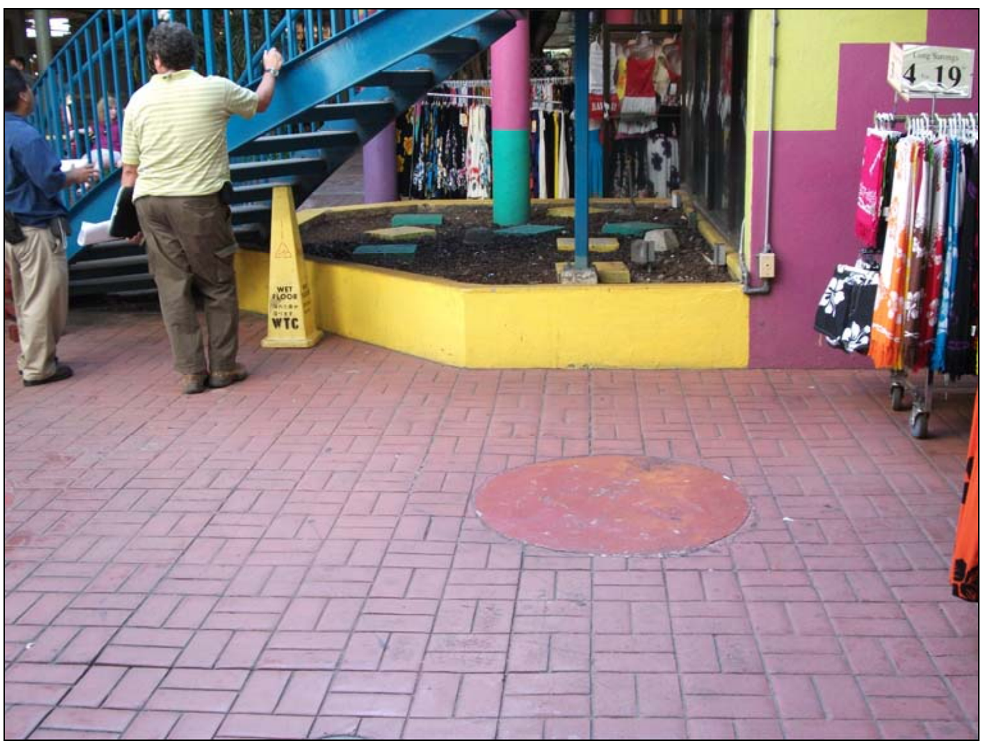

Figure 46. Trench 16, north central interior walkway by staircase, view to southwest (*makai*)

Figure 47. Trench 17, central portion of campus, interior walkway, view to northwest (*mauka/'ewa*) (note anomalous boulder at right)

Figure 48. Trench 18, north central portion of campus (for lease space) (proposed trench in southwest interior) view to southwest (*makai*)

Figure 49. Trench 19, southeast central portion of campus, interior hallway (Chinese restaurant at right) view to south (*makai*/Diamond Head)

Figure 50. Trench 20, southeast side of inland portion of project area, gravel paved alley, view to northwest *(‘ewa*)

Figure 51. Trench 21, central northwest edge of campus car parking area, view to southwest (*makai*)

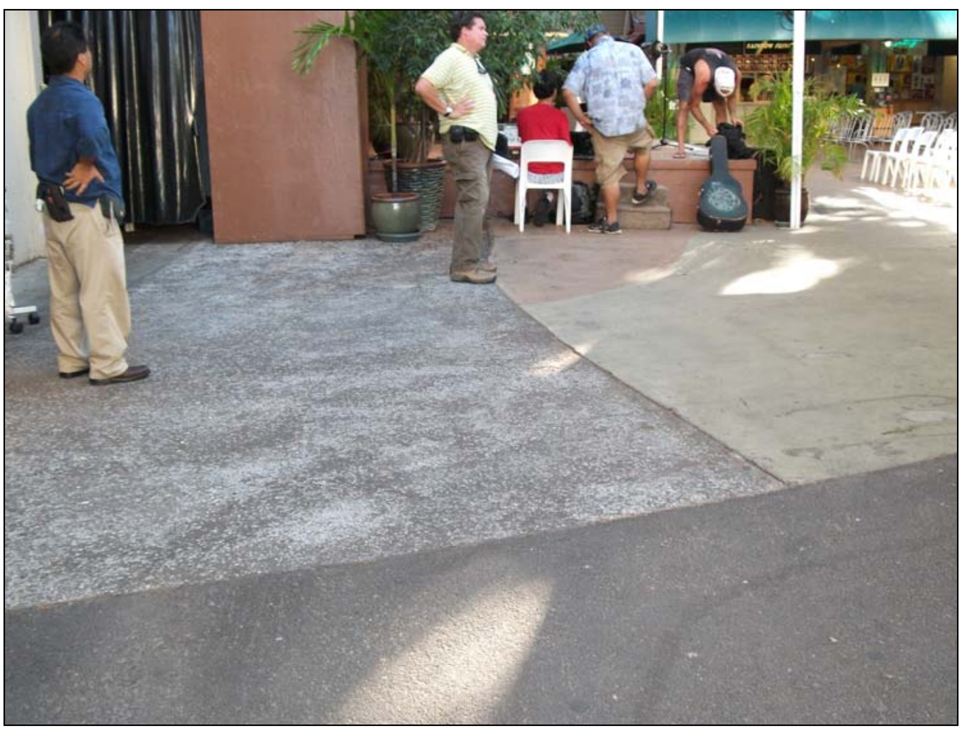

Figure 52. Trench 22, northwest central portion of campus, northeast of stage, view to southwest (*makai*)

Figure 53. Trench 23, central portion of campus, interior hallway, view to northwest (*‘ewa*)

Figure 54. Trench 24, southeast central portion of campus, interior hallway, view to east

Figure 55. Trench 25, southeast side of central portion of project area, interior walkway by "Gold Classics" shop, view to southeast (Diamond Head)

Figure 56. Trench 26, southeast side of central portion of project area, interior walkway, view to southeast (Diamond Head)

Figure 57. Trench 27, central northwest edge of campus, back-of-house area view to northeast (*mauka*)

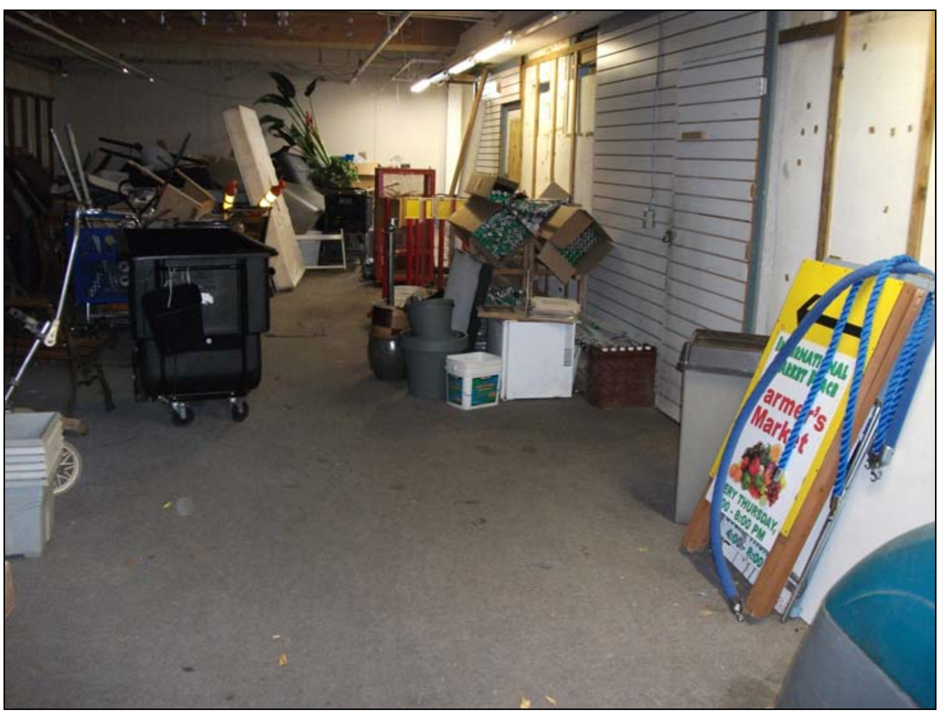

Figure 58. Trench 28, west edge of campus “Halau Building”, interior back-of-house area view to southeast (Diamond Head)

Figure 59. Trench 29, northwest central portion of campus, open dining area, view to south (Diamond Head/*makai*)

Figure 60. Trench 30, central campus, walkway, view to southwest (*makai*)

Figure 61. Trench 31, southeast central portion of campus, walkway by staircase, view to northeast (*mauka*)

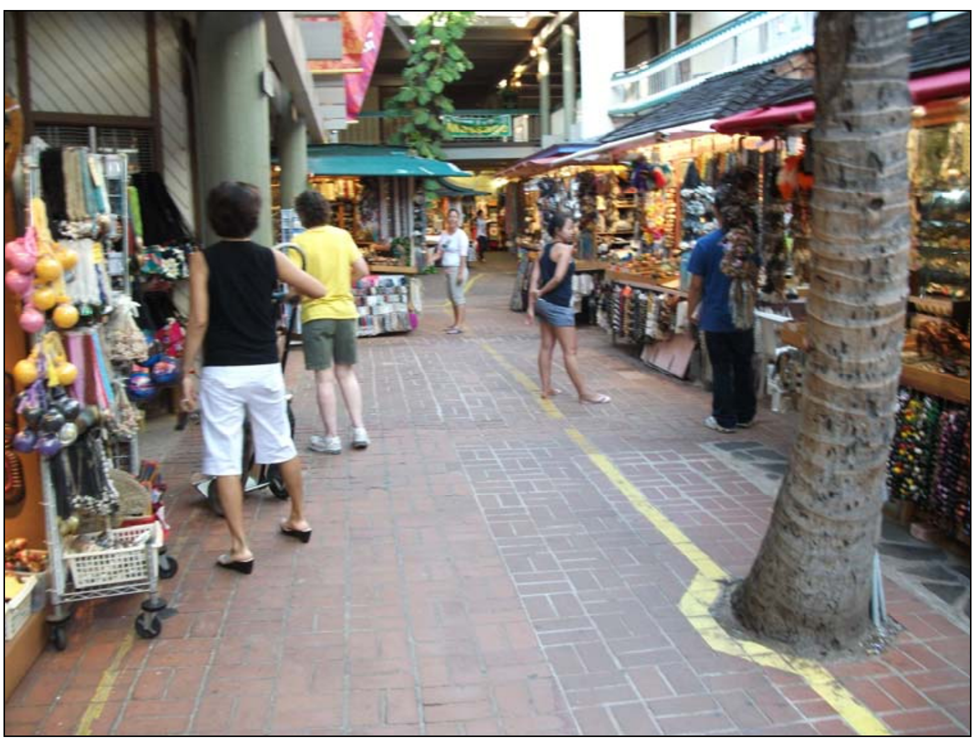

Figure 62. Trench 32, southeast central portion of campus, walkway, view to northeast (*mauka*)

Figure 63. Trench 33, northwest central portion of campus, open dining area, view to southeast (Diamond Head)

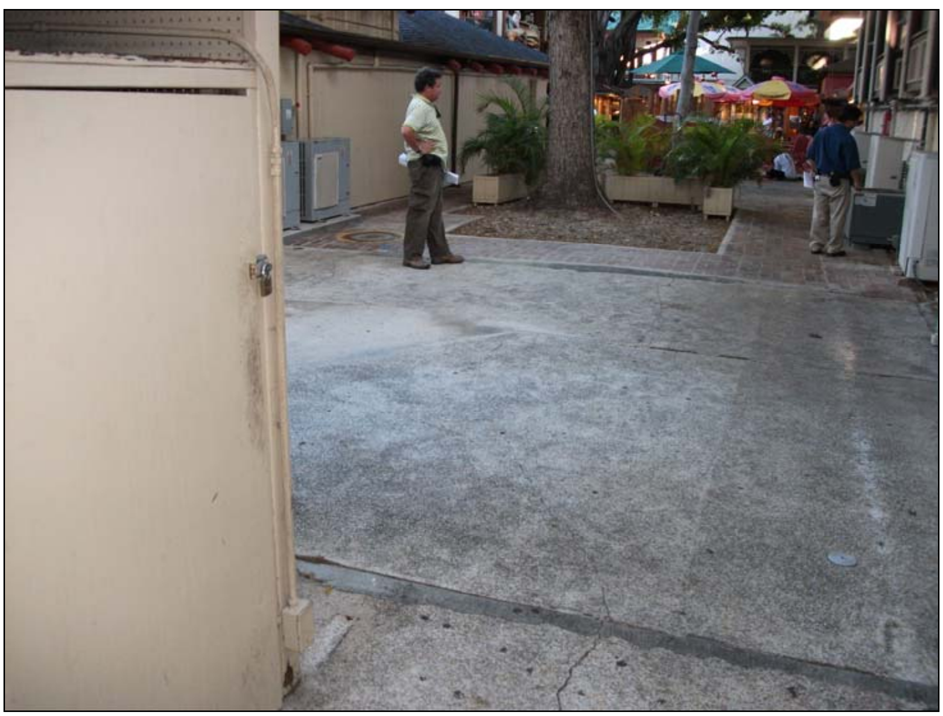

Figure 64. Trench 34, west central side of campus, walkway inland of semi-subterranean Lava Rock Bar, view to southeast (Diamond Head)

Figure 65.Trench 35, southwest central portion of campus, walkway inland of semi-subterranean Lava Rock Bar, view to southeast (Diamond Head)

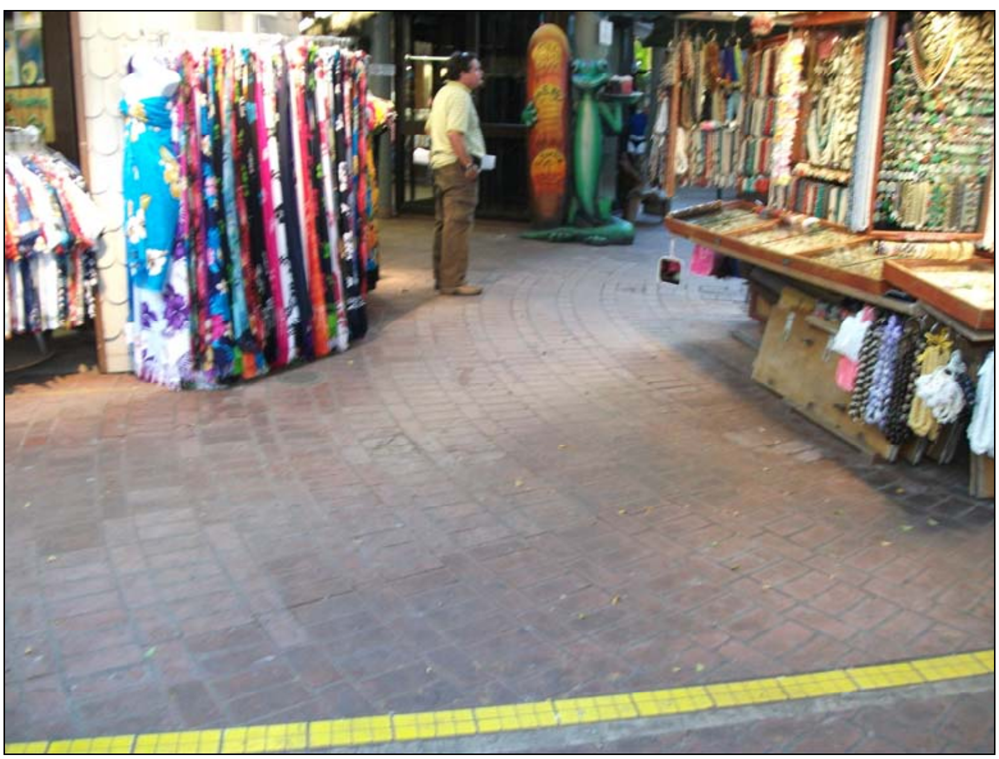

Figure 66. Trench 36, southwest central portion of campus, walkway, view to northeast

Figure 67. Trench 37, southwest central portion of campus, walkway, view to southeast

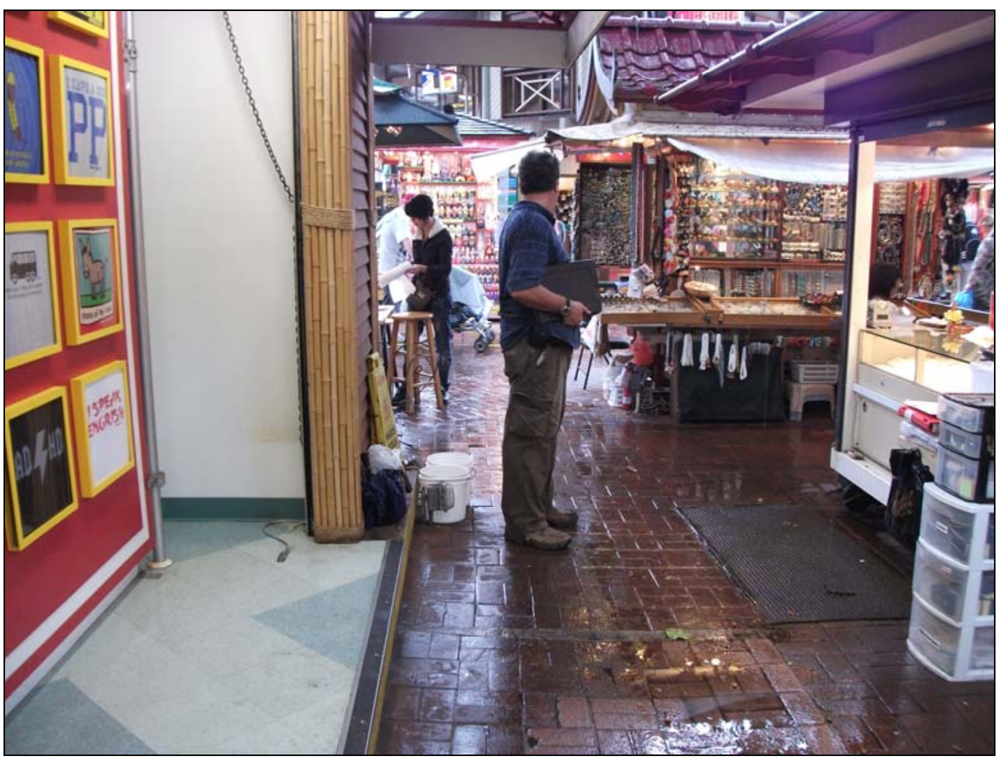

Figure 68. Trench 38, southwest central portion of campus, walkway, view to northeast

Figure 69. Trench 39, southeast central portion of campus, walkway by staircase, view to northeast (*mauka*)

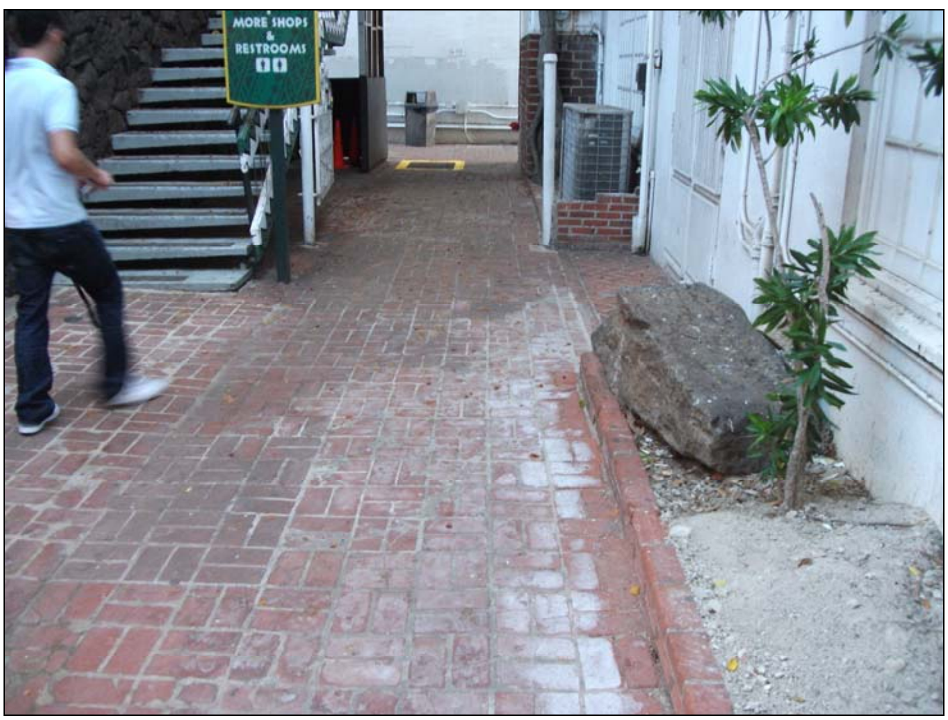

Figure 70. Trench 40, southeast edge of seaward campus, alley walkway, view to southeast (Diamond Head)

Figure 71. Trench 41, south corner of campus, alley walkway, view to southeast (Diamond Head)

Figure 72. Trench 42. west side of southwest main entrance to campus, walkway, view to northeast

Figure 73. Trench 43, central southwest main entrance to campus, walkway, view to northeast (*mauka*)

Figure 74. Trench 44, southeast side of southwest main entrance to campus, walkway, view to northeast

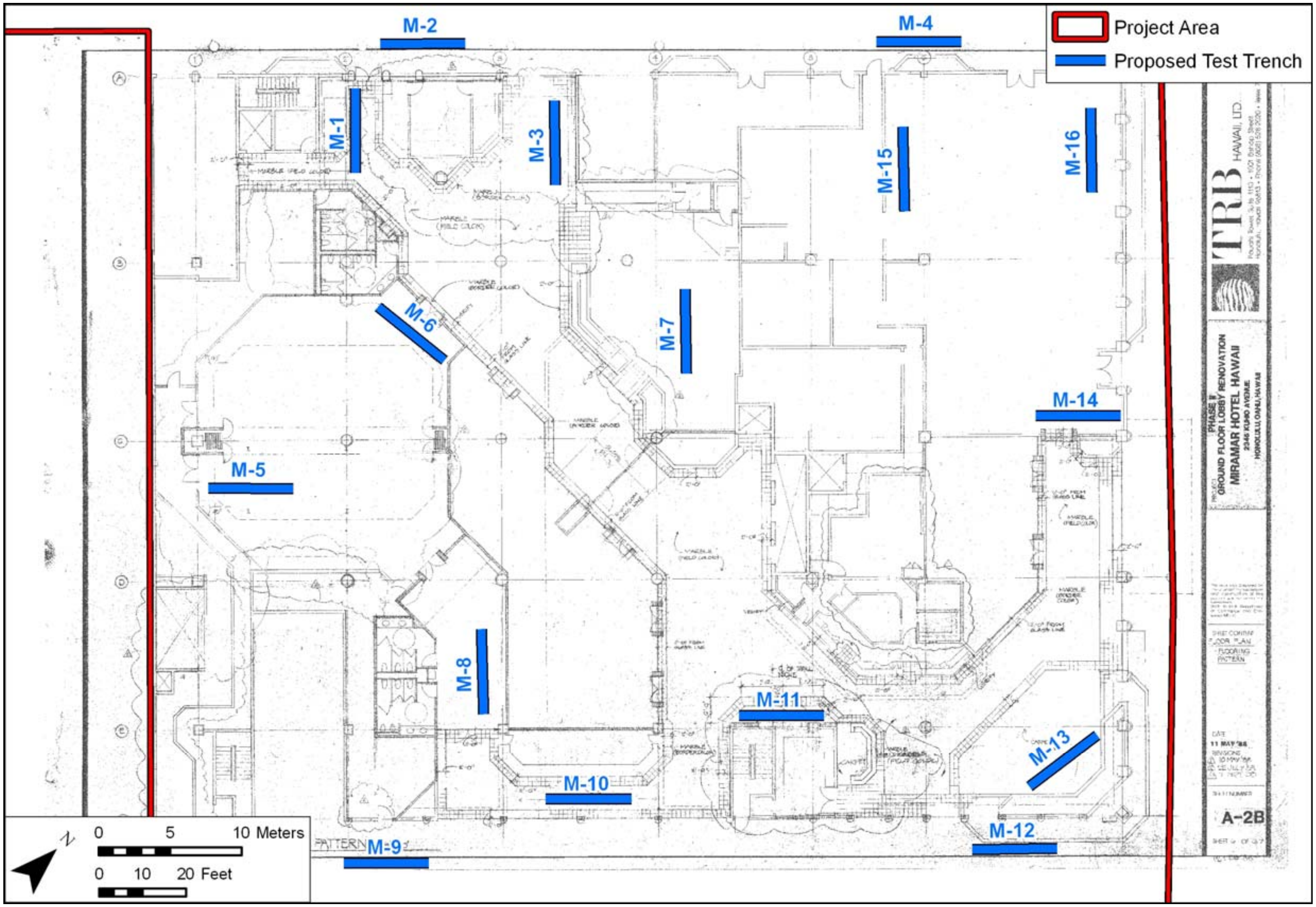

Figure 75. Trenching Plan for the Miramar Hotel

Figure 76. Trench M-1 Miramar Hotel, west corner interior, view to northwest

Figure 77. Trench M-2 Miramar Hotel, outside northeast of west corner, view to northeast

Figure 78. Trench M-3 Miramar Hotel, west interior hall, view to northwest

Figure 79. Trench M-4 Miramar Hotel, outside northeast of north corner, view to northeast

Figure 80. Trench M-5 Miramar Hotel, southwest interior, Coral Ballroom, view to southwest

Figure 81. Trench M-6 Miramar Hotel, west central interior, Coral Ballroom, view to northeast

Figure 82. Trench M-7 Miramar Hotel, bar, view to southeast

Figure 83. Trench M-8 Miramar Hotel, south interior, view to southeast

Figure 84. Trench M-9 Miramar Hotel, main driveway south exterior, view to southwest

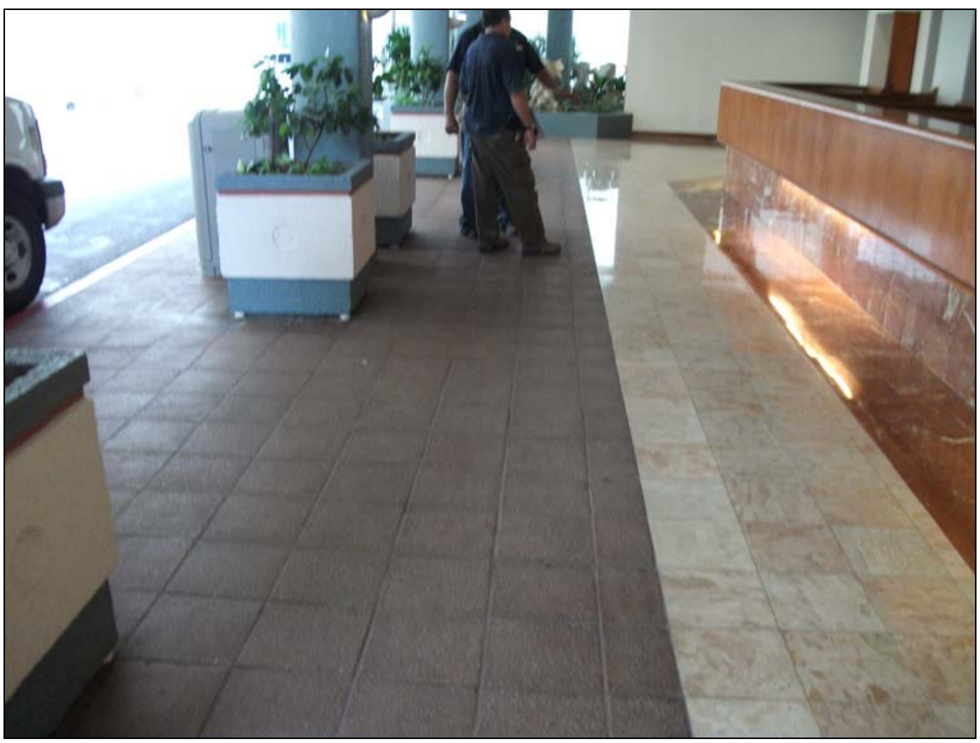

Figure 85. Trench M-10 Miramar Hotel, exterior, southeast side, view to southwest

Figure 86. Trench M-11 Miramar Hotel, southeast interior, view to northeast

Figure 87. Trench M-12 Miramar Hotel, exterior, east corner, view to northeast

Figure 88. Trench M-13 Miramar Hotel, interior, east corner, view to east

Figure 89. Trench M-14 Miramar Hotel, Denny’s Restaurant, southeast corner interior

Figure 90. Trench M-15 Miramar Hotel, Denny's Restaurant, north corner interior

Figure 91. Trench M-16 Miramar Hotel, Denny's Restaurant, west interior

Trench excavation methodology for the 60 backhoe assisted test trenches will initially consist of saw cutting of the asphalt, concrete, or specialty paving surface and removal by backhoe of the overlying fill deposits. If undisturbed, in situ sand deposits are encountered, excavation will be conducted by hand. This hand excavation in sand deposits will be specifically undertaken to identify potential buried cultural deposits including burial deposits prior to sand excavation with the backhoe. The sand will be carefully scraped off in thin layers in order to minimize any possible disturbance to the cultural deposits. Only once the hand excavation through the sand deposit is completed will the backhoe's bladed bucket be used to further excavate to the coral shelf or water table.

The stratigraphy in each trench will be drawn and photographed. The sediments will be described for each of the trenches using standard USDA soil description observations/ terminology. Sediment descriptions include Munsell color, texture, consistence, structure, plasticity, cementation, origin of sediments, descriptions of any inclusions such as cultural material and/or roots and rootlets, lower boundary distinctiveness and topography, and other general observations. Where burial pits or other cultural features may be exposed, these will be carefully represented on the trench profile. Feature documentation will include profiles and/or plan views, collected samples, stratigraphic descriptions, and photographs. When exposed in plan view within trenches, pit features will be drawn and sampled.

If any significant cultural resources and/or human remains are identified, SHPD will be notified immediately, and the remains shall not be disturbed further, no further work will take place, including no screening of back dirt, no cleaning and/or excavation of the burial area, and no exploratory work of any kind unless specifically requested by the SHPD. Skeletal element inventory forms, plan view and profile drawings, and written descriptions will be prepared to document any burials if so directed by the SHPD. Burial and any other significant feature locations will be recorded with GPS (sub-meter horizontal accuracy).

In consultation with the SHPD, in order to delineate burial areas, additional trenches may be excavated to search for additional burials in the vicinity. Again, initially the backhoe will only be used to remove the fill overburden. Hand shovel trenching will be undertaken prior to using the backhoe within sand deposits. As appropriate, plan views will be prepared to record horizontal provenience of finds, such as burials or pit features associated with a cultural layer.

The sampling of subsurface cultural layers and/or A horizons will be carried out to characterize the cultural content of these layers. Sampling may also help establish geographic boundaries to these layers and the general time frame of their deposition (prehistoric/traditional Hawaiian, and/or historic, and/or modern). The sampling will be undertaken on both pit features associated with the stratigraphic layer, and "sample areas" taken from the portion of the stratigraphic layer that was not part of a particular cultural feature. The distinction between samples from pit features and sample areas is hoped to reflect the difference in cultural material content between sediment from specific events, such as the excavation and use of a pit, and the more general accumulation of sediment as part of a culturally enriched stratigraphic layer. When possible, pit features will be distinguished in trench profiles and plan views by their shape, content, distinctness and degree of protrusion below the lower boundary of the overall cultural layer.

The location of each of the trenches, and significant features will be recorded using a Trimble Pro XR mapping grade GPS unit with a TSCI Datalogger and real-time differential correction. This unit provides sub-meter horizontal accuracy in the field. GPS field data will be post-processed, yielding horizontal accuracy between 0.5 and 0.3 m. GPS location information will be converted into GIS shape files using Trimble's Pathfinder Office software, version 2.80, and graphically displayed using ESRI's ArcGIS 9.1.

4.2.2 Timing of the Archaeological Inventory Survey Work and Merit of Pre-Demolition Identification of Historic Properties

It is presently envisioned that the subsurface testing work will be undertaken in the Spring/Summer of 2011. It is hoped that all of the proposed work can be addressed in one Archaeological Inventory Survey report. Because of certain uncertainties involving leassees it may be advisable to carry out the work in two phases. This may result in the submittal of two Archaeological Inventory Survey reports one addressing the International Market Place (TMK parcels (:36, :37, :38 and 43) and one addressing the Miramar Hotel (TMK parcel :39).

A Chapter 6E-42 Historic Preservation Review (dated May 23, 2011; Log No 2010.3950, Doc No. 1105MV26) addressing an earlier (December 2010) draft of this plan noted correctly that the proposed archaeological inventory survey would be carried out prior to demolition (with specific reference to the Miramar at Waikiki Hotel) and asked for a description of how historic properties, potentially including burials, could be protected during the demolition of the Miramar Hotel. It is true that the demolition of a 22-story hotel over any previously identified subsurface cultural properties would potentially create challenges (that would be addressed in detail within a preservation plan prior to demolition – if indeed any historic properties were identified and were to be preserved in place). Cultural Surveys Hawai‘i has experience in protecting archaeological sites from high energy explosions in the immediate vicinity (in the context of ordinance disposal near historic properties needing to be addressed through a "blow-in-place" methodology). In our experience archaeological sites can be potentially protected from massive impacts through relatively simple processes such as construction of a wedge of sand-bags over a historic property to both cushion the historic property from impact and also to deflect impact away from the historic property. At any rate, presumably all would agree that any historic properties as may be present, and meriting preservation in place, potentially can be better protected if they are identified prior to demolition (and protective measures can be instituted) than if they are not identified prior to demolition.

4.2.3 Consultation with SHPD Regarding Need for Supplementary Testing

The results of the presently envisioned 60 test trenches will be reported to the SHPD to determine if additional testing is to be required. It is understood that there is a potential need for additional testing if such testing is warranted by the results of the initial round of testing.

4.3 Laboratory Methods

This phase of work will involve the following specific procedures:

1) Charcoal samples will be submitted for radiocarbon dating, if available. Those samples containing pieces suitable for wood identification, as available, will be submitted for species

analysis first. Selection of charcoal samples for dating will be in part based on the wood species findings.

2) Invertebrate remains collected from specific subsurface features or cultural layers will be identified to genus and species, weighed, and analyzed. Data will be tabulated by depth and stratigraphic unit. Common marine shells will be identified and analyzed at the Cultural Surveys Hawaiʻi laboratory in Waimānalo, Oʻahu using an in-house comparative collection and reference texts (i.e. Abbott and Dance 1990; Eisenberg 1981; Kay 1979; Titcomb 1979). If any rare and/or extinct marine or freshwater shells are recovered, an outside expert will be consulted for identification of the material. The total weight of any midden will be tabulated by collection unit.

3) Non-human vertebrate faunal material collected from specific subsurface features or cultural layers will be identified to the lowest possible taxa at the CSH laboratory using an in-house comparative collection and reference texts (i.e. Olsen 1964; Schmid 1972; Sisson 1914). If a large number of bird or fish bones, or any unusual bones are recovered, they will be submitted to an expert in faunal analysis for identification. The total weight of any midden will be tabulated by collection unit.

4) Identification and cataloguing of traditional Hawaiian artifactual material will be completed. Artifacts will be measured with representative samples drawn and/or photographed to scale. The forms and functions will be determined using reference material (i.e. Barrera and Kirch 1973; Brigham 1974; Buck 2003; Emory et al. 1968).

5) Identification and cataloguing of historic artifacts will be completed. This research will focus on the function and manufacturing dates of the items, using reference texts (i.e. Bureau of Land Management 2008; Elliott 1971; Elliott and Gould 1988; Fike 1987; Lebo 1997; Lister and Lister 1989; Millar 1988; Munsey 1970; Toulouse 1971; Zumwalt 1980).

6) A comprehensive catalogue of all collected cultural material will be prepared and included with the report.

4.4 Historic Property Evaluation for Hawaiʻi Register Eligibility

Under state of Hawaiʻi historic preservation legislation, historic property significance is evaluated and expressed as eligibility for listing on the Hawaiʻi Register of Historic Places (Hawaiʻi Register). To be considered eligible for listing on the Hawaiʻi Register, a historic property must possess integrity of location, design, setting, materials, workmanship, feeling, and association, and meet one or more of the following broad cultural/historic significance criteria: "A" reflects major trends or events in the history of the state or nation; "B" is associated with the lives of persons significant in our past; "C" is an excellent example of a site type/work of a master; "D" has yielded or may be likely to yield information important in prehistory or history; and, "E" has traditional cultural significance to an ethnic group, includes religious structures and/or burials. For this report, historic property integrity and significance were assessed based on the guidance provided in National Register Bulletin # 15, "How to Apply the National Register Criteria for Evaluation."

4.5 Report Preparation

An Archaeological Inventory Survey report will be prepared in conformance with HAR 13-276-5. This inventory survey report will include the following:

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

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

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

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

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

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

A draft of the archaeological inventory survey report shall be prepared and submitted in a timely manner, within three months following the end of fieldwork. Following the receipt of review comments on the draft report from SHPD, the revised and corrected report shall be submitted within one month.

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Appendix A Land Commission Awards

LCA 8559-B

No. 8559B*O, (W.C. Lunalilo) C. Kanaina

F.T. 551-552v3

W.H. Uana, sworn, says he knows the house lot of Lunalilo, in Kaluaaha, Molokai. It is bounded:

Mauka by the public road
On the Halawa side by a fish pond of the government called "Neaupala"
Makai by the sea beach
On Kaluaakoi side by a government fish pond called "Kaluaaha."

This lot formerly was ordered to be enclosed by Hoapili wahine and Kekauluohe when Eseta Kipa was Governess of Molokai. The people of Kekauluohi's lands erected a stone house on this lot in the year 1835. It is now in possession of Lunalilo as heir of Kekauluohi.

E. Kipa, sworn says, she knows the lot. I was Governess of Molokai under Hoapili wahine & Kekauluohi in former times, and by their orders enclosed this lot and built a stone house on it with the labor of the people of their own lands. When the government sold the land of "Kaluaaha" to the Missionaries, I heard Kalolou come and ask permission from Kanaina to live in the stone house, which permission she got.

(A. Paki sets up a claim for this lot as heir of Kalaolou.)

L. Haalelea, sworn says, he knows the house lot claimed by Lunalilo in Kailua, Hawaii. It is bounded:

On Kiholo side by the church lots
Makai by the public road
On Keauhou side by a road leading *mauka*
Mauka by some house lots.

It is enclosed by a wall. This lot I have heard belonged formerly to Keaho, the father of Mahuka. I have heard that when Keaho died he left this lot to Kekauluohi, and I have recently seen a letter from Mahuka to W.C. Lunalilo requesting him to allow Mahuka to retain charge of this lot under Lunalilo. In 1843 I was at Kailua & Kekauluohi was there. I then saw the later Governor Adams give her some money which he said was rent received for this same lot. Part of this lot is claimed by the heir of W.P. Leleiohoku. There is a fence remaining though and dividing the lot into two parts.

F.T. 82-84v16 and N.T. 82-84v16
No. 8559B, William C. Lunalilo

Polea, sworn says, he knows the lots claimed by William C. Lunalilo, at Lahaina, Maui.
The first called Luaehu, is bounded as follows:
Mauka by Kaiheekai and Hiram's land
Olowalu by King's land
Makai by Sea beach
Kaanapali by Polea and M.J. Nouliau [Nowlien].

The second in Pakala is bounded as follows:
Mauka by Public street
Olowalu by Kaiheekai's land
Makai by H.S. Swinton's and others' land
Kaanapali by Public road.

The third lot called Hawaikaekea is also bounded as follows:
Mauka by Kalaleikio's land
Olowalu by Public road
Makai by Alaloa Kahiko street
Kaanapali by Daniela Ii's land.

This lot is disputed by Manuahina the wife of George Shaw, whose claim in right of her father.
She has already got an award for a part of this lot.

The fourth lot in Paunau is bounded as follows:
Mauka by Keaweiheuhu's and Kahula's land
Olowalu by Keaweluaole's land
Makai by Old road
Kaanapali by Street leading to Lahainaluna.

The fifth lot called Loinui is bounded as follows:
Mauka by Keaweluaole; Kauhi and Kalolou's land
Olowalu by Mr. Baldwins
Makai by Old road
Kaanapali by Kamakinui's land.

The sixth lot in Aki is bounded as follows:
Mauka by Kaweka's land
Olowalu by Wahie's land
Makai by Main road
Kaanapali by M.I. Nowlein's land.

The seventh lot in Puunoa is bounded as follows:
Mauka by Main road
Olowalu by Iosua Kaeo
Makai by Iosua Kaeo
Kaanapali by King's land.

The eighth lot in Kelawea is bounded as follows:
Mauka by Lahainaluna
Olowalu by Road from the beach
Makai by Keleikini and Kahookano's lands
Kaanapali by A stream.

All these lots have descended to William C. Lunalilo from his mother, Kekauluohi, and are now in the hands of his *lunas*. The lot in "Pakala" is disputed by Paki and others.

N.T. 619-620v3
No. 8559, [C. Kanaina], Section 49, C. Kanaina, From pg. 597 Vs. No. 2619 Pahau

C. Kanaina has come before the land commissioners and stated, "I am opposing Pahau's interest in section 2 consisting of nine patches They are in my land which is the *lele* Opukaala of the Pau ili land in Waikiki.

Here is the reason Pahau had acquired that land. Kaaha had given land to him and when he /Kaaha / died all of the lands in Pau were returned to Wm. C. Lunalilo; therefore, I feel that these patches in that section should be returned to me permanently, or else they should be divided between him and me.

Postponed until they make their own settlements and present the best one to the land officers who will approve it.

N.T. 185-187v10
No. 8559B, William Charles Kanaina, [for Lunalilo], Honolulu, 24 April 1850

COPY
Greetings to you Highness, John Young, the Minister of Interior.
My desire is to have the government claim separated from my lands; therefore I hereby give some of my land for the government to have forever and the same shall apply to mine. Here are the names of my lands:

Kawela ahupuaa, Hamakua, Hawaii.
Waikaekoe ahupuaa, Hamakua, Hawaii.
Makapala ahupuaa, Kohala, Hawaii.
Kehena ahupuaa, Kohala, Hawaii.
Puhau ili of Iole, Kohala, Hawaii.
Puakoa ili of Waimea, Kohala, Hawaii.

Honuainonui ahupuaa, Kona, Hawaii.
Puapuanui ahupuaa, Kona, Hawaii.
Lehuulanui ahupuaa, Kona, Hawaii.
Kawainui ahupuaa, Kona, Hawaii.
Lanihaunui ahupuaa, Kona, Hawaii.
Pakiniili ahupuaa, Kau, Hawaii.
Hanuapo ahupuaa, Kau, Hawaii.
Kahanalea ahupuaa, Puna, Hawaii.
Keahialaka ahupuaa, Puna, Hawaii.
Keaau ahupuaa, Puna, Hawaii.
Makahanaloa ahupuaa, Hilo, Hawaii.
Pepekeo ahupuaa, Hilo, Hawaii.

Kaapuhu ahupuaa, Kipahulu, Maui.
2 Waiehu, Puali, West Maui.
Ahipuli ili for Waiehu, West Maui.
Pepee ili for Wailuku, West Maui.
Honolua ahupuaa, Kaanapali, Maui.
Kalimaohe ahupuaa, Lahaina, Maui.
Polanui ahupuaa, Lahaina, Maui.
Kuholilea ahupuaa, Lahaina, Maui.

Waialua ahupuaa, Kona, Molokai.
Kawela ahupuaa, Kona, Molokai.

Pau ili for Waikiki in Manoa, Kona, Oahu.
Kamoku ili for Waikiki in Manoa, Kona, Oahu.
Kaluaokau ili for Waikiki in Manoa, Kona, Oahu.
Kapahulu ili for Waikiki in Manoa, Kona, Oahu.
Kaalaea ahupuaa, Koolaupoko, Oahu.
Kapaka ahupuaa, Koolauloa, Oahu.
Laiewai ahupuaa, Koolauloa, Oahu.
Laiemaloo ahupuaa, Koolauloa. Oahu.
Pahipahialua, Koolauloa, Oahu.

Kahili, Koolauloa [sic], Koolau, Kauai.
Kalihiwai, Koolauloa [sic], Koolau, Kauai.
Pilauwai, Koolauloa [sic], Koolau, Kauai.
Manuahi ili, Kona, Kauai.
Waipouli ahupuaa, Puna, Kauai.

These lands listed above shall be for me fee simple forever, it would not be right for the government to claim my land.

The following lands, I shall give to the government fee simple forever.

Kapulena ahupuaa, Hamakua, Hawaii.
Kukuihaele ahupuaa, Hamakua, Hawaii.
Auau ahupuaa, Kohala, Hawaii.
Keopuhuikahi ahupuaa, Kona, Hawaii.
Papaakoko ili of Honokohau, Kona, Hawaii.
Ninole ahupuaa, Kau Hawaii.
Laepaoo ahupuaa, Puna, Hawaii.
Koae 1 ahupuaa, Puna, Hawaii.
Koae 2 ahupuaa, Puna, Hawaii.
Laeapuki ahupuaa, Puna, Hawaii.
Kaiuiiki ahupuaa, Hilo, Hawaii.
Kahuku ahupuaa, Hilo, Hawaii.

Waiakoa ahupuaa, Kula, Maui.
Kou ili of Waiehu Puali, Komohana Maui.
Kapoino ili of Waiehu Puali, Komohana, Maui.
Halelena ili of Waiehu Puali, Komohana, Maui.
Keokamu ili of Waiehu Puali, Komohana, Maui.
Wainee ahupuaa, Lahaina, Maui.

Mahana ahupuaa, Lanai.

Kamalomalo ahupuaa, Puna, Kauai.
Kumukumu ahupuaa, Koolau, Kauai.

I've given the lands listed above to the government forever, all of them are for the government.
Please consider my request with compassion for me.
With appreciation, I am,
William Charles Lunalilo, Charles Kanaina (child guardian)
Department of Interior, 6 April 1852.

This is a try copy of Lunalilo's division with the government,
A.G. Thruston, Secretary

N.T. 450v10
No. 8559B, William C. Lunalilo, Protested by Kaai

Mahuna, sworn, it is true my own place was written in the bill of sale to C. Kanaina, the place is just mauka of the land in Kailua of Kona, Hawaii, over which there is a dispute by Kaai. That is the lot I have transmitted to him, Kanaina, but I have not seen the property Kaai has at this present time; however, I had seen my parents living on this land at the time [of] Kaahumanu I. I had gone on a tour. Houses had been built, but I have not lived there since that time to the present, nor have I seen this lot over which there is a dispute with Kaai.

C. Kanaina, relates - the witnesses for this land on which Kaai and I are working are dead;

although, I had thought they (two) would be my witnesses, but today they have denied by claim to this place. It is true this place had been for their father, Keoho, where he lived until he had died and they (two) are his own children, but I am demanding according to the old bequest of Keaho to M. Kekauluohi as well as by many other statements.

Naea, sworn, I have seen Kaai's place in Keopu of Kona, Hawaii, which is a house lot.
Mauka by Mahuka's lot
South Kona by a road
Makai by Government road
Kohala by vacant lot.

Land from Keoho (his father) upon his (Keoho) death in 1833. Keoho had obtained it long ago as idle land.

Kaai has always lived there peacefully to the present time.

Now C. Kanaina has offered a protest, I do not know the reason for it.

Kioloa, sworn, all of the statements above are true. I have known in the same way. I have not known the place was for C. Kanaina. It had been for Keoho, Kaai's father and now Kaai is the true claimant of this place.

[Award 8559B; (Oahu); R.P. 7635; Kamoku Waikiki (apana 30); R.P. 8193, 8311 & 8416; Pau Waikiki (apana 29)(see Kapahulu award); R.P. 8434; Pau Waikiki Kona; (ap. 29); R.P. 8124; Kapahulu Kona; 1 ap.; 31.50 Acs (apana 32); R.P. 8165; Kapahulu Kona; 2 ap.; 2,184.44 Acs (apana 32); R.P. 8514; Kaea Kapahulu Waikiki; 1 ap.; 6.16 Acs; R.P. 7652; Kaluakou Waikiki (apana 31); R.P. 7531; Kaalaea Koolaupoko; 1 ap.; 1340 Acs;(apana 33); R.P. 7494; Laie-wai Koolauloa (apana 35); Laie-maloo Koolauloa (apana 36); R.P. 5688; Pahipahialua Koolauloa (apana 37); 704 Acs; no R.P.; Kapaka Koolauloa (apana 34); (Maui) R.P. 8395; Polanui Lahaina; 1 ap.; 440 Acs (apana 25); R.P. 8129; Honolua Kaanapali; 1 ap.; 3860 Acs (ahupua`a, apana 23); R.P. 7664; Pepee Wailuku; R.P. 8396; 1 ap.; 255.7 Acs; Kalimaohe Lahaina; 2 ap.; 4.93 Acs; (apana 24); R.P. 8397; Kuholilea Lahaina; 2 ap.; 184. 5 Acs; (apana 26); R.P. 5637; Paunau Lahaina; 1 ap.; 2 roods 24 perkas (apana 4); R.P. 5639; Aki Lahaina; 1 ap.; 16 perkas (apana 6); no R.P.; Paeohi Lahaina; 1 ap.; 1 Ac. 52 rods; R.P. 5699; Loiniu (Luaehu Waianae) Lahaina; 2 ap.; 2.75 Acs 37 rods; R.P. S8550/S8546 & S8537. Kaapahu Kipahulu; 1 ap.; (ahupuaa, apana 19); Waiehu 2 Wailuku; no R.P. Ahikuli Waiehu; (Hawaii) R.P. 478; Pakiniiki Kau; 1 ap.; 2357 Acs; Makanaloa Hilo; 2 ap.; 7600 Acs; R.P. 7049; Honuapo Kau; 1 ap.; ahupuaa 2200 Acs; Honuaino nui; 1 ap.; 262 Acs; R.P. 7454; Kawainui iki Kona; 1 ap.; 380 Acs; R.P. 7455; Lehuula nui; 1 ap.; 290 Acs; Lehuula nui; 1 ap.; 2840 Acs; Puapuaanui Kona; 1 ap.; 370 Acs; R.P. 7680; Kahena 2 N. Kohala; 1 ap.; (ap.4); ahupuaa; Puako S. Kohala; 1 ap.; Iliaina (Ap.6); Kahaualea Puna; 1 ap.; 26,000; Keahialaka Puna; 1 ap.; 5562 Acs; Pepeekeo Hilo; Keaau Puna; 1 ap.; 64.275 Acs; Kawela Hamakua; R.P. 7434; Honuainonui N. Kona; R.P. 7456; Lanihau Nui Kona; R.P. 8452; Waikoekoe Hamakua; no R.P.; Makapala Kohala; R.P. 7192 Makanaloa Hilo; 2 ap.; 7600 Acs; (Molokai) R.P. 7655; Waialua; R.P. 7656 Kawela; (Kauai) R.P. 8173; Kalihiwai Halelea; no R.P. Manuahi Hanapepe; R.P. 8323; Kahili Koolau; R.P. 7060; Pilaa Koolau; R.P. 7373; Waipouli Puna; See 8559 to C. Kanaina who is awarded a property at Ukumehame under 8559B; see also Award 277]

LCA 104 F.L. (Fort Land)

Kekuanaoa, Haliimaile, 3 December 1851 N.R. 765-766v3

The Honorable William L. Lee, Greetings: I hereby present my claim in some ‘*Ilis* in Honolulu and in Waikīkī in the lands of the Fort which I am caring for. Here are the names:

[Following discussion of Honolulu ‘*Ili* lands omitted]

Here are my claims at Waikīkī:

2 *lo‘i* at Kalia, ‘Ili in Waikīkī.

5 fish ponds at Kalia in Waikīkī.

1 *muliwai* of Piinaio, in Waikīkī.

Those are my claims which I have thought of. There is one cocoanut grove. Makalii, also at Kalia. That is what I state to you. Farewell to you. M. KEKUANAOA

N.T. 390v10 No. 104 F.L. M. Kekuanaoa (from page 320) for 17 August 1854, Victoria Kamamalu L. Kukoa, sworn, I have seen his house site in Kapuni, Waikīkī, Kona, O‘ahu.

Mauka, Road

Waialae, Hamohamo boundary

Makai, beach

Honolulu, a meeting house.

This place was received from Kinau in 1839. She had received it from her mother.

Mahuka, sworn, the statements above are correct and I have seen his other claims. 2 ponds named Paweo, also Kaipuni, Pau, Kaihikapu, Manolepa and Kaohai in Waikīkī, Kona, O‘ahu.

He had received the land from Kinau in 1839. She had received it from Kaahumanu in 1832. No objections.

[Award 104 F.L.; R.P. 4492 (Kaihikapu Puuiki)& 4493; Kalia Waikīkī Kona; 1 ap.; 1.49 Acs; Kuhimana Honolulu Kona; 1 ap.; 2 Acs; no R.P. ; Kamanolepa Waikīkī Kona; 1 ap.; 2.06 Acs; R.P. 4492; Kapuni Waikīkī Kona; 1 ap.; 31 Acs; R.P. 4492; Uluniu Waikīkī Kona; 1 ap.; 31 Acs; R.P. 4493; Uluniu Waikīkī Kona; 1 ap.; 71.7 Acs]

LCA 1506

No. 1506, Waikiki /Female/
N.R. 138v3

To the Land Commissioners, Greetings: I, the undersigned, hereby tell of my land claim for two rows of hills /of taro/ in the lo`i of Hohe in Waikīkī, also a small *kula* and also a house lot. That is what I have to tell you.
WAIKĪKĪ /Female/
Ulukou at Waikīkī, December 4, 1847

F.T. 67v3
Cl. 1506, Waikīkī, *wahine*, December 27, 1848

Kamae, sworn, I know this land. It is in Hohe, Waititi, consisting of *kalo* land, and in Uluko of House lot.

1. House lot. Claimant has 1 house, partly fenced:
Mauka is Government land
Waialae is Opupahoa
Makai, sea
Honolulu is Keawe.

2. Two rows of kalo in a large patched owned by many.
Mauka by my kalo ground
Waialae is Paku
Makai is my land separated by water course
Honolulu, Kaluahinenui.

Claimant had these two lots from Kaʻahumanu I, and then held them from Kinau & now under Victoria, and never had them disputed.

Second witness.

N.T. 393v3
No. 1506, Waikīkī (Female), December 27, 1848

Kanae, sworn, I have seen Waikīkī's (Female) land at Hohe in Waikiki. There is one patch and a house lot at Ulukou. One house is there and one side of the property has been enclosed.

[No.] 1.
Mauka is a government pasture
Waialae, Opupahaa's place

Makai, the sea
Honolulu, Keawe's land.

2. Two rows of taro at Hohe where:
Mauka are my taro rows
Waialae, Paku's land
Makai, my land
Honolulu here, Kaluahinenui's land.

Waikīkī's land and house site are from Ka‘ahumanu I. After her death, the land was under Kinau and at his death, it is now under V. Kamamalu.

Postponed until a witness has been summoned.

[Award 1506; R.P. 4723; Ulukou Waikīkī; 1 ap.; .16 Ac.]

LCA 2006

No. 2006, Male
N.R. 321v3
I, the one whose name is below, hereby state my claim for four *lo`i* in Kalokoeli in Waikīkī, the banks of two separate irrigation ditches, a house lot which has not been completely fenced, and some coconut trees within my lot. I pay my landlord four times a year /There is/ a pool for fish fry in the stream. -
MALE X His mark
Waikīkī, Oʻahu, 23 December 1847

F.T. 238-239v3
Cl. 2006, Male
Kaaha, sworn, I know the land of the claimant. It is in the *ʻili* of Kalokoeli, Waikīkī, Oʻahu. It consists of five *loʻi* in one piece and a house lot on the sea beach, but he has no title to this sea beach, except that of residing there at suffrance.

There *loʻi* are bounded:
Mauka by Kauhao's land
Waialae by Kamakahonu's land
Makai by Kalia's land
Honolulu by Kalaimoku's land.

The claimant received this land from Waiaania, the *konohiki* in the days of Kaʻahumanu I, and his title has never been disputed.
Kamakahiki, sworn, I know the land of Male, and what Kaaha testified concerning it is correct.

N.T. 575v3
No. 2006, Male, December 28, 1848

Kaaha, sworn, I have seen his place at Kalokoeli in Waikīkī.

5 taro patches in one section together:
Mauka, Kauhao's land
Waialae, Kamakahonu's land
Makai, Kalia's land
Honolulu, Kalaimoku's land.

Waiaania, the konohiki, had given him his land during the time of Kaʻahumanu I and he has lived comfortably; no one has ever objected.
Makahiki, sworn, We both have known alike; no ne has objected.

[Award 2006, R.P. 5066; Kalokoeli Waikīkī Kona; 2 ap.; .98 Ac.; Kamoomuku Waikīkī Kona; 1 ap.; .27 Ac.]

LCA 2027

No. 2027, Palaualelo, Waikiki kai

N.R. 329v3

To the Land Commissioners, Greetings: Be it known to you all that I, the one whose name is below, hereby state my claim for three taro lo`i, four bulrush lo`i, and two irrigation ditches, at Mokahi. There is a house at Hamohamo and one hau tree. I have occupied it from the time of Kaahumanu I, with no objection.

Farewell and thanks

PALAUALELO X

December 21, 1847

F.T. 474v14

No. 2027, Palaualelo, claimant

Kaiho, sworn, say he knows the land of claimant. It is a mooaina called Mookalu in the ili Mookahi, Waikiki, Oahu. It consistes of 1 piece of lois, land & Apana 2, 4 house lot in Ponahakeone in Hameohamo, Waikiki, Oahu.

Apana 1 is bounded:
Mauka by the land of Kuewa
Kekeha by the land of Kaukau
Makai by the land of Peleuli
Honoluu by the land of Kahakai.

Apana 2 is bounded:
Mauka by the coconuts in Hamohamo
Kekaha by house lot of Paku
Makai by sea shore
Honolulu by house lot of Kauaohilo

Claimant received his land from Peleuli in the time of Kaahumanu & has held it in quiet until this time.

[Award 2027; R.P. 2575; hamohamo Waikiki Kona; 1 ap.; .25 Ac.; Pau Waikiki Kona; 1 ap.; .55 Acs]

LCA 2079

N.R. 349v3

I, the one whose name is below, hereby state my claim for my 7 lo`i, however, 3 are for my keiki. They are at Kiki, an `ili in Waikiki. There is also a house lot. There are some other lo`is at a place for my kane, at Mookahi, a mo`o auwai /path between irrigation ditches/, a row* at Hohe and with it a section of irrigation ditch. Some other lo`is are at Kawalaala, and 2 kula, a house lot, and one small kiopua.** Some lauhala trees of the mat variety are in a kula of mine. These are my claims which I hereby tell.

KAUHOLA X, her mark

Waikiki, 23 December 1847

/*a row of taro/
/** pool for raising fish fry/
F.T. 23-24v3

Cl. 2079, Kauhola, wahine, October 16 [1848]

Paele, sworn, This land is in the ilis of Makiki and Mookahi, Waititi, consisting of 7 kalo patches in Makiki, 2 in Mookahi, 1 line of kalo and 1 kahawai of kalo in Hohe, 4 kalo patches in Kawaiaala and 1 kula land in Kaluahole.

1. Seven kalo ptaches in Makiki

   Mauka & makai is "Kahia"
   Waialae by aupuni kalo patches
   Honolulu by Alex. Adams' land.

2. Two kalo patches in Mokahi

   Mauka & Honolulu is "Kalia"
   Waialae and Makai si Kanaina's.

3. One line (lolani) of kalo and Kahawai in Hohe:

   Mauka and Waialae is Kanealoa's
   Makai, Mahuka's
   Honolulu, "Kaloa."

4. Four kalo patches in Kawaiaala:

   Mauka is Nalaweha's
   Waialae, Government kalo land
   Makai, "Kalia"
   Honolulu, A. Adams.

5. Kula land in Kaluahole is included in the last described boundaries.

These lands were given to claimant in time of Kaahumanu 1 by Kamaukoli and she has occupied them ever since in peace. She has a husband named Kiku.

N.T. 349-350v3
No. 2079, Kauhola, October 16, 1848

Paele, sworn, I have seen Kauhola's land of 7 patches at Kiki. There are 2 patches at Mookahi, a row of taro at Hohe, also a ditch and a stream, four patches at Kawaiaala and a pasture in the ili of Kaluahole.

1. Seven patches at Kiki:

Mauka is Kalia
Waialae is Friday patches
Makai is Kalia
Honolulu is Alika's land.

2. Two patches at Mookahi:

Mauka is Kalia
Waialae and makai is Kanaina's land
Honolulu is Kalia.

3. A row at Hohe:

Mauka and Waialae by Kaneloa's land
Makai by Mahuka's land
Honolulu by Kalia.

4. Four patches at Kawaiaala:

Mauka is Nalaweha's land
Waialae is Tuesday patches
Makai is Kalia
Honolulu is Alika's land.

5. 1 pasture at Kaluahole: The boundaries are not known.

Kamaukoli had given Kauhola land and this land had been from Kaahumanu received during the time of Kaahumanu. She has lived there in peace and both she and her husband, Kiha, are taking care of this land. See page 104. Vol. 10

N.T. 204v10

No. 2079, Kauhala (from page 349, volume 3), 4 March 1852

Kamaukoli, sworn, I have seen this house lot. It is in Kalia, Waikiki in one section.

Mauka and Honlulu, Kanaina's land

Makai and Waialae, konohiki's land.

Land from Kamaukoli at the time of Kaahumanu I. Peaceful living.

[Award 2079; R.P. 723; Waikiki Kona; 2 ap.; 7.25 Acs]

LCA 2082

No. 2082, Kuene
N.R. 350v3

I, the one whose name is below, hereby state my claim for four lo`i and an edge of an irrigation ditch. There is also a house lot which has been enclosed with fence, and with two houses in it. There are four coconut trees in my lot with which I pay my annual tax. This place is at Mookahi, Waikīkī.
I am, with thanks,
KUENE X, his mark
Waikīkī, O‘ahu 23 December 1847

N.T. 637-638v3
No. 2082, Kuene, July 3, 1850

Haumalu, sworn, I have seen his land at Mookahi in Waikīkī - 2 land sections.

1. 4 taro patches and stream:
Mauka, Kihewa
Waialae, Kamakahonu
Makai, my land
Honolulu, land of Makoli.

2. House lot:
Mauka, Kaluahinenui
Waialae and *Makai*, Keohokalole
Honolulu, Kanaina.

Kuene received section 1 from Kuluehu in 1829; section 2 was an idle land on which he had worked before the death of Kinau in 1837 and he has lived comfortably to this time. No one has objected.

Ku, sworn, We have known similarly; the report above is true.

[Award 2082; R.P. 2418; Kalia Waikīkī Kona; 2 ap.; .90 Ac.]

LCA 2084

No. 2084, Keohokahina
N.R. 350-351v3

I hereby state my claim to you for two small *lo`i*, at Kalokoeli; also a row /of taro/ at Hohe, and my house lot at Ulukou. *Mauka* and to the east of my lot is an unused place, *makai* is Male, towards Hono-lulu is a stream.
KEOHOKAHINA X, his mark
Waikīkī, O‘ahu, 23 December 1847

N.T. 638-639v3
No. 2084, Keohokahina, July 3, 1850

Kaniho, sworn, I have seen his sections of land in Waikīkī as follows:

Section 1 - house lot in the ‘*ili* of Hamohamo.
Section 2 - 1 patch and ditch in Kalokoele ‘ili.
Section 3 - 1 patch, 1 ditch in Kalokoeli ‘ili.

He had received sections 2, & 3 in 1830 from Male. Male had received his interest from Kana, the konohiki; Section 1, an idle land in 1833 and he has lived in peace on these lands to the present time. No one has objected.

[Award 2084; R.P. 3640; Kalokoeli Waikīkī Kona; 1 ap.; .25 Ac.; Kamookahi Waikīkī Kona; 1 ap.; .38 Ac.; Ulukou Waikīkī Kona; 1 ap.; .53 Ac.]

LCA 2843

No. 2843, Kaanaana, Waikiki, Oahu, January 11, 1848

N.R. 660-661v3

To the Land Commissioners, Greetings: I hereby state my claim for land at Hamohamo in Waikiki. There is one lo`i and also a house lot. I got these places in the year 1839. In the year 1847 two lo`i were taken by Kapaakea and have not been returned until this time. There is also a kula of mine.

Farewell to you all,

KAANAANA X

[Award 2843; R.P. 6484; Hamohamo Waikiki Kona; 2 ap.; .73 Ac.]

LCA 6324

No. 6324, Kameheu
N.R. 361v5

To the Land Commissioners, Greetings: I, the one whose name is below on this letter, hereby state my claim for three taro *loʻi* in the *ʻIli* of Auaukai, one and a half rows of taro in Hohe, these are in the Ahupuaʻa of Waikīkī. My right in the aforesaid things was from Kamaukoli, in the time when Kīnaʻu was living. There is one weed-grown *kula*, planted in sweet potato and gourd and one house lot.
I am, respectfully,
KAMEHEU X
Waikīkī, January 27, 1848

F.T. 483-484v14
No. 6324, Kameheu, claimant

Kamaukoli, sworn say, the land of claimant contains 3 *loʻi*, a *kula* in one piece in the *ʻʻili* of Auaukai, Waikīkī, and *ʻĀpana 2,* a house lot in Ulukou, Kālia, Waikīkī.

ʻĀpana 1 is bounded:

Mauka by Hamohamo
Kekaha by Hamohamo
Makai by Kalia
Honolulu by Kalia.

ʻĀpana 2, Kahuahale is bounded:
Mauka by the hale of Kauai
Kekaha by the hale of Kamaukoli
Makai by the sea shore
Honolulu by the watercourse.

Claimant received the land from me in the time of Kaʻahumanu & has held the same in quiet until now.

Aua, sworn says, the testimony above is correct and is also his own.

[Award 6324; R.P. 2566; Auaukai Waikīkī Kona; 1 ap.; .72 Ac.]

LCA 8452

No. 8452*O, Keohokalole, Waikiki, Oahu, February 5, 1848
N.R. 567-568v5

I, the one whose name is below, hereby state my claims in my lands to enter in the lands of the Mo`i. These are things done by my own hands, with my people.

At Waiomao, one orange tree and my cultivated valley, an `Ili in Waikiki, with seven lo`i.
At Kapiwai are two mala of coffee and one mala of lauhala, one lo`i, and also a cultivated lot.
This in an `Ili in the Ahupua`a of Honolulu, Island of Oahu.
At Makua, on the Island of Oahu, one orange tree.

At Aamakao, an Ahupua`a on the Island of Hawaii, is one lo`i, and a house lot and an orange tree.
In the District of Kau, Ahupua`a of Wailau, is a house lot in the land.
In the Ahupua`a of Kaalaiki is a lot like that /in Wailau/. These are on the Island of Hawaii.

At Lahaina, in Kuhua Ahupua`a, is a mala of lauhala.

At Honouliwai, an Ahupua`a o;n the Island of Molokai are two orange trees.

At Kula, Island of Maui, Keokea Ahupua`a, there are three small mala of sweet potatoes and one mala of taro, made by our own hands, not by /those of/ the /people of the/ land.
At Kooka, an Ahupua`a in Lahaina, are four coconut trees and a single coconut tree at the shore in the lot of Kualaula, in Kiika, a /total of/ five coconut trees, and some kou trees at Pahoa, which have not been counted, also a hala clump is there, at the seashore.
I am with aloha, respectfully,
KEOHOKALOLE, who affirms this is my name, signed by Z. Kaauwai

F.T. 573v3
No. 8452, Keohokalole

Awahua, sworn, says he knows the House lots claimed by Keahokalole at Kaawaloa, Hawaii. The first one is fenced all round with a stone wall.

It is bounded:
Makai by the sea shore
On Kailua side by the Government land
Mauka by the land of Kahaku and Awahua
and on the other side by the road.

Claimant derived this lot from her ancestors, who held it from very ancient times. There is a stone house and several grass houses in it, belonging to claimant, besides a Tomb.

The second Lot is called "Aeoili" and is fenced all round.
It is bounded:
Makai by Government land
On Kailua side by the same
Mauka the same
On the side next the Pali by the Road.

Claimant derived this lot from her ancestor, who held it from olden times.

Witness knows the three House Lots in Kealakeakua claimed by Keohokalole. The first Lot is called "Kulou" and is fenced in.

It is bounded:
Makai by the Sea beach
Kaawaloa side by Government land
Mauka by the Road
South Kona side by a lot belonging to T. Cummings.

The second Lot is called "Kaahaloa" it is enclosed all round, and [is] bounded on:
Kona Hema by a lot belonging to T. Cummings
Mauka by the lot of Nakoko
North Kona by an old Heiau
Makai by the Road.

The third Lot is called "Hailokoalii" and is bounded on:
The south Kona side by an old Heiau
Mauka by a Government Lot & the lot of Ialua
Makai by the Sea Beach
On the other side by a pali.

Claimant inherited these Lots from her ancestors by the mother's side, who possessed them from ancient times.

Kekaalua, sworn, says he knows there lots perfectly & confirms in full the testimony of Awahua.

N.T. 326-327v10
No. 8452, A. Keohokalole; K. Kapaakea

To His Highness, John Young, Minister of Interior
Greetings:
This is to inform you and the Privy Council of my desire to convey some of my lands for the Governments one third in the land which remain as mine. Grant me this, of course, with the approval of the Privy Council

Below is a list of the lands I wish to convey to the government.

Aapueo ahupuaa, Kula, Maui
5 Omaopio ahupuaa, Kula, Maui.
Makehu ahupuaa, Kula, Maui
Kuikuiaeo ahupuaa, Kula, Maui
2 Kailua ahupuaa, Kula, Maui
2 Pukalani ahupuaa, Kula, Maui.
Kukuiula ahupuaa, Kipahulu, Maui.
Alaakua ahupuaa, Kaupo, Maui.

Kanakau ahupuaa, Kona, Hawaii.
Kaipuhao ahupuaa, Kohala, Hawaii.
Halaula ahupuaa, Kohala, Hawaii,
Keahakea ahupuaa, Hamakua, Hawaii.
Kaioula ahupuaa, Kau, Hawaii.
2 Makahakupa ahupuaa, Kau, Hawaii.
Kouhuhuula ahupuaa, Kau, Hawaii.
Pohina ahupuaa, Kau, Hawaii.
Puhalanui ahupuaa, Kau, Hawaii.
Wiliwilinui ahupuaa, Kau, Hawaii.
2 Papohaku ahupuaa, Kau, Hawaii.

The boundaries of all of these lands above have been established.
With appreciation,
(sign) A. Keohokalole

Honolulu, Jan. 3, 1850
To Your Highness, John Young, Minister of Interior
Greetings:

Here is a list of the names of my lands which has been left for me pending for an approval of its distribution.

Kahana ahupuaa, Koolauloa, Oahu.
Hamohamo ili, Waikiki, Oahu.
Malaekahana ahupuaa, Koolauloa, Oahu.

Paeohi ahupuaa, Lahaina, Maui.
2 Koheo ahupuaa, Kula, Maui.
3 Alae ahupuaa, Kula, Maui.
2 Kealahou 3,4, ahupuaaa, Kula, Maui.
Aapueo ahupuaa, Kula, Maui.
Kamehame ahupuaa, Kula, Maui.
Kuikuiaeo ahupuaa, Kula, Maui.
Muolea, Hana, Maui.

Kealakekua, Kona, Hawaii.
Kaawaloa ahupuaa, Kona, Hawaii.
Onouli ahupuaa, Kona, Hawaii.
Keahuolu ahupuaa, Kona, Hawaii.
Pau ahupuaa, Kohala, Hawaii.
Paauhau ahupuaa, Hamakua, Hawaii.
Puna ahupuaa, Puna, Hawaii.
Keaiwa ahupuaa, Kau, Hawaii.
Kawela ahupuaa, Kau, Hawaii.

With appreciation,
A. Keohokalole,
Honolulu, Jan. 3, 1850

Resolved, that the Minister of the Interior be and is hereby authorized to transfer to the list of lands belonging to Keohokalole, Kaapuna, Kona, Hawaii, and Aapueo 2, Kula, Maui, and transfer to the Government and list one of the Alae's in Kula, Maui, in lieu of Aapueo 2, sold by Kapaakea through mistake.

By order of Privy Council
December 22, 1850
Resolved, that the Government shall accept the division of lands of the chiefs as made by them, and those laid off for the Government shall be the government third of their lands.
By order of the King and Council
August 27th, 1850

I hereby certify the foregoing to be true copies of the original documents now on file in this Department.
(sign) A.G. Thruston, Chief Clerk, Interior Department
November 9th, 1853

[Award 8452; (Oahu) R.P. 5616; Malaekahana Koolauloa; 1 ap.; 3280 Acs; R.P. 5616; Kapiwai Pauoa; 1 ap.; 10.5 Acs; R.P. 5588; Hamohamo Waikiki; 3 ap.; 99.68 Acs; Land Patent 8330; Hamohamo Waikiki; 3 ap.; 2.24 Acs; R.P. 4387; Kahana Koolauloa; 1 ap.; 5050 Acs (ahupuaa); (Maui); R.P. 4388; 1 ap. Aapueo Kula Ahupuaa; Alae 3 Kula 1 ap. (ahupuaa), Kamehame Kula, R.P. 4388 & 7453; Kealahou 3-4 Kula; R.P. 4388 & 7453; Koheo 2 Kula Ahupuaa Ap. 19; R.P. 4388; Kukuiaeo Kula; Muolea Hana; 1 ap.; ahupua`a; Paeohi Lahaina; Kukuiokaea Kula Ahupuaa Ap. 7; (Hawaii): Kealakekua S. Kona R.P. 7533 & 3607; Honohina Hilo R.P. 4386 & 7693; Kaawaloa S Kona R.P. 7532 & 4386, & 4385; Onouli S Kona R.P. 4386 & 7146; Keahuolo N. Kona; R.P. 6886; Paauhau Hamakua; Land Patent 8123; Pau N. Kohala; Land Patent 8083; Puua Puna R.P. 7788; Kawela Kau R.P. 6886; Keaiwa Kau; See Award MA 3 for Hamoa Hana award]

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
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KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 22, 2011

Dr. Hallett H. Hammatt
Cultural Surveys Hawaii
P.O. Box 1114
Kailua, Hawaii 96734

LOG NO: 2010.1654
DOC NO: 1106MV09
Archaeology

Dear Dr. Hammatt:

SUBJECT: Chapter 6E-42 Historic Preservation Review – Revised Archaeological Inventory Survey Plan for the International Market Place Re-Development Project Waikiki Ahupua'a, Kona District, Island of O'ahu TMK: (1)-2-6-022:036, :037 through :038 & :043

Thank you for the opportunity to review this revised draft plan titled: *Archaeological Inventory Survey Plan for the International Market Place Re-Development Project Waikiki Ahupua'a, Kona District, Island of O'ahu TMK: (1)-2-6-022:036, :037 through :038 & :043* (C. O'Hare, D. Shideler, and H. Hammatt June 2011). This draft was received on June 8, 2010. The AISP was prepared to support the redevelopment of the International Market Place in Waikiki. The International Market Place campus has had very little intrusive excavation over the years. Therefore, the subsurface material likely remains relatively undisturbed within this project area. This AISP contains a wealth of background information on the Waikiki area. This information indicates that this project has a tremendous potential to encounter archaeological sites including human burials.

This revision is based on comments generated through a previous SHPD review (SHPD Log No 2010.3950, Doc. No. 1105MV26). The revisions that were made to this document adequately address SHPD's concerns. We believe that the burial that was previously removed from the international marketplace in the 1960's has been adequately addressed. We agree that additional testing may be required depending on the results of the initial testing. We also agree that separating the AIS work for the international marketplace parcels and the Miramar Hotel parcels is a justified alternative if the work cannot be completed together. Finally, we agree that a Preservation Plan is the appropriate outlet for discussing preservation during demolition if significant historic resources are identified. **The report is accepted as final pursuant to Hawai'i Administrative Rule 13§13-284.** Please send one hardcopy of the document, clearly marked FINAL, along with a copy of this review letter and a text-searchable PDF version on CD to the Kapolei SHPD office, attention SHPD Library. Please contact Mike Vitousek at (808) 692-8029 or Michael.Vitousek@Hawaii.gov if you have any questions or concerns regarding this letter.

Aloha,

Mike Vitousek

Michael Vitousek,
Acting Lead Oahu Island Archaeologist
State Historic Preservation Division

LCA 10677

No. 10677, Pupuka

N.R. 576v4

Greetings to you, kaulakaauwai: Here is my little letter of explanation to you concerning my lo`is here at Kukahi. There is one taro lo`I, one weed-grown lo`I, also a pnd, and a kula. The name of it all is Kalihi.

PUPUKA

F.T. 476-477v14

No. 10677, Pupuka, Claimant, Deceased, Paku, heir

Palaualelo, sworn, say[s] he is the konohiki of claimant's land. It contains 3 lois, 3 auwai in Mookahi, in Waikiki, Oahu. Apana 2. A house lot in Hamohamo, Waikiki.

Apana 1 is bounded:
Mauka by the land of Kalia
Kekaha by the land of Kauko
Makai by the land of Uluoni
Honolulu by the land of Kauai

Apana 2 is bounded:
Mauka by the Uluniu
Kekaha by the house of Nuewa
Makai by the sea shore of Hamohamo kai
Honolulu by the House of Nae.

Claimant received the land from me in the time of Kaahumanu & has held it in quiet ever since.

Naohe, sworn, says the above testimony is true & his own is like it.

[Award 10677; R.P. 4631; Kamookahi Waikiki; 1 ap.; .43 Ac]