APPENDICES (FEIS Volume 3)

Appendix C

Draft Cultural Impact Assessment
Cultural Surveys Hawai‘i, June 2019

Draft
Cultural Impact Assessment for the Board of Water Supply Beretania Complex Project, Honolulu Ahupua‘a, Honolulu District, O‘ahu TMKs: [1] 2-1-036:001 and 005

Prepared for
HHF Planners
on behalf of the
Honolulu Board of Water Supply

Prepared by
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(Job Code: HONOLULU 86)

June 2019

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APPENDICES (Volume 2)

Management Summary

Reference	Cultural Impact Assessment for the Board of Water Supply Beretania Complex Project, Honolulu Ahupuaʻa, Honolulu District, Oʻahu, TMKs: [1] 2-1-036:001 and 005 (Spencer et al. 2019)
Date	June 2019
Project Number(s)	Cultural Surveys Hawaiʻi, Inc. (CSH) Job Code: HONOLULU 86
Agencies	State of Hawaiʻi, Department of Health, Office of Environmental Quality Control (DOH/OEQC)
Land Jurisdiction	City and County of Honolulu (CCH) Board of Water Supply (BWS)
Project Proponent	BWS
Project Location	The project area is a portion of the BWS Beratania Complex property. It is bounded by Beretania Street to the south, Lauhala Street to the west, Lusitana Street to the north, and Alapai Street to the east. The project area is depicted on a portion of the 1998 Honolulu U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle.
Project Description	BWS will be issuing a Request for Proposals (RFP) to redevelop a portion of the Beretania Complex. The purpose of this action is to provide a revenue stream for BWS to help offset a portion of its operating expenses and capital improvement costs. The redeveloped area would not include the existing BWS Public Service Building, Engineering Building, or Pump Station Building. The selected developer will be issued a ground lease for the use of the property and will be allowed to redevelop the site, subject to the conditions of the lease. The maximum lease term would be 65 years. At the end of the lease, full ownership and control over the property and improvements constructed would revert to BWS. The specific redevelopment plan will be determined by the developer. Implementation of the proposed action will involve the use of public lands and funds and, therefore, will be subject to the requirements of Hawaiʻi Revised Statutes (HRS) §343 and Hawaiʻi Administrative Rules (HAR) §11-200. BWS is preparing an Environmental Impact Statement (EIS) to evaluate the following three potential development scenarios, all of which could be implemented under the property's existing A-2 Medium Density Apartment zoning. • Scenario 1: Assisted care living facility and office building • Scenario 2: Affordable senior rental apartments and office building • Scenario 3: Parking structure and office building

Project Acreage	The project includes two separate areas on the BWS Beretania Complex property. The larger area is a portion of TMK parcel [1] 2-1- 036:005 on the northwest side of Lisbon Street; the smaller area is TMK parcel [1] 2-1-036:001 on the southeast side of Lisbon Street. The two areas together total 2.95 acres, or 1.19 hectares (ha).
Document Purpose	This cultural impact assessment (CIA) was prepared to comply with the State of Hawaiʻi's environmental review process under HRS §343, which requires consideration of the proposed project's potential effect on cultural beliefs, practices, and resources. Through document research and cultural consultation efforts, this report provides information compiled to date pertinent to the assessment of the proposed project's potential impacts to cultural beliefs, practices, and resources (pursuant to the Office of Environmental Quality Control's *Guidelines for Assessing Cultural Impacts*) which may include traditional cultural properties (TCPs). These TCPs may be significant historic properties under State of Hawaiʻi significance Criterion e, pursuant to HAR §13-275-6 and §13-284-6. Significance Criterion e refers to historic properties that "have an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts—these associations being important to the group's history and cultural identity" (HAR §13-275-6 and §13-284-6). The document will likely also support the project's historic preservation review under HRS §6E and HAR §13-275 and §13-284.The document is also intended to support the project's environmental review.
Results of Background Research	Background research for this study yielded the following results which are presented in approximate chronological order: 1. The project area is considered within the *ahupuaʻa* (traditional land division usually extending from the mountain to the sea) of Honolulu. However, in the pre-Contact period, Honolulu was only a small village and the *ahupuaʻa* of Pauoa probably once extended from the mountains to the shore, encompassing the eastern section of downtown Honolulu. The project area in the pre-Contact and early post-Contact periods would have been considered within the boundary of Pauoa Ahupuaʻa. 2. Pauoa Ahupuaʻa, a small valley along Pauoa Stream, is located between Nuʻuanu and Makiki valleys and extends from an elevation about 2,000 feet (ft) at the *mauka* (inland) point to Vineyard Street, the modern *makai* (seaward) boundary. Pauoa, meaning "ear," was so named because it was viewed as a "side valley" of the larger Nuʻuanu Ahupuaʻa to the west (Lyons 1901:181).

	3. Mid-nineteenth century land records indicate the project area was in ʻAuwaiolimu (meaning "ditch of moss"; Pukui et al. 1974:14), an *ʻili* (smaller land division within an *ahupuaʻa*) of Pauoa Ahupuaʻa. The *ʻili* was said to have been named for a chiefess, perhaps the famous beauty of Mānoa Valley, Kahalaopuna, who bathed in the waters of the ʻAuwaiolimu Stream. Her long hair floating in the stream resembled the long strands of moss, or *limu*. 4. Pauoa Valley was associated with two famous invasions, both with battles near the project area in ʻAuwaiolimu ʻIli and near a *heiau* (pre-Contact place of worship) called Kānelāʻau. 5. Pukui et al. (1974:49–50) literally translate Honolulu as "protected bay," which refers to the protection of Honolulu Harbor. Older names for the harbor are Kou and Māmala. 6. Kou was comprised of shoreward fishponds and taro *loʻi* (irrigated fields) fed by ample streams descending from Nuʻuanu and Pauoa valleys, but it was Waikīkī to the southeast that could claim preeminence as the traditional residence of the *aliʻi* (royalty) and as the center of political power on the island. 7. Six *heiau* and one home for priests were located on Pūowaina, some on the Makiki side of the crater and some on the Pauoa (or ʻAuwaiolimu) side. These *heiau* acted as temples, forts, and as part of the complex for the priests of Pūowaina. These *heiau* were important sites during the Battle of Nuʻuanu in 1795 when Kamehameha invaded and conquered the island of Oʻahu. Four of these *heiau* are on the southwestern slope of Punchbowl near the current project area. 8. In 1846, Honolulu was made the capitol of the Hawaiian Kingdom and was well on its way to becoming the commercial and political hub of the Islands. During this period there was an obvious increase in land use density and urbanization. ʻIolani Palace was constructed in the 1880s. 9. Water in the early post-Contact period in the Honolulu area depended on the availability of streams, pools, wells, and springs. As Honolulu expanded, it became necessary to provide water to the "dusty plains" east of Honolulu. In 1879, James Campbell drilled down 273 ft on his cattle ranch in ʻEwa and found a vast aquifer of fresh water lay below the Hawaiian Islands (James Campbell Estate 1978:14). Many other wells were dug, including ones in Honolulu, but by the 1890s, the levels of water from wells was so low that supplying water to the city became a real problem.

	10. After the establishment of the Republic, the water works were under the direction of the Superintendant of Public Works, then under the Department of Public Works in 1913. The Honolulu Sewer and Water Commission was formed in 1927, but continued disruptions in the water supply led to the creation of the BWS in 1929 (Murai 2000:2–3).
Results of Community Consultation	CSH attempted to contact 89 Native Hawaiian Organizations (NHOs), agencies, and community members. Of the seven people that responded, one provided written testimony and one participated in an in-person interview. Below is a list of individuals who shared their *mana‘o* (thought, opinions) and *‘ike* (knowledge) about the project area and the Honolulu Ahupua‘a: 1. Chester Lao, former geologist for the Honolulu Board of Water Supply (BWS) 2. Kiersten Faulkner, Executive Director, Historic Hawai‘i Foundation
Impacts and Recommendations	Based on information gathered from the community consultation, participants voiced and framed their concerns in a cultural context: 1. The BWS Beretania Complex is located adjacent to the Hawai‘i Capitol Special District and adjacent to the Special District’s sub-district, titled “Queen’s Medical Center Precinct.” Historic Hawai‘i Foundation recommends that the Area of Potential Effect (APE) in the Draft Environmental Impact Statement (DEIS) be expanded in order to sufficiently assess any off-site impacts to historic, cultural, and natural resources including visual or contextual effects on the larger Capitol Special District and the adjacent historic BWS buildings. Historic Hawai‘i Foundation stated that existing special district guidelines addressing design and development parameters for new construction need to be followed to avoid additional effects on the setting of the historic buildings and district. 2. Historic Hawai‘i Foundation and interviewee Chester Lao mentioned the existence of an underground tunnel system and bomb shelter which were built on the BWS site during World War II. Historic Hawai‘i Foundation believes the existence, location, and condition of the tunnel system needs to be assessed. An assessment of historic resources and how these resources will be avoided or preserved should be included in the Draft Environmental Impact Statement (DEIS). Additional measures to protect historic resources include preparation of a preservation plan for the three historic BWS buildings, treatment guidelines for the World War II tunnels, and providing historic

	interpretation on the site to educate future residents and visitors about its historic and cultural significance. 3. Historic Hawaiʻi Foundation recommends that sensitive areas and key locations to be avoided or preserved should be identified during the planning stages of the redevelopment. Historic Hawaiʻi Foundation also recommends that a reconnaissance-level survey to identify probable subsurface cultural resources should be conducted prior to the selection of locations for new buildings. 4. Interviewee Chester Lao mentioned that the BWS installed wells within the project area. Mr. Lao stated, "Eventually, I think they will have to relocate the wells," as a result of the proposed project. 5. Historic Hawaiʻi Foundation stated that the project area also includes known and likely Native Hawaiian burials. Project construction workers and all other personnel involved in the construction and related activities of the project should be informed of the possibility of inadvertent cultural finds, including human remains. In the event that any potential historic properties are identified during construction activities, all activities will cease and the SHPD will be notified pursuant to HAR §13-280-3. In the event that *iwi kūpuna* (Native Hawaiian skeletal remains) are identified, all earth moving activities in the area will stop, the area will be cordoned off, and the SHPD and Police Department will be notified pursuant to HAR §13-300-40. In addition, in the event of an inadvertent discovery of human remains, the completion of a burial treatment plan, in compliance with HAR §13-300 and HRS §6E-43, is recommended. 6. In the event that *iwi kūpuna* and/or cultural finds are encountered during construction, project proponents should consult with cultural and lineal descendants of the area to develop a reinterment plan and cultural preservation plan for proper cultural protocol, curation, and long-term maintenance.

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Section 1 Introduction

1.1 Project Background

At the request of HHF Planners, on behalf of the Board of Water Supply (BWS), Cultural Surveys Hawai‘i, Inc. (CSH) is conducting a cultural impact assessment (CIA) for the BWS Beretania Complex Redevelopment project, Honolulu Ahupua‘a, Honolulu District, O‘ahu, TMKs: [1] 2-1-036:001 and 005. The total project area is approximately 128,100 square feet (sq ft). The project area is a portion of the BWS Beretania Complex property, which is bounded by Beretania Street to the south, Lauhala Street to the west, Lusitana Street to the north, and Alapai Street to the east. Although the 6.3-acre Beretania Complex property is city-owned, it is under the control and use of BWS and consists of three tax map parcels: TMKs: [1] 2-1-036:001, 004, and 005. The Beretania Complex is bisected by Lisbon Street, which divides the complex into an "‘Ewa Block" and a "Diamond Head Block." The project area is depicted on a portion of the 1998 Honolulu U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle (Figure 1), a tax map plat (Figure 2), and a 2013 aerial photograph (Figure 3).

BWS will be issuing a Request for Proposals (RFP) to redevelop a portion of the Beretania Complex. The purpose of this action is to provide a revenue stream for BWS to help offset a portion of its operating expenses and capital improvement costs. The redeveloped area would not include the existing BWS Public Service Building, Engineering Building, or Pump Station Building. The selected developer will be issued a ground lease for the use of the property and will be allowed to redevelop the site, subject to the conditions of the lease. The maximum lease term would be 65 years. At the end of the lease, full ownership and control over the property and improvements constructed would revert to BWS. The specific redevelopment plan will be determined by the developer. Implementation of the proposed action will involve the use of public lands and funds and, therefore, will be subject to the requirements of Hawai‘i Revised Statutes (HRS) §343 and Hawai‘i Administrative Rules (HAR) §11-200.

BWS is preparing an Environmental Impact Statement (EIS) to evaluate the following three potential development scenarios, all of which could be implemented under the property's existing A-2 Medium Density Apartment zoning.

- Scenario 1: Assisted care living facility and office building
- Scenario 2: Affordable senior rental apartments and office building
- Scenario 3: Parking structure and office building

All three scenarios show a new BWS office building (ten stories, plus one story of parking below grade) near the corner of Alapai and Lusitana streets. All scenarios also include a larger multi-level parking structure between Lisbon and Lauhala streets. This structure would replace BWS's lost ground level parking and support the proposed residential uses.

The main component of Scenario 1 is an assisted living facility located in the northwest corner of the property. Assisted living is a form of residential care for seniors that provides residents with as much independence as they want, but with available personal care and support services. Assisted living communities do not offer complex medical services and are considered non-medical facilities.

Figure 1. Portion of the 1998 Honolulu USGS 7.5-minute topographic quadrangle showing the location of the project area

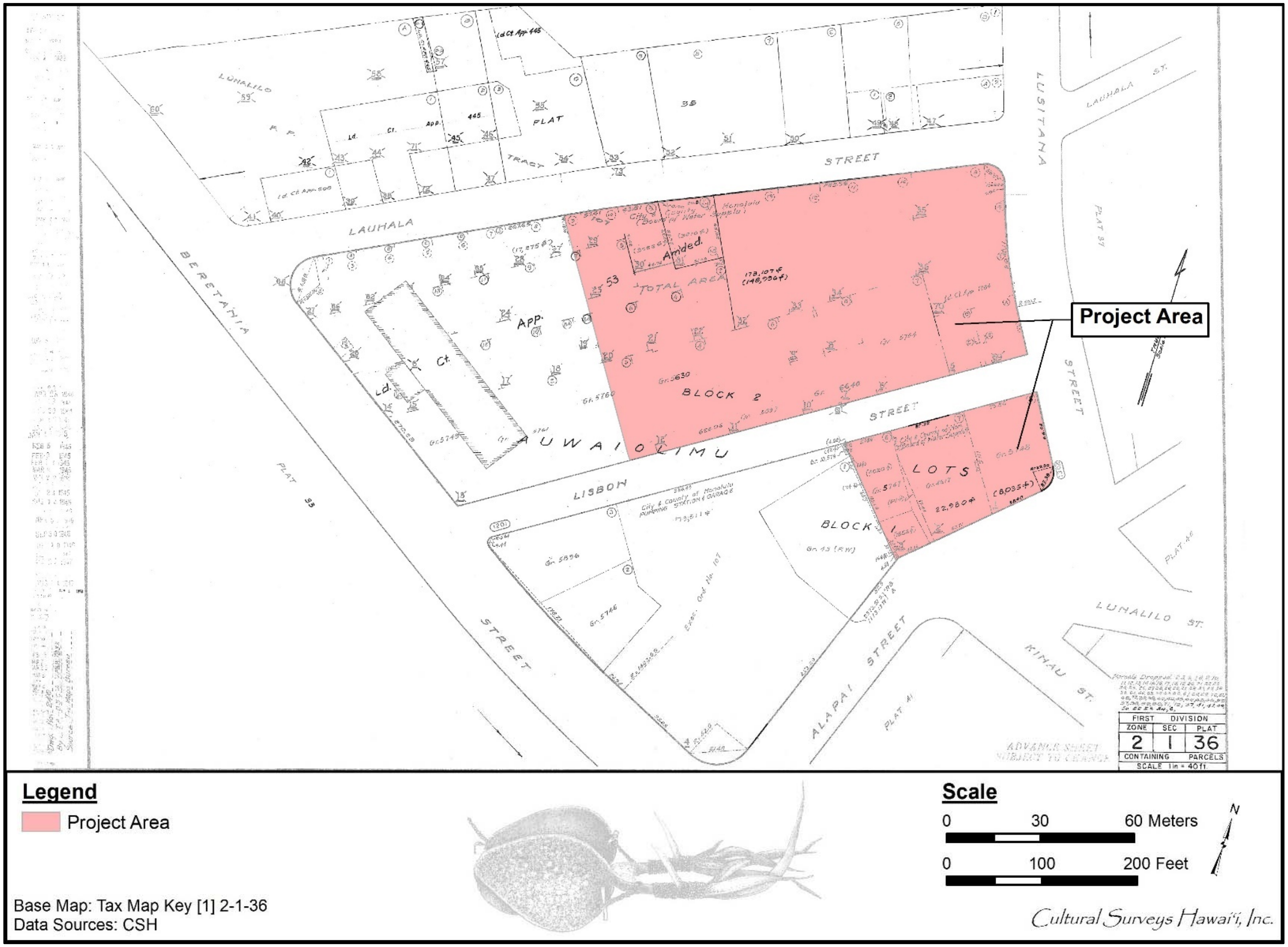

Figure 2. Tax Map Key (TMK) [1] 2-1-36 showing both project areas (Hawai‘i TMK Service 2014)

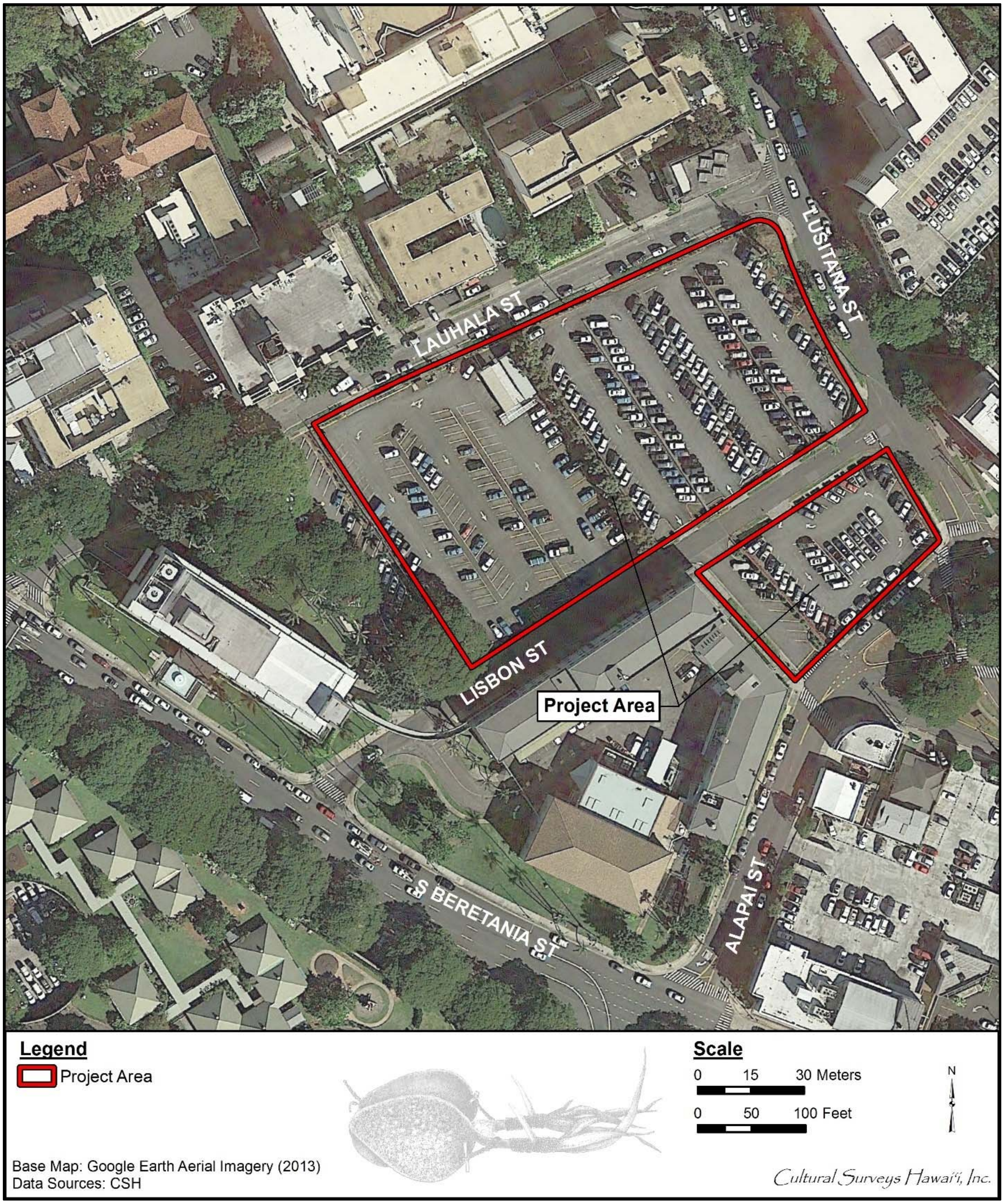

Figure 3. Aerial photograph showing the location of the project area (Google Earth 2013)

The concept plan being evaluated in the EIS shows an assisted living facility with ten floors. The ground floor and a portion of the second floor would be used for amenities and utilities. Upper floors would consist of living units and an activity room on each floor. Parking for employees, residents, and guests would be provided in the adjacent ten-floor parking structure.

Scenario 2 includes the development of senior rental apartments in the northwest corner of the property. These would be rent-controlled apartments for individuals 60 to 65 years and older. In contrast to Scenario 1, there would be no on-site support services for residents, other than standard building security and maintenance.

The concept plan shows the building footprint for two ten-story buildings. The ground floor and a portion of the second floor of each building would most likely be used for amenities and utilities. Residential units would be located on the upper floors. Parking would be provided in the adjacent ten-floor parking structure.

Under Scenario 3, there would be no residential component on the property. The northwest corner of the property, near the intersection of Lauhala and Lusitana streets, would remain as ground level parking. The proposed parking structure off Lauhala Street would be ten floors but larger in footprint, with some stalls for BWS use and others available for lease.

1.2 Document Purpose

The purpose of this CIA is to comply with the State of Hawai‘i’s environmental review process under HRS §343, which requires consideration of the project’s potential effect on cultural beliefs, practices, and resources. Through document research and cultural consultation efforts, this report provides information compiled to date pertinent to the assessment of the proposed project’s potential impacts on cultural beliefs, practices, and resources (pursuant to the Office of Environmental Quality Control’s *Guidelines for Assessing Cultural Impacts*), which may include traditional cultural properties (TCPs). These TCPs may be significant historic properties under State of Hawai‘i significance Criterion e, pursuant to HAR §13-275-6 and §13-284-6. Significance Criterion e refers to historic properties that “have an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts—these associations being important to the group’s history and cultural identity” (HAR §13-275-6 and §13-284-6). The document will likely also support the project’s historic preservation review under HRS §6E and HAR §13-275 and §13-284. The document is intended to support the project’s environmental review and may also serve to support the project’s historic preservation review under HRS §6E-8 and HAR §13-284.

1.3 Scope of Work

The scope of work for this CIA includes the following:

1. Examination of cultural and historical resources, including Land Commission documents, historic maps, and previous research reports with the specific purpose of identifying traditional Hawaiian activities including gathering of plant, animal, and other resources or agricultural pursuits as may be indicated in the historic record.

2. Review of previous archaeological work at and near the subject parcel that may be relevant to reconstructions of traditional land use activities; and to the identification and description of cultural resources, practices, and beliefs associated with the parcel.
3. Consultation and interviews with knowledgeable parties regarding cultural and natural resources and practices at or near the parcel; present and past uses of the parcel; and/or other practices, uses, or traditions associated with the parcel and environs.
4. Preparation of a report that summarizes the results of these research activities and provides recommendations based on findings.

1.4 Environmental Setting

1.4.1 Natural Environment

The project area is within the Honolulu Plain, which is underlain by a broad elevated coral reef, partly covered by alluvium carried out from the Ko‘olau mountain range. The fossils found in the reef indicate the reef is not older than the late Pleistocene. However, fossil associations also indicate these creatures lived in waters warmer than the present, which means the reef likely formed in one of the interglacial periods when the sea level was higher than it is at present (Macdonald and Abbott 1974:420–421). The elevation of the project area is approximately 3-13 m or 10-45 ft above mean sea level (AMSL). Temperatures around Honolulu range from 52 to 95° F, with the warmest temperatures in September and the coolest temperatures in January. Average annual rainfall ranges between 20 and 30 inches, with 15 to 20 inches between November and March and 0 to 5 inches between June and August (Armstrong 1973:62–64).

1.4.2 *Ka Lepo* (Soil)

According to the U.S. Department of Agriculture (USDA) Soil Survey Geographic (SSURGO) database (2001) and soil survey data gathered by Foote et al. (1972), the project area's soils consist of Makiki clay loam, 0 to 2% slopes (MkA) and Tantalus silty clay loam, 8 to 15% slopes (TCC). Figure 4 illustrates the various soil sediments within the vicinity of the project area.

Soils of the Makiki Series are described as follows:

> This series consists of well-drained soils on alluvial fans and terraces in the city of Honolulu on the island of Oahu. These soils formed in alluvium mixed with volcanic ash and cinders. They are nearly level. Elevations range from 20 to 200 feet. The annual rainfall amounts to 30 to 60 inches. Most of it falls between November and April. The mean annual soil temperatures is 73° F. Makiki soils are geographically associated with Kaena and Tantalus soils. [Foote et al. 1972:91]

Soils of the Tantalus Series are described as follows:

> This series consists of well-drained soils on uplands on the island of Oahu. These soils developed in volcanic ash and material weathered from cinders. They are moderately sloping to very steep. Elevations range from 100 to 2,200 feet. The annual rainfall amounts to 50 to 150 inches. It is well distributed throughout the year. The mean annual soil temperature is 70° F. Tantalus soils are geographically associated with Makiki soils.

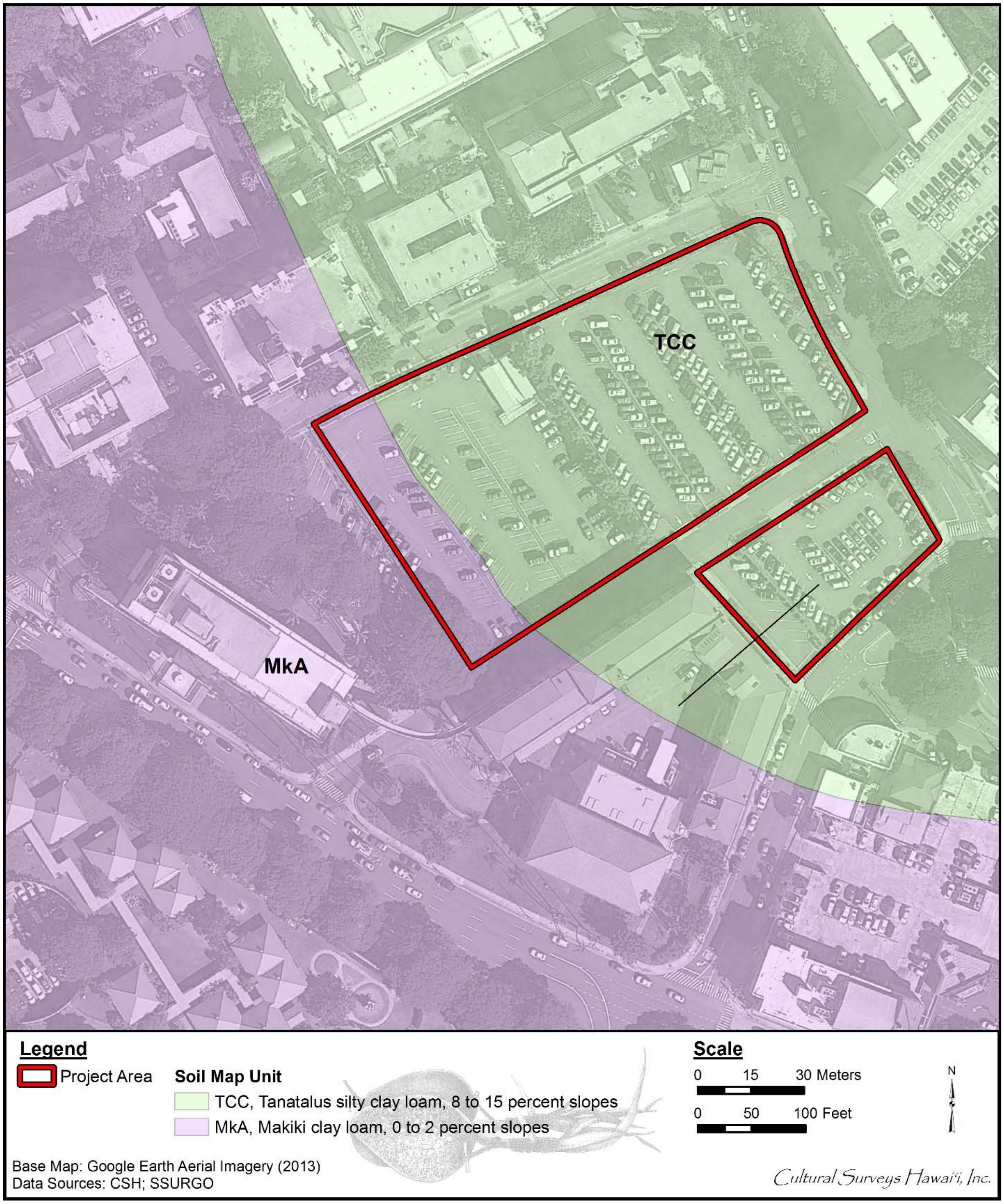

Figure 4. Overlay of the *Soil Survey of the State of Hawaii* (Foote et al. 1972) on a 2013 Google Earth aerial photograph indicating soil types within and surrounding the project area (USDA SSURGO 2001)

> These soils are used for homesites, water supply, and recreation. The natural vegetation consists of ferns, Formosa koa, koa haole, kukui, and eucalyptus. [Foote et al. 1972:121]

1.4.3 *Ka Makani* (Wind)

Northeasterly trade winds 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 (Wilson Okamoto & Associates 1998:1-2).

The Hawaiian word for wind is *makani*. *The Wind Gourd of Laʻamaomao* tells the story of Pākaʻa and his son Kuāpākaʻa, descendants of the wind goddess Laʻamaomao. With their possession of her special wind gourd, they had the ability to control and call forth the winds of all of Hawaiʻi. Pākaʻa's chant traces the winds of and surrounding Honolulu Ahupuaʻa. Pākaʻa's chant is listed below:

He Kuehu lepo ko Kahua,	Kuehu-lepo is of Kahua,
He Kukalahale ko Honolulu,	Kukalahale is of Honolulu,
He Ao-a-oa ko Mamala,	ʻAoʻaoa is of Māmala,
He Olauniu ko Kapalama,	ʻŌlauniu is of Kapālama,
He Haupeepee ko Kalihi	Haupeʻepeʻe is of Kalihi

[Nakuina 1902:56–57;1992:50]

1.4.4 *Ka Ua* (Rain)

Precipitation is a major component of the water cycle accountable for depositing fresh water on local flora. Pre-Contact *kānaka ʻōiwi* (Native Hawaiians) recognized two distinct annual seasons. The first, known as *kau* (period of time, especially summer), lasts typically from May to October and is a season marked by a high-sun period corresponding to warmer temperatures and steady trade winds. The second season, *hoʻoilo* (winter, rainy season), continues through the end of the year from November to April and is a much cooler period when trade winds are less frequent, and widespread storms and rainfall become more prevalent (Giambelluca et al. 1986:17). Typically the maximum rainfall occurs in January and the minimum in June (Giambelluca et al. 1986:17).

Annual rainfall in the project area varies between 25 and 125 inches, higher volumes occurring in the rainy season between November and April. The mean rainfall in the project area is 600 mm (23.625 inches) (Giambelluca et al. 1986:138). In the Honolulu District, rainfall averages less than 30 inches per year (Armstrong 1983:62).

1.4.4.1.1 *Ka Ua Kuiʻilima*

The Kuiʻilima rain (same as the Kuilima rain) is one closely associated with the Honolulu Ahupuaʻa. Kuiʻilima means "to string ʻilima flowers" and Kuilima means "to lock arms" (Pukui and Elbert 1986:174). This rain was mentioned in a *mele inoa* or name chant for Albert Ka Haku o Hawaiʻi composed by his uncle, Kamehameha V, Lot Kapuāiwa:

Kuʻu hoa i ka ua Kuilima

Ua Kūkalahale o Honolulu

My companion in the Kuilima rain
The Kūkalahale rain of Honolulu
[Akana and Gonzalez 2015:126]

Mentioned in another *mele inoa,* the Kuilima rain is described below:

Aloha Nuʻuanu i ke kāmakahala lā
Ke kuia maila e ka ua noe ē
Ka ua Kuilima o Nuʻuanu lā
Ke hehi [maila] i ka maka o ka ʻāhihi ē
Beloved Nuʻuanu with its kāmakahala plants
Strung together by the misty rain
The Kuilima rain of Nuʻuanu
Treading on the face of the ʻāhihi flowers
[Akana and Gonzalez 2015:127]

1.4.4.2 *Ka Ua Kūkalahale*

The Kūkalahale rain is another rain associated with Honolulu and the larger Kona district of Oʻahu. *Kū kala hale* means "standing under the eaves of the house" or "striking the house gables" while *Kūkala hale* means "announcing to the homes" (Akana and Gonzalez 2015:127). This rain was mentioned in a *mele kanikau* or lamentation song for Joseph Nāwahīokalaniʻōpuʻu by people of Oʻahu:

Nākolo, nakulu, paʻapaʻaʻina kaupoku o Kākuhihewa ē
Hewa ka iʻa a ʻUmiamaka i ka lili a ka ua Kūkalahale
The roofs of Kākuhihewa are roaring, rumbling, and crackling
The fish of ʻUmiamaka was wronged by the jealousy of the Kūkalahale rain
[Akana and Gonzalez 2015:127]

The Kūkalahale rain is also referred to in the legend of Hiʻiakaikapoliopele:

A i ia wā i uhau aʻe ai ʻo Hiʻiaka i kēia kau, ʻoiai nō ka ua Kūkalahale o Honolulu nei e hoʻokawewe ana i ka lau lāʻau a me nā hākala hoʻi o nā hale pili o ia mau lā aloha o ka nohona o ko kākou mau kūpuna.

Then Hiʻiaka offered up this chant, while the Kūkalahale rain of Honolulu pattered upon the leaves of the trees and the thatched roofs of those beloved days of our ancestors.

[Akana and Gonzalez 2015:127]

Another section of the same legend notes the Kūkalahale rain:

> *I ia wā i haʻalei aku ai ʻo Kauakahiapaoa i kāna kilu. . . . ʻHe mau wahi hua mele paoa loa kā hoʻi kaʻu i oli aʻe nei. Eʻeha ana hoʻi au i ke kaikamahine o ka ua Kūkalahale.ʼ*
>
> *I kēlā wā, lālau ihola ʻo Peleʻula i kāna ipu, a oli aʻela noō hoʻi.*
>
> . . . .
>
> *Eia au ē, ka ua Kūkalahale*
>
> *A pā!*
>
> At that point, Kauakahiapaoa tossed his kilu. . . . ʻThose were certainly unlucky lines I just chanted. I shall be wounded by the girl of the Kūkalahale rains.ʼ
>
> Whereupon Peleʻula reached for her gourd maker and chanted.
>
> . . . .
>
> Here am I, the Kūkalahale rain
>
> Let it strike!
>
> [Akana and Gonzalez 2015:127]

1.4.5 Built Environment

The project area is within the densely developed urban core of Honolulu, although its location on the north edge of the Capitol District, which includes many of the State and City and County government buildings, is not as densely developed as other parts of the urban core. The project area is within the BWS Beretania Complex, which has a campus-type layout, with multiple buildings and functional areas. The project area is located on the *mauka* (toward the mountain) half of the BWS Beretania Complex property and encompasses two separate areas currently used as parking lots. The built environment in the project area consists of asphalt paved parking areas, concrete and basalt curbs, concrete sidewalks, concrete and mortared basalt retaining walls and landscape planters, and limited landscaping that includes exotic grasses, shrubs, and trees.

Section 2 Methods

2.1 Archival Research

Research centers on Hawaiian activities including *ka‘ao* (legends), *wahi pana* (storied places), *‘ōlelo no‘eau* (proverbs), *oli* (chants), *mele* (songs), traditional *mo‘olelo* (stories), traditional subsistence and gathering methods, ritual and ceremonial practices, and more. Background research focuses on land transformation, development, and population changes beginning with the early post-Contact era to the present day.

Cultural documents, primary and secondary cultural and historical sources, previous archaeological reports, historic maps, and photographs were reviewed for information pertaining to the study area. Research was primarily conducted at the CSH library. Other archives and libraries including the Hawai‘i State Archives, the Bishop Museum Archives, the University of Hawai‘i at Mānoa’s Hamilton Library, Ulukau, The Hawaiian Electronic Library (Ulukau.org 2004), the State Historic Preservation Division (SHPD) library, the State of Hawai‘i Land Survey Division, the Hawaiian Historical Society, and the Hawaiian Mission Houses Historic Site and Archives are also repositories where CSH cultural researchers gather information. Information on Land Commission Awards (LCAs) were accessed via Waihona ‘Aina Corporation’s Māhele database (Waihona ‘Aina 2000), the Office of Hawaiian Affairs (OHA) Papakilo Database (Office of Hawaiian Affairs 2015), and the Ava Konohiki Ancestral Visions of ‘Āina website (Ava Konohiki 2015).

2.2 Community Consultation

2.2.1 Scoping for Participants

We begin our consultation efforts by utilizing our previous contact list to facilitate the interview process. We then review an in-house database of *kūpuna* (elders), *kama‘āina* (native born), cultural practitioners, lineal and cultural descendants, Native Hawaiian Organizations (NHOs; includes Hawaiian Civic Clubs and those listed on the Department of Interior’s NHO list), and community groups. We also contact agencies such as SHPD, OHA, and the appropriate Island Burial Council where the proposed project is located for their response to the project and to identify lineal and cultural descendants, individuals and/or NHO with cultural expertise and/or knowledge of the study area. CSH is also open to referrals and new contacts.

2.2.2 “Talk Story” Sessions

Prior to the interview, CSH cultural researchers explain the role of a CIA, how the consent process works, the project purpose, the intent of the study, and how their *‘ike* (knowledge) and *mana‘o* (thought, opinion) will be used in the report. The interviewee is given an Authorization and Release Form to read and sign.

“Talk Story” sessions range from the formal (e.g., sit down and *kūkā* [consultation, discussion] in the participant’s place of choice over set interview questions) to the informal (e.g., hiking to cultural sites near the study area and asking questions based on findings during the field outing). In some cases, interviews are recorded and transcribed later.

CSH also conducts group interviews, which range in size. Group interviews usually begin with set, formal questions. As the group interview progresses, questions are based on interviewees' answers. Group interviews are always transcribed and notes are taken. Recorded interviews assist the cultural researcher in 1) conveying accurate information for interview summaries, 2) reducing misinterpretation, and 3) adding missing details to *moʻolelo*.

CSH seeks *kōkua* (assistance) and guidance in identifying past and current traditional cultural practices of the study area. Those aspects include general history of the *ahupuaʻa* (traditional land division extending from the mountain to the sea); past and present land use of the study area; knowledge of cultural sites (for example, *wahi pana*, archaeological sites, and burials); knowledge of traditional gathering practices (past and present) within the study area; cultural associations (*kaʻao* and *moʻolelo*); referrals; and any other cultural concerns the community might have related to Hawaiian cultural practices within or in the vicinity of the study area.

2.2.3 Interview Completion

After an interview, CSH cultural researchers transcribe and create an interview summary based on information provided by the interviewee. Cultural researchers give a copy of the transcription and interview summary to the interviewee for review and ask that they make any necessary edits. Once the interviewee has made those edits, we incorporate their *ʻike* and *manaʻo* into the report. When the draft report is submitted to the client, cultural researchers then prepare a finalized packet of the participant's transcription, interview summary, and any photos that were taken during the interview. We also include a thank you card and honoraria. This is for the interviewee's records.

It is important that CSH cultural researchers cultivate and maintain community relationships. The CIA report may be completed, but CSH researchers continuously keep in touch with the community and interviewees throughout the year—such as checking in to say hello via email or by phone, volunteering with past interviewees on community service projects, and sending holiday cards to them and their *ʻohana* (family). CSH researchers feel this is an important component to building relationships and being part of an *ʻohana* and community.

"*I ulu no ka lālā i ke kumu*—the branches grow because of the trunk," is an *ʻōlelo noʻeau* (#1261) shared by Mary Kawena Pukui with the simple explanation: "Without our ancestors we would not be here" (Pukui 1983:137). As cultural researchers, we often lose our *kūpuna* but we do not lose their wisdom and words. We routinely check obituaries and gather information from other informants if we have lost our *kūpuna*. CSH makes it a point to reach out to the *ʻohana* of our fallen *kūpuna* and pay our respects including sending all past transcriptions, interview summaries, and photos for families to have on file for genealogical and historical reference.

Section 3 *Kaʻao* and *Moʻolelo* (Legends and Stories)

Hawaiian storytellers of old were greatly honored; they were a major source of entertainment and their stories contained teachings while interweaving elements of Hawaiian lifestyles, genealogy, history, relationships, arts, and the natural environment (Pukui and Green 1995:IX). According to Pukui and Green (1995), storytelling is better heard rather than read for much becomes lost in the transfer from the spoken to the written word and *kaʻao* are often full of *kaona* or double meanings.

Kaʻao are defined by Pukui and Elbert as a "legend, tale […], romance, [and/or], fiction" (Pukui and Elbert 1986:108). *Kaʻao* may be thought of as oral literature or legends, often fictional or mythic in origin, and have been "consciously composed to tickle the fancy rather than to inform the mind as to supposed events" (Beckwith 1970:1). Conversely, Pukui and Elbert define *moʻolelo* as a "story, tale, myth, history, [and/or] tradition" (Pukui and Elbert 1986:254). The *moʻolelo* are generally traditional stories about the gods, historic figures or stories that cover historic events and locate the events with known places. *Moʻolelo* are often intimately connected to a tangible place or space.

In differentiating *kaʻao* and *moʻolelo* it may be useful to think of *kaʻao* as expressly delving into the *wao akua* (realm of the gods), discussing the exploits of *akua* (gods) in a primordial time. However, it is also necessary to note there are exceptions, and not all *kaʻao* discuss gods of an ancient past. *Moʻolelo* on the other hand, reference a host of characters from *aliʻi* (royalty), to *akua* and *kupua* (supernatural beings), to finally *makaʻāinana* (commoners), and discuss their varied and complex interactions within the *wao kānaka* (realm of man). Beckwith elaborates, "In reality, the distinction between kaʻao as fiction and moʻolelo as fact cannot be pressed too closely. It is rather in the intention than in the fact" (Beckwith 1970:1). Thus, a so-called *moʻolelo*, which may be enlivened by fantastic adventures of *kupua*, "nevertheless corresponds with the Hawaiian view of the relation between nature and man" (Beckwith 1970:1).

Both *kaʻao* and *moʻolelo* provide important insight into a specific geographical area, adding to a rich fabric of traditional knowledge. The preservation and passing on of these stories through oration remains a highly valued tradition. Additionally, oral traditions associated with the study area communicate the intrinsic value and meaning of a place, specifically its meaning to both *kamaʻāina* as well as others who also value that place.

The following section presents traditional accounts of ancient Hawaiians living in the vicinity of the project area. Many relate an age of mythical characters whose epic adventures inadvertently lead to the Hawaiian race of *aliʻi* and *makaʻāinana.* The *kaʻao* in and around the project area shared below are some of the oldest Hawaiian stories that have survived; they still speak to the characteristics and environment of the area and its people.

3.1 *Kaʻao*

Pukui et al. (1974:49–50) literally translate Honolulu as "protected bay," which refers to the protection of Honolulu Harbor. Older names for the harbor are Kou and Māmala. According to Westervelt, Honolulu is a name made by the union of the two words "Hono" and "lulu." Westervelt explains as follows:

> Some say it means ‘Sheltered Hollow.’ The old Hawaiians say that ‘Hono’ means ‘abundance’ and ‘lulu’ means ‘calm,’ or ‘peace,’ or ‘abundance of peace.’ The navigator who gave the definition ‘Fair Haven’ was out of the way, inasmuch as the name does not belong to a harbor, but to a district having ‘abundant calm,’ or ‘a pleasant slope of restful land.’ ‘Honolulu’ was probably a name given to a very rich district of farm land near what is now known as the junction of Liliha and School Streets, because its chief was Honolulu, one of the high chiefs of the time of Kakuhihewa, according to the legends. [Westervelt 1915:14]

3.1.1 Haumea and Muleiʻula’s Tree, Kū-hoʻoneʻe-nuʻu

Westervelt shares his account of the Polynesian deity Haumea and a young Hawaiian girl named Muleiʻula who has traveled to Tahiti with her father and soon after goes into labor. The deity Haumea, on her own supernatural journey, passes by and offers to help successfully deliver the difficult labor in exchange for the girl’s beautiful tree named Kūhoʻoneʻenuʻu. In this version, the young princess in her stubbornness retracts the exchange and almost loses her life and that of her child due to her fondness for her favorite tree. The voyage of this tree continues in a second *moʻolelo*, as this is the wooden source used to carve the god of Pākākā Heiau:

> The story of the god of this temple is a story of voyages and vicissitudes. Olopana had sailed away from Waipio, Hawaii, for the island of distant seas. Somewhere in all the great number of islands which were grouped under the general name ‘Kahiki’ Olopana found a home. Here his daughter Mu-lei-ula (Mu-with-the-red-garland) was experiencing great trouble being near to childbirth. For some reason, Haumea, one of the Polynesian ancestors, had stopped for a time to visit the people of that land. When the friends were afraid that Mu-lei-ula would die, Haumea came to help, saying: ‘In our land the mother lives. The mother and child both live.’ The people said, ‘If you give us aid, how can we render payment or give you a reward?’
>
> Haumea said: ‘There is a beautiful tree with two strange but glorious flowers, which I like very much. It is “the tree of changing leaves” with two flowers, one kind singing sharply, and the other singing from time to time. For this tree I will save the life of the chief’s daughter and her child.’
>
> Gladly, the sick girl and her friends promised to give this beautiful tree to Haumea. It was a tree dearly loved by the princess.
>
> Haumea commenced the prayers and incantations which accompanied her treatment of the sick, and the chiefess rapidly grew stronger. This had come so quickly and easily that she repented the gift of the tree with the beautiful flowers, and cried out, ‘I will not give the tree.’
>
> Immediately she began to lose strength and called to Haumea that she would give the tree if she could be forgiving and healed. However, as strength came to her once more she again felt sorry for her tree and refused to let it go. Again, the incantations were broken off and the divine aid withdrawn.
>
> Olopana in agony cried to his daughter: ‘Give up the tree. Of what use will it be with its flowers if you die?’ Haumea, with the most powerful incantations, gave her the final strength, and mother and child both lived and became well and strong.

> Haumea took the tree and travelled over the far seas to distant Hawaii. On that larger island she found no place to plant the tree. She crossed over to the island Maui and came to the 'four rivers.' There she found the awa of the gods and prepared it for drinking but needed fresh water to mix with it.
>
> She laid her tree on the ground at Puu-kume by the Wai-hee stream and went down after water. When she returned the tree had rooted. While she looked it began to stand up and send forth branches. She built a stone wall around it, to protect it from the winds. When it blossomed, Haumea returned to her divine home in Nuumealani, the land of mists and shadows where the gods dwelt. [Westervelt 1915:21–25]

3.1.2 The Story of Kū-hoʻoneʻe-nuʻu

The following *moʻolelo* describes the same great tree known by the name of Kalauokekāhuli; this tree was given to the deity Haumea in exchange for her services as a midwife. The tree goes with Haumea on a mythical journey eventually becoming carved into a god form of Kūhoʻoneʻenuʻu used for worship at the Pākākā Heiau in Honolulu. The following is an excerpt from Kamakau's account of this epic story:

> PĀKĀKĀ was an ancient *heiau*, a *waihau poʻo kanaka*. It was built by Ka-maunu-i-Halakaipo; the god for whom it was built was Kū-hoʻoneʻe-nuʻu. Kū-hoʻoneʻe-nuʻu was a god from Kahiki-kū; this is his story.
>
> When Haumea was traveling in Kahiki-kū and Kahiki-moe, Muleiʻula, the daughter of ʻOlopana, ruler of those lands, was having difficulty in childbirth. Sounds of lamentation filled the air, and preparations were being made to cut open her stomach. The mother would die, but the child would live. Haumea said, 'In our land the mother lives. The mother and the child would both live.' ʻOlopana said to her, 'Then deliver my daughter so that my daughter and my grandchild may live. What payment do you want for the delivery?' Haumea answered, 'This tree with beautiful flowers.'
>
> The name of the tree was Ka-lau-o-ke-kāhuli, and its flowers were Kanikawī and Kanikawā. This precious tree with exceedingly beautiful flowers belonged to the daughter of ʻOlopana of Kahiki-kū, the 'ʻ*iwa kilau moku*' of Kahiki, whose perfection among the chiefs was without compare in the world. Not wanting to die, she consented to the giving of the tree. [Kamakau 1991:6–8]

The story of the tree continues:

> One branch of this tree was made into a rack on which wooden bowls or netted calabashes were slung (that was Ka-haka-iki). Another branch became a shelf on which bundles were placed (that was Keoloʻewa). Another branch landed of the seashore at Oneawa, in Kailua, Oʻahu. The fish followed it, and this became a place where schools of fish would come in. When this branch (that is, Mākālei) was taken inland of Kailua, the fish of Kawainui Pond followed it inland. The trunk of the tree was used as a dung heap and as a place for throwing wastes. This was Kū-hoʻoneʻe-nuʻu.

> Wai-la‘ahia the husband and Halelua the wife were people without gods. The god Kū-ho‘one‘e-nu‘u came at night in a dream to have them go and get it [the tree trunk] for a god themselves. For three nights and three days they were urged to go and carve a god [from the tree] for themselves. On the third day of urging. Wai-la‘ahia prepared the things that had been ordered—a pig, coconuts, red fish, garments, and *kohekohe* grass. Then he went and laid down his offering and freed the *kapu.* Then he took the tree trunk inland to Polipoli at Nāpoko there in Waiehu. Wai-la‘ahia erected a *waihau* [a *heiau* for Kū-ho‘one‘e-nu‘u], dedicated it, and freed it.
>
> This god became famous as a god of *mana* [divine power] and a god who seized kingdoms (*he akua kā‘ili aupuni*). The chiefs as far as O‘ahu heard of him. Wai-la‘ahia was a *kahu* of Ka-maunu-i-Halakaipo, chief of O‘ahu. He brought the god to O‘ahu, and Ka-maunu-i-Halakaipo built Pākākā as a *heiau* for it.
>
> Kū-ho‘one‘e-nu‘u was a god of the chiefs of O‘ahu from remote times to the times of Kūali‘i, Ka-pi‘i-oho-o-ka-lani, Pele-i‘ō-hōlani, Kūmahana, and Kahahana. It is said that this was the most ancient god from Hawai‘i to Kaua‘i. [Kamakau 1991:6–8]

3.1.3 Hi‘iaka Travels to Kou

Kou was known as a place where chiefs gathered to play and where the people gathered to watch them. Pukui (1983:1128) relates the poetical saying *“Hui aka nā maka i Kou”* (“the faces will meet at Kou”) in reference to just such gatherings. It is briefly mentioned in the legend of Hi‘iaka, beloved sister of the Hawaiian volcano goddess, Pele. Hi‘iaka and her companions have been traveling around O‘ahu on the land trails, but decide to travel from Pu‘uloa (on Pearl Harbor in ‘Ewa) to Waikīkī by canoe. At Pu‘uloa, Hi‘iaka met a party who were planning to travel to the house of the chiefess Pele‘ula in Waikīkī. Hi‘iaka recited a chant, telling the people that although they were going by land and she was going by sea, they would meet again in Kou:

Kou is the coral flat	*‘O Kou ka papa*
Ka‘ākaukukui is the pool	*‘O Ka‘ākaukukui ka loko*
Some ‘alamihi [a black crab], indeed	*‘O ka ‘alamihi a‘e nō*
Wait all day until night	*‘O ka lā a pō iho*
Friends shall meet in Kou.	*Hui aku i Kou nā maka*.

[Ho‘oulumāhiehie 2008b:277; Ho‘oulumāhiehie 2008a:297]

3.1.4 The Legend of ‘Ai‘ai

‘Ai‘ai was the son of Kū‘ula and Hina who lived in Niolapa, an *‘ili* (smaller land division within an *ahupua‘a*) of Nu‘uanu around Wyllie Street. The couple had a pearl fishhook named Kahu‘oi. The fishhook was kept at Kaumakapili by the bird Kamanuwai. When Kū‘ula went to fish at Māmala (Honolulu Bay), the lure was so enticing that the *aku* (skipjack tuna; *Kawsuwonus pelamis*) would jump into the canoe, enough fish to feed both his family and the bird. One day the king of Honolulu, Kipapalaulu, saw the amazing behavior of the fish and stole Kahu‘oi, the fishhook:

> This act not only deprived Kuʻula of his favorite hook, but the bird also hungered from loss of its food. Through this seizure of the pearl hook by Kipapalaulu the bird went without any food, it would fly on its roosting place and go to sleep. It was because the bird, Kamanuwai, closed its eyes from hunger was the reason why the place where it lived was called Kaumakapili, and the place is so called to this day. [Fornander 1917:4(3):556]

3.2 *Wahi Pana* (Legendary Places)

Wahi pana are legendary or storied places of an area. These legendary or storied places may include a variety of natural or human-made structures. Oftentimes dating to the pre-Contact period, most *wahi pana* are in some way connected to a particular *moʻolelo*, however, a *wahi pana* may exist without a connection to any particular story. Davianna McGregor outlines the types of natural and human-made structures that may constitute *wahi pana*:

> Natural places have mana, and are sacred because of the presence of the gods, the akua, and the ancestral guardian spirits, the ʻaumakua. Human-made structures for the Hawaiian religion and family religious practices are also sacred. These structures and places include temples, and shrines, or heiau, for war, peace, agriculture, fishing, healing, and the like; puʻuhonua, places of refuge and sanctuaries for healing and rebirth; agricultural sites and sites of food production such as the loʻi pond fields and terraces slopes, ʻauwai irrigation ditches, and the fishponds; and special function sites such as trails, salt pans, holua slides, quarries, petroglyphs, gaming sites, and canoe landings. [McGregor 1996:22]

As McGregor makes clear, *wahi pana* can refer to natural geographic locations such as streams, peaks, rock formations, ridges, offshore islands and reefs, or they can refer to Hawaiian land divisions such as *ahupuaʻa* or *ʻili*, and man-made structures such as fishponds. It is common for places and landscape features to have multiple names, some of which may only be known to certain *ʻohana* or even certain individuals within an *ʻohana*, and many have been lost, forgotten, or kept secret through time. Place names also convey *kaona* and *huna* (secret) information that may even have political or subversive undertones. Before the introduction of writing to the Hawaiian Islands, cultural information was exclusively preserved and perpetuated orally. Hawaiians gave names to literally everything in their environment, including points of interest that may have gone unnoticed by persons of other cultural backgrounds. Hawaiians have named taro patches, rocks and trees that represented deities and ancestors, sites of houses and *heiau* (pre-Contact place of worship), canoe landings, fishing stations in the sea, resting places in the forests, and the tiniest spots where miraculous or interesting events are believed to have taken place (Pukui et al. 1974:x).

The project area is considered to be within the *ahupuaʻa* of Honolulu. In the post-Contact period, the boundary of downtown Honolulu extended from the coast to approximately Hotel Street in the early nineteenth century, expanding inland to approximately Vineyard or School Street in the present period. However, in pre-Contact times, Honolulu was only a small village and the *ahupuaʻa* of Pauoa probably once extended from the mountains to the shore, encompassing the eastern section of downtown Honolulu. The project area in pre-Contact and early post-Contact period would have been considered within the boundary of Pauoa Ahupuaʻa. Therefore, the early background history for the project area will focus on Pauoa Ahupuaʻa, and the late nineteenth to early twentieth century history will focus on the project area as part of Honolulu.

3.2.1 Place Names of Pauoa

The boundaries of Pauoa differ on historic maps. On modern maps, it generally is bounded by Vineyard Street to the south, Nu‘uanu Ahupua‘a to the west, Makiki Ahupua‘a to the east, and extends to a point at the peak Kaumuhonu in the Ko‘olau Mountains on the inland northern corner. On modern maps, the hill called Pacific Heights is generally within Pauoa, but on some older historic maps, the boundary separating Nu‘uanu and Pauoa extends over the elevation, splitting Pacific Heights between Nu‘uanu and Pauoa. The same is true for Punchbowl on the eastern side; modern maps show only the eastern slopes of the crater within Makiki, but older maps show the dividing line bisecting the crater.

Pauoa Ahupua‘a, a small valley along Pauoa Stream, is located between Nu‘uanu and Makiki valleys and extends from an elevation of about 2,000 ft at the *mauka* (inland) point to Vineyard Street, the modern *makai* (seaward) boundary. Pauoa, meaning “ear” was so named because it was viewed as a “side valley” of the larger Nu‘uanu Ahupua‘a to the west (Lyons 1901:181).

Mid-nineteenth century land records indicate the project area was in ‘Auwaiolimu (meaning “ditch of moss,” Pukui et al. 1974:14), an *‘ili* of Pauoa Ahupua‘a. The *‘ili* was said to have been named for a chiefess, perhaps the famous beauty of Mānoa Valley, Kahalaopuna, who bathed in the waters of the ‘Auwaiolimu Stream. Her long hair floating in the stream resembled the long strands of moss, or *limu*.

> Chiefess Kahalaopuna went from Waikiki to live . . . on the Punchbowl road. It was her custom to bathe in the stream below there very early in the morning. The mud ran down the stream to the sea. Two men came to the stream to look for her, and one man, Kelumaikai looked in and remarked, ‘What a lot of limu there is in the stream. The water looks so dark.’ The second man, named Kailiula looked and said, ‘There is no limu here where we are standing. That is mud that you are looking at.’ The other exclaimed and looked closely at the darkened water. Kahalaopuna spoke in a soft, gentle voice, ‘Can’t you see me?’ Kelumaikai said, ‘We did not see you, o chiefess Kahalaopuna.’ She replied, ‘Let us go up to the house. Perhaps you want to see me about something.’ They said that they did. It was through Kahalaopuna that the name Auwai-o-limu was given to the place forever more. [Original from *Hoku o Hawai‘i*, 11 February 1930; English translation in Sterling and Summers 1978:292]

3.2.2 Historic Battles in Pauoa Valley

Pauoa Valley was associated with two famous invasions, both with battles near the project area in ‘Auwaiolimu ‘Ili and near a *heiau* called Kānelā‘au.

In 1783, the Maui chief Kahekili invaded O‘ahu, landing first at Waikīkī. The chief of O‘ahu, Kahahana, was in the uplands of Nu‘uanu.

> In the beginning of 1783—some say it was in the month of January—Kahekili, dividing his forces in three columns, marched from Waikiki by Puowaina, Pauoa, and Kapena [in Nu‘uanu], and gave battle to Kahahana near the small stream of Kaheiki. Kahahana’s army was thoroughly routed, and he and his wife Kekua-poi-ula fled to the mountains. [Fornander 1996:224–225]

Samuel Kamakau (1992:136) gives additional information on this battle and the distribution of forces in Pauoa:

> *I ka malama ʻo Ianuari 1, o ka A.D. 1783, ua ʻākoakoa nā aliʻi a me nā pūkaua, nā pūʻali a me nā koa o Kahekili, a māhele ʻia ihola ʻelua poʻe kaua. Māhele I. ʻO Kahekili ka pūkaua. Māhele 2. ʻO Hūʻeu ka pūkaua. ʻO kā Hūʻeu poʻe kaua ma uka o Kānelāʻau a ma Kapapakōlea, ma uka o Pūowaina. ʻO ka māhele mua ma luna o Hekili a hiki i Kahēhuna a me ʻAuwaiolimu. ʻʻO Kaheiki ke kahua kaua.*
>
> *Ma kēia hoʻouka kaua ʻana, ua lilo ka wai o ke kahawai o Kaheiki i koko, no ke āhua lālā kukui o ka heana i ka wai, no ka mea, ua kūmano ʻia ke kahawai i ke kino o nā kānaka i make i ke kaua. ʻO ke kaua ma luna iho o ka heiau ʻo Kaheiki ke 19au ai heʻe ai, no ka mea, ua piʻi aʻela kekahi kaua ma ka kualapa pili o Pauoa, a iho ma Kapena, a uluāoʻa aʻela ka hoʻouka ʻana o ke kaua. ʻO ka puehu ihola nō ia o nā koa o Kahahana*. [Kamakau 1867; *Ka Nūpepa Kūʻokoʻa*, 30 March 1867]

Translation:

> In January, 1783, a decisive battle was fought with Kahe-iki as the battlefield. Kahekili's forces were divided into two companies, one under Huʻeu's leadership stationed at Kanelaʻau and Kapapakolea back of Puʻowaina and the other under his own command stationed from above Hekili to Kahehuna and ʻAuwaiolimu. In this battle the waters of the stream of Kahe-iki ran red with blood from the heaps of broken corpses that fell into the water; the stream was dammed back with the corpses of those who died in battle. On the ridge facing Pauoa and from thence down to Kapena another attack was made against the defense station back of the heiau of Kahe-iki. Confusion seized the ranks; the warriors of Kahahana were dispersed. [Kamakau 1992:136]

In 1795, Kamehameha I landed his army at Waikīkī to make war against Kalanikūpule, king of Maui and Oʻahu, and begin to unite all of the Hawaiian Islands under his rule:

> Immediately on disembarking the army was formed in lines of battle and marched to Nuuanu Valley to meet Kalanikupule. Several running engagements took place between the opposing forces, commencing at the opening of the valley on the Ewa side of Punchbowl (Puowaina), then again at about the present cemetery sites, and around where the royal mausoleum stands. . . [Nakuina 1904:18]

The forces met at a pitched battle at Pūʻiwa, where the men of Kalanikūpule were then pushed further in Nuʻuanu Valley. They fled up the valley and were finally driven over the *pali* (cliff); thousands were killed. A young chiefess who lived on Punchbowl Crater was forced to marry one of Kamehameha's generals, but in defiance she named her first born son Kaheananui, which means "the great heap of the slain," to commemorate the slaughter (Nakuina 1904:17–21).

Six *heiau* and one home for priests were located on Pūowaina, some on the Makiki side of the crater and some on the Pauoa (or ʻAuwaiolimu) side. These *heiau* acted as temples, forts, and as part of the complex for the priests of Pūowaina. These *heiau* were important sites during the Battle of Nuʻuanu in 1795 when Kamehameha invaded and conquered the island of Oʻahu. Four of these *heiau* are on the southwestern slope of Punchbowl near the current project area. The approximate locations (Figure 5) of the *heiau* were first noted by Emma Nakuina (1909) in an article on the

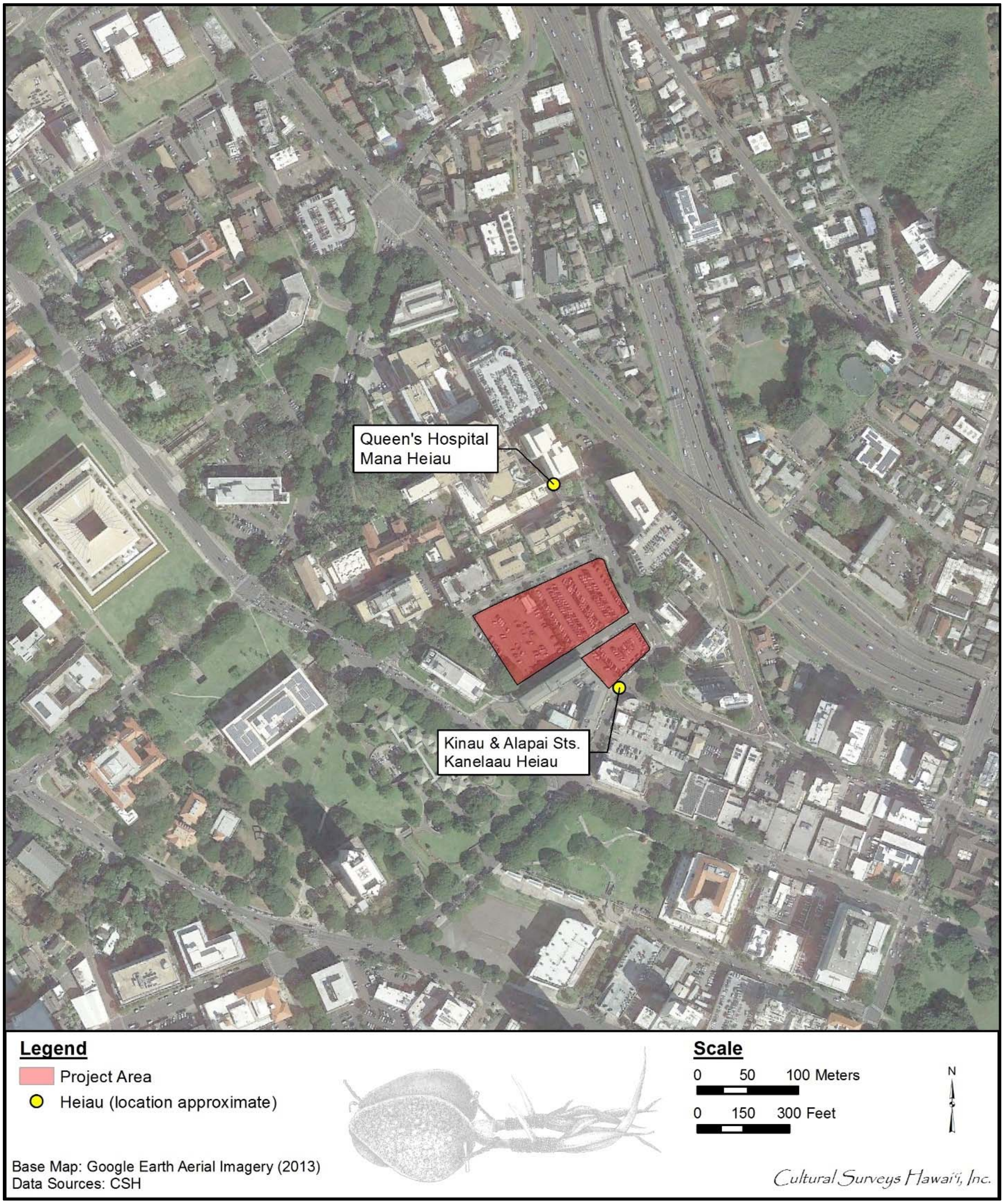

Figure 5. Google aerial image with outline of project area and *heiau* location

battle published in the *Pacific Commercial Advertiser*. Note that one of the *heiau*, Kānelā‘au, was located around the junction of Kīna‘u and Alapa‘i streets, near or within the current project area. In addition, Mana Heiau was located somewhere on or near the Queen’s Hospital property, which is adjacent and west of the current project area.

Emma Nakuina, in a 1909 newspaper account, describes the locations and battles around these *heiau*:

> The battle of Nuuanu commenced at the heiau of Kanelaau just below the old flagstaff station on Punchbowl about where Alapai joins Kinau and Lunalilo Streets and raged along a series of heiaus that formed the guard or outposts of the Puowaina sacred *heiau*. There was one called Mana above the Queen’s Hospital, Kahehuna (Royal School site) and one at Kaakopua (Princess Ruth’s now the Central Grammar). Here the battle raged the fiercest and the Oahuans were so hard pressed they were divided into two sections, one fleeing Ewa-ward . . .
>
> The main portion of the Oahu army retreated fighting up Pauoa way but were met by the Hawaiians under Heulu who had stole a march around Punchbowl and poured down on the retreating defenders by the pass above Punchbowl, Papakolea. [Emma Nakuina, *Pacific Commercial Advertiser* 29 June 1909 in Sterling and Summers 1978:317]

In a recent study on the Nu‘uanu battle, Neil Dukas (2010) noted,

> The two armies meet in full-on battle at the foot of Pūowaina (Punchbowl Crater). The allied defenders . . . are well entrenched, employing several heiau as forward bastions or redoubts. These are prepared defenses.
>
> . . . it is more than likely the defenders have established gun emplacements atop these heiau. The first position to receive a direct assault by the Hawaiians is Kānelā‘au heiau, located somewhere near the intersection of today’s Alapa‘i and Kīna‘u streets. The other three bastions [Mana, Kahehuna, and Kaakopua] come into play one at a time as the Hawaiian vanguard, and then the main body, pivots around to face the defenders.
>
> Arranged in a rough semi-circle, the fortified heiau divide the attentions of the attacking force, luring the enemy into a shared killing ground. [Dukas 2010:24]

It is at these fortified *heiau* that the “battle raged the fiercest” (Nakuina 1909). However, the invading forces soon isolated the defenders of each fort, destroying their united force. The invading Hawaiians somehow managed to take Papakōlea Heights *mauka* of Punchbowl, thus surrounding the O‘ahu forces on two sides. The O‘ahu warriors made a strategic retreat from Punchbowl upward into Pauoa Valley. Eventually they were cornered on the Pali at the head of Nu‘uanu Valley, where the remaining forces were destroyed or escaped in small groups.

3.2.3 Kānelā‘au Heiau and Human Sacrifice

The eastern boundary of Pauoa includes a portion of the volcanic crater called Pūowaina, now called Punchbowl. The ejection of hot lava through cracks in the old coral reefs resulted in the formation of this crater 75,000 to 100,000 years ago. According to Hawaiian legends, the goddess Pele created Pūowaina as a home for herself and her family (Kamehameha Schools 1987). In pre-

Contact Hawai'i, Pūowaina was famous as a place of human sacrifice, and indeed took its name "Hill of Placing" from this custom (Pukui et al. 1974:195) (Figure 6).

C.J. Lyons reported on the origin of the place name Pūowaina and its legendary association.

> Pu-o-Waina, a poetical contraction of Pu-o-waihoana (the spot for placing). It was the spot for placing the bodies of those who had broken the *kapu*. A natural flue exists by the trig. station where the bodies were burned. [Lyons 1896, HEN Vol. 1:620]
>
> Puowaina means 'the hill of offering' or sacrifice, puu o waiho ana, an antique form. The bodies of those slain for breaking tabu were laid on the altar-like ledge at the top and burned, the crack below giving a good draught of air. [Lyons 1901:182]

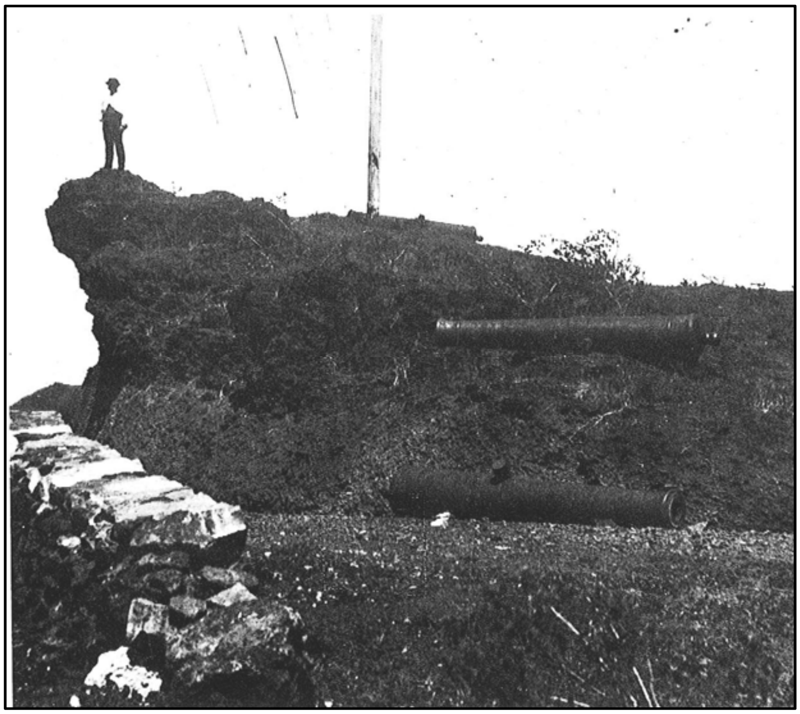

Figure 6. Undated photograph of the sacrifical rock at Pūowaina and the abandoned cannons once placed on the rim of the crater; these cannon were removed in 1893 (Original photograph at Bishop Museum Archives; reprinted in Carlson 1982:18)

The practice of human sacrifice in Makiki was said to have involved a three-step process. First the victim, a slave (*kauwā*) or *kapu* (tabu) breaker, was drowned at a fishpond in the *'ili* of Kewalo, (south of the modern *makai* boundary of Makiki Ahupua'a) in a sacrificial ritual known as *kānāwai kaihehe'e* (Kamakau 1991:6), or *ke-kai-heehee*, which translates as "sea sliding along," suggesting the victims were slid under the sea (Westervelt 1963:16). The place name Kewalo was described as:

> A fishpond and surrounding land on the plains below King Street, and beyond Koula. It contains a spring rather famous in the times previous to the conversion to

> Christianity, as the place where victims designed for the Heiau of Kanelaau on Punchbowl slopes, was first drowned. The priest when holding the victim's head under water would say to her or him on any signs of struggling, 'Moe malie i ke kai o ko haku.' 'Lie still in the waters of your superior.' From this it was called Kawailumalumai, 'Drowning waters.' [*Saturday Press* 1883]

The corpse was then moved to Kānelā‘au Heiau on the slopes of Punchbowl for a ritual to appease the gods (Kelsey n.d., HEN Vol. I:819). This *heiau* was in the general area of the present-day grounds of the Robert L. Stevenson School on the eastern slope of Pūowaina, within Makiki Ahupua‘a.

> Human sacrifices were drowned in Kewalo, then brought to the heiau of Kāne-laau, situated at the Robert Louis Stevenson School and extending west to Kehehuna, then taken up to the top of Puuo-waina to an altar on the little prominence where the cross was set up at the time of the Missionary Centennial and where a concrete base is now. The heiau was for the purpose of appeasing the gods of the ruling chief. There was a saying, 'Hanau a moe i ka wai o Pōhaku' [meaning, "life and death in the essence of the stone"]. [Kelsey n.d., HEN Vol. 1:820]

The corpse was finally transported to the top of Pūowaina for burning, in a ritual known as *puhi-kanaka*.

> The Puhi-Kanaka was a royal prerogative. Puuoioina (Punchbowl) was the heiau puhi-kanaka. Kapouhiwa was the last custodian chieftain, before Hawai‘i took possession of O‘ahu. [Puea Mokakaualii, as told to J.F. Stokes, Site Notes, in Sterling and Summers 1978:291]

Note that in Kelsey's version, above, Kānelā‘au Heiau is said to be located near Robert Louis Stevenson School. This school was built in 1950 on Prospect Street in Makiki on the east slopes of Pūowaina, over 1.2 km northeast and *mauka* of the project area. However, according to Emma Nakuina, this was the location of a different *heiau*/fort called Po‘ouahi, suggesting that Kelsey was confused.

All of these *heiau* around Punchbowl Crater had been destroyed before the advent of the twentieth century. In Thomas Thrum's list of *heiau* in 1906, he mentions only Mana Heiau (which he spelled as Manua), and he notes that the "actual site of same now lost" (Thrum 1906:45), indicating it had been destroyed by that time.

3.2.4 *Ala Hele* (Trails)

The two major centers of population, Honolulu and Waikīkī, were navigated and connected through a network of trails. The following is an excerpt describing some of the pathways used by the ancient Hawaiians, as recorded by Hawaiian historian Papa ‘Ī‘ī.

> 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 and to Paliiki . . .
>
> From Paliiki the trail ran up to Kalahu, above Leahi, and on to the place where the Waialae stream reached the sand. The trail that ran through Kaluahole went to Kaalawai, up over, and down into Kahala, to meet the other trail at the place where the stream reached the sand. [‘Ī‘ī 1959:92–94]

3.3 *‘Ōlelo No‘eau* (Proverbs)

Hawaiian knowledge was shared by way of oral histories. Indeed, one’s *leo* (voice) is oftentimes presented as *ho‘okupu* (“to cause growth,” a gift given to convey appreciation, to strengthen bonds); the high valuation of the spoken word underscores the importance of the oral tradition (in this case, Hawaiian sayings or expressions), and its ability to impart traditional Hawaiian “aesthetic, historic, and educational values” (Pukui 1983:vii). Thus, in many ways these expressions may be understood as inspiring growth within reader or between speaker and listener:

> They reveal with each new reading ever deeper layers of meaning, giving understanding not only of Hawai‘i and its people but of all humanity. Since the sayings carry the immediacy of the spoken word, considered to be the highest form of cultural expression in old Hawai‘i, they bring us closer to the everyday thoughts and lives of the Hawaiians who created them. Taken together, the sayings offer a basis for an understanding of the essence and origins of traditional Hawaiian values. The sayings may be categorized, in Western terms, as proverbs, aphorisms, didactic adages, jokes, riddles, epithets, lines from chants, etc., and they present a variety of literary techniques such as metaphor, analogy, allegory, personification, irony, pun, and repetition. It is worth noting, however, that the sayings were spoken, and that their meanings and purposes should not be assessed by the Western concepts of literary types and techniques. [Pukui 1983:vii]

Simply, *‘ōlelo no‘eau* may be understood as proverbs. The Webster dictionary notes it as “a phrase which is often repeated; especially, a sentence which briefly and forcibly expresses some practical truth, or the result of experience and observation.” It is a pithy or short form of folk wisdom. Pukui equates proverbs as a treasury of Hawaiian expressions (Pukui 1995:xii). Oftentimes within these Hawaiian expressions or proverbs are references to places. This section draws from the collection of author and historian Mary Kawena Pukui and her knowledge of Hawaiian proverbs describing *‘āina* (land), chiefs, plants, and places. The following proverbs concerning the larger area of Honolulu come from Mary Kawena Pukui’s *‘Ōlelo No‘eau* (Pukui 1983).

3.3.1 *‘Ōlelo No‘eau* #407

The following *‘ōlelo no‘eau* paints a picture of Honolulu as an area of fun recreation where games were held.

> *Hāhā pō‘ele ka pāpa‘i o Kou.*
>
> The crabs of Kou are groped for in the dark.
>
> Applied to one who goes groping in the dark. The chiefs held *kōnane* and other games at the shore of Kou (now central Honolulu), and people came from

everywhere to watch. Very often they remained until it was too dark to see and had to grope for their companions. [Pukui 1983:51]

3.3.2 *‘Ōlelo No‘eau* #656

The following *‘ōlelo no‘eau* is taken from the chant of Kūali‘i.

He kai hele kohana ko Māmala.

A sea for going naked is at Māmala.

The entrance to Honolulu Harbor was known as Māmala. In time of war the people took off their clothes and traveled along the reef to avoid meeting the enemy on land. [Pukui 1983:74]

3.3.3 *‘Ōlelo No‘eau* #1016

The following *‘ōlelo no‘eau* describes the early landscape of Honolulu.

Ho‘ā ke ahi, kō‘ala ke ola. O na hale wale no ka i Honolulu; o ka ‘ai a me ka i‘a i Nu‘uanu.

Light the fire for there is life-giving substance. Only the houses stand in Honolulu; the vegetable food and meat are in Nu‘uanu.

An expression of affection for Nu‘uanu. In olden days, much of the taro lands were found in Nu‘uanu, which supplied Honolulu with *poi,* taro greens, *‘o‘opu,* and freshwater shrimp. So it is said that only houses stand in Honolulu. Food comes from Nu‘uanu. [Pukui 1983:109]

3.3.4 *‘Ōlelo No‘eau* #1128

The following *‘ōlelo no‘eau* speaks of Kou and its popularity in leisure and recreation.

Hui aku na maka i Kou.

The faces will meet in Kou.

We will all meet there. Kou (now central Honolulu) was the place where chiefs played games, and people came from everywhere to watch. [Pukui 1983:120]

3.3.5 *‘Ōlelo No‘eau* #1338

The following *‘ōlelo no‘eau* mention the *‘alalauwā* (young species of *aweoweo* [*Priacanthus*]) that gathered in numbers on Honolulu‘s waterfront.

Ka i‘a ho‘ohihia makau o ‘Āinahou.

The fish of ‘Āinahou that tangles the fishline.

The *‘alalauwā,* which came in great schools to the waterfront of Honolulu. Fishermen of all ages came with their poles to fish, and the crowds were sometimes so great that the lines tangled. [Pukui 1983:146]

3.3.6 *‘Ōlelo No‘eau* #1423

The following *‘ōlelo no‘eau* speaks of the usual weather of Honolulu.

Ka lā ikiiki o Honolulu.

The intensely warm days of Honolulu.

People from the country often claim that Honolulu is excessively warm. [Pukui 1983:154]

3.3.7 *‘Ōlelo No‘eau* #1510

The following *‘ōlelo no‘eau* mentions the origins of the name Māmala.

Ka nuku o Māmala.

The mouth of Māmala.

The entrance to Honolulu Harbor, named for a shark goddess who once lived in the vicinity. [Pukui 1983:163]

3.3.8 *‘Ōlelo No‘eau* #1575

The following *‘ōlelo no‘eau* mentions the Kūkalahale rain previously mentioned in Section 1.4.4.

Ka ua Kukalahale o Honolulu.

The Kukalahale rain of Honolulu.

The rain that announces itself to the homes by the pattering it makes on the roofs as it falls. Often mentioned in songs. [Pukui 1983:170]

3.3.9 *‘Ōlelo No‘eau* # 1625

The following *‘ōlelo no‘eau* recalls the popularity of Honolulu Harbor.

Ka ulu lā‘au ma kai.

The forest on the seaward side.

Refers to the masts of the ships that came into the harbors of Lahaina or Honolulu. [Pukui 1983:175]

3.3.10 *‘Ōlelo No‘eau* #2202

The following *‘ōlelo no‘eau* highlights Māmala, the entrance to the Honolulu Harbor.

Na ‘ale kuehu o Māmala.

The billows of Māmala with wind-blown sprays.

Māmala is the entrance to Honolulu Harbor. [Pukui 1983:241]

3.3.11 *‘Ōlelo No‘eau* #2351

The following *‘ōlelo no‘eau* recalls the first roundtrip completed by carrier pigeons first brought to Maui in 1893.

Nūnū lawe leka o Kahului.

Letter-carrying pigeon of Kahului.

> In 1893 carrier pigeons arrived at Kahului, Maui. One was brought to Honolulu and released with a letter tied to its neck. It flew back to Kahului. This was of such great interest to the people that a song was written and a quilt design made to commemorate the event. [Pukui 1983:255]

3.4 *Mele* (Songs)

The following *mele* retraces the sea routes of the famed ship *Maunaloa*. These routes included Honolulu to Maui and onward to the west coast of Hawaiʻi. This *mele* also describes the feel of the landscape with a different rain and wind for each place.

3.4.1 He Aloha Nō ʻO Honolulu

He aloha nō ʻo Honolulu i ka ua Kūkalahale
Ka nuku aʻo Māmala ʻae aʻe nei ma hope
Kau mai ana ma mua ka malu ʻula aʻo Lele
Kukui ʻaʻā mau, pio ʻole i ke Kauaʻula

ʻAu aku i ke kai loa oni mai ana ʻo ʻUpolu
Hoʻokomo iā Mahukona i ka makani ʻĀpaʻapaʻa
E wiki ʻoe ʻapa nei eia aʻe ʻo Kawaihae
Hoʻohaehae Nāulu, i ka makani kuʻehu ʻale

ʻO ka hao a ka Mūmuku poho pono nā peʻa heke
ʻO ka heke nō nā Kona i ke kai māʻokiʻoki
Kiʻina ke koiʻi koi i ka piko o Hualālai
A laʻi wale ke kaunu ʻaʻole pahuna hala

Hale ʻole nō kāua i ke kole maka onaona
E haupā ʻoe a kena i ka piko ʻoe a lihaliha
Hāliʻaliʻa mai ana kou aloha kākia iwi
Hoʻokomo iā Honuʻapo i ke kai kauhaʻa

Haʻalele ka Maunaloa i ka pohu laʻi aʻo Kona
Hoʻokomo iā Hoʻokena i ka pewa aʻo ka manini
Haʻina mai ka puana ʻo ka heke nō nā Kona
No Kona ke kai malino kaulana i ka lehulehu

Translation:

Dearly loved is Honolulu in the Kūkalahale rain
The entrance of Māmala Bay fares on behind

Up ahead is the breadfruit shade of Lele
The ever-blazing torch unextinguished by the Kaua‘ula wind

Faring out to the deep sea of ‘Upolu Point appears
Entering Mahukona in the ‘Āpa‘apa‘a wind
Make haste, slowpoke, for hers is Kawaihae
Where the Nāulu showes stir up wave gustling winds

The buffering of the Mūmuku wind fills out the topsails
The Kona districts are foremost with their sea-patterned hues
The rush sweeps to the summit of Hualālai
And love is contended, no thrust is missed

We make no error with the tender-eyed kole fish
You eat heartily, right to the rich oily belly
I’m reminded of your love holding me fast
Coming in to Honu‘apo in the restless sea
The *Maunaloa* departs the quiet tranquility of Kona
Porting into Ho‘okena in her bay like a manini tail
The story is told that the Kona districts are the finest
For Kona are the calm seas, famous among all people.
[Wilcox et al. 2003:50–51]

3.4.2 Nā Ka Pueo

In the song *Nā ka Pueo*, the *Pueo-kahi* was a ship named for a place near Hāna, Maui, which had been named for a *pueo kupua* (owl demigod). Honolulu harbor was called Māmala; note the play on words with *mālama* (to care for), to protect:

Nā ka Pueo-kahi ke aloha	Love from the *Pueo-kahi*,
Nēnē ‘au kai o Maui.	The Maui goose that sails the sea.
Ma ka ‘ilikai a‘o Māmala.	Over the sea at Māmala.
Mālama ‘ia iho ke aloha	Keep your love
I kuleana na‘u e hiki aku ai	And I have the right to come.
Ha‘ina ‘ia mai ka puana	Tell the refrain:
Nā ka Pueo-kahi ke aloha	Love from the *Pueo-kahi*.

[Elbert and Mahoe 1971:81–82]

3.5 *Oli* (Chants)

3.5.1 The Epic Tale of Hi‘iakaikapoliopele

The Epic Tale of Hi‘iakaikapoliopele takes the reader on a literary adventure throughout the Hawaiian Islands. The saga begins with the fire goddess, Pele, in pursuit of a lover. Hi‘iakaikapoliopele, Pele’s younger sister, is tasked with bringing back the handsome *ali‘i* of Kaua‘i, Lohi‘au.

Hi‘iakaikapoliopele, her *aikāne* (friend) Wahine‘ōma‘o, and Lohi‘au board a canoe at Pu‘uloa (now known as Pearl Harbor) and plan to sail to Waikīkī. At Pu‘uloa, Hi‘iaka meets a party who were planning on traveling to the house of the chiefess Pele‘ula in Waikīkī. Hi‘iaka recites the following chant, telling the party that despite her traveling by boat and their traveling by foot, they would meet again in Kou:

‘O Kou ka papa	Kou is the coral flat
‘O Ka‘ākaukukui ka loko	Ka‘ākaukukui is the pool
‘O ka ‘alamihi a‘e nō	Some *‘alamihi* [a black crab], indeed
‘O ka lā a pō iho	Wait all day until night
Hui aku i Kou nā maka.	Friends shall meet in Kou.

[Ho‘oulumāhiehie 2008a:277; Ho‘oulumāhiehie 2008b:297]

The party continues to sail toward Waikīkī where they reach the outside area of Kou. Hi‘iaka turns, looks toward the uplands of Nu‘uanu and sees Hāpu‘u and Kala‘ihauola. Hi‘iaka says to them, “I might have forgotten you two, Hāpu‘u and Kala‘ihauola. I do not want you to say I did not acknowledge you, so here are the chanted regards from the traveler.” She then offers the following *kānaenae* (chanted supplicating prayer):

E Hapuu laua me Kalaihauola e

E na wahine no noho Koolau

E no nonoho ana i ke Alanui

Kanaenae au a ka mea hele i‘ai‘a.

[*Ka Na‘i Aupuni*, Volume II, Number 10, 13 June 1906]

Section 4 Traditional and Historical Accounts

4.1 Pre-Contact to 1800s

By the time of first contact with Europeans during the late eighteenth century, the area today encompassed by downtown Honolulu—also known to the Hawaiians as Kou—had long been an area of population and activity on the south shore of Oʻahu. Kou was comprised of shoreward fishponds and taro *loʻi* fed by ample streams descending from Nuʻuanu and Pauoa valleys, but it was Waikīkī to the southeast that could claim preeminence as the traditional residence of the *aliʻi* and as the center of political power on the island. Thus, it was in Waikīkī that Kamehameha took up residence after winning control of Oʻahu in 1795.

Increasing commerce and association with newly arrived foreigners altered the traditionally evolved patterns of Hawaiian life on Oʻahu, typified by the shifting fortunes of Waikīkī and Honolulu. By the first decade of the nineteenth century, as Ralph S. Kuykendall notes,

> . . . Honolulu was becoming a place of some importance commercially. It was situated in a rich and productive island and its protected harbor, the only accessible one in the entire group, caused foreign ships to go there in preference to other places. To the Hawaiians themselves, Honolulu and its snug harbor had been of very little importance compared with the nearby reef-protected romantic beach and town of Waikiki. But the foreigners' rendezvous at Honolulu caused the natives to congregate in the place. [Kuykendall 1938:27]

By 1809, Kamehameha himself had moved his residence to Honolulu. Francisco de Paula Marin, a Spaniard who'd arrived in the Hawaiian Islands in 1793 or 1794, and had become a confidant of the king, recorded in his journal, "In the end of 1809 and beginning of 1810 was employed building a stone house for the king. . ." (Gast and Conrad 1973:200).

This was the first stone structure in Honolulu, which, according to Ross Gast, was

> . . . [by 1810] a village of several hundred native dwellings centered around the grass house of Kamehameha on Pakaka Point near the foot of what is now Fort Street. Of the sixty white residents on Oahu, nearly all lived in the village, and many were in the service of the king. [Gast and Conrad 1973:29]

Kamehameha himself likely never resided in the completed house; in 1810 he returned to Hawaiʻi Island where he lived the remainder of his life. Building in Honolulu, however, continued apace with Marin and other foreign residents building their own stone houses and buildings during the ensuing decade.

4.2 The Early Nineteenth Century and the Māhele

The development of Honolulu during the nineteenth century was inevitably a rapid substitution of the traditional patterns that had once shaped the land by new responses to the pressures of a burgeoning western presence. Into the 1820s, Honolulu remained more notable for its native culture than for any western urbanization imposed on that culture.

The map (Figure 7) of southern Oʻahu drawn by Kotzebue ca. 1817 shows taro fields (rectangles with solid lines), salt ponds (squares with dotted lines), and fishponds (wavy lines around irregular

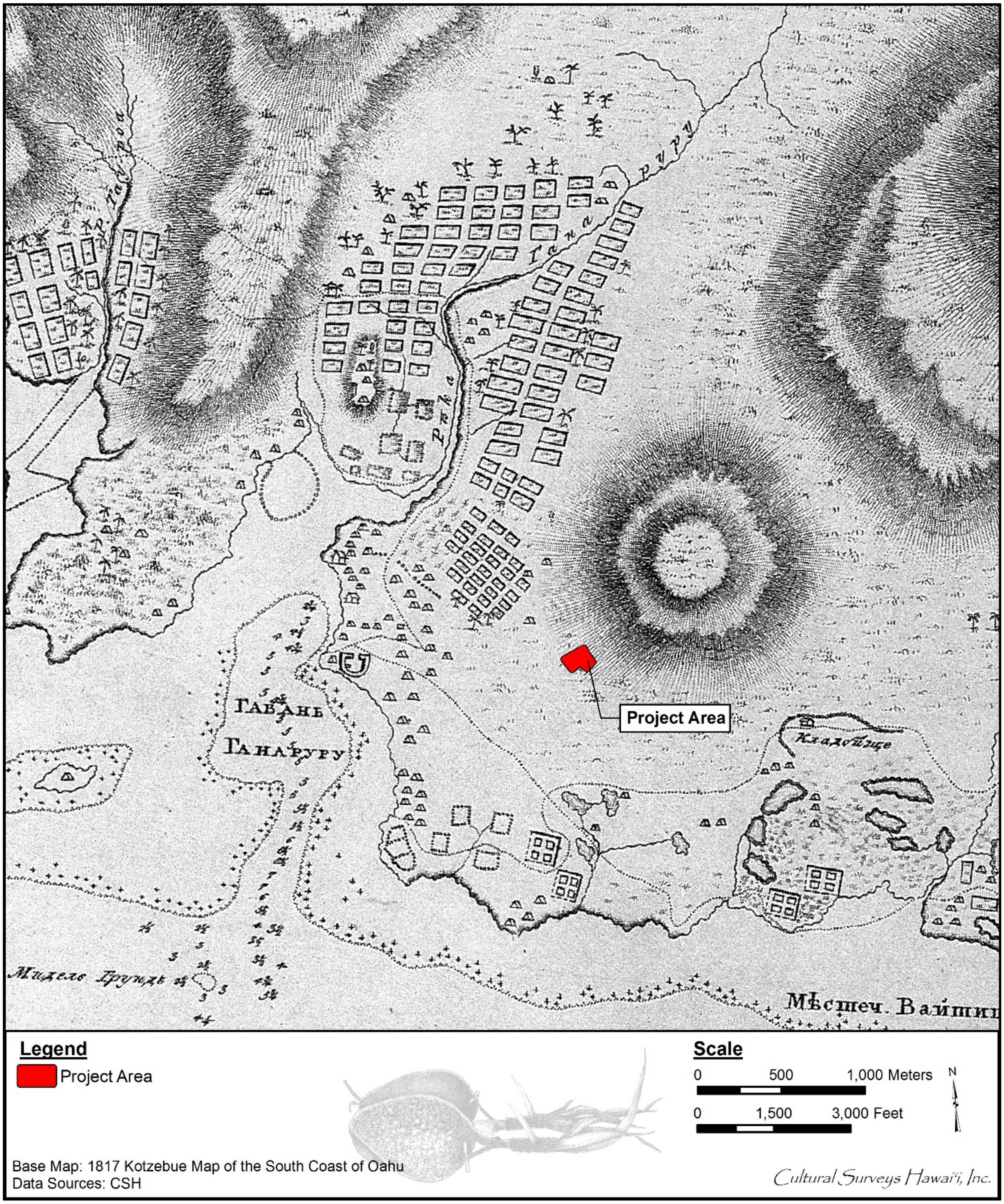

Figure 7. 1817 Kotzebue map of Oʻahu showing project area

ovals), with the taro fields located along Nuʻunau Stream in Honolulu, the salt pans in the arid plain to the east (now called Kakaʻako), and more taro fields and fishponds in Waikīkī. The map also shows a large portion of the Honolulu section as offshore or in Nuʻuanu Stream and not on solid land. Portions of the Waikīkī section may have also been offshore or on high reef lands rather than on solid land.

In 1818, an early trader, Peter Corney, described the village:

> The village consists of about 300 houses regularly built, those of the chiefs being larger and fenced in. Each family must have three houses, one to sleep in, one for the men to eat in, and one for the women, the sexes not being allowed to eat together. . . .
>
> The ground is laid out in beautiful square patches, where the tarrow grows, round which they plant sugar canes and Indian corn. They also have a number of fine fish ponds, in which they keep mullet and a fish they called awa. [Corney 1896:98–99]

A visitor to Honolulu in 1819 (de Freycinet 1978) wrote,

> The port of Onorourou, generally frequented today by all the European vessels that come to the islands, is without doubt the most favorable location with respect to shelter, commerce, and resources for the supply of ships. The town of Onorourou is located on a large, flat plain. It is on the shores of a bay of the same name. The houses, similar to the most part to those of Owhyhi [Hawaiʻi] and of Mowi [Maui], are however interspersed with a certain number of houses built of stone that belong for the most part to Europeans or to Anglo-Americans. [de Freycinet 1978:42]

A visitor to Honolulu in the 1820s, Jacobus Boelen (1988), hints at the possible pre-Contact character of the Honolulu lands that include the present project site:

> It would be difficult to say much about Honoruru. On its southern side is the harbor or the basin of that name . . . The landlocked side in the northwest consists mostly of tarro fields. More to the north there are some sugar plantations and a sugar mill, worked by a team of mules. From the north toward the east, where the beach forms the bight of Whytetee [Waikīkī] the soil around the village is less fertile, or at least not as greatly cultivated. [Boelen 1988:62]

Lord Byron, captain of the British ship the HMS *Blonde* described the village:

> Honoruru is a considerable town, in general very irregular, each house having a small enclosure secured by stakes or wicker work around it; there are, however, two or three tolerably regular streets, and what may be called the public place, where Karaimoku's [Chief Kalanimoku, governor of Oʻahu] house is situated, and near it the Christian church [Kawaiahaʻo Church]. [Byron 1826:119]
>
> The town appears to great advantage from the anchoring ground. Besides the houses and huts of the natives, there are several good stone dwellings built by Europeans, and timber houses, the frames of which have been brought from America and finished here. [Byron 1826:110]

The 1830s marked a profound shift in the character of the Honolulu area as perceived by its inhabitants. Western and urban ideals propelled Honolulu's growth. Such ideals found expression in practices such as the formal naming of streets that commenced in September 1836. It was then that the Sandwich Island Gazette began soliciting suggestions for street names from its readers. Among those accepted were King Street, Beretania Street, and Garden Lane. During earlier years the naming of streets had been haphazard and informal—e.g., Beretania Street was also known as "Beretane," "Pelekane," "Mauka" and "Back."

By the 1840s, western commercial and missionary interests had supplanted the Native Hawaiian traditions that had previously shaped the environment. Gorman D. Gilman (1903:97), who arrived in Honolulu in 1841, described the limits of the town of Honolulu during the early 1840s:

> The boundaries of the old town may be said to have been, on the *makai* side, the waters of the harbor; on the *mauka* side, Beretania Street; on the Waikīkī side [i.e., the area just beyond Punchbowl Street], the barren and dusty plain, and on the ‘ewa side, the Nu‘uanu stream. [Gilman 1903]

Thus, the present project area was on the boundary of the "old town" to its south and the "barren and dusty plain" beyond Punchbowl Street to its east. However, by the end of the 1840s, maps of Honolulu included two streets, Miller and Beretania. Miller Street, also called "Puawaena," is named for William Miller, Consul General of Great Britain from 1844 to 1858, whose residence was located between the street and Washington Place. Beretania, meaning "Britain," was so named because the British Consul Office was located on this street in the 1800s. Vineyard Street was also an older street, named because it passed through the vineyards of Spanish Don Francisco de Paula Marin, who lived in this area in the 1800s. Lisbon Street, within the current project area, was named for Lisbon, the capitol of Portugal. Many Portuguese immigrants who were transported from the Azores in 1883 as plantation workers settled around the slopes of Punchbowl Crater and built small, whitewashed houses on the lower slopes (Pukui et al. 1974:136). Many of the streets in this area have a Portuguese origin.

About Punchbowl Street, Gilman (1903:89) remembered:

> There was on the entire length of this street, from the *makai* side to the slopes of Punchbowl, but one residence, the two-story house of Mr. Henry Dimond, *mauka* of King Street. Beyond the street was the old Kawaiahao church and burying ground. A more forsaken, desolate-looking place than the latter can scarcely be imagined. [Gilman 1903:89]

Thus, the present project site in the early nineteenth century was considered just outside (north) of Honolulu town. The latter half of the nineteenth century was a period of rapid change for Honolulu. Reverend Sereno Bishop (1916) offers a unique perspective of the changes in the layout of Honolulu and the structures that lined the streets:

> When I returned to Honolulu in 1853, after an absence of thirteen years, I was struck by the many changes. . . . [in 1840] the major portion of the residents of Honolulu still lived in thatched houses. In fact the town was almost entirely composed of this kind of dwellings. . . . When I went away there were only Punchbowl Road, Beretania Street, King Street and Merchant Street. This was the condition of the city in 1840. . . . The settled portion of the city was then [1853] substantially limited

> by the present Alapai and River streets and mauka at School street. There was hardly anything outside of those limits and the remainder was practically an open plain. . . . Above Beretania street, on the slopes and beyond Alapai street, there was hardly a building of any nature whatever. . . . [Bishop 1916:58]

There is one dissenting source for the boundaries of the town in the early twentieth century, by the long term resident Warren Goodale (1898):

> In the early 50s Paul Emmert, an artist, was living in Honolulu. . . . While in Honolulu he made a series of sketches of the town, one from the harbor and five from the bell-deck of the Catholic Cathedral, . . . I would here notice a point that I cannot understand, why the artist has not sketched a single building east of Punchbowl street. In all future times, as long as Honolulu may exist, there is no quarter that has had the influence or would hold the interest that clings around the block bounded by King, Punchbowl, Beretania and Alapai streets. . . . the [Kawaiahaʻo Church] Mission was in that block containing the depository of their supplies . . . Kapaakea and his wife, Keohokalole, had their large and comfortable thatched house near the Pumping station on the slope of Punchbowl. [Goodale 1898:80–81]

Many of the prominent *aliʻi* moved their residences to near the Kawaiahaʻo Church and Mission Houses in the nineteenth century. Kapaʻakea (ca. 1817-1866) was a high chief who married Analea Keohokālole in 1835. She bore him ten children, two of which, David Kalākaua and Liliʻuokalani, became the last two monarchs of the Hawaiian Islands (Day 1984:70). This recollection indicates that at least one high chief lived within or near the project area sometime between 1835 and 1866.

4.2.1 Agricultural Lands Transitioning to Urbanization

E.S. Craighill Handy described the Pauoa valley as it appeared in the late 1930s:

> Pauoa is a small valley between the ridge that borders Nuʻuanu on the east (Pacific Heights) and the mountain (Tantalus) behind Makiki. This little valley had its streams, and the entire flatland in and below the valley was terraced for wet taro. All this land is now covered by subdivisions, streets, and some commercial buildings. Below and east of this area much of the land was swampy because of the runoff from Tantalus and Round Top. Taro plantations covered this area. Now the land is under streets and houses. [Handy and Handy 1972:478]

Handy lists Pauoa as a taro planting locale in Oʻahu, and the slopes of Punchbowl as a sweet potato garden area:

> The flatland in the bottom of Pauoa Valley above Punchbowl was completely developed in terraces. About half of the old terrace area is now covered by streets and school and dwelling houses. Of the upper portion, a considerable area is still under cultivation. Below Punchbowl, between Pacific Heights and King Street, there must have been more or less continuous terraces on the ground now covered by the city. [Handy 1940:78]

> Punchbowl Crater (Pūowaina), on both the inner and outer slopes, was also famous in ancient times as a sweet potato locality. The planting was especially good on the inland side near the present Hawaiian homestead of Papakolea. [Handy 1940:156]

An 1847 map (Figure 8) shows the grid of Honolulu streets at mid-nineteenth century, with Beretania Street still defining the *mauka* edge of the town. There are no large structures shown between Kawaiaha‘o Church (Pr. Church-Cemetery on map) and the project area in an area called “Auwaiolimu makai to sea.” ‘Auwaiolimu, the name of the *‘ili*, is also written in on the area to the west of the project area (location of the British Consulate and Washington Place) and lightly penciled in on the area around and *mauka* of the project area.

4.2.2 The Māhele

The Organic Acts of 1845 and 1846 initiated the process of the Māhele—the division of Hawaiian lands—that introduced private property into Hawaiian society. In 1848, the crown and the *ali‘i* received their *Konohiki* (land manager) land titles. *Kuleana* (right, title, property) awards to commoners for individual parcels began to be granted in 1850. It is through records for Land Commission Awards (LCAs) generated during the Māhele that the first specific documentation of daily activities in the vicinity of the project area, as it had evolved up to the mid-nineteenth century, come to light (Chinen 1958:15–16).

The *ahupua‘a* of Pauoa was not awarded to any *ali‘i*, and thus it became government land. The *‘ili* of ‘Auwaiolimu was awarded to the *ali‘i* Kaleokekoi, who returned it to pay the commutation fee on the lands he retained. The land then became Crown Land (Soehren 2012), owned by the Hawaiian Monarchy. A total of 46 *kuleana* claims were made within the *‘ili* of ‘Auwaiolimu; however, not all of these were in the Pauoa area near Punchbowl Crater. ‘Auwaiolimu was an unusual type of *‘ili* called a *lele*, or jump land, as it contained several non-contiguous parcels, one which extended from School Street to the lower slopes of Punchbowl, one around Beretania and King Street, and one located at the coast near the foot of Punchbowl Street in the district now called Kaka‘ako. An 1883 newspaper defines the boundary of the upper section as the “district above School street, and bounded by that street, Punchbowl, the Pauoa stream and Kaalaa [Ka‘āla‘a ‘Ili, Nu‘uanu-Judd street area], Honolulu” (*Saturday Press* 1883:5).

There are six LCAs near the current project area, four on the *mauka* side of Beretania Street and two on the *makai* side of the street (Figure 9 and Table 1). On Beretania Street, between Punchbowl and Alapa‘i streets, there were five awards on the *mauka* side of the street. At Punchbowl, there was a large *Konohiki* award, LCA 5874 to Analea Keohokālole, who was married to Caesar Kapa‘akea and mother of two Hawaiian monarchs, King Kalākaua and Queen Lili‘uokalani. As previously mentioned, they had a house “near the pumping station” (Goodale 1898:81). This lot was generally square, but a small section near the southeast corner was awarded as LCA 1818 to Kaiahua. East of these two lots was LCA 656, a *kuleana* award to Kuhia for a rectangular fenced lot with two houses. This was adjacent to LCA 268, awarded to John ‘Ī‘ī, a respected retainer who had been a childhood companion to Kamehameha II and advisor to Queen Kīna‘u as an adult. His rectangular lot had an adobe (mud) wall, two houses, and a well. ‘Ī‘ī did not live on the land himself, but allowed some of his servants to live there. This lot generally covered half of the lot adjacent to the east side of Lauhala Street to the west of the current project area. Located *makai* of Beretania Street and directly below the current project area is LCA 804 awarded to Kaluahine. This lot contained a fence, house, and garden and was confirmed in writing

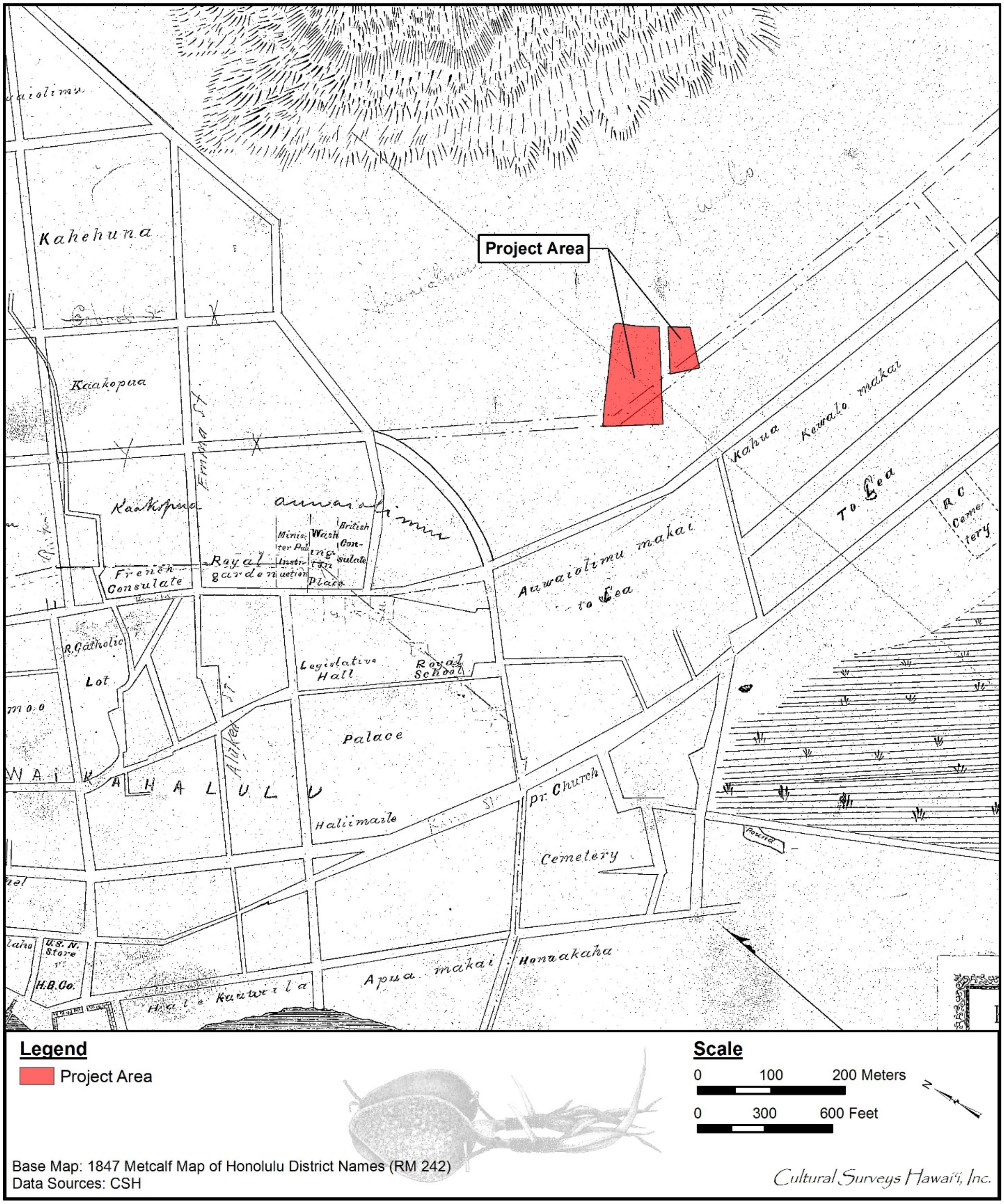

Figure 8. 1847 Metcalf map of Honolulu showing project area

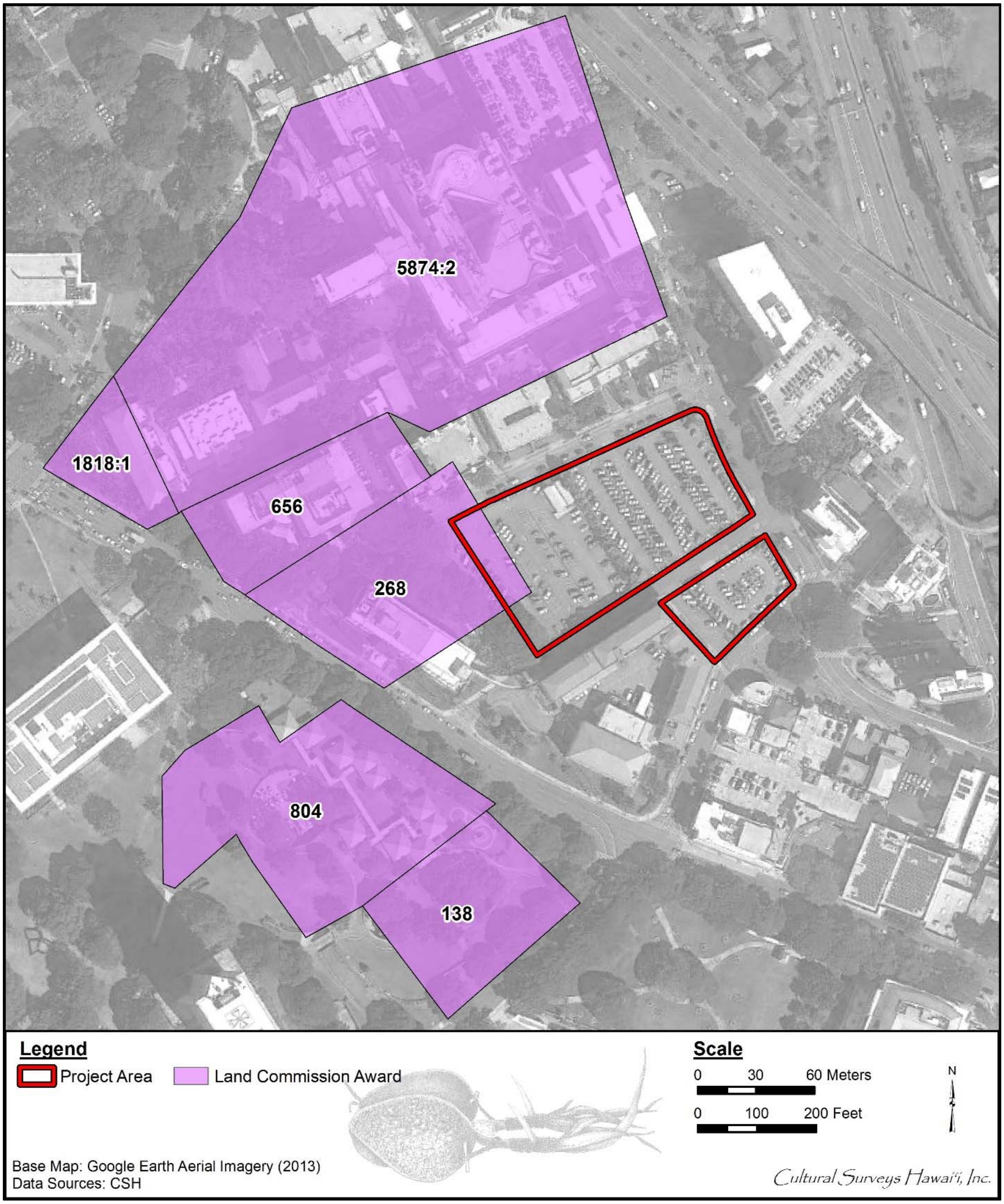

Figure 9. LCAs within a portion of the project area and nearby

Table 1. LCAs located in close proximity of the project area

LCA #	Claimant	Location	Land Use
138	Kekuinau	Alapai St	*Pāhale* (House lot)
268	John ‘Ī‘ī	Beretania St	House lot?
656	E. Kuhia	Beretania St	*Pāhale* (House lot)
804	Kaluahinenui	Kawaiahao	*Pāhale* (House lot)
1818	Kaiahua	Beretania St	*Pāhale* (House lot)
5874	A. Keohokalole	Beretania St	Not stated

by ‘Ī‘ī. Adjacent to this lot is LCA 138 which was awarded to Kekuinau. The remaining portion of the project area to Alapa‘i Street was in the Crown Lands of ‘Auwaiolimu.

An 1855 map (Figure 10) shows the rapid growth of Honolulu, the expansion to the east toward the project area and the development of several structures, including one likely associated with LCA 5874. An 1860 photograph (Figure 11), taken soon after the construction of Queen's Hospital, shows three of these lots, separated by low walls. Assuming that these correspond to the walls described in the LCA testimony, this photo shows the LCA lots for Kapa‘akea, Kuhia, and ‘Ī‘ī. Kapa‘akea had a two-story house on his property, described as "near the pumping station." A house does appear on the photograph on the west end of the LCA 5874 (the end nearest the future pumping station on Alapa‘i Street), and this may be the house that Warren Goodale (1898:81) is referencing. The LCA awardees are listed in Table 1.

Although no information about early historic land use for the project area can be deduced from the LCA testimonies, two facts do stand out. Most of the people said they took the land as "wasteland" and then built one or more houses, and these claims all took place around 1828 or later. John ‘Ī‘ī said that he had claimed unused lands in 1828, Kuhia said he had lived on his land since 1829, while Kaiahua had claimed unused land and lived on it only since 1843.

Ane Keohokālole may have been the only one of the four with long-standing ties to this particular land area, but since the description of her Honolulu lots is missing, this is difficult to determine. It seems that as the town of Honolulu expanded, roads were improved, the *makai* lands filled with people, the *mauka* lands on the slopes of Pūowaina became desirable house lots, and the unclaimed and unused dusty lots in this area were claimed by Native Hawaiians for living. There is no evidence that they used the land for dryland agriculture in the early to mid-eighteenth century. Some of the Crown Lands were sold in the late nineteenth century to generate funds for the living expenses of the monarchy. In the Honolulu area, these areas were quickly gridded to create residential subdivisions.

4.3 Late Nineteenth Century

By 1850 Honolulu was described by Charles Wilkes as "very conspicuous from the sea and has more the appearance of a civilized land, with its churches and spires, than any other island in

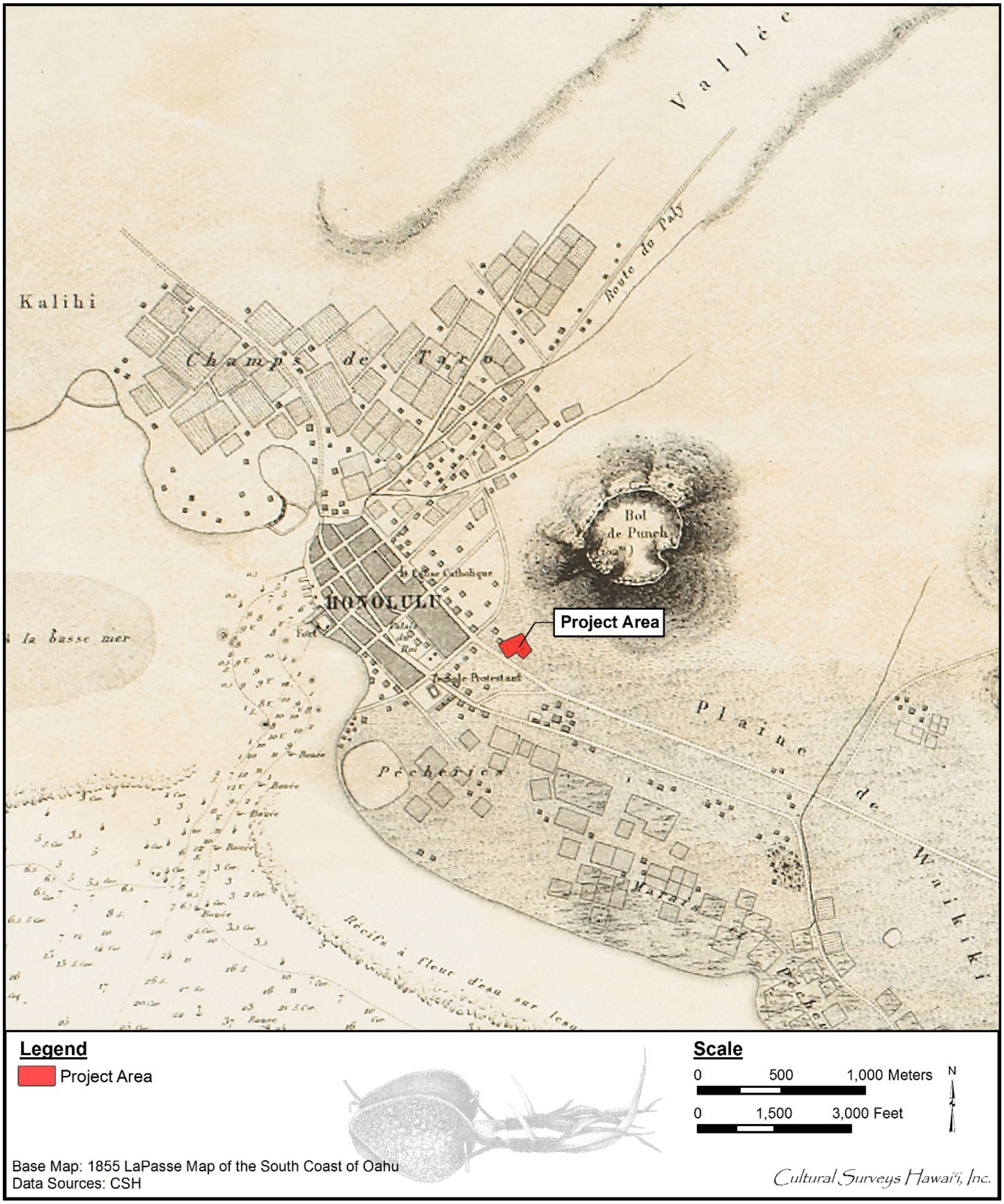

Figure 10. Portion of 1855 LaPasse map of the south coast of O‘ahu showing the project area and the expansion of Honolulu east toward the project area and beyond

Figure 11. Panorama photo, ca. 1860, taken from Punchbowl Crater, showing general barrenness of the surrounding area; wall remnants probably correspond to boundaries of LCA lots for John ʻĪʻī, Kuhia, and Kapaʻakea (Hawaiʻi State Archives; reprinted in Greer 1969:124)

Polynesia" (Wilkes 1844 in Fitzpatrick 1986:69). In 1846, Honolulu was made the capitol of the Hawaiian Kingdom and was well on its way to becoming the commercial and political hub of the Islands. During this period there was an obvious increase in density of land use and urbanization. ʻIolani Palace was constructed in the 1880s.

The first real public hospital in the Hawaiian Islands was founded in 1837 in Waikīkī. The American Hospital was established to care mainly for ailing seamen. Other seamen's hospitals, in addition to a few small private hospitals, also used mainly by foreign seamen and residents, were opened in the following years. These small establishments were woefully inadequate to deal with the health of the population, especially the health of Native Hawaiians, whose numbers had declined from approximately 300,000 in 1778 (according to Schmitt 1956:338), to 124,449 in 1832, and to 73,138 in 1853. More than 6,000 people, mainly Native Hawaiians, had died during the 1854 smallpox epidemic, and the temporary pest houses that had been set up had been overwhelmed (Schmitt 1969:110).

To address this problem, King Kamehameha IV, Alexander Liholiho, approved "An Act to Institute Hospitals for the Sick Poor" at Honolulu and Lahaina on May 25, 1855. During his maiden speech to the Hawaiian parliament, he presented the need for public hospitals for Native Hawaiians. Because of the interest of his wife, Queen Emma, and her aid in funding the hospital, the cabinet chose the name of The Queen's Hospital on 24 May 1859.

In March 1860, the doctors moved into an existing two-story wooden building on the new grounds at "the foot of Punchbowl hill." In December they moved to a new stone building constructed on the grounds, shown on an 1887 map (Figure 12). The old wooden building was then used for the treatment of prostitutes, who were required by law to be examined by a physician at least once every two weeks, and could then receive free treatment for venereal diseases and other ailments (Daws 1967:68; Greer 1969:127).

By 1860, the hospital consisted of the main edifice, two out-buildings, and Kapaʻakea's wooden building (Greer 1969:125). The grounds were bare and dusty, but improved in 1861 when water was brought down from Pauoa Valley (Schmitt 1956:125–126). In 1885, Emma Kaleleonalāni (Queen Emma) died and left the bulk of her estate to her cousin, Albert Kūnuiākea and to her business agent, Alexander Cartwright. Alexander Cartwright managed a trust that was used to pay for four scholarships, called the "Queen Emma Scholarships," for certain annuities to former servants and friends, and to provide income to Albert during his life. When the annuitants died, half of the value of these bequeaths was given to the Queen's Hospital and half went into the trust for her cousin Albert. At Albert's death, the remainder of his trust would have been inherited by his children. However, Albert died childless in 1903, and the entire trust was given to Queen's Hospital, as Emma's will had instructed (Kanahele 1999:365).

During the last 20 years of the 1800s the pace of development and eastward expansion of Honolulu continued. The gridded street plan was extended and expanded and the development and construction of ʻIolani Palace and other government buildings, as well commercial and residential development, boomed (see Figure 12 and Figure 13). The need for a modern infrastructure was great.

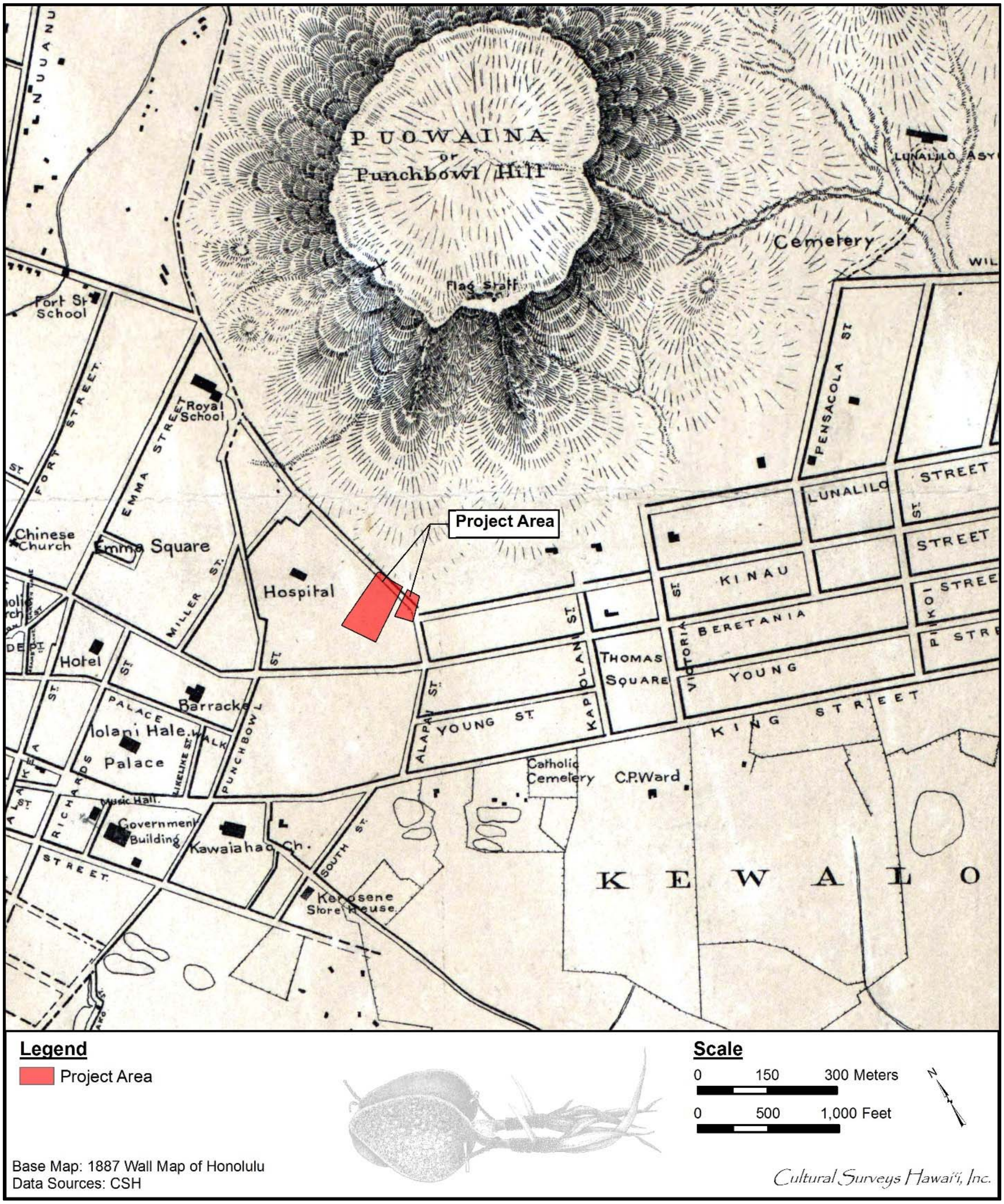

Figure 12. Portion of 1887 Wall map of Honolulu, showing the proximity of the first building of Queen's Hospital to the west of the project area and continued eastward expansion of Honolulu

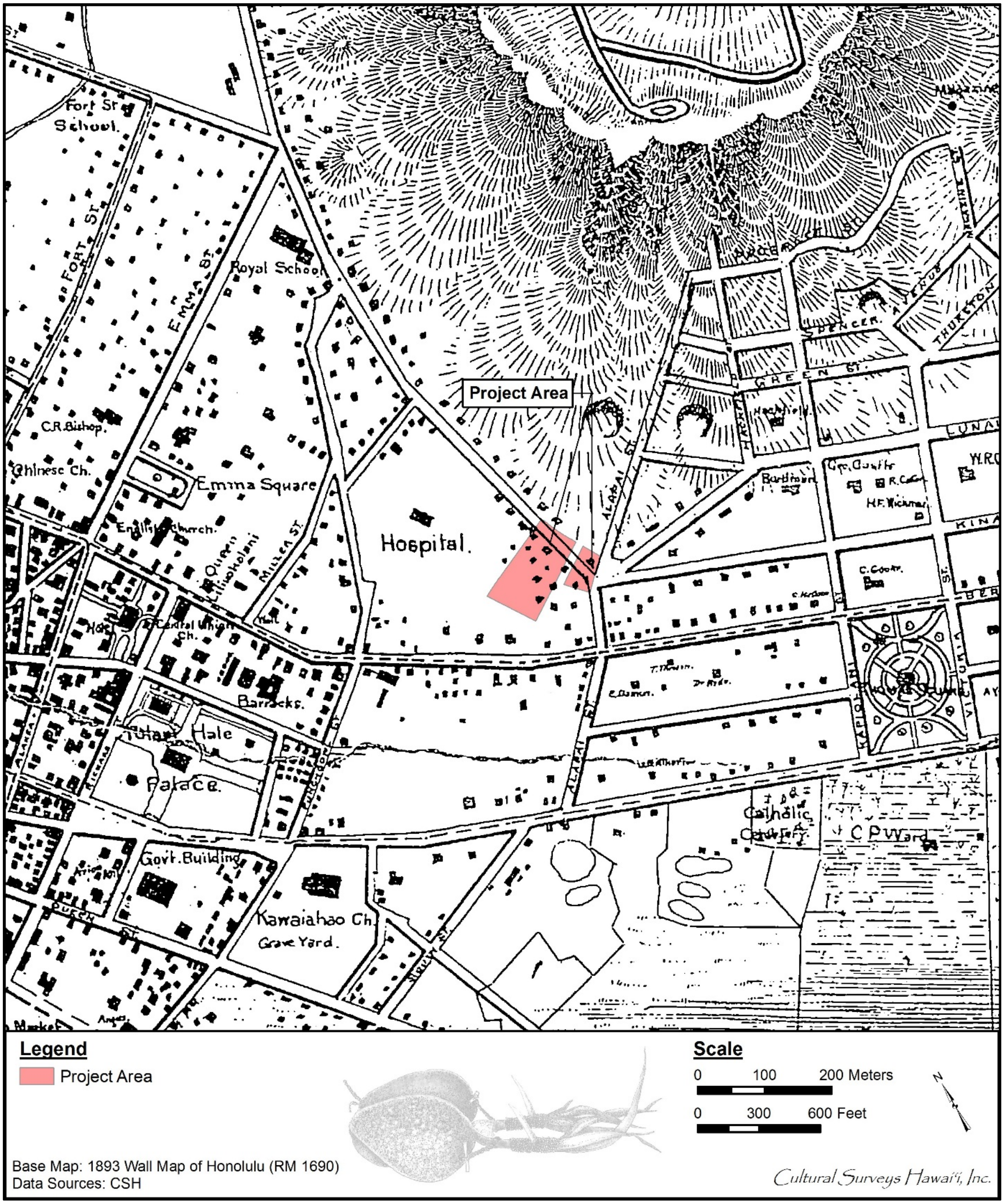

Figure 13. Portion of 1893 Wall map of Honolulu, showing the development and continued eastward expansion of Honolulu

Water in the early post-Contact period in the Honolulu area depended on the availability of streams, pools, wells, and springs. As Honolulu expanded, it became necessary to provide water to the "dusty plains" east of Honolulu. In 1879, James Campbell drilled down 273 ft on his cattle ranch in 'Ewa and found that a vast aquifer of fresh water lay below the Hawaiian Islands (James Campbell Estate 1978:14). Many other wells were dug, including ones in Honolulu, but by the 1890s, the levels of water from wells was so low that supplying water to the city became a real problem. It was then that the Minister of the Interior began to plan for pumping stations and inland reservoirs. Thomas Thrum, in his yearly almanac for the Hawaiian Islands, mentions some of the details of this planning and construction, beginning in 1894, when a brick pumping station was built at the corner of Beretania and Alapa'i streets (Figure 14 and Figure 15):

> The desirability of the establishment of a plant for the pumping of artesian water to a storage reservoir on the slope of Punchbowl was mooted in 1892, and led to the erection of the pumping station and sinking of two ten-in wells of two million gallons daily capacity, at the corner of Beretania and Alapai streets. [Thrum 1922:53]
>
> Steps are taken toward the long needed increase of our city's water supply; to be obtained through artesian wells to be sunk at the corner of Beretania and Alapai streets, which, with the aid of a powerful pumping plant, already contracted for, will augment the reservoir supply very materially. Pipe laying in connection with the combined system has already commenced. [Thrum 1894:133]
>
> The new spirit of public improvements mentioned in the last issue as being inaugurated, has been pushed with vigor. The relaying of larger water mains through a number of streets and completion of the new pumping plant, auxiliary to the reservoir system, was effected in time to do valuable service during the cholera period by shutting off the reservoir supply with its possible contamination, and flushing the mains with artesian water. This pumping plant is housed in a substantial and commodious brick structure at the corner of Beretania and Alapai streets, and will connect with the reservoir in course of construction on the slope of Punchbowl. [Thrum 1896:143]
>
> The patience of Honolulans have the promise of reward in an ample water supply for the growing city's needs, as, in addition to the above extension of the Nuuanu system, steps are taken to augment the artesian supply by sinking two more wells at the Beretania station and installing the high lift pump that has lain idle since its purchase several years ago for want of funds. [Thrum 1909:166]
>
> For the first time in the history of Honolulu since it took on the expansive spirit the city has not been shortened during the summer of its water supply, due partly to the generous rainfall, the increased water supply by two fine flowing additional wells sunk at the Beretania pumping station, and the completion at last of the Nuuanu dam. [Thrum 1910:164]
>
> With the completion of the new and enlarged pumping station, at the corner of Beretania and Alapai streets, a concrete structure, the former brick building, a monument to the efficiency of the late W. E. Rowell as superintendent of

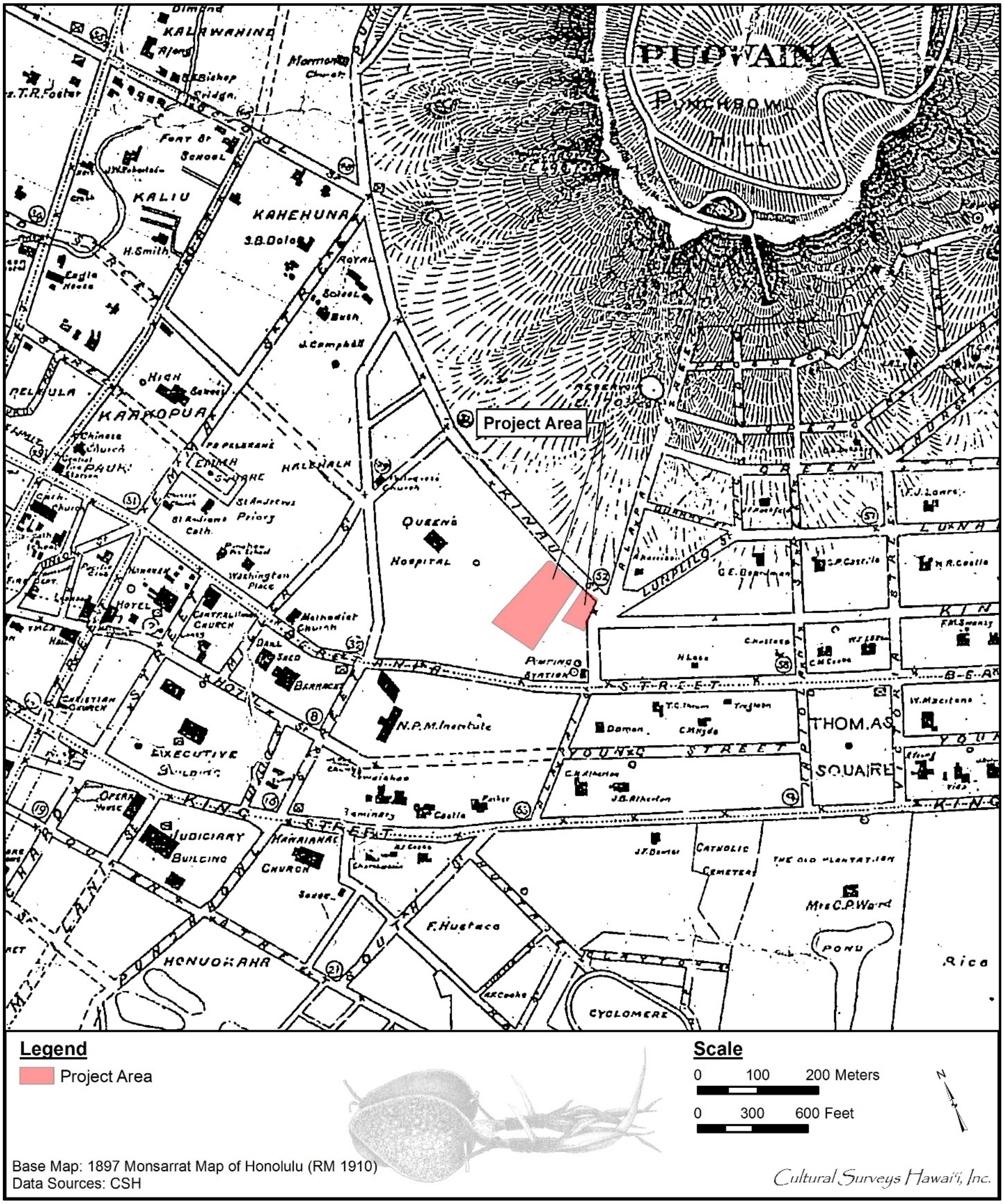

Figure 14. Portion of 1897 Monsarrat map showing the continued development of Honolulu and the establishment of the first water pumping station on the current BWS Beretania Complex

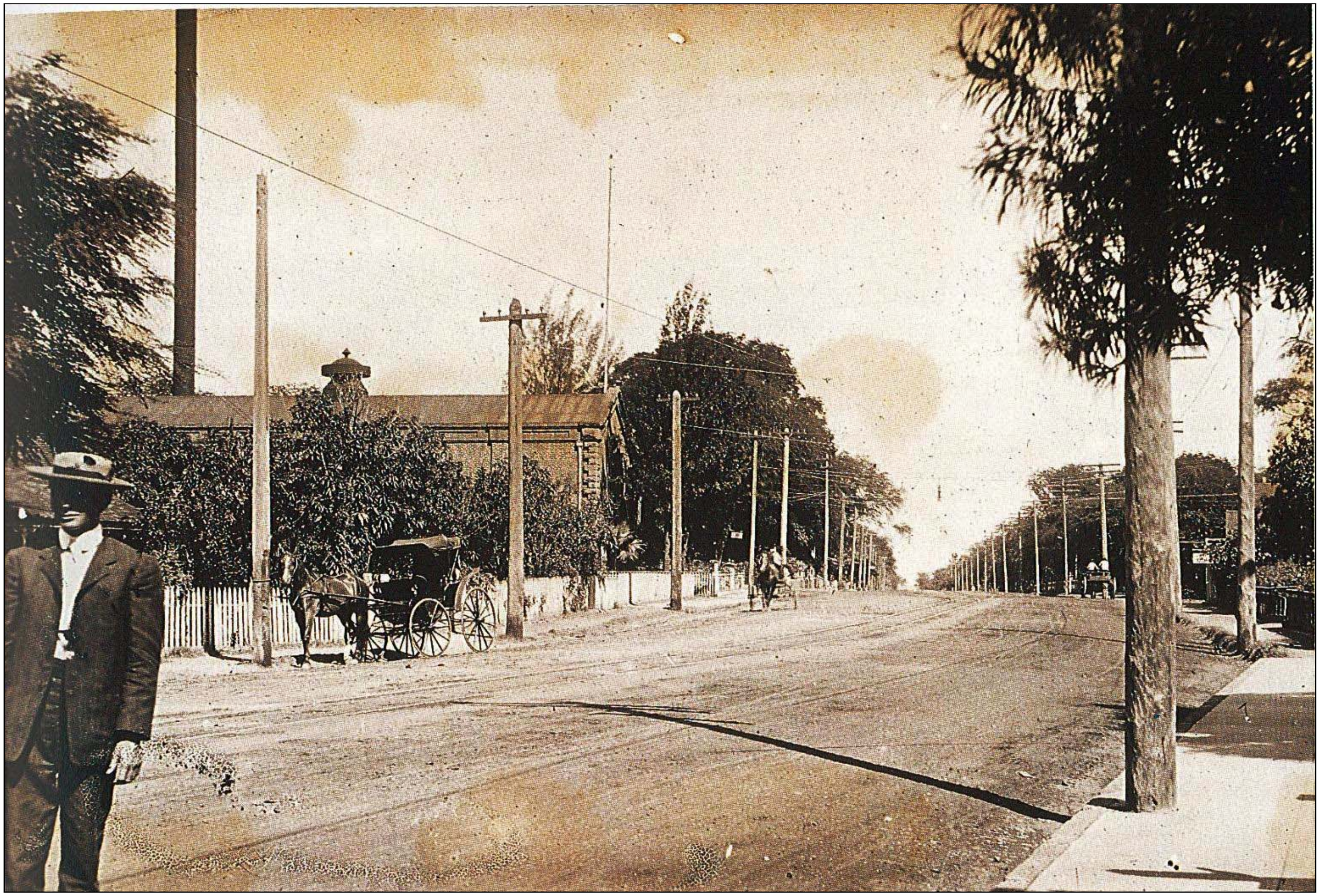

Figure 15. Beretania Street ca. 1890s, showing original 1894 brick Beretania Pump Station on left, view to the east (Hawai‘i State Archives)

> publicworks, of the former Interior Department, about 1890, has also had to give way to the march of progress. [Thrum 1927:78]

Thus, Thrum noted several expansions of the pumping station and the replacement of the original 1894 brick building, shown on Figure 15, with the present concrete structure around 1927.

After the establishment of the Republic, the water works were under the direction of the Superintendant of Public Works, then under the Department of Public Works in 1913. The Honolulu Sewer and Water Commission was formed in 1927, but continued disruptions in the water supply led to the creation of the BWS in 1929 (Murai 2000:2–3).

The BWS Public Service Building was constructed in 1958 (Figure 16), designed by the architectural firm of Wood, Weed, and Kubala. The most famous of the partners was Hart Wood, who designed many homes, commercial buildings, and public buildings in Hawai‘i with a specific mix of Hawaiian/Asian designs. The building is made of reinforced concrete and has three stories and a basement. The theme of water runs throughout the building. The lobby features a mural on “Pure Water” by Juliettte May Fraser and an aquarium built into an interior wall. The exterior walls have a Chinese-inspired fretwork of gridded louvers and green slate and colors used near the entrance and on the sidewalks represent water. In addition, there is a large fountain near the Beretania Street entrance and a landscaped area behind the building. The building is connected to the Engineering Building by an elevated footbridge across Lisbon Street. The Engineering Building was actually built before the Public Service Building; it was constructed in 1939, and is used by employees who plan and maintain the water system (Hibbard 2011:119; Murai 2000:4–6).

4.4 Twentieth Century to Present

The following account describes the jumbled character typical of many areas of Honolulu in the 1920s and 1930s:

> Mainland visitors to Honolulu were still struck by the exotic appearance of even the city’s most populated sections. . . . [There] were still densely packed areas threaded by narrow, twisted lanes, especially in the Vineyard, Kukui, Kapālama, and Iwilei areas adjoining downtown. Elsewhere, particularly where the city planning commission had authorized local business development, the old type of two-story structure, with shops below and living quarters above, lined major streets. Equipped with permanent awnings of wood or corrugated sheeting, projecting over the sidewalks, these buildings, most often painted a shade of green, gave the city a sort of tropical look. [Johnson 1991:326]

With the establishment of a new water system by the Hawai‘i state government, areas of the former “dusty plains” of O‘ahu east of Honolulu began to be developed for residential subdivisions. One of the first of these subdivisions was an area north of Lunalilo Highway called the “Auwaiolimu Lots” as shown on a plan made in 1912 (Figure 17). As more people moved from the city center and from the outlying areas, the suburbs of Honolulu expanded to the east, until finally all of the area between Honolulu and Waikīkī was gridded off with new roads into new residential lots. The growth of the city can be seen on a 1919 U.S. War Department map (Figure 18), when some coastal areas were still undeveloped marshes, such as the area southeast of the current project area, a site now occupied by McKinley High School.

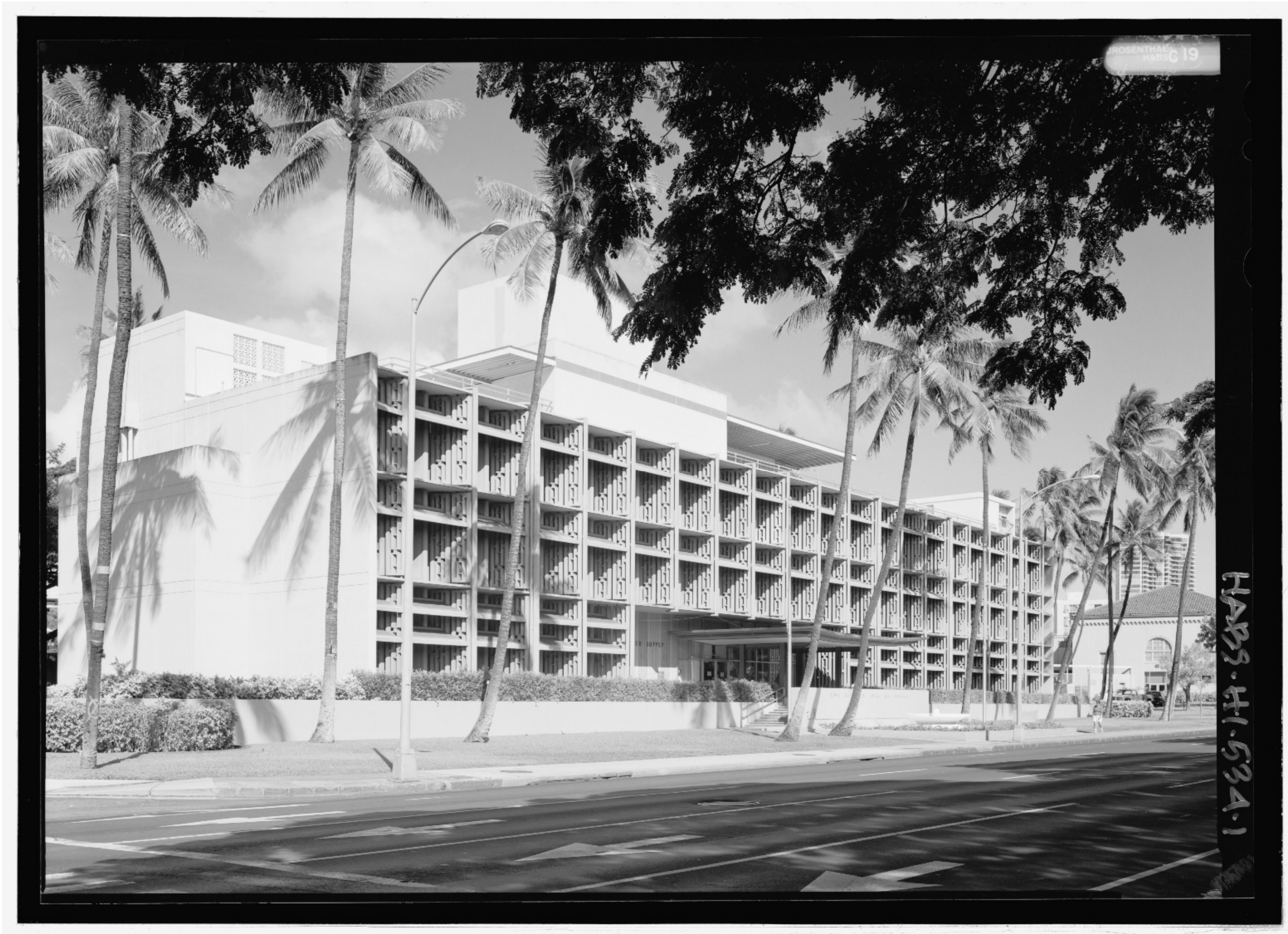

Figure 16. Board of Water Supply Public Service Building 2007 (Photograph by James W. Rosenthal, National Park Service 2007, HABS HI-534)

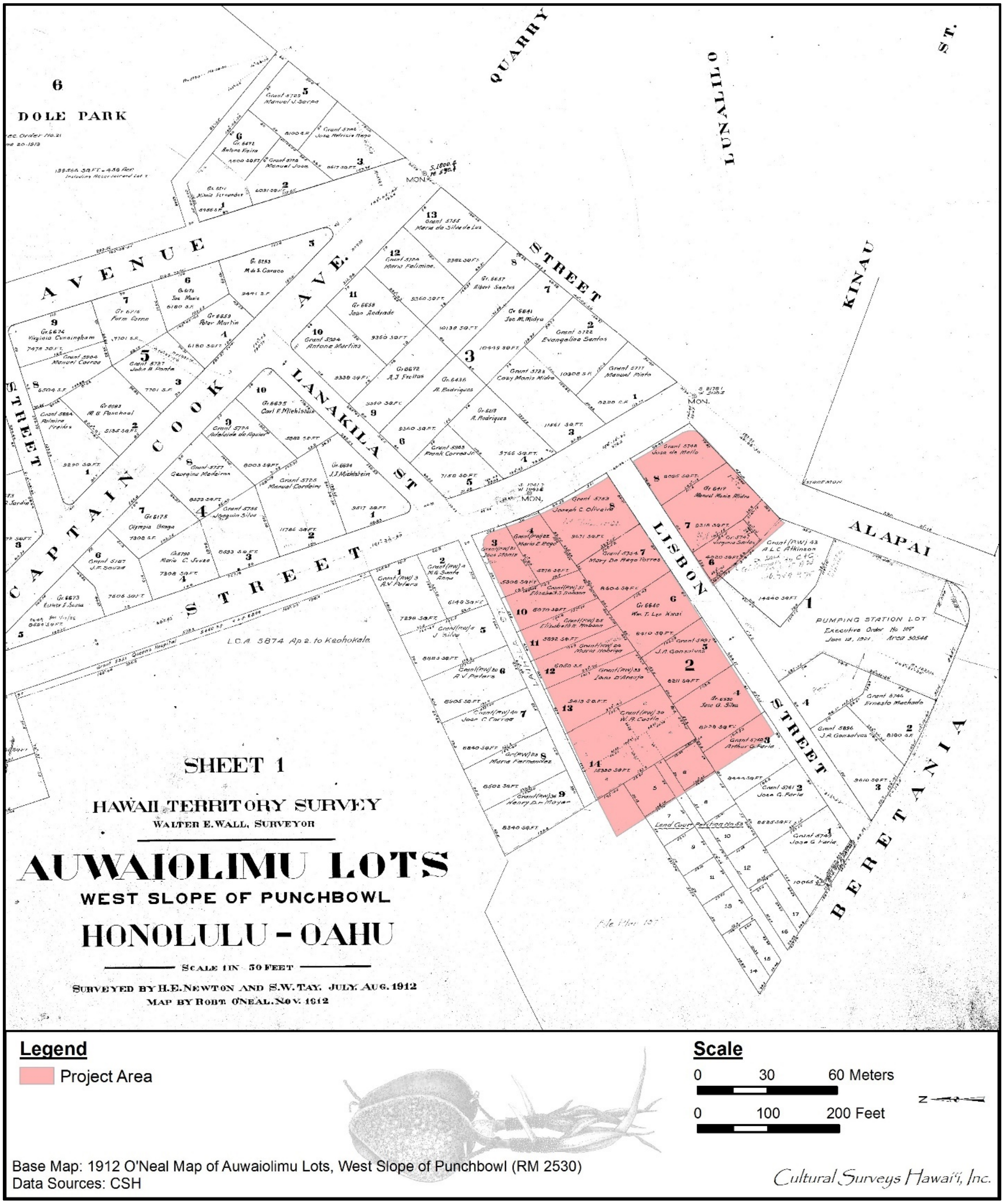

Figure 17. 1912 O‘Neal map of Auwaiolimu Lots with highlighted project area

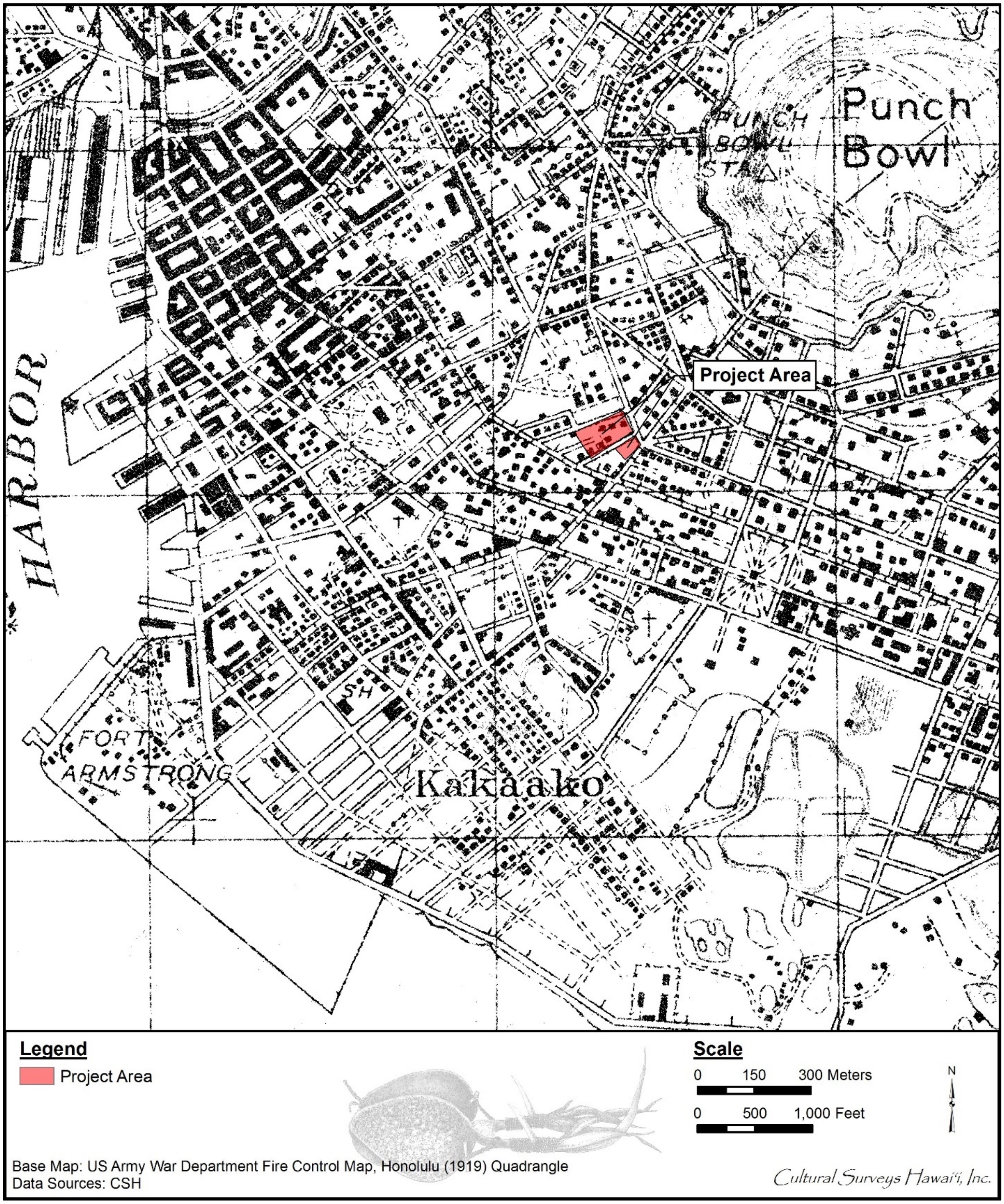

Figure 18. 1919 U.S. Army War Department map with outline of project area

A photograph taken from the slopes of Punchbowl crater in 1940, depicts the development of Honolulu (Figure 19). By 1943, all of the former marshes, rice fields, and fishponds in the Honolulu and Waikīkī area had been filled and developed, although there were still dirt and unpaved roads in the area *makai* of McKinley High School, as shown on a 1943 U.S. War Department map (Figure 20). A 1968 aerial photograph (Figure 21) shows the dense development around the project area with the current buildings present, all of which had been constructed by 1958.

4.4.1 History of the Current Project Area

A series of Sanborn Fire Insurance maps (Figure 22 through Figure 24) of Honolulu show the development of the project area in the twentieth century. The 1914 Sanborn Fire Insurance map (see Figure 22) shows the original brick pumping station on the corner of Beretania and Alapa‘i, with two drilled wells to the west in the same lot. The remaining portion of the project area is covered with single-family dwellings, a few small shops (clothes cleaning, photo shop) along Beretania Street, and a factory for the Honolulu Wire Bed Company. Jacob Bailey was an Englishman who came to the Hawaiian Islands in 1894 and began to make woven wire bed springs, branching out into the furniture business and founding the Bailey Furniture Company in 1895 (Siddall 1917, Vol. 1:27). In 1910, the Honolulu Wire Bed Company was officially incorporated (*Hawaiian Star* 16 February 1910:1), although it was established earlier.

The 1927 Sanborn map (see Figure 23) indicates the new concrete pumping station is under construction and the old brick station is slated for “removal.” In the V-shaped section on which the Engineering Building would eventually be constructed in 1939, there are already three concrete slabs in the same configuration, although they are used for open-sided automobile sheds. There is also a Wagon Shop and Electrical Shop building, which will later be replaced by the *makai* end of the west wing of the Engineering Building. The number of dwellings and shops (cleaner, restaurant) has been reduced and is limited to the western end of Beretania Street.

The 1950 Sanborn Fire Insurance map (see Figure 24) shows the removal of the 1894 brick pumping station, the new 1927 concrete pumping station, and the 1939 Engineering Building. All of the dwellings and shops on the west end of the parcel along Beretania Street have been demolished, to make way for the new Public Service Building constructed in 1958. Many of the dwellings in the *mauka* portion of the project area have also been removed, probably to create parking lots. In the present, the entire *mauka* portion consists of public and employee paved asphalt parking lots. The *makai* portion contains the 1958 Public Service Building, with an elevated walkway to the 1939 Engineering Building, which is *mauka* of the 1927 Beretania Street Pumping Station.

Figure 19. 1940 photograph of Honolulu, from the slopes of Punchbowl Crater (Hawai‘i State Archives)

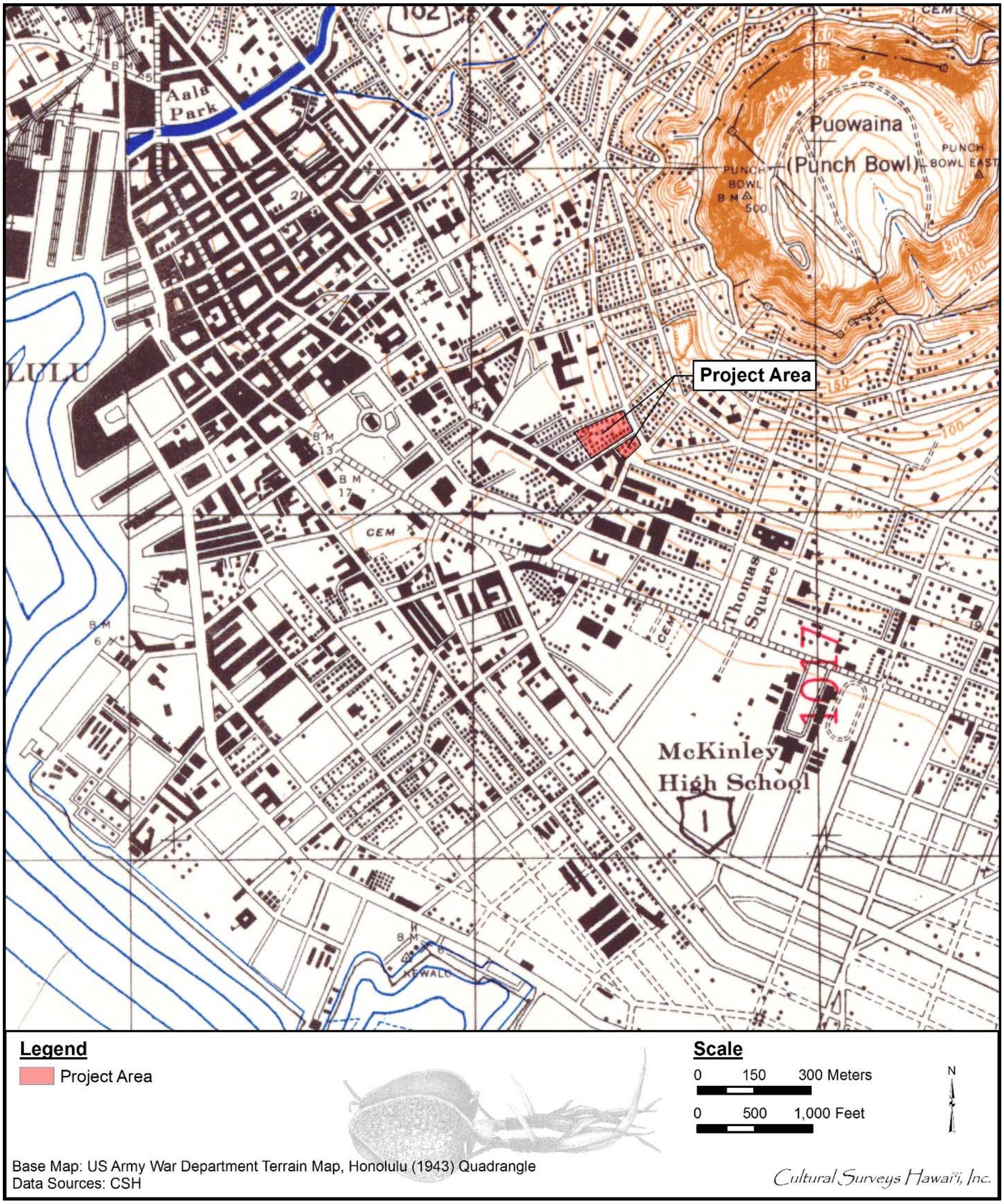

Figure 20. 1943 U.S. War Department map

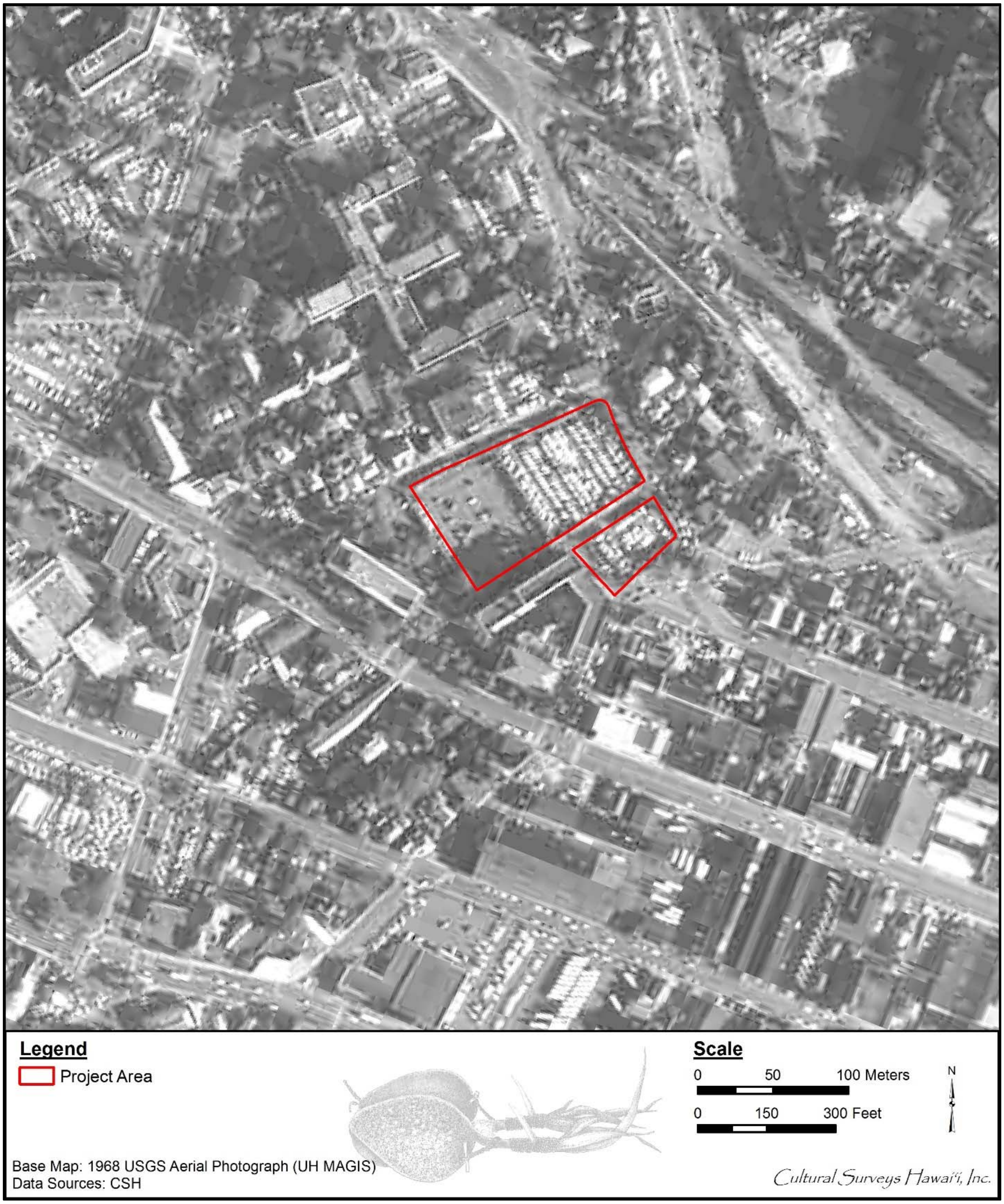

Figure 21. 1968 USGS aerial photograph showing progression of development of the project area and surrounding areas

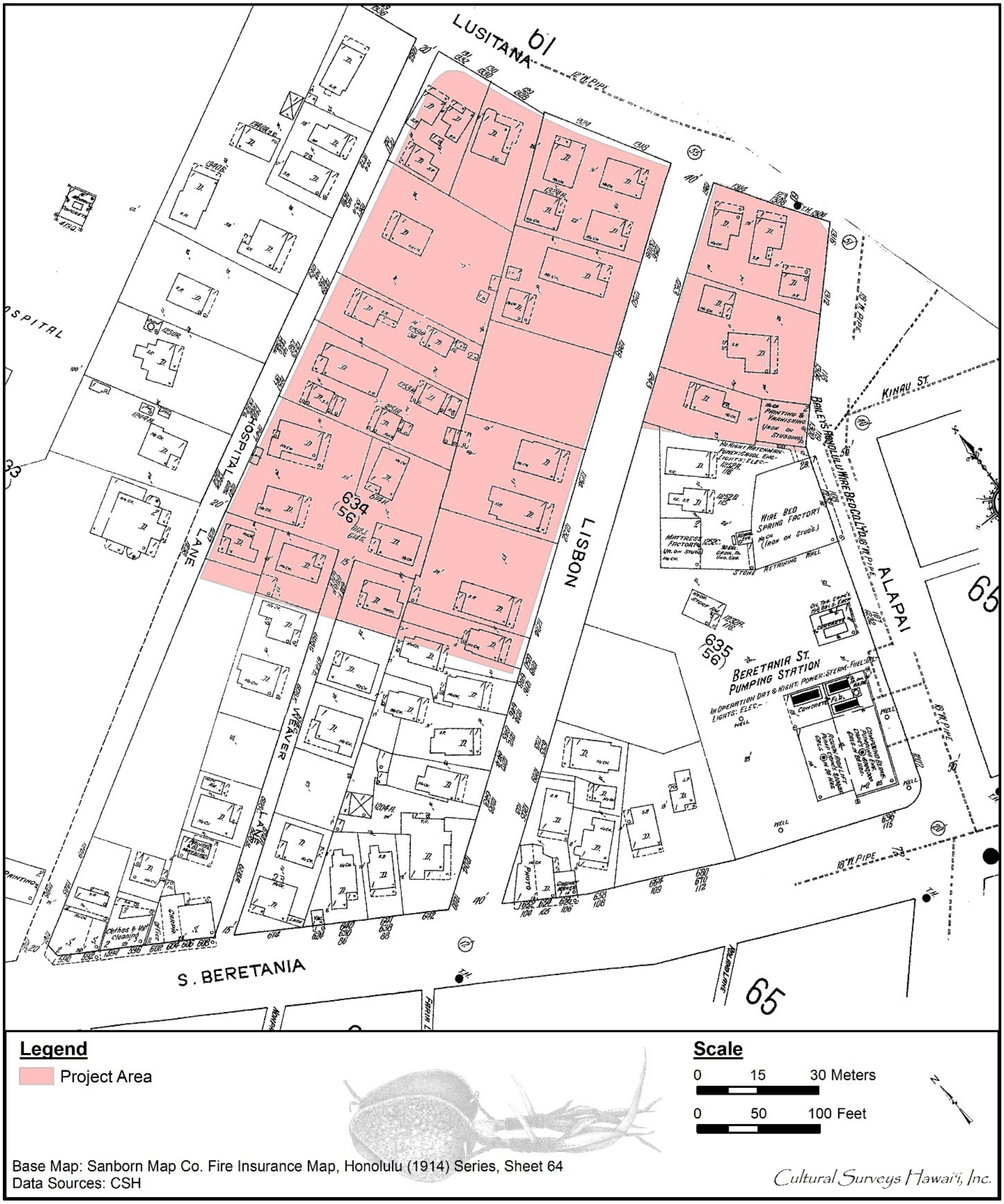

Figure 22. 1914 Sanborn Fire Insurance map showing outline of project area

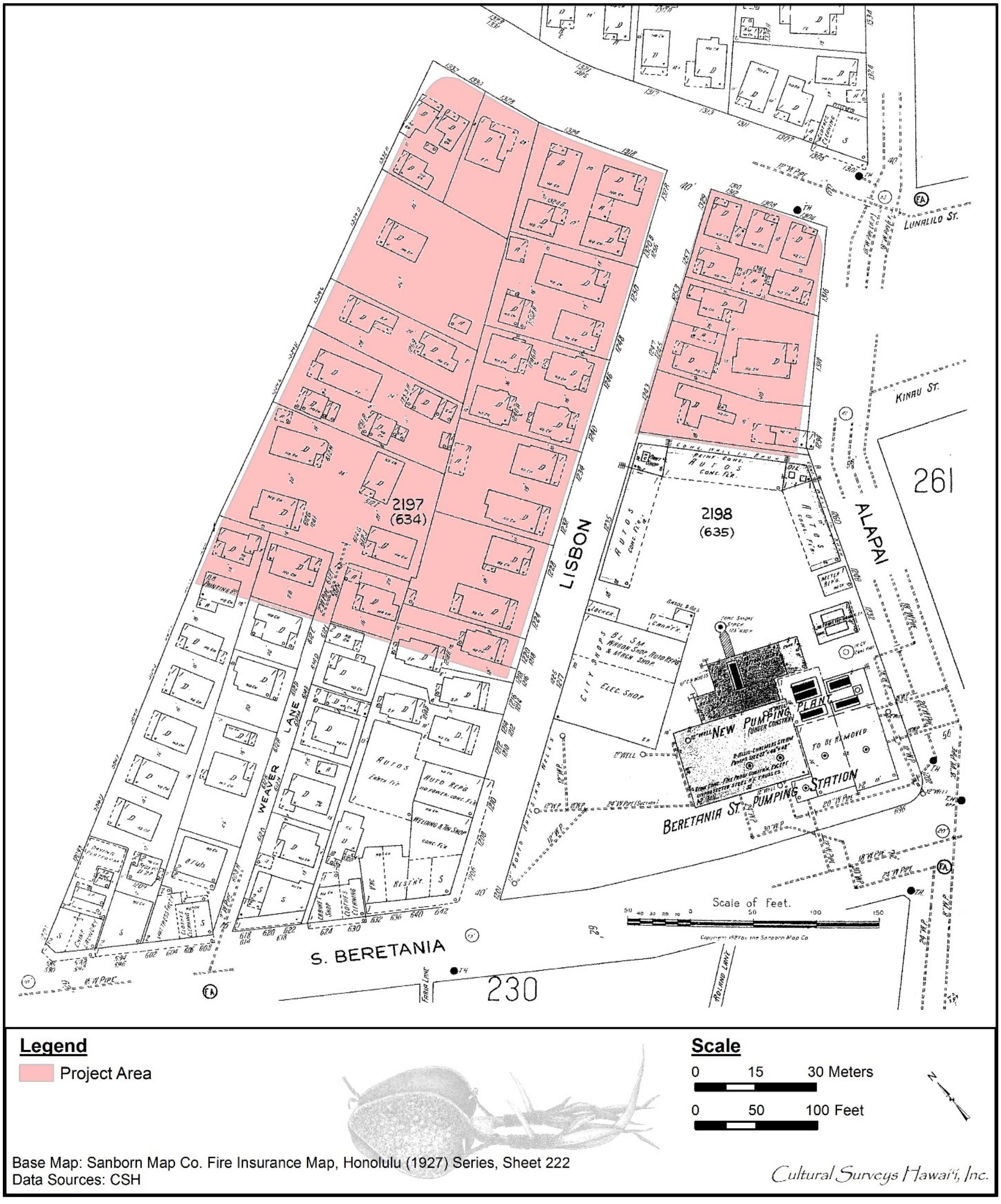

Figure 23. 1927 Sanborn Fire Insurance map showing outline of project area

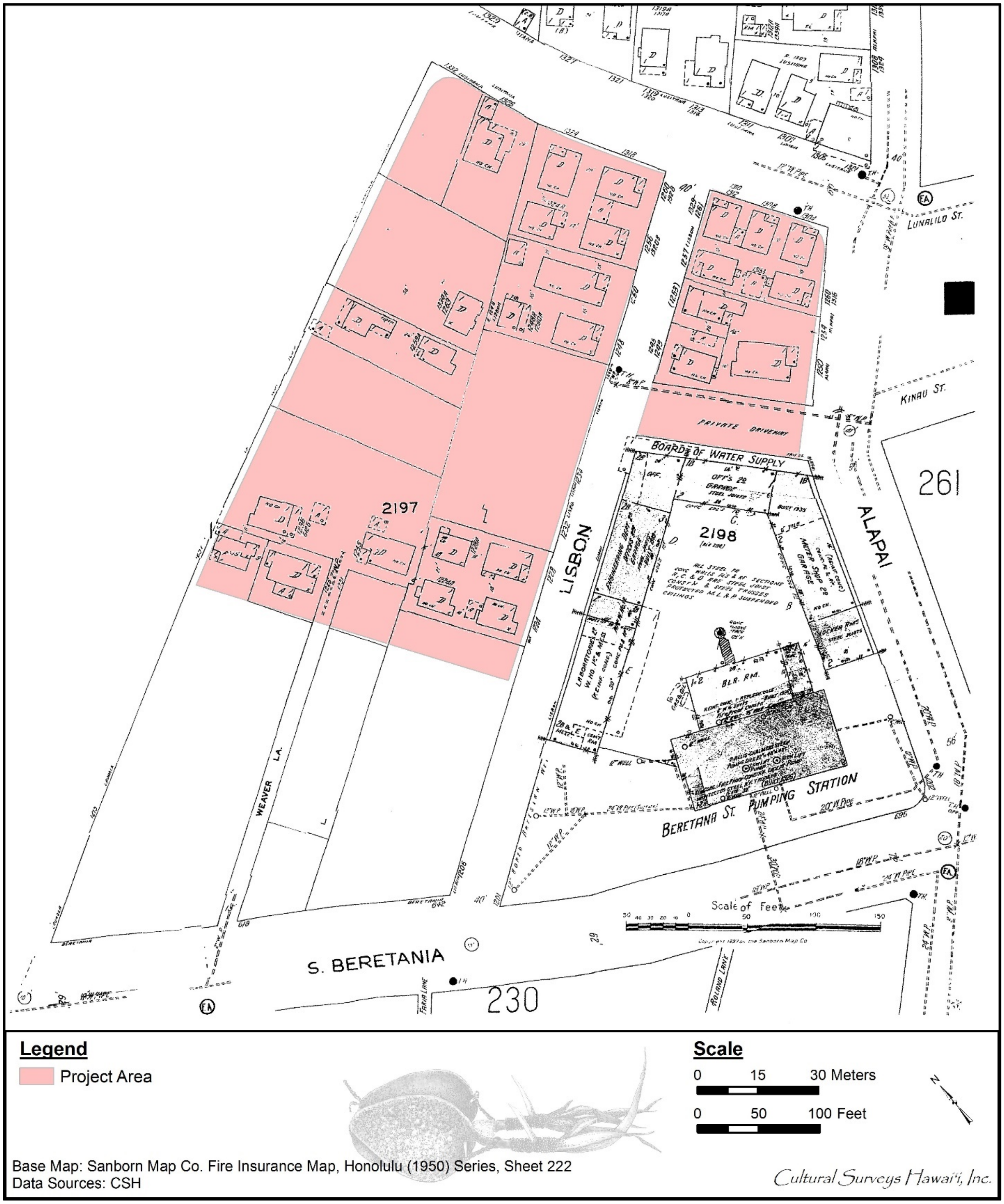

Figure 24. 1950 Sanborn Fire Insurance map showing outline of project area

Section 5 Previous Archaeological Research

The following is intended as an orientation to the archaeological potential of the current project area based on previous archaeological studies in the vicinity. It is not a comprehensive discussion of the previous archaeology for the entire *ahupua‘a*. Locations of these previous archaeology studies germane to the project area (within approximately 300 m) are illustrated in Figure 25 and summarized in Table 2. Previously identified historic properties near the project area (within approximately 300 m) are shown in Figure 26 and summarized in Table 3. Several significant historic properties and districts are near the project area, including

- Two National Historic Landmarks (NHL), Washington Place and Grounds (State Inventory of Historic Places [SIHP] # 50-80-14-1345) and ‘Iolani Palace and Grounds (SIHP # -9709); and
- One National Register of Historic Places (NRHP) Historic District, Capitol Historic District (SIHP # -1307), which is comprised of many buildings (including Washington Place and ‘Iolani Palace) and structures contributing to the historic district, some of which are also listed under individual SIHP numbers (see Figure 26 and Table 3).

5.1.1 Seelye 1968

In 1968, the Division of State Parks conducted salvage archaeology on the ‘Iolani Palace grounds to locate the foundations of Hale Akala, the Royal Bungalow (near the present-day location of the Barracks) and to search for other sites, including a possible *heiau* foundation (Seelye 1968). Hale Akala (the Pink House), built in 1882, was the personal residence of King Kalākaua; it was demolished in 1919. Two features, architectural/infrastructure remnants, were documented and numerous historic artifacts were recovered. Further data recovery was recommended. The features and artifacts were later included in SIHP # -4606, which includes all of the subsurface historic properties documented during the multiple archaeological studies conducted through the 1970s, and one in 1993, on the ‘Iolani Palace grounds.

5.1.2 Rosendahl 1971

In 1971, the Bishop Museum conducted an archaeological research project that focused on locating the remains of the roadbed surface of the old carriage road at the Hotel Street Gate to the ‘Iolani Palace Grounds (Rosendahl 1971). The old macadam carriage road was located beneath the existing asphalt road. Also, the concrete foundation of an old gate pier was identified beneath the asphalt road. The old carriage road was designated SIHP # -4606.

5.1.3 Cliver 1972

In the early 1970s, ‘Iolani Palace underwent a widespread restoration project that involved several archaeological and architectural studies in support of multiple projects. Cliver (1972) was a compendium of assorted data that included appendices of artifacts and faunal laboratory analysis from excavations for an electrical line; several stratigraphic profile drawings and photographs, project photographs, and artifact photographs; and transcribed (typewritten) field notes from ‘Iolani Palace moat wall waterproofing excavations. The features and artifacts described in this report were included under SIHP # -4606.

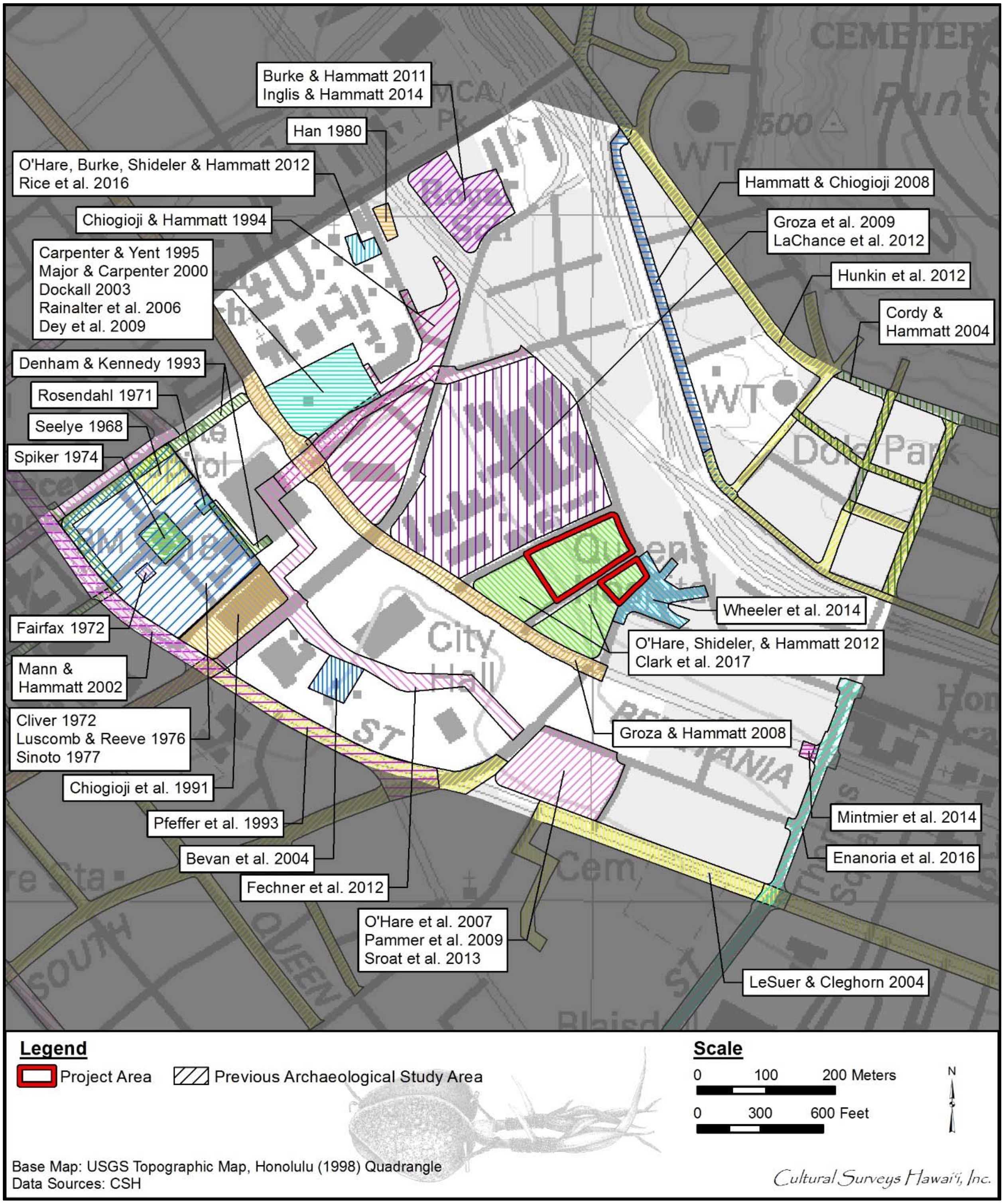

Figure 25. Previous archaeological studies near the project area (within approximately 300 m) on a portion of the 1998 Honolulu USGS 7.5-minute topographic quadrangle

Table 2. Previous archaeological studies near the project area (within approximately 300 m)

Reference	Type of Study	Location	Results (SIHP # 50-80-14****)
Seelye 1968	Archaeological excavation	ʻIolani Palace and Grounds	Excavation to determine location of Hale Akala, Royal Bungalow; only historic artifacts recovered, later included under SIHP # -04606
Rosendahl 1971	Archaeological excavation	ʻIolani Palace and Grounds	Excavation of old macadam Carriage Road; only historic artifacts documented, designated SIHP # -04606
Cliver 1972	Archaeological excavation, data compendium	ʻIolani Palace and Grounds	Archaeological excavation and compendium of assorted data from several archaeological and architectural studies in support of multiple projects during ʻIolani Palace restoration, included under SIHP # -04606
Fairfax 1972	Archaeological excavation	ʻIolani Palace and Grounds	Excavation to locate pathways of parterre garden; historic artifacts identified; portion of pathway identified; further excavation recommended to identify other portions of pathways, included under SIHP # -04606
Spiker 1974	Archeological salvage	ʻIolani Palace and Grounds	Several historical features (structural remnants) and numerous historical artifacts recovered, included under SIHP # -04606
Luscomb and Reeve 1976	Archaeological monitoring	ʻIolani Palace and Grounds	Numerous historic artifacts recovered, and features identified in top two stratigraphic sequences, included under SIHP # -04606
Sinoto 1977	Archaeological monitoring	ʻIolani Palace and Grounds	Historic artifacts found during monitoring, included under SIHP # -04606
Han 1980	Inadvertent discovery	Royal Queen Emma Apts, Vineyard and Pali Hwy, TMKs: [1] 2-1-018:042; 8-4-002	Two Hawaiian burials found during construction, designated SIHP # -02299
Chiogioji et al. 1991	Archaeological investigations	Hawaiʻi State Public Library Addition	Historic subsurface features and artifacts recovered, designated SIHP # -09959
Denham and Kennedy 1993	Archaeological monitoring	State Capitol Complex Telecommunication Conduits, Phase III	Two historic trash pits recorded, designated SIHP # -04606

Reference	Type of Study	Location	Results (SIHP # 50-80-14****)
Pfeffer et al. 1993	Archaeological summary	Kaka‘ako Improvement District 1, Kaka‘ako	Determined to be near boundaries of Honuakaha Cemetery
Chiogioji and Hammatt 1994	Archaeological assessment (no finds AIS)	8.4-acre parcel, Downtown Honolulu	No surface archaeological or historic features
Carpenter and Yent 1995	Archaeological monitoring	Washington Place and Grounds	Historic artifacts and two marine shells identified, included under SIHP # -09907 designation for Washington Place
Major and Carpenter 2000	Archaeological monitoring	Washington Place and Grounds	Historic artifacts identified during monitoring of sidewalk construction, designated SIHP # -05944
Nagata 2000	Archaeological monitoring	Washington Place and Grounds	No further work for sidewalk monitoring recommended
Mann and Hammatt 2002	Archaeological monitoring	King Street Rehabilitation project	One probable traditional Hawaiian burial identified and one historic pit with butchered bone recorded, designated SIHP # -06371
Dockall 2003	Archaeological inventory survey, monitoring	Washington Place and Grounds	Volcanic glass, basalt flakes, construction materials, phonograph record fragment, nineteenth century tobacco pipe stem, two-hole button recovered from 11 test units, included under SIHP # -09907 designation for Washington Place
Bevan et al. 2004	Archaeological monitoring	City Hall Annex Auditorium Restoration project	Excavations encountered modern trash
Cordy and Hammatt 2004	Archaeological monitoring	Punchbowl St Improvements	No historic properties identified
LeSuer and Cleghorn 2004	Archaeological assessment	King St and HECO Ward Ave Complex	Noted possibility of encountering fishponds beneath HECO Ward Ave Complex and human burials near Roman Catholic Cemetery bounded by Archer Lane, King St, and Ward Ave
Rainalter et al. 2006	Archaeological monitoring	Washington Place	No historic properties identified, previous research indicated subsurface historic and pre-Contact artifacts may still be present

Reference	Type of Study	Location	Results (SIHP # 50-80-14****)
O’Hare et al. 2007	Archaeological inventory survey, cultural impact evaluation	Alapai Transit Center-Joint Traffic Management Center	Documented historic trash pits, designated SIHP # -6901, and three human burials, designated SIHP # -06902
Groza and Hammatt 2008	Archaeological monitoring	Beretania St between North King and Alapa‘i streets	No archaeological or cultural deposits identified
Hammatt and Chiogioji 2008	Archaeological inventory survey	Kapālama to Honolulu, water main corridor	Two historic properties identified: late nineteenth century or early twentieth century Judd St bridge and Nu‘uanu Ave bridge
Dey et al. 2009	Archaeological monitoring	Improvements to walkways and irrigation systems at Washington Place	No significant archaeological deposits identified
Groza et al. 2009	Archaeological monitoring	Queen’s Medical Center Redevelopment project	Four trash pit features encountered, no historic properties identified
Pammer et al. 2009	Addendum to archaeological inventory survey (O’Hare et al. 2007)	Alapai Transit Center and Joint Traffic Management Center project	Three additional historic trash pit features of SIHP # -06901 documented and sampled
Burke and Hammatt 2011	Archaeological monitoring	Pacific Club, Vineyard Ave	Inadvertently discovered burial, SIHP # -07149, disinterred prior to monitoring, no cultural deposits identified
Fechner et al. 2012	Archaeological inventory survey	Portions of Kaka‘ako and Downtown Honolulu	No cultural deposits or historic properties identified
Hunkin et al. 2012	Archaeological monitoring	Phase 1 Kalihi/Nu‘uanu Sewer Rehabilitation project, Nu‘uanu, Pauoa	No cultural deposits identified, a single human bone fragment encountered in fill

Reference	Type of Study	Location	Results (SIHP # 50-80-14****)
LaChance et al. 2012	Archaeological monitoring	Queen’s Medical Center Redevelopment project	Four trash pit features encountered, no historic properties identified
O’Hare, Shideler, and Hammatt 2012	Literature review and field inspection	BWS Beretania Complex	No surface historic properties identified, recommended archaeological monitoring due to high probability of late nineteenth through 1930s subsurface burials and cultural deposits
O’Hare, Burke, Shideler, and Hammatt 2012	Archaeological assessment	Proposed American Cancer Society Hope Lodge	No cultural deposits identified
Sroat et al. 2013	Archaeological monitoring, burial preservation measures	Alapai Transit Center	Three additional historic trash pit features of SIHP # -06901 documented and sampled, burial preservation measures for SIHP # -06902 implemented
Inglis and Hammatt 2014	Archaeological monitoring	Pacific Club	No new historic properties identified
Mintmier et al. 2014	Archaeological monitoring	Ward Ave and South Beretania St	No historic properties identified, archaeological monitoring of future ground disturbance recommended
Wheeler et al. 2014	Archaeological monitoring	Kīnaʻu, Alapaʻi and Lusitana streets	No cultural material identified
Enanoria et al. 2016	Archaeological monitoring	Ward Ave between Kīnaʻu St and Kapiʻolani Blvd	No cultural material or historic properties identified, archaeological monitoring of future ground disturbance recommended
Rice et al. 2016	Archaeological monitoring	American Cancer Society’s Hope Lodge at 251 Vineyard St	One historic property identified during archaeological monitoring, designated SIHP # -7920, consisted of six component features: one inadvertently discovered historic coffin burial and five historic trash pits

Reference	Type of Study	Location	Results (SIHP # 50-80-14****)
Clark et al. 2017	Archaeological inventory survey	BWS Beretania Complex	Identified 63 archaeological features, including 44 above-ground features and 19 subsurface features within 21 test excavations; three SIHP site numbers assigned: • SIHP # -8038, a Native Hawaiian burial (Feature 1) encountered in a backhoe excavation designated as Trench 15 • SIHP # -8039, 18 historic subsurface features (Features 1–18) associated with residential use, including possible pits, post molds, a concentration of rusted metal, and a cobble concentration; subsurface features and Layer I of SIHP # -8039 yielded over 700 residential/ household artifacts from late 1800s through 1930s and small quantity of faunal remains • SIHP # -8040, 44 historic surface features (Features 1–33, 33.1–33.8, 34–36) and three historic buildings (Features 37–39)

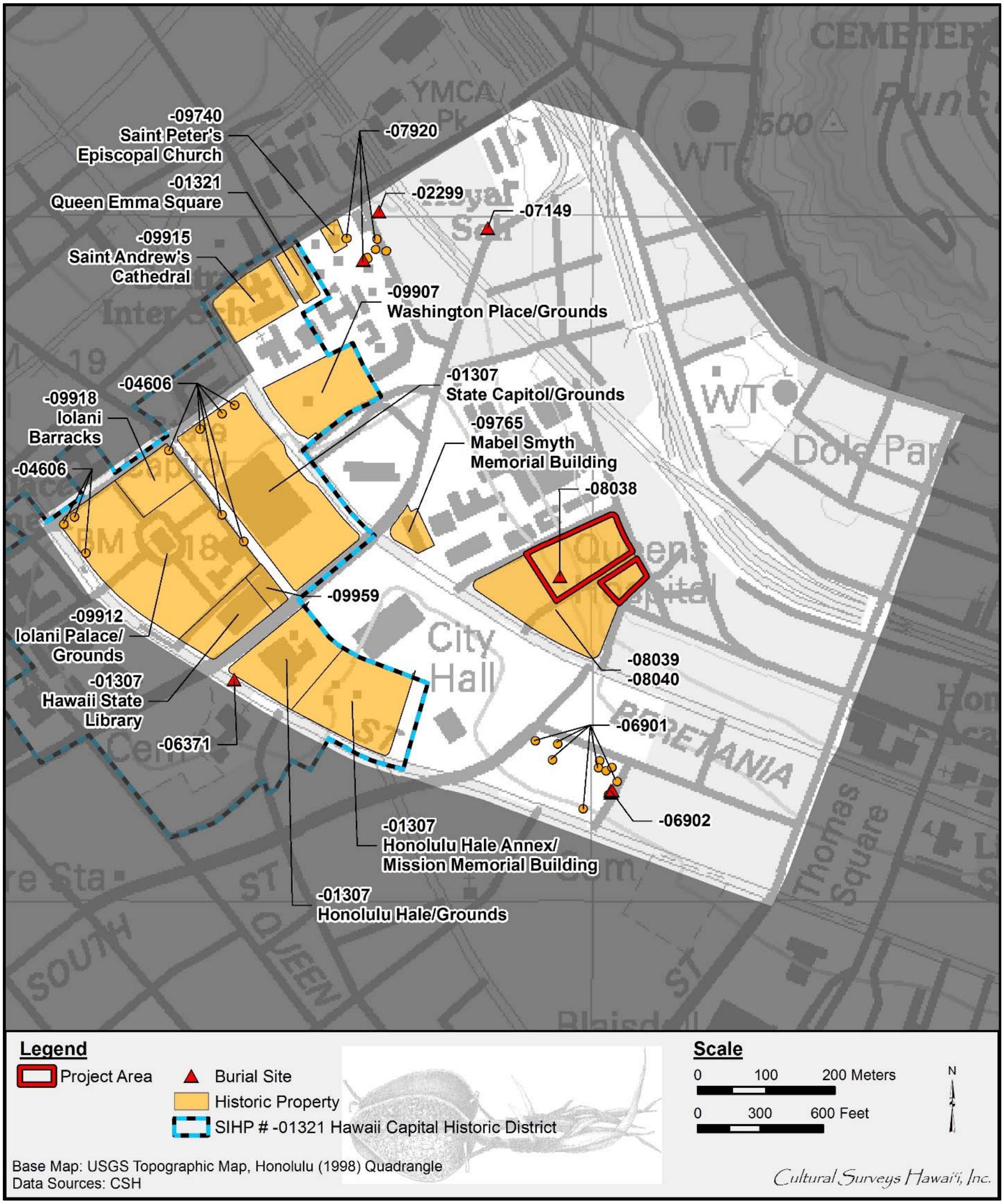

Figure 26. Previously identified historic properties near the project area (within approximately 300 m)

Table 3. Previously identified historic properties near the project area (within approximately 300 m; historic properties within the project area are bold)

SIHP # 50-80-14	Formal Type/Name	Description	Reference
-01307	Honolulu Hale and Grounds	Post-Contact, historic building and grounds, contributing to SIHP # -01307 Capitol Historic District	National Register of Historic Places Registration Form–Hawaii Capitol Historic District 1976
-01307	Honolulu Hale Annex/Mission Memorial Building	Post-Contact, historic building and grounds, contributing to SIHP # -01307 Capitol Historic District	National Register of Historic Places Registration Form–Hawaii Capitol Historic District 1976
-01307	Hawai‘i State Library	Post-Contact, historic building and grounds, contributing to SIHP # -01307 Capitol Historic District, also designated SIHP # -1352	National Register of Historic Places Registration Form–Hawaii Capitol Historic District 1976
-01307	Hawai‘i State Capitol and Grounds	Post-Contact, historic building and grounds, contributing to SIHP # -01307 Capitol Historic District	National Register of Historic Places Registration Form–Hawaii Capitol Historic District 1976
-01307	Hawai‘i Capitol Historic District	Post-Contact, NRHP Historic District	National Register of Historic Places Registration Form–Hawaii Capitol Historic District 1976
-01321	Queen Emma Square	Post-Contact, historic building and grounds, contributing to SIHP # -1307 Capitol Historic District, also designated SIHP # -1321	National Register of Historic Places Registration Form–Queen Emma Square 1973
-01321	‘Iolani Palace and Grounds	Post-Contact, historic building and grounds, NHL, contributing to SIHP # -01307 Capitol Historic District	National Register of Historic Places Registration Form–Iolani Palace 1988
-02299	Human burials	Two Native Hawaiian human burials	Han 1980
-04606	‘Iolani Palace and Grounds	Post-Contact, subsurface historic artifacts, infrastructure and structure remnants, and features	Seelye 1968; Rosendahl 1971; Cliver 1972; Fairfax 1972; Spiker 1974; Luscomb and Reeve 1977; Sinoto 1977; Denham and Kennedy 1993

SIHP # 50-80-14	Formal Type/Name	Description	Reference
-05944	Washington Place and Grounds	Post-Contact, historic artifacts, historic cultural material, coral cobbles, possible historic trash dump or demolished structure	Major and Carpenter 2000; Nagata 2000
-06371	Human burial	One Native Hawaiian human burial	Mann and Hammatt 2002
-06901	Historic subsurface features	Post-Contact, historic trash pits	O'Hare et al. 2007; Pammer et al. 2009; Sroat et al. 2013
-06902	Human burial	Post-Contact, three human burials	O'Hare et al. 2007; Sroat et al. 2013
-07149	Human burial	One Native Hawaiian human burial	Burke and Hammatt 2011
-07920	Human burial	Post-Contact, one coffin human burial	Rice et al. 2016
-08038	**Human burial**	**One Native Hawaiian human burial**	**Clark et al. 2017**
-08039	**Historic subsurface features**	**Post-Contact, subsurface historic residential features and artifacts from the late 1800s through the 1930s**	**Clark et al. 2017**
-08040	**Historic surface features**	**Post-Contact, historic surface features and three historic buildings from the late 1800s through 1958**	**Clark et al. 2017**
-09740	Saint Peter's Episcopal Church	Post-Contact, historic building and grounds	National Register of Historic Places Registration Form–St. Peter's Episcopal Church 1989
-09765	Mabel Smyth Memorial Building	Post-Contact, historic building and grounds	National Register of Historic Places Registration Form–Smyth, Mabel, Memorial Building 1993
-09907	Washington Place and Grounds	Post-Contact, historic building and grounds, NHL, contributing to SIHP # -01307 Capitol Historic District; multiple projects documented subsurface historic artifacts; included under SIHP # -09907 designation for Washington Place	Carpenter and Yent 1995; Major and Carpenter 2000; Dockall 2003; Rainalter et al. 2006; Dey et al. 2009

SIHP # 50-80-14	**Formal Type/Name**	**Description**	**Reference**
-09915	Saint Andrew’s Cathedral	Post-Contact, historic building and grounds, contributing to SIHP # -01307 Capitol Historic District	National Register of Historic Places Registration Form–St. Andrew’s Cathedral 1973
-09918	‘Iolani Barracks	Post-Contact, historic building and grounds, contributing to SIHP # -01307 Capitol Historic District	
-09959	Hawai‘i State Library Addition	Post-Contact, subsurface historic features and artifacts	Chiogioji et al. 1991

5.1.4 Fairfax 1972

As part of the ‘Iolani Palace restoration work, one trench was excavated on the ‘Ewa side of ‘Iolani Palace to expose the moat wall and locate remnants of road beds. This was a supplementary report to the 1971 Rosendahl report. The work documented historic fills, remnants of the old carriage road, a trench used during the construction of the moat wall, and an additional, unnamed road remnant by the old construction trench; all were included under SIHP # -4606.

5.1.5 Spiker 1974

As part of the ongoing restoration work at ‘Iolani Palace, an archaeological salvage project was conducted to extract as much data as practicable from an area around the moat wall that was going to be excavated for waterproofing (Spiker 1974). Eleven trenches were excavated and several historical structural remnants and numerous historical artifacts were documented during the study, all of which were included under SIHP # -4606.

5.1.6 Luscomb and Reeve 1976

In 1976, the Bernice Pauahi Bishop Museum (BPBM) completed archaeological monitoring of the installation of public utilities to the main palace building (Luscomb et al. 1976). Numerous historic artifacts were recovered and features were identified in the top two stratigraphic sequences; the third layer was culturally sterile. The artifacts and features were included under SIHP # -4606.

5.1.7 Sinoto 1977

In 1977, the BPBM completed archaeological monitoring of the installation of public utilities to the ‘Iolani Barracks (Sinoto 1977). Historic artifacts and features were identified in the top two stratigraphic sequences, and the third layer was culturally sterile. The artifacts and features were included under SIHP # -4606.

5.1.8 Han 1980

In 1980, the BPBM (Han 1980) reported on the inadvertent discovery of two Hawaiian burials at the Royal Queen Emma Apartments on Vineyard Avenue and the Pali Highway. The two burials were designated SIHP # -2299.

5.1.9 Chiogioji et al. 1991

CSH conducted archaeological investigations at the Hawai‘i State Public Library Addition site (SIHP # -9959) in 1991 (Chiogioji et al. 1991). The present library building was built in 1911 and opened in 1913. The investigations included preliminary test excavations and on-site monitoring during construction activities. These procedures revealed the presence of 16 features, two of which—a manhole shaft and a coral construction fill layer—were assessed as modern and related to maintenance or landscaping activities on the library grounds. The remaining 14 features—which included trash pits, privies, septic tanks, and a posthole—were determined to have dated from the last half of the nineteenth century to the first quarter of the twentieth century, when the project area was incorporated into the Library of Hawai‘i grounds.

A total of 344 historic-era artifacts were recovered from the features and from random localities within the project area. Sixty-five percent of the artifacts were glass and included many whole champagne, liquor, beer, soda, medicine, and perfume bottles. These bottles provided the clearest evidence dating features within the project area to the period between the 1880s and the 1920s. Historical research conducted by CSH suggested this was the period when the project area was most likely to have been intensively utilized (Chiogioji et al. 1991).

5.1.10 Denham and Kennedy 1993

In 1993, Archaeological Consultants of Hawaiʻi, Inc., conducted archaeological monitoring for excavations within the State Capitol Complex, including on the grounds of ʻIolani Palace (Denham and Kennedy 1993). Two sites were identified, SIHP #s -4605, on the grounds of the Keʻelikōlani Building, and -4606, on the grounds of ʻIolani Palace. SIHP # -4605 is a multi-component site with an historic trash pit, a ditch, a pit, a fire pit, six postholes, and a burial. The fire pit was dated to AD 1390-1700, and the posthole dated to AD 830-1330. SIHP # -4606 consisted of nine historic trash pits. Only one traditional artifact, a drilled *Nerita* shell, was found. The rest of the artifacts were all historic, dating to the late nineteenth and twentieth centuries.

5.1.11 Pfeffer et al. 1993

From April 1986 to August 1988, CSH conducted archaeological monitoring for the Kakaʻako Improvement District 1 construction (Pfeffer et al. 1993). Four burial site areas were located, two cemeteries and two isolated burials. The cemetery found on Queen Street (SIHP # -4534) contained 116 sets of remains. The cemetery found on South Street/Quinn Lane (SIHP # -3712) contained 31 sets of remains. Two isolated burials were found on Punchbowl Street (SIHP # 4532) and on Halekauwila Street (SIHP # -4533). A total of 147 burials were encountered in Kakaʻako Improvement District 1. Other archaeological and historic features were noted and recorded during monitoring: historic trash layers, historic cultural layers, and fill layers associated with the urbanization of the Kakaʻako area.

5.1.12 Chiogioji and Hammatt 1994

In 1994, CSH conducted an archaeological assessment (archaeological inventory survey [AIS] with no finds) of an 8.4-acre parcel between Punchbowl, Miller, and Beretania streets, which is the triangular block directly west of The Queen's Medical Center (on the opposite side of Punchbowl Street) (Chiogioji and Hammatt 1994). No surface structures or remnants of archaeological concern were identified in the project area. However, background research did indicate pre-Contact and historic artifacts and cultural deposits could be found intact during subsurface excavations.

On these grounds now are the Department of Health Building (Hale Kīnaʻu), the Armed Forces Memorial, and a roadway connecting Punchbowl Street to the underground parking area of the State Capitol Building via a tunnel under Beretania Street. Eight LCA parcels were claimed within this property, including two for foreign residents, Henry Farmer and Stephen Reynolds. Farmer took possession of the land in the 1820s and built a house on the property; Reynolds acquired his land in the 1840s and lived there with his family. By 1892, this area was called the "Miller Street Block" and was fully developed as a residential block of downtown Honolulu.

5.1.13 Carpenter and Yent 1995

In 1995, Division of State Parks archaeologists monitored kennel construction at Washington Place (Carpenter and Yent 1995). Subsurface excavations, consisting of six footings and two shallow trenches, revealed no cultural deposits yet yielded a small collection of historic artifacts comprised of ceramic, glass, and metal fragments dating from the early nineteenth century up to the recent past (SIHP # -09907). The majority of artifactual material recovered dated from the nineteenth century and appears to be associated with occupation of the residence by the Dominis family and Queen Lili‘uokalani. In addition, recovery of two shells of traditional marine shell food species, according to the report, “although secondarily deposited, does provide evidence for the archaeological potential of the grounds, even at relatively shallow depth . . . and suggests that there may be intact cultural deposits, refuse pits, etc. buried within the compound” (Carpenter and Yent 1995:12).

5.1.14 Major and Carpenter 2000 / Nagata 2000

In 2000, during the placement of footings and foundation material for the construction of sidewalks in compliance with the Americans with Disabilities Act (ADA), Division of State Parks archaeologists again monitored ground-disturbing activity at Washington Place (Major and Carpenter 2000). Consistent with previous findings, the three excavation trenches yielded historic artifacts, including metal, glass, and building materials. No indigenous artifacts were collected. A higher density of historic cultural material and coral cobbles found in the *makai* halves of Trenches 1 and 3 indicated a possible dump or demolished structure, and the area was designated SIHP # -05944. Due to historic disturbance and the lack of significant cultural deposits, no further work was recommended (Nagata 2000).

5.1.15 Mann and Hammatt 2002

Archaeological monitoring was carried out between August 2001 and June 2002 by CSH for the King Street Rehabilitation project (Mann and Hammatt 2002). During the course of monitoring, one human burial (SIHP # -6371) was recovered near the intersection of South King Street and Punchbowl Street, *makai* of Honolulu Hale. In addition to the human burial, a pit feature contained nonhuman skeletal remains. The pit appeared to have been used for disposing of butchered animal remains.

5.1.16 Dockall 2003

In 2003, the BPBM conducted an AIS to locate, identify, and assess the significance of subsurface cultural materials within the portion of the Washington Place grounds *mauka* and Diamond Head of the current residence to be impacted by construction of the proposed new Governor’s residence. Eleven 1.0 m by 0.5 m test units were excavated and, despite extensive subsurface investigations, the only indigenous artifacts collected were a few scattered volcanic glass and basalt flakes. According to the excavation summary (Dockall 2003):

> . . . much of the area is composed of three basic strata. Layer I is composed of turf or grass cover and occasional artifacts of various time periods. Layer II is the primary artifact-bearing layer but is similar in overall structure and appearance to Layer I with the exception of fewer roots and more artifacts. Layer III in most areas is a volcanic cinder that is fairly close to the surface in most areas . . . Layer II contains a mix of artifacts from different time periods. Within every test unit, Layer II yielded primarily nineteenth and twentieth century artifacts related to domestic uses and construction-related debris. Artifact types include window glass fragments, ceramics (Japanese and English/American), machine-cut and wire nails, glass bottle fragments, plastic, and rubber fragments. [Dockall 2003:14–15]

In addition, three personal items collected consisted of a phonograph record fragment, a nineteenth century tobacco pipe stem, and an early twentieth century two-hole button (Dockall 2003:37). Due to the high level of historic ground disturbance, the cultural materials collected provided little insight into particular residential and building activities.

Based on the results of the inventory survey, the following recommendation for archaeological monitoring was provided:

> The Miller property is unique in that its nineteenth century buildings were spread out over the parcel, leaving open spaces, providing some measure of protection for underlying deposits. It is possible that intact native Hawaiian cultural deposits may still exist; therefore, it is recommended that any construction or ground altering processes be monitored to mitigate impacts to cultural resources. [Dockall 2003:43]

5.1.17 Bevan et al. 2004

Archaeological Consultants of the Pacific, Inc. conducted archaeological monitoring for the City Hall Annex Auditorium restoration from May 2003 to January 2004 (Bevan et al. 2004). During monitoring, modern trash was encountered, as well as multiple active utility lines.

5.1.18 Cordy and Hammatt 2004

CSH (Cordy and Hammatt 2004) completed archaeological monitoring for the Punchbowl Water System Improvements project, located on the south slope of Punchbowl, and included work on portions of Prospect Street, Prospect Place, Mauna Ihi Place, Magazine Street, Spencer Avenue, Avon Way, Ward Avenue, Victoria Street, and Emerson Street. No historic properties were identified, however, the stratigraphy did contain evidence of prehistoric or early historic land use.

5.1.19 LeSuer and Cleghorn 2004

In 2004, Pacific Legacy, Inc. (LeSuer and Cleghorn 2004) conducted an archaeological assessment for the HECO East O‘ahu Transmission project. Historic documents and previous archaeological studies were reviewed to determine the potential for encountering archaeological sites during construction. The assessment noted the possibility of encountering fishponds beneath the HECO Ward Avenue Complex and human burials near the Roman Catholic Cemetery bounded by Archer Lane, King Street, and Ward Avenue.

5.1.20 Rainalter et al. 2006

In 2005, CSH conducted archaeological monitoring for a health and safety improvements project at Washington Place (Rainalter et al. 2006). No historic properties were observed during the project. However, based on previous research in and around the project area, it was stated that historic and possibly pre-Contact artifacts may still lie below the surface.

5.1.21 O’Hare et al. 2007

CSH performed an AIS and cultural impact evaluation for the Alapai Transit Center and Joint Traffic Management Center project (O’Hare et al. 2007). Fieldwork took place in December 2006, January 2007, and June 2007. Twenty-eight test trenches were excavated, documented, and sampled. Two sites were identified within the project area. SIHP # -6901 consisted of four historic trash pits dating from between 1820 and 1920. SIHP # -6902 consisted of three burials.

Burials 1 and 2 were historic coffin interments. In the case of Burial 3, the presence or absence of a coffin was not determined.

5.1.22 Groza and Hammatt 2008

In 2008, CSH (Groza and Hammatt 2008), completed archaeological monitoring for the Beretania Street Rehabilitation project, a portion of which is located adjacent and south of the project area. No archaeological cultural deposits were identified. No evidence of pre-Contact land use was present, although most of the soils encountered directly beneath the asphalt road surface or the concrete sidewalk were fill soils indicating a significant amount of the natural ground surface had been altered or displaced. Those areas excavated beneath the fill contained volcanic cinder.

5.1.23 Hammatt and Chiogioji 2008

In 2006, CSH performed an AIS of the proposed Board of Water Supply Kalihi Beretania 24-inch Water Main project (Hammatt and Chiogioji 2008). No surface historic properties related to traditional Hawaiian culture were identified within the project area corridor. The fieldwork and follow-up research identified two historic properties, the Judd Street and the Nu‘uanu Avenue bridges.

5.1.24 Dey et al. 2009

CSH conducted archaeological monitoring between September 2008 and October 2008 (Dey et al. 2009). The ground disturbance occurred within Washington Place grounds and in close proximity to the Washington Place structures (SIHP # -9907). No significant archaeological deposits were exposed during the project-related excavations.

5.1.25 Groza et al. 2009

Three phases of monitoring were conducted within The Queen’s Medical Center campus (Groza et al. 2009). All project-related archaeological monitoring was carried out by CSH archaeologists. During Phase I, no cultural deposits were identified, however, historic trash, building materials, and one animal bone were observed within fill material. During the course of Phase II monitoring, two trash pits were encountered. Phase III monitoring yielded two trash pit features. One feature contained broken bottles and refuse; the other feature contained sea urchin, *‘opihi*, and broken bottles.

5.1.26 Pammer et al. 2009

Pammer et al. (2009) was an addendum following the O’Hare et al. (2007) study after project plans were revised and the proposed building footprints were changed and relocated. The addendum was prepared to address the project redesign. Fieldwork for this AIS addendum was accomplished between 17 and 20 August 2009. Three additional historic trash pit features of SIHP # -6901 were identified, documented, and sampled.

5.1.27 Burke and Hammatt 2011

One Native Hawaiian human burial (SIHP # -7149) was encountered during facility and utility upgrades on the Pacific Club property. Following the inadvertent discovery, CSH (Burke and Hammatt 2011) was asked to prepare an archaeological monitoring plan and subsequently conducted archaeological monitoring of ground disturbing activities. No new historic properties, including human burials, were encountered during monitoring. Upon permission from the SHPD, the Pacific Club planned to disinter and reinter the human burial on another part of the property (Burke and Hammatt 2011:45-50).

5.1.28 Fechner et al. 2012

Pacific Legacy, Inc. (Fechner et al. 2012) conducted an AIS in support of the Honolulu Seawater Air Conditioning project in portions of Kakaʻako and downtown Honolulu. The AIS was conducted through subsurface testing, consisting of archaeological monitoring of keyholing activities along the proposed routes. Archaeological monitoring during all keyholing activities was necessary due to previously encountered human burials and both pre-Contact and historic cultural deposits near the project area. Nine of the keyholes contained historic cultural material. No subsurface archaeological features were encountered. A diagnostic sample of historic artifacts was collected and consisted mostly of broken glass bottles and ceramic fragments. A variety of construction debris and existing utilities was encountered but determined not significant. No pre-Contact period cultural material or human skeletal remains were encountered, and no new historic properties were identified.

5.1.29 Hunkin et al. 2012

CSH (Hunkin et al. 2012) completed archaeological monitoring for Phase 1 of the Kalihi/Nuʻuanu Sewer Rehabilitation project. Archaeological monitoring nearest to the current project area included multiple streets in Area 6 – Punchbowl and Area 7 – Punchbowl South. No historic properties were identified. The project area's subsurface deposits were disturbed by past land use, which included extensive earthmoving activities and importing fill into the project area. A single, isolated, human skeletal fragment was encountered in fill material during excavation in Area 6.

5.1.30 LaChance et al. 2012

CSH (LaChance et al. 2012) conducted archaeological monitoring in support of The Queen's Medical Center Redevelopment project, Honolulu. The Queen's Medical Center project included construction of a new four-story generator building, trenching for the installation of the new electrical line and switch pad at Miller Street, trenching for the installation of the new grease interceptor, trenching to tie into the sewer line, and trenching for utilities and excavation to expand the basement of the existing library building. Four trash pit features were encountered during construction work; contents included historic glass bottles (complete and broken), ceramic fragments, a few pieces of metal, numerous butcher-cut faunal remains (mostly cow), some marine shell (urchin and *ʻopihi*), and some construction and demolition debris (both modern and historic). Sediments generally consisted of fills and some volcanic cinders. No historic properties were identified.

5.1.31 O'Hare, Shideler, and Hammatt 2012

CSH (O'Hare, Shideler, and Hammatt 2012) completed an archaeological literature review and field inspection (LRFI) report for the Technical Advisory Services project for the development of the Board of Water Supply Beretania property, Honolulu. No historic properties were noted during the field inspection. Based on background research, the report stated a high probability for the presence of subsurface pre-Contact and/or eighteenth and nineteenth century burials and cultural deposits associated with the use of the land for habitation. The report also concluded there may also be trash deposits associated with the twentieth century use of the property by the BWS, which built a pump station on the lot in 1894. CSH recommended an archaeological monitoring program during any future construction that involved subsurface disturbance or excavation to a depth greater than 12 inches.

5.1.32 O'Hare, Burke, Shideler, and Hammatt 2012

CSH (O'Hare, Burke, Shideler, and Hammatt 2012) conducted an AIS of a 0.34-acre parcel located at 251 Vineyard Street in Honolulu for the American Cancer Society Hope Lodge. A 100% pedestrian inspection of the project area was undertaken for historic property identification and documentation. The project also included a subsurface testing program and seven test trenches were excavated. No historic properties were identified within the project area, which is characterized by extensive disturbance. Because no historic properties were identified within the project area, the project was termed an archaeological assessment per HAR §13-284-5 (b)5(A).

5.1.33 Sroat et al. 2013

CSH (Sroat et al. 2003) completed archaeological monitoring of the Alapai Transit Center and Joint Traffic Management Center project. The project area consisted of the existing Alapai Transit Center, located at 710 and 752 South King Street, bounded by King Street to the south (*makai*), Alapaʻi Street to the west, the *mauka* edge of Hotel Street to the north, and Kealamakai Street to the east. The monitoring program identified three additional features of SIHP # -6901. Features 8–10 consist of three historic trash pits containing residential refuse of a predominantly European origin, dating to the mid-1800s to early 1900s. Burial preservation measures described in the project's burial treatment plan (O'Hare et al. 2008), were also implemented as part of the monitoring program, during project construction.

5.1.34 Inglis and Hammatt 2014

CSH conducted archaeological monitoring (Inglis and Hammatt 2014) for a clubhouse renovation project at the Pacific Club. The clubhouse renovation project involved trenching to accommodate new electric and gas lines, as well as excavation for walk-in freezer/cooler footings, a building access ramp, and a chairlift. Human skeletal remains (SIHP # -7149) were previously identified in the project area in 2010.

Observed stratigraphy consisted of multiple layers of fill underlying grass landscaping, asphalt pavement, and/or base course of structural foundations. Only two out of six excavations were deep enough to encounter natural sediment. Fill layers of either dark reddish-brown clay loam or dark yellowish-brown, silty clay loam were found throughout the project area. Artifacts identified in the field were noted and documented as part of imported fill deposits of the site. Diagnostic marks and manufacture methods dated artifacts from the late 1800s to the late 1950s. No inadvertent burials were encountered. No new historic properties were identified. Due to past burial discoveries on the property, it is recommended that archaeological monitoring occur during any future renovations and/or redevelopment that requires subsurface work.

5.1.35 Mintmier et al. 2014

Pacific Consulting Services, Inc. (Mintmier et al. 2014), conducted archaeological monitoring of all ground disturbing activities in support of traffic infrastructure improvements at the intersection of Ward Avenue and South Beretania Street. No historic properties were encountered during archaeological monitoring; however, because of the proximity of human burials previously identified in the surrounding area during prior investigations, archaeological monitoring for any future ground disturbing activities was recommended.

5.1.36 Wheeler et al. 2014

CSH conducted archaeological monitoring for the Electrical Duct Line Trenching project at the intersection of Kīnaʻu, Alapaʻi and Lusitana streets, adjacent and east of the BWS lots. During archaeological monitoring, no cultural material and/or historic deposits were identified. In general, stratigraphy within the project area consisted of one to three fill layers overlying natural silty clay loam and black sand/cinder sediments. Fill sediments extended to a depth of approximately 140 cmbs (centimeters below surface). No artifacts were observed in the trench excavations.

5.1.37 Enanoria et al. 2016

CSH (Enanoria et al. 2016) conducted archaeological monitoring of the BWS Water Main Replacement project which consisted of a 40-m wide corridor from the intersection of Ward Avenue and Kīnaʻu Street to the intersection of Ward Avenue and Kapiʻolani Boulevard. Due to prior disturbance of construction related activities there were no cultural deposits or historic properties identified; however, archaeological monitoring was recommended for any future ground disturbance within the project area due to the presence of undisturbed cinder deposits as well as significant cultural deposits, including human burials identified during previous investigations.

5.1.38 Rice et al. 2016

CSH (Rice et al. 2017) conducted archaeological monitoring of the construction of the American Cancer Society's Hope Lodge at 251 Vineyard Street. The project consisted of approximately 20 residential units on two floors above a ground-floor parking level and ground disturbance included excavations for foundations, drywells, an elevator, associated utilities (e.g., water and electrical lines), and landscaping (e.g., irrigation and planting). One historic property, SIHP # -7920, was identified during the project's archaeological monitoring program. SIHP # -7920 consists of six component features. Feature A is an inadvertently discovered historic coffin burial; Features B through F are historic refuse disposal pits containing glass bottle fragments, ceramic fragments, faunal osseous remains, nails, and charcoal.

5.1.39 Clark et al. 2017

Pacific Consulting Services, Inc. (PCSI; Clark et al. 2017) conducted an AIS in support of the proposed construction of photovoltaic (PV) arrays for the BWS' Energy Savings Performance Contracting (ESPC) project that included 58 BWS facilities on Oʻahu. The AIS work was carried out within the current project area 1 and the BWS property that contains the Pump House and Engineering Building, southwest of the current project area 2. The purpose of the AIS was to identify and record any historic properties within the Area of Potential Effect (APE).

In an 18 October 2016 letter (Log. No: 2016.02181; Doc. No: 1610GC09), SHPD required the AIS in response to recommendations provided in a draft report (Vernon et al. 2016). In conjunction with Vernon et al.'s report, Mason Architects, Inc. (MAI) conducted an architectural assessment of the buildings and other structures for the 58 BWS sites that comprised BWS's ESPC project.

The AIS consisted of a pedestrian survey and subsurface testing program. Sixty-three archaeological features were identified during the AIS, including 44 above-ground features and 19 subsurface features identified within 21 test excavations (Clark et al. 2017:186–188, 190–193).

Three SIHP site numbers were assigned to the historic properties (see Figure 27) and all three historic properties were assessed as significant under Section 106 of the National Historic Preservation Act (NHPA) as well as under §6E and were assessed as eligible for inclusion on the National Register of Historic Places (NRHP) and Hawaiʻi Register of Historic Places (HRHP). The three previously identified historic properties in the current project area are as follows:

- SIHP # -8038, a Native Hawaiian burial (Feature 1) encountered in a backhoe excavation designated as Trench 15; eligible under Criterion D (NRHP/HRHP) and significant under Criteria d and e.
- SIHP # -8039, 18 historic subsurface features (Features 1–18) associated with residential use, and including possible pits, post molds, a concentration of rusted metal, and a cobble concentration. Subsurface features and Layer I of SIHP # -8039 yielded over 700 residential/household artifacts from the late 1800s through the 1930s and a small quantity of faunal remains; eligible under Criterion D (NRHP/HRHP) and significant under Criteria d.
- SIHP # -8040, 44 historic surface features (Features 1–33, 33.1–33.8, 34–36) and three historic buildings (Features 37–39); eligible under Criteria A, C, and D (NRHP/HRHP) and significant under Criteria a, c, and d.

Under HRS §6E8 and its implementing regulations, HAR §13-275-7(2), the AIS report recommended "effect with proposed mitigation commitments" in the form of preparation of a burial treatment plan (BTP) and archaeological monitoring for SIHP # -8038, and archaeological monitoring for SIHP #s -8039 and -8040. Under Section 106 and its implementing regulations 36 CFR §800, the AIS report recommended "no adverse effect" on historic properties eligible for listing on the NRHP, as the mitigation commitments recommended under §6E would mitigate any adverse effect to the three historic properties.

In August 2018, a BTP for SIHP # -8038 (Clark and Collins 2017) was approved by the Oʻahu Island Burial Council (OIBC). Long-term protection and preservation measures for SIHP # -8038 included preservation of the burial in place, a burial preserve area with a buffer, a metes and bounds survey that recorded the burial preserve with the Bureau of Conveyances (BOC) to create a permanent preservation easement on the property, construction of an enclosure wall around the perimeter of the burial preserve, and establishment of site visitation protocols (Clark and Collins 2017:35). The metes and bounds survey was performed on 5 June 2017 and the burial preserve was recorded with the BOC (Clark and Collins 2017: Appendix B). It appears there is a discrepancy between PCSI's plotting of SIHP # -8038 (which appears to be correct) and the metes and bounds survey map (which appears to be incorrect). The burial preserve area is intended to encompass parking stall #76 (Clark and Collins 2017:35), however, as it is plotted on the metes and bounds survey map, it does not align with the parking stall. As shown in Figure 27, the burial preserve area as depicted on the metes and bounds survey map is located approximately 16.7 m (57.8 ft) northeast of SIHP # -8038 (Clark and Collins 2017:32, Appendix B).

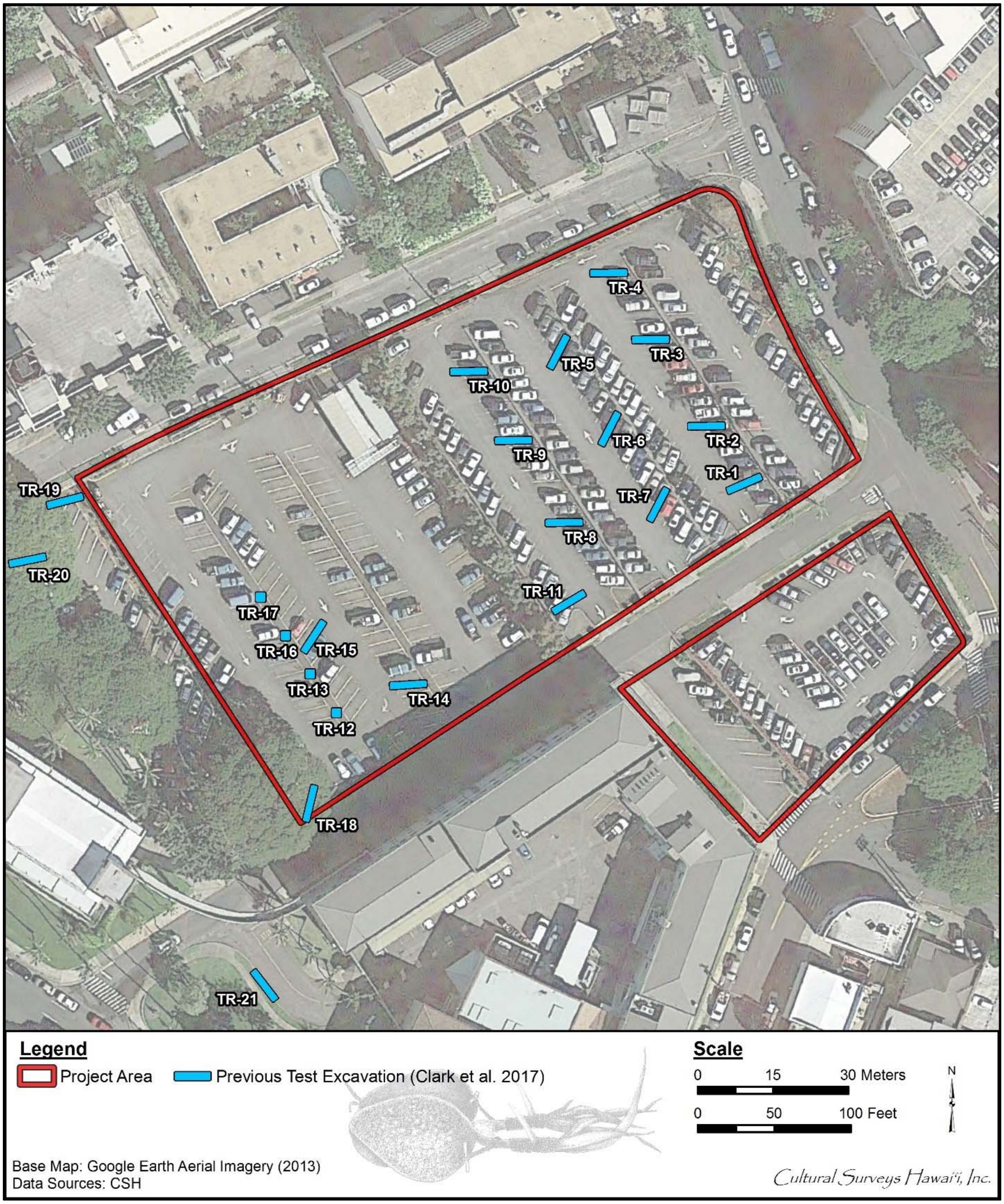

Figure 27. Aerial photograph (Google Earth 2013) of project area showing previous AIS test excavations (Clark et al. 2017:41) and SIHP # -8038 with overlay of metes and bounds survey map of burial preserve area (Clark and Collins 2017: Appendix B)

Section 6 Community Consultation

6.1 Introduction

Throughout the course of this assessment, an effort was made to contact and consult with Native Hawaiian Organizations (NHOs), agencies, and community members including descendants of the area, in order to identify individuals with cultural expertise/and or knowledge of the *ahupua‘a* where the project areas are located. CSH initiated its outreach effort in November 2018 through letters, email, telephone calls, and in person contact. CSH completed the community consultation in June 2019.

6.2 Community Contact Letter

Letters (Figure 28, Figure 29, Figure 30) along with a map and aerial photograph of the project were sent with the following text:

> At the request of HHF Planners, on behalf of the Board of Water Supply (BWS), Cultural Surveys Hawai‘i, Inc. (CSH) is conducting a cultural impact assessment (CIA) for the BWS Beretania Complex Redevelopment project, Honolulu Ahupua‘a, Honolulu District, O‘ahu, Hawai‘i, TMKs: [1] 2-1-036:001 and 005. The total project area is approximately 128,100 square feet (sq ft). The project area is a portion of the BWS Beretania Complex property, which is bounded by Beretania Street to the south, Lauhala Street to the west, Lusitana Street to the north, and Alapai Street to the east. Although the 6.3-acre Beretania Complex property is City-owned, it's under the control and use of BWS and consists of three tax map parcels: TMKs: [1] 2-1-036:001, 004, and 005. The Beretania Complex is bisected by Lisbon Street, which divides the complex into an "Ewa Block" and a "Diamond Head Block." The project area is depicted on a portion of the Honolulu (1998) U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle and a 2013 Google Earth aerial photograph.
>
> BWS will be issuing a Request for Proposals (RFP) to redevelop a portion of the Beretania Complex. The purpose of this action is to provide a revenue stream for BWS to help offset a portion of its operating expenses and capital improvement costs. The redeveloped area would not include the existing BWS Public Service Building, Engineering Building, and Pump Station Building. The selected developer will be issued a ground lease for the use of the property and will be allowed to redevelop the site, subject to the conditions of the lease. The maximum lease term would be 65 years. At the end of the lease, full ownership and control over the property and improvements constructed would revert to BWS. The specific redevelopment plan will be determined by the developer. Implementation of the proposed action will involve the use of public lands and funds and, therefore, will be subject to the requirements of Hawai‘i Revised Statutes (HRS) §343 and Hawai‘i Administrative Rules (HAR) §11-200.
>
> .

Cultural Surveys Hawai'i, Inc.
Archaeological and Cultural Impact Studies
Hallett H. Hammatt, Ph.D., President

P.O. Box 1114 Kailua, Hawai‘i 96734 Ph: (808) 262-9972 Fax: (808) 262-4950

Job code: HONOLULU 86 ktanaka@culturalsurveys.com www.culturalsurveys.com

October 2018

Aloha,

At the request of HHF Planners, on behalf of the Board of Water Supply (BWS), Cultural Surveys Hawai‘i, Inc. (CSH) is conducting a cultural impact assessment (CIA) for the BWS Beretania Complex Redevelopment project, Honolulu Ahupua‘a, Honolulu District, O‘ahu, Hawai‘i, TMKs: [1] 2-1-036:001 and 005. The total project area is approximately 128,100 square feet (sq ft). The project area is a portion of the BWS Beretania Complex property, which is bounded by Beretania Street to the south, Lauhala Street to the west, Lusitana Street to the north, and Alapai Street to the east. Although the 6.3-acre Beretania Complex property is City-owned, it's under the control and use of BWS and consists of three tax map parcels: TMKs: [1] 2-1-036:001, 004, and 005. The Beretania Complex is bisected by Lisbon Street, which divides the complex into an “Ewa Block” and a “Diamond Head Block.” The project area is depicted on a portion of the Honolulu (1998) U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle and a 2013 Google Earth aerial photograph (Figure 1 and Figure 2).

BWS will be issuing a Request for Proposals (RFP) to redevelop a portion of the Beretania Complex. The purpose of this action is to provide a revenue stream for BWS to help offset a portion of its operating expenses and capital improvement costs. The redeveloped area would not include the existing BWS Public Service Building, Engineering Building, and Pump Station Building. The selected developer will be issued a ground lease for the use of the property and will be allowed to redevelop the site, subject to the conditions of the lease. The maximum lease term would be 65 years. At the end of the lease, full ownership and control over the property and improvements constructed would revert to BWS. The specific redevelopment plan will be determined by the developer. Implementation of the proposed action will involve the use of public lands and funds and, therefore, will be subject to the requirements of Hawai‘i Revised Statutes (HRS) §343 and Hawai‘i Administrative Rules (HAR) §11-200.

BWS is preparing a Environmental Impact Statement (EIS) to evaluate the following three (3) potential development scenarios, all of which could be implemented under the property's existing A-2 Medium Density Apartment zoning.

- Scenario 1: Assisted care living facility and office building
- Scenario 2: Affordable senior rental apartments and office building
- Scenario 3: Parking structure and office building

All three scenarios show a new BWS office building (ten stories, plus one story of parking below grade) near the corner of Alapai and Lusitana Streets. All scenarios also include a larger multi-level parking structure between Lisbon and Lauhala Streets. This structure would replace BWS's lost ground level parking and support the proposed residential uses.

Figure 28. Community consultation letter, page one

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Page 2

The main component of Scenario 1 is an assisted living facility located in the northwest corner of the property. Assisted living is a form of residential care for seniors that provides residents with as much independence as they want, but with available personal care and support services. Assisted living communities do not offer complex medical services and are considered non-medical facilities.

The concept plan being evaluated in the EIS shows an assisted living facility with ten floors. The ground floor and a portion of the second floor would be used for amenities and utilities. Upper floors would consist of living units and an activity room on each floor. Parking for employees, residents, and guests would be provided in the adjacent ten-floor parking structure.

Scenario 2 includes the development of senior rental apartments in the northwest corner of the property. These would be rent-controlled apartments for individuals 60 to 65 years and older. In contrast to Scenario 1, there would be no on-site support services for residents, other than standard building security and maintenance.

The concept plan shows the building footprint for two ten-story buildings. The ground floor and a portion of the second floor of each building would most likely be used for amenities and utilities. Residential units would be located on the upper floors. Parking would be provided in the adjacent ten-floor parking structure.

Under Scenario 3, there would be no residential component on the property. The northwest corner of the property, near the intersection of Lauhala and Lusitana Streets, would remain as ground level parking. The proposed parking structure off Lauhala Street would be ten floors but larger in footprint, with some stalls for BWS use and others available for lease.

The purpose of this CIA is to gather information about the project area and its surroundings through research and interviews with individuals knowledgeable about this area in order to assess potential impacts to the cultural resources, cultural practices, and beliefs identified as a result of the planned project. We are seeking your *kōkua* and guidance regarding the following aspects of our study:

- **General history as well as present and past land use of the project area**
- **Knowledge of cultural sites that may be impacted by future development of the project area—for example, historic and archaeological sites, as well as burials.**
- **Knowledge of traditional gathering practices in the project area, both past and ongoing.**
- **Cultural associations of the project area, such as *moʻolelo* and traditional uses.**
- **Referrals of *kūpuna* or elders and *kamaʻāina* who might be willing to share their cultural knowledge of the project area and the surrounding *ahupuaʻa* lands.**

Figure 29. Community consultation letter, page two

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Page 3

- **Any other cultural concerns the community might have related to Hawaiian cultural practices within or in the vicinity of the project area.**

In advance, we appreciate your assistance in our research effort. If you are interested in participating in this study, please contact Kellen Tanaka at ktanaka@culturalsurveys.com. We are also available by phone at (808) 262-9972.

Mahalo nui loa,

Kellen Tanaka
Cultural Researcher

Figure 30. Community consultation letter, page three

BWS is preparing a Environmental Impact Statement (EIS) to evaluate the following three (3) potential development scenarios, all of which could be implemented under the property's existing A-2 Medium Density Apartment zoning.

- Scenario 1: Assisted care living facility and office building
- Scenario 2: Affordable senior rental apartments and office building
- Scenario 3: Parking structure and office building

All three scenarios show a new BWS office building (ten stories, plus one story of parking below grade) near the corner of Alapai and Lusitana Streets. All scenarios also include a larger multi-level parking structure between Lisbon and Lauhala Streets. This structure would replace BWS's lost ground level parking and support the proposed residential uses.

The main component of Scenario 1 is an assisted living facility located in the northwest corner of the property. Assisted living is a form of residential care for seniors that provides residents with as much independence as they want, but with available personal care and support services. Assisted living communities do not offer complex medical services and are considered non-medical facilities.

The concept plan being evaluated in the EIS shows an assisted living facility with ten floors. The ground floor and a portion of the second floor would be used for amenities and utilities. Upper floors would consist of living units and an activity room on each floor. Parking for employees, residents, and guests would be provided in the adjacent ten-floor parking structure.

Scenario 2 includes the development of senior rental apartments in the northwest corner of the property. These would be rent-controlled apartments for individuals 60 to 65 years and older. In contrast to Scenario 1, there would be no on-site support services for residents, other than standard building security and maintenance.

The concept plan shows the building footprint for two ten-story buildings. The ground floor and a portion of the second floor of each building would most likely be used for amenities and utilities. Residential units would be located on the upper floors. Parking would be provided in the adjacent ten-floor parking structure.

Under Scenario 3, there would be no residential component on the property. The northwest corner of the property, near the intersection of Lauhala and Lusitana Streets, would remain as ground level parking. The proposed parking structure off Lauhala Street would be ten floors but larger in footprint, with some stalls for BWS use and others available for lease.

The purpose of this CIA is to gather information about the project area and its surroundings through research and interviews with individuals knowledgeable about this area in order to assess potential impacts to the cultural resources, cultural practices, and beliefs identified as a result of the planned project. We are seeking your *kōkua* and guidance regarding the following aspects of our study:

- General history as well as present and past land use of the project area

- Knowledge of cultural sites that may be impacted by future development of the project area—for example, historic and archaeological sites, as well as burials.
- Knowledge of traditional gathering practices in the project area, both past and ongoing.
- Cultural associations of the project area, such as *moʻolelo* and traditional uses.
- Referrals of *kūpuna* or elders and *kamaʻāina* who might be willing to share their cultural knowledge of the project area and the surrounding *ahupuaʻa* lands.
- Any other cultural concerns the community might have related to Hawaiian cultural practices within or in the vicinity of the project area.

In most cases, two or three attempts were made to contact individuals, organizations, and agencies. Community outreach letters were sent to 89 individuals or groups, seven responded, one provided written testimony and one met with CSH for an in-person interview. The results of the community consultation process are presented in Table 4.

6.3 Community Contact Table

Table 4 contains names, affiliations, dates of contact, and comments from NHOs, individuals, organizations, and agencies contacted for this project. Results are presented below in alphabetical order.

Table 4. Community contact table

Name	**Affiliation**	**Comments**
Amaral, Annelle	Association of Hawaiian Civic Clubs	Letter and figures sent via email 28 November 2018
Becket, Jan	Author, photographer, retired teacher from Kamehameha Schools – Kona Moku Representative for the Committee on the Preservation of Histori Sites and Cultural Properties	Letter and figures sent via email 28 November 2018
Caceres, Mana	Cultural descendant	Letter and figures sent via email 11 December 2018 Letter and figures sent via email 4 January 2019 Mr. Carceres replied via email 4 January 2019: *Mahalo for the email and Happy New Year! The 'ohana and I look forward to reviewing the attachments and if we find that we can provide information to you regarding the area where this project is located, we would be happy to do so.* CSH replied via email 4 January 2019: *Mahalo for your quick response. We look forward to hearing from you.*
Cayan, Coochie	SHPD Intake Specialist	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018
Christensen, Makani	ʻAha Moku Kona Rep	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019 Mr. Christensen replied via email 4 January 2019: *I do not have objections to project that will benefit the people of Hawaii.*
Chu, Kippen de Alba	Executive Director, Friends of ʻIolani Palace	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019

Name	Affiliation	Comments
Crabbe, Kamanaʻopono	Ka Pouhana, Office of Hawaiian Affairs	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
DaMate, Leimana	Executive Director, DLNR-Aha Moku	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019
Del Toro, Benjamin	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Del Toro, Daniel	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Del Toro, Rachel	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Del Toro, Samuel	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Dillard, Adrienne	Executive Director, Kula no na Poʻe Hawaii	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019
Faulkner, Kiersten	Executive Director, Historic Hawaiʻi Foundation	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019 Ms. Faulkner replied via email 10 January 2019: *Thank you for reaching out to Historic Hawaiʻi Foundation for information about historic and cultural sites associated with the Board of Water Supply redevelopment site in Honolulu. I have attached our previous comments on the EISPN for your reference. In particular, we asked for information about the World War II tunnels on the site to be included in the EIS. I've attached maps and drawings that show this historic resource and its relationship to the redevelopment parcels.*

Name	Affiliation	Comments
Gomes, Phoebe	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Gon III, Sam ʻOhu	The Nature Conservancy of Hawaiʻi	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Hawaiian Civic Club of Honolulu		Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Higa, Jennifer	Executive Director, Hawaiian Historical Society	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019
Higgins, Colette	Professor of History, Windward Community College	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019
Hilo, Regina	SHPD Burial Sites Specialist	Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019
Holt Takamine, Victoria	Executive Director, PAʻI Foundation	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019
Kai, G. Umi	President, ʻAha Kāne	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019
Kaleikini, Aliʻikaua	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Kaleikini, Hāloa	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Kaleikini, Kala	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019

Name	Affiliation	Comments
Kaleikini, Mahiamoku	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Kaleikini, Moehonua	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Kaleikini, No‘eau	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Kaleikini, Paulette Ka‘anohi	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018
Kaleikini, Tuahine	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Kapanui, Lopaka	Honolulu Ghost Tours	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018
Kapuniai, Lilia	Executive Director, Papakōlea Community Development Corporation	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019 Ms Kapuniai replied via email 18 January 2019: *I received your notification regarding the above mentioned project. The Papakōlea Community Development Corporation and Kula No Na Po’e Hawai’i (leadership cc’d above), is interested in participating in ongoing research. Both nonprofit organizations serve the Hawaiian homestead community of Papakōlea located above Punchbowl Cemetery, and we have over 500 individuals living in our homestead over the age of 55. Currently, Kula No Na Po’e Hawai’i is administering the Kūpuna Community Care Network, and is working directly with kūpuna in community to help them “age in place”. There are circumstances where “aging in place” is not an option, thus we could provide referral services and would be happy to contribute. We look forward to working with you.* CSH replied via email 22 January 2019: *Mahalo for your response. We appreciate your willingness to participate in this study. If you have any referrals of kupuna who may be willing to share their mana‘o of the*

Name	Affiliation	Comments
		project area and the ahupua‘a of Honolulu, could you please provide us with their contact information or if you would like to distribute the information regarding the project (I have attached a pdf of the outreach letter) and have anyone interested in participating contact us.
Keana‘āina, Betty	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Keana‘āina, Kīhei	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Keana‘āina, Luther	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Keana‘āina, Michelle	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Keana‘āina, Noelani	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Keana‘āina, Regina	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Keana‘āina, Vicky	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Keana‘āina, Wilsam	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Kekaula, Ashford	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Mail returned 9 December 2018 Letter and figures sent via email 4 January 2019
Keli‘inoi, Kalahikiola	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Keli‘inoi, Kilinahe	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019

Name	Affiliation	Comments
Keli‘inoi, Moani	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Keli‘ipa‘akaua, Justin	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Keohokālole, Adrian	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Keohokālole, Emalia	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Keohokālole, Joseph Moses Keaweaheulu	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Keohokālole, Lori Lani	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Kini, Debbie	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Kini, Nalani	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Kuloloio, Manuel	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Lao, Chester	Former Board of Water Supply employee knowledgeable in water	Letter and figures sent via email 28 November 2018 Mr. Lao replied via email 13 January 2019 to schedule interview: *I can meet Monday on at the Kahala Mall. I will call you Monday morning*. CSH spoke with Mr. Lao via telephone on 14 January 2019 CSH met with Mr. Lao 15 January 2019 CSH sent Mr. Lao a draft of summary for review on 31 January 2019 Mr. Lao replied to CSH with revisions on 3 May 2019 CSH sent Mr. Lao a revised summary for approval on 6 May 2019

Name	Affiliation	Comments
		Mr. Lao approved his summary 25 June 2019
Lapilio, Lani Maʻa	Maʻa ʻOhana	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019
Lee, Vivien	Researcher for 1978 UHCOH Kakaʻako Study	Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019
Lopes, Darren	Cultural Ddescendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Lopes, Ellen Leinaʻala	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Lopes, Kamahaʻo	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Lopes, Poʻohui	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Lopes, Puahone Kini	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Lopes, Wilfred "Antone"	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Lopez, Kealii	Imua Hawaii	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Luka, Alika	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Mamac, Violet	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Medeiros Jr., Clarence (and ʻOhana)	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019

Name	Affiliation	Comments
Nakayama, Perry	Researcher for 1978 UHCOH Kaka‘ako Study	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Norman, Carolyn	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Norman, Eileen	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Norman, Kaleo	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Norman, Keli‘inui	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Norman, Theodore	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Olds, Nalani	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Paik, Kaleo	Cultural practitioner/ Secretary/Treasurer for Koa Ike Cultural Specialist; Former History and Culture, SHPD ‘Aha Wahine Aha Moku Committee, Kona District, Oahu	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019
Papa Jr., Richard Likeke	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Pascua, Bruce H.	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Patterson, Kaleo	Native Hawaiian Church	Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019

Name	Affiliation	Comments
Puahala, Roth	President, Ke One O Kakuhihewa	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019
Rash, Regina	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Roy Jr., Corbett	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019
Shubert-Kwock, Chu Lan	Chair, Downtown-Chinatown Neighborhood Board No. 13	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Ms. Shubert-Kwock replied via email 29 November 2018: *I will schedule you for the Dec 6, 2018 Neighborhood Board 13 Meeting at Aloha Market Place Multipurpose room 3 at 6 pm* Mail returned 4 December 2018 CSH gave a short presentation at Neighborhood Board 13 Meeting on 6 December 2018
Silva, Adrian Nakea	Chariman, Hui Huliau Inc.	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019
Solis, Sheleigh Christina Ka‘āhiki	*SHPD, Cultural Historian (O‘ahu)*	Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019
Stroud, Soulee LKO	Former President, Association of Hawaiian Civic Clubs Affiliation: Hui Hawaii o Utah	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019
Suganuma, La‘akea	President, Royal Hawaiian Academy of Traditional Arts and Nā Lei Ali‘i Kawananakoa	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019

Name	Affiliation	Comments
Wong-Kalu, Hinaleimoana	OIBC Chair	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019
Woode, Napali	Native Hawaiian Economic Alliance	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018 Letter and figures sent via email 4 January 2019
Yamaguchi, Mae	Pohukaina School	Letter and figures sent via USPS 27 November 2018 Mail returned 9 December 2018
Yee, Christian		Letter and figures sent via USPS 27 November 2018 Letter and figures sent via email 28 November 2018
Yokooji, Dayleen	Cultural descendant	Letter and figures sent via USPS 27 November 2018 Letter and figures sent via USPS 4 January 2019 Letter and figures sent via email 4 January 2019

6.4 Written Testimony from Historic Hawai‘i Foundation

CSH contacted Kiersten Faulkner, Executive Director of Historic Hawai‘i Foundation, on 4 January 2019. Ms. Faulkner responded to CSH via email on 9 January 2019, providing CSH with a copy of Historic Hawai‘i Foundation’s comments, dated 13 December 2018, submitted in response to the Environmental Impact Statement Preparation Notice (EISPN) for the Board of Water Supply Beretania Complex Redevelopment Project (See Appendix A).

The BWS Beretania Complex site is located adjacent to the Hawai‘i Capitol Special District which includes the seat of state and county government (ROH Sec. 21-9.30-3 [c]). Many of the buildings within the Hawai‘i Capitol Special District are listed on the state and national registers of historic places. The Hawai‘i Capitol Special District has been established to “provide for its protection, preservation, enhancement and orderly development” and to “emphasize that the Hawaii capital [*sic*] special district and its landmarks are sources of education, pleasure and intangible benefit for the people of the State of Hawaii and to foster civic pride in the beauty of the district and accomplishments of the past” (ROH Sec. 21-9.30-3). The BWS Beretania Complex site is also located adjacent to the Special District’s sub-district, titled “Queens Medical Center Precinct.” The Historic Hawai‘i Foundation recommends that the area of potential effect in the Draft Environmental Impact Statement (DEIS) should be expanded in order to sufficiently assess any off-site impacts to historic, cultural, and natural resources including visual or contextual effects on the larger Capitol Special District and the adjacent historic BWS buildings.

Historic Hawai‘i Foundation shared documentation that indicates a system of underground tunnels and a bomb shelter were built on the BWS site during World War II (ca. 1942) (Figure 31 and Figure 32). They believe the existence of the tunnel system needs to be investigated and confirmed, to determine whether it is underlying the project area or is underneath the existing buildings or streets. Historic Hawai‘i Foundation would like the assessment of historic resources in the DEIS to include the existence, location, and condition of the tunnel system, and how these resources will be avoided or preserved.

Historic Hawai‘i Foundation stated the project area also includes known and likely Native Hawaiian burials. They mentioned the EISPN noted that a burial treatment plan has been

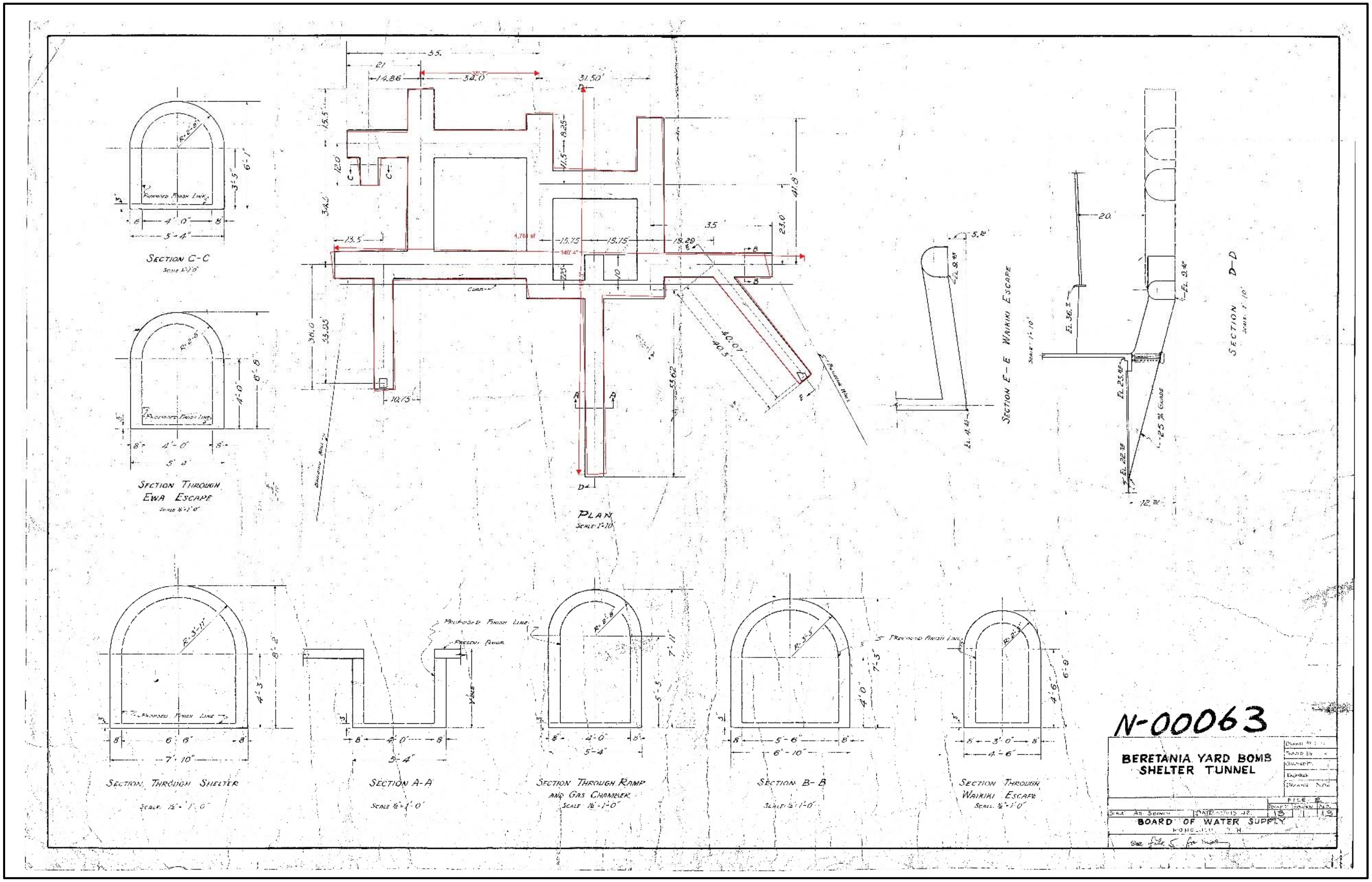

Figure 31. Beretania Yard Bomb Shelter Tunnel (courtesy of Historic Hawai‘i Foundation)

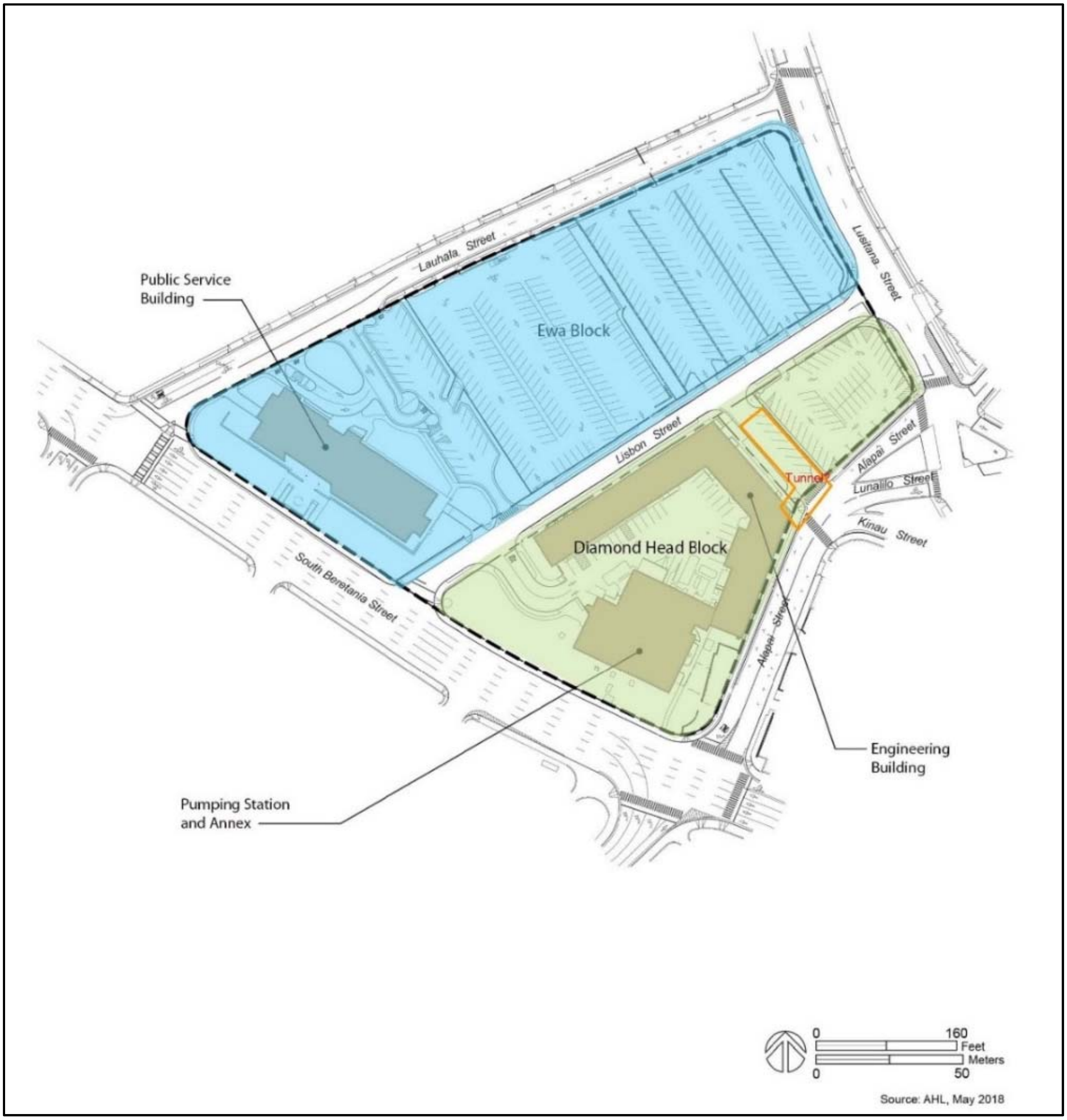

Figure 32. BWS Beretania Complex site depicting location of tunnel (courtesy of Historic Hawaiʻi Foundation)

completed and will be followed by the developer. The EISPN also noted further archaeological assessment and treatment will be delayed pending the proposal of a specific development plan.

Historic Hawai‘i Foundation recommends identifying sensitive areas and key locations to be avoided or preserved during the planning stages of the redevelopment, rather than conducting an archaeological survey after the development scheme has been selected. Historic Hawai‘i Foundation also recommends that prior to selecting locations for new buildings, a reconnaissance-level survey to identify probable subsurface cultural resources should be conducted.

Historic Hawai‘i Foundation stated that the proposed action does not include modification to existing historic buildings located within the overall BWS Beretania Complex including the BWS Engineering Building, which was designed by the architectural firm of Wood, Weed, and Associates and constructed in 1939; the Public Service Building, which was designed by architect Hart Wood and constructed in 1958; and the BWS Pump Station Building, which was also designed by Wood, Weed, and Associates and completed in 1939.

Historic Hawai‘i Foundation stated that existing special district guidelines that address design and development parameters for new construction need to be followed to avoid additional effects on the setting of the historic buildings and district (See Appendix B). Additional measures to protect historic resources include preparation of a preservation plan for the three historic BWS buildings, treatment guidelines for the World War II Tunnels, and providing historic interpretation on the site to educate future residents and visitors about its historic and cultural significance.

6.5 *Kama‘āina* Interviews

The authors and researchers of this report extend our deep appreciation to everyone who took time to speak and share their *mana‘o* and *‘ike* with CSH whether in interviews or brief consultations. We request that if these interviews are used in future documents, the words of contributors are reproduced accurately and in no way altered, and that if large excerpts from interviews are used, report preparers obtain the express written consent of the interviewee/s.

6.5.1 Chester Lao Interview

Mr. Chester Lao is a retired geologist for the Honolulu BWS. Mr. Lao was employed by the BWS for over 30 years, from 1968 through 2006. On 15 January 2019, Mr. Lao met with CSH at Kahala Mall to discuss the Board of Water Supply Beretania Complex Redevelopment project and to share his extensive knowledge of the history of the Board of Water Supply and the *ahupua‘a* of Honolulu.

Born in Menlo Park, California, Mr. Lao grew up in the Bay Area. He attended San Jose State University where he attained a bachelor’s degree before attending Stanford University where he earned a master of science degree. Mr. Lao’s parents immigrated to America from the Kwungtung Provence in China. His father had many occupations.

> . . . when he [Mr. Lao’s father] should have been working in the store, he was actually working in a granite quarry in the Central Valley. He was pretty handy, he knew how to lay out a sidewalk, little bit about carpentry. He was a translator, he ran a restaurant.

Mr. Lao began the interview by discussing the traditional water sources of Honolulu. He stated that "traditionally, the community of Honolulu got their water from Nuʻuanu Stream or some springs." In ancient times, *kamaʻāina* believed that water was "the possession of no man" (Handy and Handy 1972:63). They believed water "was something that 'belonged' to Kane-i-ka-wai-ala (Procreator-in-the-water-of-life) and came through the meteorological agency of Lono-makua the Rain-provider" and "the right to use it [water] depended solely on the use of it" (Handy and Handy 1972:63–64).

> So long as a family lived upon and cultivated land, using a given water source, and continued to contribute its share of the labor required to maintain that water source, just so long did it maintain its "right" to that water. [Handy and Handy 1972:63–64]

During the 1860s, the arrival of whaling ships in Honolulu resulted in an increase in the population. Mr. Lao stated that during this time, "all water was under the King and the chiefs of Oʻahu." As the demand for an additional water supply increased, the Honolulu Water Company was established.

> They formed this water company and what they did, they charged everybody a dollar, 2 dollars, and then they formed this company and it was always run by the King.
>
> The King drilled wells on Kalakaua Ave. The first did not last because of the thin casing used. The second well lasted longer with thicker line pipe casing until it was sealed. Both wells were located near King and Kalakaua Avenues.

Once the whaling industry failed, other industries like cattle ranching and sugarcane cultivation rose to the top, the availability of fresh water was pivotal for these developing industries. Mr. Lao discussed the discovery of underground fresh water by cattle rancher James Campbell on his ʻEwa ranch. In 1879, Mr. Campbell hired James Ashley, a well driller from California, to drill a well to a depth of 273 ft. When the well reached 240 ft, water began to flow (James Campbell Estate 1978:14).

> He [James Ashley] came out and he drilled at a position, at a location that he was familiar with in California, nearby streams, he could see gravel deposits, along the streams. . . he drilled out there for gravel deposits cause he could see the gravel in the stream there and he didn't get much in the way of water until he got very close to the basalt and that's when they got the artesian water. He didn't know it, but he found some artesian supplies but very small supply in the sediments too.

After Hawaiʻi became a Territory of the United States of America, Honolulu's water system became a department under the Superintendent of Public Works of the Territory of Hawaii (Board of Water Supply 2018). In 1913, the territorial legislature passed Act 138 which transferred the Honolulu Water and Sewer Works from the Territory [of Hawaii] to the City and County of Honolulu (*Honolulu Star-Bulletin* 1913:225–228).

In 1925, the territorial legislature granted the governor authority to appoint a commission of five members, known as the Honolulu Sewer and Water Commission, whose goal was to "expedite and complete the sewer and water systems and to ensure its adequacy and to safeguard the watersheds and artesian base of Honolulu" (Board of Water Supply 2018). The Commission lasted for four years during which Honolulu continued to suffer water shortages. Mr. Lao stated that the Honolulu Sewer and Water Commission was run by the Board of Supervisors, ". . . the Board of Supervisors decided they will form an agency called the Honolulu Sewer and Water Commission . . . An entity run by the Board of Supervisors at that time."

In 1929, the territorial legislature passed Act 96 which dissolved the Honolulu Sewer and Water Commission and established the BWS. BWS assumed control of the Sewer and Water Commission and full management of the Honolulu Water Works from the City and County of Honolulu. The objectives of the BWS were to "modernize the system, to meter all water distributed and to seal all faulty, leaking artesian wells in an effort to halt the waste of fresh water" (Board of Water Supply 2018). Mr. Lao discussed the establishment of the BWS:

> The territorial government passed an act, . . . that created the Honolulu Board of Water Supply. . . It was a semi-autonomous agency . . . they could charge but the charges had to be based on what it cost to run the company. It was a city agency but semi-autonomous and it left it up to the Mayor to appoint the members of the Board of Water Supply.

Mr. Lao mentioned that creation of the BWS was delayed due to a lawsuit filed in the Hawaiʻi Supreme Court by Mayor of Honolulu John Wilson.

> Mayor Johnny Wilson . . . He filed suit in the Hawaiʻi Supreme Court. Since the Board of Water Supply was to occur on January 1st, it didn't incur until April something, April 6 or something. . . It took the Supreme Court that long, 4 months or so, to hand down its verdict. When they did the Honolulu Board of Water Supply was created.

Mr. Lao discussed the numerous chairmen who ran the Board of Water Supply since its beginning.

> . . . the first chairman of the board, the head of the board, was Fred Ohrt. . . He served a long time and he was succeeded by this guy [Edward J.] Morgan. Morgan served quite a long time. . . From then on it was a succession of political appointees . . . The next longest serving member was Kazu Hayashida. He came from DLNR [Department of Land and Natural Resources] . . . He went to [Department of] Public Works first, and from Public Works he came over to Board of Water Supply and he served until about 15 years ago or so. He took the job and served at least 10 years . . . Another guy who served quite a while was, Chinese guy, George Yuen. . .
>
> George Yuen was the first manager to organize under the concept of having divisions and sections. Yuen came from BWS ranks until Mayor [Neal] Blaisdell was replaced by Mayor [Frank] Fasi who tried to gain control of BWS and its separately controlled fund. He did this by getting the necessary board members to terminate Yuen and appoint a new Manager more amenable to him and this person was Hayashida who lasted many years until transferring to the state Department of Transportation.

Mr. Lao mentioned that communities located outside Honolulu were provided water by a separate company, the Suburban Water System. In 1959, Suburban Water System was acquired by the BWS creating an island-wide operation (Board of Water Supply 2018).

> Even on O‘ahu, when the Board of Water Supply was split in half. There were two companies, there was Suburban Water [System] and the Board of Water Supply. Suburban Water ran all of these small community, public agency . . . the Hawaii Water Plan was printed . . . with the plans for connecting all the communities together on O‘ahu so there would be a unitized Board of Water Supply. The Land and Natural Resources . . . which actually under the provisions of the law, ran all the other communities on the neighbor islands.

Under the leadership of George Yuen, BWS started to expand to other areas on O‘ahu. Mr. Lao stated that in the time he worked as a geologist for BWS, between 1968 and the end of 2006, BWS successfully drilled the areas that contained the most water. He mentioned that fresh water in Honolulu became increasingly brackish over the years.

> The geology showed various basins were formed and depending on the water table height above sea level. That determines the depth to salt water, so the fresh water floats on top of the salt water like an ice cube. You put an ice cube in a glass, it floats because the ice is only 90% of the density of fresh water. And then one time, the fresh water line in Honolulu by the Board of Water Supply was probably close to 30 to 40 feet. The maximum recorded about 37 feet. The ratio for every foot of water above sea level you have 40 times more. The maximum depth was well over 1000 feet, see 40x30 is 1200 so its 1200 feet to 50% salt water and 50% fresh water.

BWS installed several monitor wells that record the depths to sea level as well as the height of fresh water above sea level. Mr. Lao stated that "the more you pump, you suck up the salt water, you stop pumping, it goes down again, and every time you do this, it doesn't return to the same point."

When Mr. Lao arrived on O‘ahu, he discovered the geology of the island of O‘ahu to be more complex than he had imagined. As a result, he changed his ideas regarding the amount of water O‘ahu has, stating "we [O‘ahu] don't have as much water as the US Geological Survey thinks." Mr. Lao briefly described the geology of the island of O‘ahu:

> It varies because of the way the island of O‘ahu was developed. The geologic history we had these incursions and recessions of sea level. This dated back to, probably the most important ones, less than 25 million, closer to 10 million [years ago], and it created these coastal plains. We have coastal plains, stretching from Barbers Point almost out to Koko Head and that's where most our water is.
>
> We've had these separate water bodies created. The biggest one is Pearl Harbor, but even that's split, that's split even more than I thought it would. Maybe because of this . . . you have to remember the island has been eroding at least 5 million years here on O‘ahu and because of that you get this alluvium, all the junk that washes down. The tropical weathering is unique because . . . it formed latosols on its way to laterite. That's what's left when the volcano decays, deteriorates, all we have is this clay substance and it's compressible and once the water is removed, it's hard like a brick.

Mr. Lao mentioned that the area where the current BWS buildings are located was given to the Sewer and Water Commission by executive order by President Woodrow Wilson. He also noted that during World War II, a bomb shelter and tunnel system was constructed underneath the BWS. He recalled entering the tunnel system to search for dikes.

> That was during World War II. They’re still there. Under the rooms there. I know where it is. They got a trap door in the floor. Used to be able to access it just walking down a ramp. There’s some old equipment there. Not much. What I was looking for was a dike. That’s a feeder for the lava flow. Where the lava comes up and goes out. The lava that’s left in there is called a dike.

Mr. Lao recalled the landscape of Honolulu, which he noted as “swampy.” He recalled viewing archived maps that showed the area consisted of wetlands and taro patches. He also mentioned his mother-in-law, who lived on Beretania Street before moving near the University of Hawai‘i, remembered that the area near Ke‘eaumoku Street, where Walmart is located, consisted of fishponds and watercress patches.

Mr. Lao believes the entire area is historic. He mentioned that Honolulu was a “gathering place.” He recalled that numerous businesses were located in the vicinity of the project area including Honolulu Auto Supply, Remington Rand, and a bowling alley. He recalled that at Trader Vic’s, which was located on Ward Avenue, “You could get a meal for under $5.” He also noted that Hotel Street “used to go all the way through” until Mayor Frank Fasi “on a weekend used a bulldozer to clean out and block off the area between Punchbowl and Richards Streets to make the area a broad walkway or park.” Mr. Lao mentioned there were many famous people living in Honolulu. He recalled a “famous house” which was located on Lusitana Street. He recalled the house that belonged to a “pretty famous person of Honolulu” was three stories high and built with lava stone.

Mr. Lao mentioned that the BWS installed wells within the project area due to pressure from Queen’s Hospital which wanted to condemn the area in order to develop it. When asked whether the proposed project would impact the BWS, Mr. Lao stated, “Eventually, I think they will have to relocate the wells.”

6.6 Summary of *Kama‘āina* Interviews

Based on the written testimony of Kiersten Faulkner, in addition to the reviewed and approved interview summary of Chester Lao, the following is a synthesis of findings within Honolulu Ahupua‘a.

Chester Lao, retired geologist for the Honolulu BWS, discussed the history of the BWS. Mr. Lao stated that “traditionally, the community of Honolulu got their water from Nu‘uanu Stream or some springs.” He noted that following the arrival of whaling ships in the 1860s, which resulted in an increase in the population, the demand for an additional water supply increased. He added that during this period, “all water was under the King and the chiefs of O‘ahu.” To address the increased demand for an additional water supply, the Honolulu Water Company was established.

Mr. Lao discussed the discovery of underground fresh water by cattle rancher James Campbell in 1879, when Mr. Campbell hired James Ashley, a well driller from California, to drill a well on his ‘Ewa ranch. Mr. Lao added that “he [James Ashley] came out and he drilled at a position, at a location that he was familiar with in California, nearby streams, he could see gravel deposits, along the streams. . .”

After Hawaiʻi became a Territory of the United States of America, Honolulu’s water system became a department under the Superintendent of Public Works of the Territory of Hawaii (Board of Water Supply 2018). In 1913, the territorial legislature passed Act 138 transferring the Honolulu Water and Sewer Works from the Territory [of Hawaii] to the City and County of Honolulu (*Honolulu Star-Bulletin* 1913:225–228). In 1925, the territorial legislature granted the governor authority to appoint the Honolulu Sewer and Water Commission, however, Honolulu continued to suffer water shortages and in 1929, the territorial legislature passed Act 96 which dissolved the Honolulu Sewer and Water Commission and established the BWS which assumed control of the Sewer and Water Commission and full management of the Honolulu Water Works from the City and County of Honolulu. Mr. Lao noted that communities located outside Honolulu were provided water by a separate company, the Suburban Water System until 1959 when the Suburban Water System was acquired by the BWS (Board of Water Supply 2018).

When describing the traditional landscape of Honolulu, Mr. Lao noted historic maps indicate that the area was once comprised of wetlands and taro patches. He also stated that his mother-in-law had previously lived on Bertania Street. She recalled that the area near Keʻeaumoku Street consisted of fishponds and watercress patches.

Mr. Lao also described Honolulu as a “gathering place.” He noted that many famous people resided in Honolulu, adding that on Lusitana Street, there was a three-story home built with lava stone that belonged to a “pretty famous person.” He also noted that in the vicinity of the project area, there were numerous businesses including Honolulu Auto Supply, Remington Rand, and a bowling alley. He recalled that “You could get a meal for under $5” at Trader Vic’s, which was located on Ward Avenue. He also recalled when Mayor Frank Fasi bulldozed the section of Hotel Street “between Punchbowl and Richards Streets to make the area a broad walkway or park.”

Kiersten Faulkner, Executive Director of Historic Hawaiʻi Foundation, stated that the BWS Beretania Complex site is located “adjacent to the Hawaiʻi Capitol Special District, which is listed on the National Register of Historic Places.” The BWS Beretania Complex site is also located adjacent to the Special District’s sub-district, titled “Queens Medical Center Precinct.” Historic Hawaiʻi Foundation noted that existing special district guidelines that address the design and development parameters for new construction need to be followed to avoid additional effects on the setting of the historic buildings and district. The Historic Hawaiʻi Foundation also recommends expanding the area of potential effect in the Draft Environmental Impact Statement (DEIS) to evaluate any off-site impacts to historic, cultural, and natural resources including visual or contextual effects on the larger Capitol Special District and the adjacent historic BWS buildings. Historic Hawaiʻi Foundation noted that the proposed project does not include modification to existing historic buildings located within the overall BWS Beretania Complex including the BWS Engineering Building, the Public Service Building, and the BWS Pump Station Building.

Historic Hawaiʻi Foundation recommends identifying sensitive areas and key locations to be avoided or preserved during the planning stages of the redevelopment and conducting a reconnaissance-level survey to identify probable subsurface cultural resources prior to selecting locations for new buildings. Historic Hawaiʻi Foundation stated that an assessment of historic resources and how these resources will be avoided or preserved should be included in the Draft Environmental Impact Statement (DEIS).

Historic Hawaiʻi Foundation and Mr. Lao mentioned the existence of an underground tunnel system and bomb shelter which were built on the BWS site during World War II. Historic Hawaiʻi Foundation believes the existence, location, and condition of the tunnel system needs to be assessed. Historic Hawaiʻi Foundation also stated that the project area also includes known and likely Native Hawaiian burials, noting that a burial treatment plan has been completed and will be followed by the developer; further archaeological assessment and treatment will be delayed pending the proposal of a specific development plan. Historic Hawaiʻi Foundation discussed additional measures to protect historic resources including the preparation of a preservation plan for the three historic BWS buildings, treatment guidelines for the World War II tunnels, and providing historic interpretation on the site to educate future residents and visitors about its historic and cultural significance.

Section 7 Traditional Cultural Practices

7.1 Overview

Timothy R. Pauketat succinctly describes the importance of traditions, especially in regards to the active manifestation of one's culture or aspects thereof. According to Pauketat,

> People have always had traditions, practiced traditions, resisted traditions, or created traditions . . . Power, plurality, and human agency are all a part of how traditions come about. Traditions do not simply exist without people and their struggles involved every step of the way. [Pauketat 2001:1]

It is understood that traditional practices are developed within the group, in this case, within the Hawaiian culture. These traditions are meant to mark or represent aspects of Hawaiian culture that have been practiced since ancient times. As with most human constructs, traditions are evolving and prone to change, resulting from multiple influences including modernization as well as other cultures. It is well known that within Hawai‘i, a "broader 'local' multicultural perspective exists" (Kawelu 2015:3). While this "local" multicultural culture is deservedly celebrated, it must be noted that it often comes into contact with "traditional Hawaiian culture." This contact between cultures and traditions has undoubtedly resulted in numerous cultural entanglements. These cultural entanglements have prompted questions regarding the legitimacy of newly evolved traditional practices. The influences of "local" culture are well noted throughout this section, and understood to represent survival or "the active sense of presence, the continuance of native stories, not a mere reaction, or a survivable name. Native survivance stories are renunciations of dominance, tragedy and victimry" (Vizenor 1999:vii). Acknowledgement of these "local" influences helps to inform nuanced understandings of entanglement and of a "living [Hawaiian] contemporary culture" (Kawelu 2015:3). This section strives to articulate traditional Hawaiian cultural practices practiced within the *ahupua‘a* in ancient times, and the aspects of these traditional practices that continue to be practiced today; however, this section also challenges "tropes of authenticity" (Cipolla 2013) and acknowledges the multicultural influences and entanglements that may "change" or "create" a tradition.

This section integrates information from Sections 3–5 in examining cultural resources and practices identified within or in proximity of the Board of Water Supply Beretania Complex Project project area in the broader context of the encompassing Honolulu landscape.

7.2 Habitation

In ancient times, the area that today encompasses downtown Honolulu had long been an area of population and activity on the south shore of O‘ahu, but it was Waikīkī to the southeast that was the center of political power on the island and the traditional residence of the *ali‘i*. Following his conquest of O‘ahu in 1795, Kamehameha resided in Waikīkī before moving his residence to Honolulu in 1809. According to Ross Gast, this was the first stone structure in Honolulu (Gast and Conrad 1973:29). However, Kamehameha likely never resided in the residence himself since he returned to Hawai‘i Island in 1810 where he lived the remainder of his life.

Traditional patterns of Hawaiian life on O‘ahu were altered by the increasing commerce and association with newly arrived foreigners. Building in Honolulu continued apace with Francisco de Paula Marin, a Spaniard who’d arrived in the Hawaiian Islands in 1793 or 1794, and other foreign residents building their own stone houses and buildings during the ensuing decade.

In the 1830s, profound changes to the character of the Honolulu area were propelled by western and urban ideals. The formal naming of streets in Honolulu began in September 1836. A number of the streets in the vicinity of the project area have a Portuguese origin because many Portuguese immigrants settled and built small, whitewashed houses on the lower slopes of Punchbowl Crater (Pukui et al. 1974:136). Lisbon Street, located within the current project area, was named for Lisbon, the capitol of Portugal.

By the 1840s, Native Hawaiian traditions had been replaced by western commercial and missionary interests. Many of the prominent *ali‘i* moved their residences near the Kawaiaha‘o Church and Mission Houses in the nineteenth century. In 1835, high chief Kapa‘akea (ca. 1817-1866) married Analea Keohokālole. They had ten children, two of which, David Kalākaua and Lili‘ūokalani, became the last two monarchs of the Hawaiian Islands (Day 1984:70). This indicates that at least one high chief lived within or near the project area sometime between 1835 and 1866.

The Organic Acts of 1845 and 1846, which initiated the process of the Māhele, introduced private property into Hawaiian society. In 1848, *Konohiki* land titles were awarded to the crown and the *ali‘i* and in 1850, *kuleana* awards for individual parcels began to be granted to commoners.

The *ahupua‘a* of Pauoa was not awarded to any *ali‘i*, therefore, it became government land. The *‘ili* of ‘Auwaiolimu was awarded to the *ali‘i* Kaleokekoi, however, the land was returned to pay the commutation fee on the lands which he retained, thus the *‘ili* of ‘Auwaiolimu became Crown Land which is owned by the Hawaiian Monarchy (Soehren 2012). Within the *‘ili* of ‘Auwaiolimu, 46 *kuleana* claims were made, however, not all of them were in the Pauoa area, in the vicinity of the project area.

There were six awards on the *mauka* side of Beretania Street, between Punchbowl and Alapa‘i streets. At Punchbowl, LCA 5874, a large Konohiki award, was awarded to Analea Keohokālole. This lot had a two-story house on the property, described as “near the pumping station” (Goodale 1898:81). A small section near the southeast corner of this lot was awarded to Kaiahua as LCA 1818. To the east of these two lots was LCA 656, a *kuleana* award to Kuhia for a rectangular fenced lot with two houses, and LCA 268, a rectangular lot with an adobe wall, two houses, and a well, which was awarded to John ‘Ī‘ī, a respected retainer who had been a childhood companion to Kamehameha II and advisor to Queen Kīna‘u as an adult. A portion of LCA 268 is located on the western corner of the current project area. On the *makai* side of Beretania Street and directly below the current project area is LCA 804 which was awarded to Kaluahine and contained a fence, house, and garden which was confirmed in writing by ‘Ī‘ī. Adjacent to this lot is LCA 138 which was awarded to Kekuinau. The remaining portion of the project area to Alapa‘i Street was located within the Crown Lands of ‘Auwaiolimu.

Following its establishment as the capitol of the Hawaiian Kingdom in 1846, Honolulu was quickly becoming the commercial and political hub of the Islands. The Queen’s Hospital, named after Liholiho’s wife, Queen Emma, was established at an existing two-story wooden building on the new grounds at “the foot of Punchbowl hill.” By 1860, the hospital consisted of the main edifice, two out-buildings, and Kapa‘akea’s wooden building (Greer 1969:125). In the 1880s, ‘Iolani Palace was constructed.

Historic Hawaiʻi Foundation noted the BWS Beretania Complex site is located adjacent to the Hawaiʻi Capitol Special District, which includes numerous buildings listed on the state and national registers of historic places, and adjacent to the Special District's sub-district, titled "Queens Medical Center Precinct." Within the BWS Beretania Complex, there are three existing historic buildings including the BWS Engineering Building designed by the architectural firm of Wood, Weed, and Associates and constructed in 1939, the Public Service Building designed by architect Hart Wood and constructed in 1958, and the BWS Pump Station Building, which was also designed by Wood, Weed, and Associates and completed in 1939.

Historic Hawaiʻi Foundation also indicated that a system of underground tunnels and a bomb shelter were built on the BWS site during World War II (ca. 1942). Interviewee Chester Lao, retired geologist for the Honolulu BWS, also noted that during World War II, a bomb shelter and tunnel system was constructed underneath the BWS. He recalled entering the tunnel system to search for dikes.

Mr. Lao described the entire area is historic, stating that Honolulu was a "gathering place" where a number of famous people lived. He noted that on Lusitana Street, there was a three-story home built with lava stone that belonged to a "pretty famous person." He also mentioned that numerous businesses were located in the vicinity of the project area including Honolulu Auto Supply, Remington Rand, and a bowling alley. He also recalled that Trader Vic's was located on Ward Avenue.

7.3 Gathering of Plant and Food Resources

Kalo was the sacred staple in the Hawaiian diet and way of life. According to the Kumulipo, the Hawaiian genesis chant, Hāloa was the second son of Wākea and Papa. Hāloa-naka was the first born who was born prematurely and died shortly after birth (Kanahele 1995:17). After burying Hāloa-naka, a *kalo* sprouted from his grave. Hāloa was born shortly after the sprouting of this *kalo* plant. Hāloa symbolizes *kalo* and man. Kanahele explains that *kalo* is a metaphor for life and that "plants have been used to symbolize human spiritual growth. Hawaiians made taro a metaphor for life because, like the taro plant, it needs to be rooted in good soil and to be constantly nourished with the waters of Kāne" (Kanahele 1995:18).

Honolulu Ahupuaʻa was abundant in taro. Upper Nuʻuanu Valley provided an abundance of water to the lower portion of the *ahupuaʻa*. Taro lands extended *makai* to at least half-way of upper Nuʻuanu Valley (Handy and Handy 1972:475). Mr. Lao stated that the landscape of Honolulu consisted of wetlands and taro patches, as well as fishponds and watercress patches in the area near Keʻeaumoku Street.

In the pre-Contact and early post-Contact period, the project area would have been considered to be located within the boundaries of Pauoa Ahupuaʻa. The Pauoa area, located to the east of Nuʻuanu Valley and the west of Mānoa Valley, was an ideal location for the cultivation of sweet potatoes. Some areas in Pauoa were cultivated in taro as well. Round Top (Tantulus) and Makiki were famous for their sweet potato production. The area was called ʻUalakaʻa or "rolling sweet potato" because the area was on a slope and if a sweet potato was displaced, the *ʻuala* would roll down the hill (Handy and Handy 1972:478).

In the early post-Contact period, water in the Honolulu area depended on the availability of streams, pools, wells, and springs. Mr. Lao stated that the water supply for the community of

Honolulu was provided by "Nuʻuanu Stream or some springs." As demand for an additional water supply increased following the arrival of whaling ships during the 1860s, the Honolulu Water Company was established. Mr. Lao noted that during this period, "all water was under the King and the chiefs of Oʻahu."

Following the discovery of a vast aquifer of fresh water by cattle rancher James Campbell in 1879, the digging of wells began, including ones in Honolulu. However, by the 1890s, the water levels of these wells were so low that supplying water to Honolulu became a real problem. Plans for pumping stations and inland reservoirs began and in 1894, a brick pumping station was built at the corner of Beretania and Alapaʻi streets. The pumping station was expanded several times and the original 1894 brick building was replaced with the present concrete structure around 1927. Following the establishment of the Republic, the water works were under the direction of the Superintendent of Public Works, and then under the Department of Public Works in 1913. In 1927, the Honolulu Sewer and Water Commission was formed, but continued disruptions in the water supply led to the creation of the BWS in 1929 (Murai 2000:2–3).

7.4 *Wahi Pana*

Cultural association with the landscape is evident in the strict observation of the natural environment most evident in the Hawaiian term *wahi pana*. Place names convey *kaona* (hidden meanings) and *huna* (secret) information that may even have political or subversive undertones. Pukui et al. (1974:49–50) literally translate Honolulu as "protected bay," which refers to the protection of Honolulu Harbor. Older names for the harbor are Kou and Māmala. According to Westervelt, Honolulu is a name made by the union of the two words "Hono" and "lulu."

In the pre-Contact and early post-Contact period, the project area would have been considered to be located within the boundaries of Pauoa Ahupuaʻa. Land records from the mid-nineteenth century indicate the project area was located within the *ʻili* of ʻAuwaiolimu. ʻAuwaiolimu, which Pukui translates as "ditch of moss" (Pukui et al. 1974:14), is said to have been named for the chiefess Kahalaopuna, a famous beauty from Mānoa whose long hair resembled the long strands of *limu* as she bathed in the waters of ʻAuwaiolimu Stream.

The eastern boundary of Pauoa Ahupuaʻa includes a portion of Pūowaina, a volcanic crater now known as Punchbowl. According to the *moʻolelo*, Pūowaina was created by the goddess Pele as a home for herself and her family (Kamehameha Schools 1987).

Six *heiau* and one home for priests were located on Pūowaina, on both the Makiki side and the Pauoa (or ʻAuwaiolimu) side of the crater. These *heiau* acted as temples, forts, and as part of the complex for the priests of Pūowaina. These *heiau* were important sites during Kamehameha's invasion of Oʻahu in 1795. During the Battle of Nuʻuanu, the "battle raged the fiercest" at these fortified *heiau* (Nakuina 1909).

Four of these *heiau* are located on the southwestern slope of Pūowaina, near the current project area, including Kānelāʻau Heiau, which was located around the junction of Kīnaʻu and Alapaʻi streets, and Mana Heiau, which was located west of the current project area, somewhere on or near Queen's Hospital.

7.5 Religious Practice and Burials

In pre-Contact times, Pūowaina was a famous place of human sacrifice. Pūowaina which translates to "Hill of Placing" (Pukui et al. 1974:195) is said to have been named after this custom. C.J. Lyons noted it as "the spot for placing the bodies of those who had broken the kapu" (Lyons 1986, HEN Vol. 1:620). In the *moʻolelo* of the ritual known as Kānāwai Kaihaheʻe or Ke-kai-heʻe-heʻe ("sea sliding along"), members of the *kauwā* class or *kapu* breakers were sacrificed (Kamakau 1991:6). The Kewalo area utilized a fishpond to drown *kauwā* while other *moʻolelo* have mentioned a place in Waikīkī that was used. The corpse was then brought to Kānelāʻau Heiau for a ritual to appease the gods before being transported to the top of Pūowaina for burning, in the ritual of *puhi-kanaka*.

Historic Hawaiʻi Foundation stated that the project area also includes known and likely Native Hawaiian burials. In 2017, PCSI (Clark et al. 2017) conducted an AIS in support of the proposed construction of photovoltaic (PV) arrays for the BWS' Energy Savings Performance Contracting (ESPC) project. The AIS work, which consisted of a pedestrian survey and subsurface testing program, was carried out within the current project area 1 and the BWS property that contains the Pump House and Engineering Building, southwest of the current project area 2. During a backhoe excavation, a Native Hawaiian burial (SIHP # -8038) was encountered.

In August 2018, a BTP for SIHP # -8038 (Clark and Collins 2017) was approved by the OIBC. The BTP involved long-term protection and preservation measures for SIHP # -8038 including preservation of the burial in place, a burial preserve area with a buffer, a metes and bounds survey that recorded the burial preserve with the BOC to create a permanent preservation easement on the property, construction of an enclosure wall around the perimeter of the burial preserve, and establishment of site visitation protocols (Clark and Collins 2017:35).

Section 8 Summary and Recommendations

CSH undertook this CIA at the request of HHF Planners and on behalf of the Board of Water Supply. The research broadly covered Honolulu Ahupua‘a focusing on the BWS Beretania complex.

8.1 Results of Background Research

Background research for this study yielded the following results which are presented in approximate chronological order:

1. The project area is considered within the *ahupua‘a* (traditional land division usually extending from the mountain to the sea) of Honolulu. However, in the pre-Contact period, Honolulu was only a small village and the *ahupua‘a* of Pauoa probably once extended from the mountains to the shore, encompassing the eastern section of downtown Honolulu. The project area in the pre-Contact and early post-Contact periods would have been considered within the boundary of Pauoa Ahupua‘a.
2. Pauoa Ahupua‘a, a small valley along Pauoa Stream, is located between Nu‘uanu and Makiki valleys and extends from an elevation about 2,000 feet (ft) at the *mauka* (inland) point to Vineyard Street, the modern *makai* (seaward) boundary. Pauoa, meaning “ear,” was so named because it was viewed as a “side valley” of the larger Nu‘uanu Ahupua‘a to the west (Lyons 1901:181).
3. Mid-nineteenth century land records indicate the project area was in ‘Auwaiolimu (meaning “ditch of moss”; Pukui et al. 1974:14), an *‘ili* (smaller land division within an *ahupua‘a*) of Pauoa Ahupua‘a. The *‘ili* was said to have been named for a chiefess, perhaps the famous beauty of Mānoa Valley, Kahalaopuna, who bathed in the waters of the ‘Auwaiolimu Stream. Her long hair floating in the stream resembled the long strands of moss, or *limu*.
4. Pauoa Valley was associated with two famous invasions, both with battles near the project area in ‘Auwaiolimu ‘Ili and near a *heiau* (pre-Contact place of worship) called Kānelā‘au.
5. Pukui et al. (1974:49–50) literally translate Honolulu as “protected bay,” which refers to the protection of Honolulu Harbor. Older names for the harbor are Kou and Māmala.
6. Kou was comprised of shoreward fishponds and taro *lo‘i* (irrigated fields) fed by ample streams descending from Nu‘uanu and Pauoa valleys, but it was Waikīkī to the southeast that could claim preeminence as the traditional residence of the *ali‘i* (royalty) and as the center of political power on the island.
7. Six *heiau* and one home for priests were located on Pūowaina, some on the Makiki side of the crater and some on the Pauoa (or ‘Auwaiolimu) side. These *heiau* acted as temples, forts, and as part of the complex for the priests of Pūowaina. These *heiau* were important sites during the Battle of Nu‘uanu in 1795 when Kamehameha invaded and conquered the island of O‘ahu. Four of these *heiau* are on the southwestern slope of Punchbowl near the current project area.
8. In 1846, Honolulu was made the capitol of the Hawaiian Kingdom and was well on its way to becoming the commercial and political hub of the Islands. During this period there

was an obvious increase in land use density and urbanization. ʻIolani Palace was constructed in the 1880s.

9. Water in the early post-Contact period in the Honolulu area depended on the availability of streams, pools, wells, and springs. As Honolulu expanded, it became necessary to provide water to the "dusty plains" east of Honolulu. In 1879, James Campbell drilled down 273 ft on his cattle ranch in ʻEwa and found a vast aquifer of fresh water lay below the Hawaiian Islands (James Campbell Estate 1978:14). Many other wells were dug, including ones in Honolulu, but by the 1890s, the levels of water from wells was so low that supplying water to the city became a real problem.
10. After the establishment of the Republic, the water works were under the direction of the Superintendant of Public Works, then under the Department of Public Works in 1913. The Honolulu Sewer and Water Commission was formed in 1927, but continued disruptions in the water supply led to the creation of the BWS in 1929 (Murai 2000:2–3).

8.2 Results of Community Consultations

CSH attempted to contact 89 NHOs, agencies, and community members. Six people/agencies responded to the consultation letter, one of them provided written testimony, and one person participated in a formal interview. CSH initiated its outreach effort in November 2018 through June 2019. Below is a list of individuals who shared their *manaʻo* and *ʻike* about the project area:

1. Chester Lao, former geologist for the Honolulu BWS
2. Kiersten Faulkner, Executive Director, Historic Hawaiʻi Foundation

8.3 Impacts and Recommendations

Based on information gathered from the community consultation, participants voiced and framed their concerns in a cultural context.

1. The BWS Beretania Complex is adjacent to the Hawaiʻi Capitol Special District and adjacent to the Special District's sub-district, titled "Queen's Medical Center Precinct." Historic Hawaiʻi Foundation recommends that the APE in the DEIS be expanded in order to sufficiently assess any off-site impacts to historic, cultural, and natural resources including visual or contextual effects on the larger Capitol Special District and the adjacent historic BWS buildings. Historic Hawaiʻi Foundation stated that existing special district guidelines addressing design and development parameters for new construction need to be followed to avoid additional effects on the setting of the historic buildings and district.
2. Historic Hawaiʻi Foundation and interviewee Chester Lao mentioned the existence of an underground tunnel system and bomb shelter which were built on the BWS site during World War II. Historic Hawaiʻi Foundation believes the existence, location, and condition of the tunnel system needs to be assessed. An assessment of historic resources and how these resources will be avoided or preserved should be included in the DEIS. Additional measures to protect historic resources include preparation of a preservation plan for the three historic BWS buildings, treatment guidelines for the World War II tunnels, and providing historic interpretation on the site to educate future residents and visitors about its historic and cultural significance.

3. Historic Hawaiʻi Foundation recommends that sensitive areas and key locations to be avoided or preserved should be identified during the planning stages of the redevelopment. Historic Hawaiʻi Foundation also recommends that a reconnaissance-level survey to identify probable subsurface cultural resources should be conducted prior to the selection of locations for new buildings.
4. Interviewee Chester Lao mentioned that the BWS installed wells within the project area. Mr. Lao stated, "Eventually, I think they will have to relocate the wells," as a result of the proposed project.
5. Historic Hawaiʻi Foundation stated the project area also includes known and likely Native Hawaiian burials. Project construction workers and all other personnel involved in the construction and related activities of the project should be informed of the possibility of inadvertent cultural finds, including human remains. In the event that any potential historic properties are identified during construction activities, all activities will cease and the SHPD will be notified pursuant to HAR §13-280-3. In the event that *iwi kūpuna* are identified, all earth moving activities in the area will stop, the area will be cordoned off, and the SHPD and Police Department will be notified pursuant to HAR §13-300-40. In addition, in the event of an inadvertent discovery of human remains, the completion of a burial treatment plan, in compliance with HAR §13-300 and HRS §6E-43, is recommended.
6. In the event that *iwi kūpuna* and/or cultural finds are encountered during construction, project proponents should consult with cultural and lineal descendants of the area to develop a reinterment plan and cultural preservation plan for proper cultural protocol, curation, and long-term maintenance.

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Appendix A Historic Hawaiʻi Foundation comments to Environmental Impact Statement Preparation Notice (EISPN)

December 13, 2018

The Honorable Kirk Caldwell
Mayor, City and County of Honolulu
c/o Board of Water Supply
630 S. Beretania Street
Honolulu, HI 96843

Via Email: bwsredevelopmenteis@hhf.com

Re: Board of Water Supply Beretania Complex Redevelopment Project;
Environmental Impact Statement Preparation Notice (EISPN)
Honolulu, Island of Oʻahu
TMK: [1] 2-1-036: 001 & 005 (por)

Dear Mayor Caldwell:

Historic Hawaiʻi Foundation (HHF) is providing comment on the EISPN for the Board of Water Supply (BWS) Beretania Complex Redevelopment Project under Hawaiʻi Revised Statutes (HRS) Chapter 343. HHF reviewed the notice of November 23, 2018 opening the public comment period and containing the scope of work and attached exhibits.

Historic Hawaiʻi Foundation is a statewide organization established in 1974 to encourage the preservation of sites, buildings, structures, objects and districts that are significant to the history of Hawaiʻi. HHF is an organization with a demonstrated interest in the undertaking and a concern for the effects on historic properties.

Project Scope
Under the proposed action, BWS will issue a Request for Proposal (RFP) for a development partner to redevelop of a portion of the Beretania Street Complex. The Project Area does not include the existing BWS Public Service Building, Engineering Building, and Pump Station Building. The selected developer will be issued a ground lease for the use of the Project Area, and will be allowed to redevelop the Project Area, subject to the conditions of the lease [EISPN 3.0].

Historic Hawaiʻi Foundation is pleased to see that the Board of Water Supply has reduced the project area to those portions of the property covered with surface parking, thus avoiding the historic structures on the makai portions of the property. HHF agrees with the project limits and the exclusion of the known historic buildings from the redevelopment site.

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Environmental Impact Statement Preparation Notice for
Board of Water Supply Beretania Complex Redevelopment
December 13, 2018
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Figure 33. Page 1 of Historic Hawaiʻi Foundation comments to EISPN

Undertaking

The Project Area is limited to portions of the BWS Beretania Complex that are currently used for parking. The specific redevelopment plan will be determined by the lessee. The DEIS will evaluate three potential development scenarios, any of which could be implemented under existing zoning and appear to be supported by market conditions. The scenarios are:

- Scenario 1: Assisted Care Living Facility and Office Building
- Scenario 2: Affordable Senior Rental Apartments and Office Building
- Scenario 3: Parking Structure and Office Building

All three scenarios show a new BWS office building (10 stories), including several stories of parking, near the corner of Lusitana Street and Alapai Street. All scenarios also include a larger multi-level parking structure between Lisbon and Lauhala Streets. This structure will replace lost ground level parking and support the proposed residential uses. The number of parking stalls varies by scenario.

Project Area: The project area is currently described as the development parcels. HHF recommends that a larger area of potential effect also be included in the DEIS in order to adequately assess off-site impacts, if any, to historic, cultural, and natural resources. These may include visual or contextual effects on the larger Capital Special District, as well as the adjacent historic BWS buildings.

The BWS Beretania Complex site is included in the City and County of Honolulu Hawaiʻi Capital Special District. The Board of Water Supply Buildings are listed as contributing to the District [ROH Sec. 21-9.30-3 (c)]. The study area is located within the Special District's sub-district, titled "Queens Medical Center Precinct."

The BWS Beretania Complex site is also adjacent to the Hawaiʻi Capital Historic District, which is listed on the National Register of Historic Places, containing 20 significant contributing historic properties.

Identification of Historic Resources: The EISPN states that the Project Area is entirely paved and that there are no historic architecture resources [EISPN Section 5.2.1.2].

However, other documentation exists that indicate that underground tunnels and a bomb shelter were built during World War II (c. 1942) on the BWS site. The existence of all or part of the reported tunnel system needs to be investigated and confirmed in the field, as it is unclear if the tunnel system is wholly or partially underlying the project area or is underneath one of the existing buildings or streets.

Figure 34. Page 2 of Historic Hawaiʻi Foundation comments to EISPN

Please include the location, condition and whether the tunnel system is still extant in the assessment of historic resources in the DEIS, and how the project will avoid or preserve these resources.

The project area also includes known and likely Native Hawaiian burials. The EISPN notes that a Burial Treatment Plan is complete and will be followed by the developer. Further archaeological assessment and treatment will be delayed until the specific development plan is proposed.

HHF is concerned that conducting the archaeological survey after selecting a development scheme would preclude planning efforts to avoid or minimize effects on archaeological resources. It would be prudent to identify sensitive areas and key locations to be avoided or preserved during the planning of the redevelopment, rather than conducting an after-the-fact assessment.

Therefore, HHF recommends conducting, at minimum, a reconnaissance-level survey to identify probable subsurface cultural resources prior to selecting locations for new buildings.

There are, additionally, historic buildings within the overall Beretania Complex, which according to BWS have been previously evaluated by Mason Architects, Inc. The proposed action does not include modification of these existing buildings [EISPN Section 5.2.1.2].

- The BWS Engineering Building was designed by the architectural firm of Wood, Weed, and Associates and was constructed in 1939.
- The Public Service Building houses the BWS's main offices. This historic structure was designed by architect Hart Wood and was constructed in 1958.
- The BWS's iconic Pump Station Building, which fronts South Beretania Street, was designed by the architectural firm of Wood, Weed, and Associates. Construction was started on this building in 1927 and completed by 1939.

HHF recommends that the DEIS technical appendices also include the Mason Architects' architectural inventory survey of the historic properties for reference.

Determination of Effect: The DEIS will discuss the project's potential impact on architectural, archaeological and cultural resources and, if necessary, recommend avoidance, minimization and mitigation measures.

HHF notes that existing special district guidelines address design and development parameters for new construction. These bulk, mass, setback and other standards need to be followed to avoid additional effects on the setting of the historic buildings and district.

Figure 35. Page 3 of Historic Hawai‘i Foundation comments to EISPN

Additional measures to protect historic resources could include commitments to prepare and follow a Preservation Plan for the three historic BWS buildings, treatment guidelines for the WWII Tunnels, and potentially other measures to provide historic interpretation on the site to educate future residents and visitors about its historic and cultural significance.

Thank you for the opportunity to comment on the EISPN for the Board of Water Supply Complex and potential effects on adjacent historic buildings, cultural resources and the Capital District.

Very truly yours,

Kiersten Faulkner

Kiersten Faulkner, AICP
Executive Director

Copies via email:

Board of Water Supply:	Ernest Y. W. Lau, P.E., Manager and Chief Engineer, bwsredevelopmenteis@hhf.com
HHF Planners:	Scott Ezer, Vice President, HHF Planners bwsredevelopmenteis@hhf.com
SHPD:	Alan Downer, Susan Lebo

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Figure 36. Page 4 of Historic Hawai‘i Foundation comments to EISPN

Appendix B Guidelines for Hawai‘i Capitol Special District (ROH Sec. 21-9.30)

Sec. 21-9.20-1 Design controls.

(a) To fulfill district design objectives, each special district may contain regulations which provide guidance for the design of new development and the renovation of existing development.

(b) Regulations may supplement or modify underlying zoning district regulations. Sections 21-9.20-2 through 21 9.20-5 shall apply to all special districts.

(c) The director may establish supplemental design guidelines for special districts to illustrate further the objectives and design controls of each special district.

(Added by Ord. 99-12)

Sec. 21-9.20-2 Major, minor, and exempt projects.

All development in any special district shall be classified into one of three categories: major, minor, or exempt. Major and minor projects shall require a special district permit and shall be processed under Sections 21-2.40-2 and 21-2.40-1, respectively. Tables 21-9.1 through 21-9.7 shall be used as a guide to determine the category of a particular project within each special district.

(a) Major Permits. These permits are intended for projects that may significantly change the intended character of the special district. All major permits shall be reviewed by the design advisory committee as specified in Section 21-2.40-2.

(b) Minor Permits. Minor permits are intended for projects which will have limited impact and are considered minor in nature. The director shall have the right to review and modify such projects.

(c) Exempt Projects. Exempt projects will have negligible or no impact and therefore do not require review. They include projects which require emergency repairs, interior work and do not change the exterior appearance of a structure.

(Added by Ord. 99-12)

Sec. 21-9.20-3 Time limits.

The special district permit shall be null and void if the applicant fails to secure building permits within two years of the date of issuance of the permit. The applicant shall be notified in writing of the change in the time period. On show of cause, the applicant may request the director to extend the time limit. (Added by Ord. 99-12)

Sec. 21-9.20-4 Utility lines.

Notwithstanding any ordinance or regulation to the contrary, utility companies shall place their utility lines underground within any special district. The director may grant an exemption to utility lines based on the applicant's satisfactory justification that no other alternative will better achieve the district's purpose and objectives. (Added by Ord. 99-12)

Sec. 21-9.20-5 Design advisory committee.

(a) The director shall appoint a design advisory committee which shall provide design input to the director on significant proposals in the special districts. The committee shall hear proposals for major special district permits and advise the director concerning the approval, denial or modification of these projects based on the purposes, objectives and design controls of the particular special district.

(b) The committee shall consist of a minimum of seven members as follows:

(1) Two architects;

(2) Two landscape architects;

(3) Two urban planners;

(4) State historic preservation officer from the department of land and natural resources or designated representative.

(Added by Ord. 99-12)

Sec. 21-9.20-6 Conflicting regulations.

If any regulation pertaining to the special districts conflicts with any provision contained within Article 3, the more restrictive regulation shall take precedence; provided, however, that this section shall not apply to TOD development regulations enacted pursuant to Section 21-9.100 and accompanying Sections 21-9.100-1, -2, -3, and -4, which shall take precedence in the event of conflict with any underlying Article 3 provision or special district regulation. (Added by Ord. 99-12; Am. Ord. 09-4)

Sec. 21-9.30 Hawaii capital special district.

(a) As the seat of state and county government, Honolulu enjoys the clustering of government facilities and buildings. Many of the buildings are listed on the state and national registers of historic places. Because of their close proximity, these facilities, and the areas adjacent to them, contribute significantly to the urban design of Honolulu.

(b) The purpose of this section is to establish a special district to be called the "Hawaii capital special district" and to provide for its protection, preservation, enhancement and orderly development.

(c) It is also the purpose of this section to emphasize that the Hawaii capital special district and its landmarks are sources of education, pleasure and intangible benefit for the people of the State of Hawaii and to foster civic pride in the beauty of the district and accomplishments of the past.

(Added by Ord. 99-12)

Sec. 21-9.30-1 Objectives.

The objectives of the Hawaii capital special district are:

Figure 37. Guidelines for Hawai‘i Capitol Special District (ROH Sec. 21-9.30)

(a) To provide safeguards for the preservation and enhancement of buildings and landmarks within the Hawaii capital special district which represent or reflect elements of the state's civic, aesthetic, cultural, social, economic, political and architectural heritage, and encourage new development which is compatible with and complements those buildings and sites.
(b) To preserve and enhance the park-like setting of the Hawaii capital special district, including its view from the Punchbowl lookout.
(Added by Ord. 99-12)

Sec. 21-9.30-2 District boundaries.
The Hawaii capital special district and its precinct boundaries are shown on Exhibit 21-9.1, set out at the end of this article. (Added by Ord. 99-12)

Sec. 21-9.30-3 Prominent views and historic places.
(a) The following streets and locations identify important pedestrian and vehicular corridors by which one experiences the Hawaii capital special district, as well as views of the mountains and the waterfront. The design of all proposed projects within the district shall be guided by the required yards as shown on Exhibit 21-9.2, set out at the end of this article.
(1) Beretania Street between Alapai Street and Alakea Street.
(2) The Hotel Street Mall between Alapai Street and Richards Street.
(3) Hotel Street between Richards Street and Alakea Street.
(4) King Street between South Street and Alakea Street.
(5) Kapiolani Boulevard at the intersection of South Street and King Street.
(6) Ala Moana Boulevard between Punchbowl Street and the district boundary.
(7) Mililani Street and Mall between Halekauwila Street and King Street.
(8) Punchbowl Street between Beretania Street and Ala Moana Boulevard.
(9) South Street between King and Pohukaina Streets.
(10) Richards Street between Halekauwila and Beretania Streets.
(11) Alapai Street between King and Beretania Streets.
(12) The fifth floor lanais of the State Capitol Building, emphasizing a mauka makai orientation.
(b) The following is a listing of sites, structures and objects which are on the state and/or national registers of historic sites and, therefore, are worthy of preservation. They are identified by number on Exhibit 21 9.3, set out at the end of this article.
(1) Kawaiahao Church and grounds.
(2) Adobe School House.
(3) Lunalilo Mausoleum.
(4) Kekuanaoa Building.
(5) Kapuaiwa Building.
(6) Hale Auhau.
(7) Kamehameha I Statue.
(8) Aliiolani Hale.
(9) U.S. Post Office.
(10) Hawaiian Electric Building.
(11) Honolulu Hale and grounds.
(12) Mission Memorial Building Annex.
(13) Honolulu Hale Annex (Mission Memorial Building and Auditorium).
(14) Iolani Palace and grounds.
(15) Iolani Barracks.
(16) Royal Burial Ground and Fence.
(17) Coronation Bandstand.
(18) Captain Cook Memorial Tablet.
(19) YWCA and grounds.
(20) Banyan tree on the Iolani Palace grounds.
(21) Old Archives Building (Attorney General's Building).
(22) Hawaii State Library.
(23) State Capitol and grounds.
(24) Armed Services YMCA and grounds (No. 1 Capitol District).
(25) St. Andrew's Cathedral, including St. Andrew's Close, Davies and Tenney Halls and Parke Memorial Chapel adjacent to the cathedral.
(26) Washington Place and grounds.
(27) Mission Houses.
(28) Aloha Tower.
(29) Royal Brewery.
(30) Podmore Building.
(31) Old Kakaako Fire Station.
(c) Several other buildings contribute to the character of the district. In reviewing applications for modifications and/or removal of the following structures, efforts to retain them are to be encouraged.
(1) St. Andrew's Priory.
(2) St. Peter's Church.
(3) Aliiolani Hale Annex.
(4) Mabel Smythe Building.

Figure 38. Guidelines for Hawaiʻi Capitol Special District (ROH Sec. 21-9.30)

(5) Harkness Nurses Home.
(6) Board of Water Supply Buildings.
(7) Arcade Building.
(8) 1919 Hawaiian Electric Company Building.
(Added by Ord. 99-12)

Sec. 21-9.30-4 Design controls.

(a) Landscaping.

(1) Open space and yard requirements for each precinct shown on Exhibits 21-9.1 and 21-9.2, respectively, set out at the end of this article, shall be landscaped in accordance with landscape guidelines and regulations contained in this subsection. If no yard or open space requirement is shown, underlying zoning district regulations shall prevail.

(2) All required yards shall be landscaped and maintained with a minimum of 75 percent of the area devoted exclusively to plant material rooted directly in the ground or permanently fixed plant containers.

(3) Vertical form trees shall be planted and maintained along the front yard perimeter of parking structures to reduce the visual impact of blank walls and parked vehicles. A tree shall be planted for every 20 feet of linear building length. Acceptable tree species include coconut palms, paperbark and eucalyptus. If there is sufficient space, canopy form trees may be substituted. Alternatively, planter boxes with vines may be provided on the facades of every parking level.

(4) Rooftop parking and mechanical equipment shall be substantially screened and/or painted to soften their appearance from the Capitol building and the Punchbowl lookouts.

(5) All required trees shall be provided in conformance with subdivision (8), and shall be a minimum two inch caliper, except palms which shall have a minimum trunk height of 15 feet. All tree planting shall be in conformance with the requirements and standards shown on Exhibit 21-9.4, except that alternative species, especially native Hawaiian or species long present and common to the Hawaiian Islands, including flowering varieties, shall be encouraged and may be substituted in all instances upon approval by the director. Other exceptions to accommodate special conditions may be approved by the director.

(6) Landscaping for the Iolani Palace grounds shall be in conformance with the master plan as approved by the department, the National Council on Historic Preservation and the state department of land and natural resources.

(7) Landscaping for the Queen's Medical Center shall include retention of its existing large front lawn along Punchbowl Street, except for the Queen Emma Tower expansion and the HML parking garage authorized by Resolution 04-224, CD1, FD1; necessary driveways providing vehicular access through the campus; and pedestrian accessways. Main entrances that exit to ground level shall include a view of landscaping, including trees wherever possible.

(8) Street trees shall be provided along major streets as delineated below, and shown on Exhibit 21-9.4.

(A) Beretania Street, except fronting the State Capitol.
(i) Species: Monkeypod (Samanea saman).
(ii) Maximum spacing: 60 feet on center.
(iii) Location: Within the required front yard.

(B) King Street, except fronting the Iolani Palace grounds and Aliiolani Hale.
(i) Species: Rainbow Shower (Cassia hybrida) or Monkeypod (Samanea saman).
(ii) Maximum spacing: 50 feet on center.
(iii) Location: First five feet of required front yard.

(C) Richards Street, except fronting Iolani Palace grounds.
(i) Species: Royal Poinciana (Delonix regia).
(ii) Maximum spacing: 60 feet on center.
(iii) Location: First five feet of required front yard.

(D) Punchbowl Street.
(i) Species: Monkeypod (Samanea saman).
(ii) Maximum spacing: 60 feet on center.
(iii) Location: Within the required front yard.

(E) Alapai Street.
(i) Species: Monkeypod (Samanea saman).
(ii) Maximum spacing: 60 feet on center.
(iii) Location: Within the required front yard.

(F) Ala Moana/Nimitz Highway.
(i) Species: Coconut Palm (Cocos nucifera).
(ii) Maximum spacing: Three palm trees shall be provided per 50 feet of street frontage.
(iii) Location: First five feet of required front yard.

(G) South Street.
(i) Species: Autograph (Clusea rosea).
(ii) Maximum spacing: 40 feet on center.
(iii) Location: Within the required front yard.

(H) Alakea Street and Queen Emma Street.
(i) Species: False Olive.
(ii) Maximum spacing: 20 feet on center.

Figure 39. Guidelines for Hawai‘i Capitol Special District (ROH Sec. 21-9.30)

(iii) Location: Within the sidewalk area.
(I) Vineyard Boulevard.
(i) Species: Monkeypod (Samanea saman).
(ii) Maximum spacing: 60 feet on center.
(iii) Location: Within the required front yard.
(9) For all other streets, except those along the State Capitol and Iolani Palace grounds, street trees shall be provided at a minimum two-inch caliper. Species and spacing shall be chosen from an approved tree list on file with the department and the department of parks and recreation.
(10) If location of street trees in the sidewalk area is infeasible, the tree(s) shall be located in the required front yard.
(11) In the event there are no feasible locations for street trees, substitute landscaping may be permitted upon approval by the director.
(12) Credit shall be given, at a ratio of one to one, for existing trees that are to be preserved.
(13) Any tree six inches or greater in trunk diameter shall not be removed or destroyed except as follows:
(A) The tree is not visible from any street, park or other public viewing area.
(B) Appropriate development of the site cannot be achieved without removal of the tree.
(C) The tree is a hazard to the public safety or welfare.
(D) The tree is dead, diseased or otherwise irretrievably damaged.
(E) The applicant can demonstrate the tree is unnecessary due to overcrowding of vegetation.
(14) Any tree removed which is visible from any street, park or other public viewing area shall be replaced by an approved tree of a minimum two-inch caliper or by alternative approved landscaping material, unless the replacement results in overcrowded vegetation.
(15) Where possible, trees proposed for removal shall be relocated to another area of the project site.

(b) Design Guidelines for the Historic Precinct. The following design guidelines shall be used in the design and review of new construction and renovation in the historic precinct. They are intended to promote the concept of "contextualism," wherein new developments are sensitive to the existing historic and other significant structures.
(1) Roof Treatment. Roof treatment should reflect existing roofscape by using combinations of overhanging eaves and pitches greater than 1:3. Roofing materials should be green or reddish earth toned tile or gray slate roofing surfaces, or roofing surfaces which closely resemble existing tile or slate roof in color, texture and appearance.
(2) Architectural Style. Architectural elements to be encouraged are the open design of arcades, porches, entryways, internal pedestrian spaces and courtyards. New developments should be influenced by the following architectural styles: modified Mediterranean, Spanish mission, Victorian, U.S. Greek revival, Italianate revival, and French second empire.
(3) Facade. Facade elements common to the precinct include recessed window openings and strong horizontal lines expressed by combinations of fenestrations, openings, wall edges and decorations. New development should incorporate and employ these elements to visually relate new buildings to adjacent facades of established historic value. Typical is the use of projections, columns, balconies and recessed openings.
(4) Color and Surface.
(A) Colors and surfaces in the precinct are characterized by being absorptive rather than reflective. The use of shiny metal or reflective surfaces, including paints and smooth or plastic-like surfaces should be avoided. Colors and surfaces which predominate include warm white walls, earth tones, natural colors of stone, coral and cast concrete. Concrete, stone, terra cotta, plaster and wood should be principal finish materials.
(B) If the use of metal surfaces is required, they should be used with black or dark earth-toned matte finishes. Copper and brass may be acceptable metal surfaces. Glass surfaces, where used, should be recessed and clear, or of light earth toned tints.
(5) Texture. Characteristic textures include those of stucco, tile, concrete, cut coral, cut stone, cast iron, grass and foliage. Development should employ surface qualities which are sympathetic to historic and original uses of material.
(6) Details.
(A) Details are of prime interest and importance at the pedestrian scale and constitute an important design element. The use of terra cotta, plaster work, ironwork, ornament painting and sculptural elements is highly encouraged.
(B) Respect for historic design including detailing should be maintained on elements such as pavers, curbs, signs, planters, benches, trash cans, fountains, lighting, bus shelters and flag and utility poles.
(7) Entry Treatment. Characteristic of places within the precinct is the treatment of building entry which provides comfortable transitions from outside to inside. These elements include arcades and porches recessed or projecting from the building mass.
(8) Orientation. In order to protect mauka views within the precinct, new development should be oriented on a mauka-makai axis.
(9) Signs. Signs shall not be directly illuminated, have moving parts, luminous paints or reflective materials. Any illumination should be from a detached source shielded from direct view. No box fluorescent signs shall be allowed.
(10) Landscape Treatment.
(A) Large open spaces, lawns and canopy-type shade trees, fountains and sculptures shall be compatible with the grounds of Iolani Palace and the Capitol building.

Figure 40. Guidelines for Hawai'i Capitol Special District (ROH Sec. 21-9.30)

(B) In small open areas, combinations of ground covers, shrub masses, flowering trees and palms may be used either to introduce rich foliage patterns, for screening purposes, or to provide contrast to large, open lawn areas.

(C) Small-scale landscape features such as courtyards, resting places, entrances and intimate gardens are encouraged and should be compatible with, and secondary to, the larger park-like landscape.

(c) Design Guidelines for Other Precincts.

(1) Open Space. All parcels shall comply with the minimum open space expressed as a percentage of lot area designated on Exhibit 21-9.1, set out at the end of this article.

(2) Visual Impacts. All major development, especially on those parcels and building facades visible and adjacent to the historic precinct, shall be reviewed to ensure that new structures do not visually intrude into the historic precinct. Articulated building walls are encouraged. The use of recessed windows, lanais, projecting eyebrows, offsets in the wall planes and exterior colors may be used to achieve this articulation.

(d) Height Regulations.

(1) Heights for all precincts are identified on Exhibit 21-9.1, set out at the end of this article.

(2) The director may exempt the following architectural features from the height regulations of the Hawaii capital special district, provided they are erected only to such height as is necessary to accomplish the purpose for which they serve, but in no case exceeding 12 feet above the maximum height limit. These building elements may be exempted only if the director finds they do not obstruct any significant views which are to be preserved, protected and enhanced and are consistent with the intent and objectives of the Hawaii capital special district.

(A) Necessary mechanical appurtenances of the building on which they are erected, provided they are screened from view.

(B) Necessary utilitarian features, including stairwell enclosures, ventilators and skylights.

(C) Decorative or recreational features, including rooftop gardens, planter boxes, flagpoles, parapet walls or ornamental cornices.

(3) Except for flagpoles and smokestacks, all items listed in Section 21-4.60(c) shall also be exempt from the height provisions of this section.

(Added by Ord. 99-12; Am. Ord. 07-8)

Sec. 21-9.30-5 Project classification.

Refer to Table 21-9.1 to determine whether specific projects will be classified as major, minor, or exempt.

(Added by Ord. 99-12; Am. Ord. 03-37)

Figure 41. Guidelines for Hawaiʻi Capitol Special District (ROH Sec. 21-9.30)

Table 21-9.1 Hawaii Capital Special District Project Classification		
Activity/Use	**Required Permit**	**Special Conditions**
Signs	E	Directly illuminated signs prohibited in historic precinct
Tree removal over six inches in diameter	m	
Detached dwellings and duplex units and accessory structures	E	
Grading and stockpiling	E	
Major modification, alteration, addition or repair to historic structures	M	This also includes structures listed in Section 21-9.30 3(c)
Major exterior repair, alteration or addition to nonhistoric structures	m	
Minor exterior repair, alteration or addition to all structures, which does not adversely change the character or appearance of the structure	m/E	Minor in historic precinct only
Exterior repainting that significantly alters the character or appearance of the structure	m/E	Minor in historic precinct only
Interior repairs, alterations and renovations to all structures	E	
Demolition of historic structures	M	This also includes structures listed in Section 21-9.30 3(c)
Demolition of nonhistoric structures	E	
Fences and walls	E	
Streetscape improvements, including street furniture, light fixtures, sidewalk paving, bus shelters and other elements in public rights-of-way	m	
Major above-grade infrastructure* improvements not covered elsewhere, including new roadways, road widenings, new substations, new parks and significant improvements to existing parks	m	
Minor above-grade infrastructure* improvements not covered elsewhere; all below-grade infrastructure improvements; and all emergency and routine repair and maintenance work	E	
New buildings not covered above	M/m	Minor for accessory structures

*Notes: "Infrastructure" includes roadways, sewer, water, electrical, gas, cable tv, telephone, drainage and recreational facilities.

A special district permit is not required for activities and uses classified as exempt, as well as other project types which do not fall into one of the categories listed above. These activities and uses, however, must still conform to the applicable objectives and standards of the special district. This conformance will be determined at the building permit application stage.

Legend--Project classification:
M = Major
m = Minor
E = Exempt

(Added by Ord. 99-12)

Sec. 21-9.40 Diamond Head special district.

(a) Diamond Head is a volcanic crater that has been declared a state and national monument. Its natural appearance and prominent public views have special values of local, state, national and international significance and are in danger of being lost or seriously diminished through changes in land use and accompanying land development.

Figure 42. Guidelines for Hawaiʻi Capitol Special District (ROH Sec. 21-9.30)

Appendix D

Historic Resources Evaluation for BWS Beretania Complex Modernization
Mason Architects, Inc. June 2019

Historic Resources Evaluation for

BWS Beretania Complex Modernization, Oahu, HI

Prepared by MASON for HHF Planners

July 2019

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Introduction

Mason Architects, Inc., (MASON) was hired by HHF Planners to perform an historic architectural assessment in support of the Environmental Impact Statement (EIS) being prepared for the Board of Water Supply (BWS) Complex, which is proposed for redevelopment under three potential scenarios. MASON identified several historic resources that will be affected under the proposed scenarios. These resources include historic buildings and structures within the BWS Complex site identified as eligible for listing on the State and/or National Register of Historic Places (NRHP), as well as two Special Districts already in place.

BWS Beretania Complex

Today's BWS Beretania Complex is made up of two property blocks, the Ewa Block and the Diamond Head Block. There are several historic structures within the complex: The Public Service Building is located on the Ewa Block fronting Beretania Street, with the Pumping Station and the Engineering Building located on the makai portion of the Diamond Head Block. In addition, there are; an underground tunnel system, a pedestrian bridge, and various landscape features also identified within the Survey Area as historic resources. (See Table 1: Historic Resources Summary and the historical overview sections to follow for additional information on these historic structures.)

Figure 1: Map showing the two main sections of the BWS Complex. Source: AHL, May, 2018

The majority of the Ewa Block is taken up by three stepped parking lots with a total of 331 stalls. The Diamond Head Block has two parking areas with a total of 60 stalls, as well as a 25-stall parking area formed by the void created by the U-shape of the Engineering Building. Rock retaining walls, some pre-dating the existing structures, can be found both within and surrounding the parking areas. Historic landscapes and trees are located along Beretania Street and to the north of the Public Service Building. A subterranean World War II bomb shelter tunnel system is located to the north of the Engineering Building, mostly beneath the employee/visitor parking area and driveway between Alapai and Lisbon Streets.

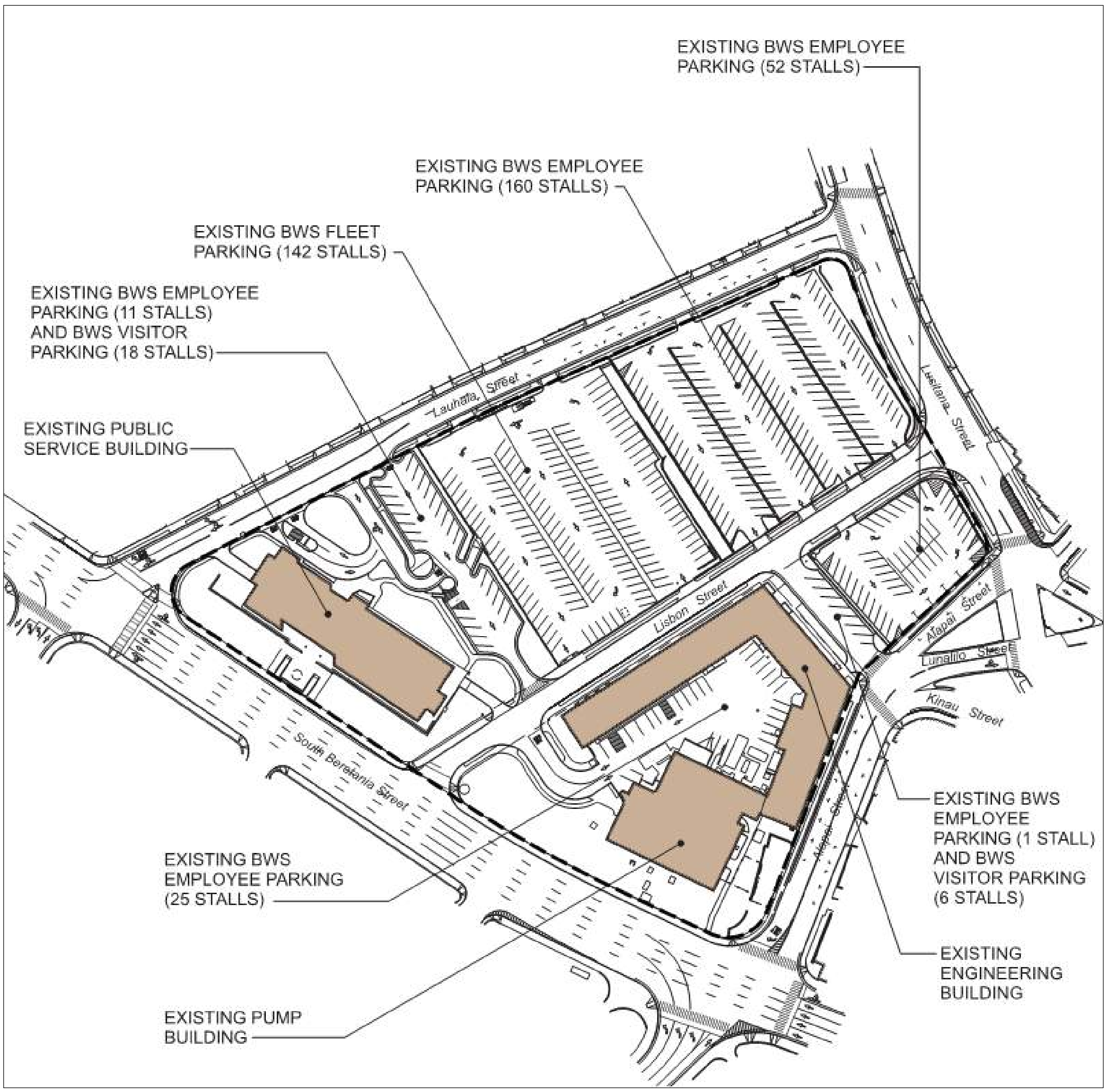

Figure 2: Map showing of BWS Complex Buildings. Source: AHL, May 2018.

Identification of Historic Properties

Although the Project Area defined in the EIS Preparation Notice (EISPN) for the proposed undertaking is limited to the portions of BWS property that are covered with surface parking and will be developed, MASON defined a larger survey area for its historic resources survey in order to capture potential adjacent historic resources. The Survey Area defined by MASON includes the entirety of the BWS Beretania Complex, which is defined by Beretania Street to the southwest, Lusitana Street to the northeast, Lauhala Street to the northwest, and Alapai Street to the southeast. The project was also evaluated for its Area of Potential Effect (APE), which is defined by federal review process as "the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties, if any such properties exist."[1]

A total of four buildings, one underground tunnel system, one bridge, and various landscape features were identified within the Survey Area as historic resources. Remnant lava rock walls on the site, which are over 50 years old, have been evaluated as not individually eligible for the State or National Registers. These are summarized in Table 1: Historic Resources Summary on the next page, followed by a historical background of the property.

[1] 36 CFR PART 800.16(d) -- Protection of Historic Properties (incorporating amendments effective August 5, 2004). https://www.achp.gov/sites/default/files/regulations/2017-02/regs-rev04.pdf. Accessed January 20, 2019.

Table 1: Historic Resources Summary

Building Address/TMK	Built	Significance Evaluation	Photo
Pumping Station TMK: (1) 2-1-036:004	1926-1927	Eligible for the State and National Registers: • Criterion A: Integral to the development of the city of Honolulu, and pumping station site since the 1890s • Criterion C: Restrained Beau Arts style	
Pumping Station Annex TMK: (1) 2-1-036:004	Btw. 1927 and 1938	Eligible for the State and National Registers: • Criterion A: Integral to the development of the city of Honolulu, and location of a pumping station since the 1890s	
Engineering Building TMK: (1) 2-1-036:004	1939	Eligible for the State and National Registers: • Criterion A: Integral to the development Honolulu • Criterion B: Frederick C. Ohrt • Criterion C: Modernist style building designed by Hart Wood & Arthur J. Russell Architects	
Underground Bomb Shelter and Tunnel System (Located under the Engineering Building and the rear drive.)	Ca. 1942	Eligible for the State and National Registers: • Criterion A: Reflective of Honolulu's response to the December 7th, 1941, Japanese attack on Pearl Harbor • Criterion C: Distinctive underground construction indicative of expedited protective measures made on Oahu after the attack.	
Public Service Building (PSB) / Administration Building TMK: (1) 2-1-036:005	1958	Eligible for the State and National Registers: • Criterion A: Represents the modernization of Honolulu's water system and establishment of BWS • Criterion B: Frederick C. Ohrt • Criterion C: Modernist building by Wood, Weed, & Assoc. combines Western, Asian, Hawaiian motifs	
Landscape elements (Fountain, palms, grass, shade trees) at Public Service Building and Pumping Station	Varies	Not individually eligible, but eligible as contributing features to the Public Service Building and Pumping Station.	
Footbridge over Lisbon Street connects Engineering and Public Service Building	1957	Eligible for the State and National Registers: Criterion C: Elevated and curved pedestrian bridge by Wood, Weed, & Assoc. as part of the Public Service Building and Engineering Building, features Asian-inspired decorative motifs along the railings.	
Remnant lava rock walls	Varies	Not individually eligible for the National Register.	

Evaluation of Significance and Historical Overview

BWS Beretania Complex

When Queens Hospital was first built in 1860, the area of the BWS site was largely barren, with a few stone walls demarcating the properties. A pumping station was built at the makai/Diamond Head corner of the Diamond Head Block in 1895. At that time, the balance of the property was still vacant. The 1895 station was first tested in early May of that year and began operations immediately thereafter.[2] Several lava rock walls and wall remnants extant today appear to have been in situ when Queen's Hospital was first built (1860) and when the first pumping station was built in 1895. The original masonry pumping station had two artesian wells with a bore of ten inches and included a reservoir located on the side of Punchbowl to provide pressure. [3]

By 1912, the land included in both lots was subdivided and developed. By 1914, the site was covered with houses, a few small shops, and a factory for the Honolulu Wire Bed Company. There were at least 45 buildings on the Ewa Block, not including small sheds or garages, and at least 17 structures on the parcel east of Lisbon Street (Diamond Head Block), not including the Pump Station and its related buildings. In 1921, a portion of land at the corner of Beretania and Lusitania Streets was set aside by the Governor of the Territory of Hawaii pursuant to Executive Order 107 for use as a pump station and municipal garage.

In 1927, the original 1895 pumping station building, which had been in continuous use since its construction, was demolished and replaced with today's concrete pumping station building. The remainder of the parcel had been partly cleared for expansion of the BWS facilities. At that time, the Ewa Block had at least 55 buildings, most of which were houses. By 1950, many of the houses on the Ewa Block were demolished in advance of the proposed Public Service Building, then in the design phase. No residential structures currently remain on either the Diamond Head or Ewa Blocks.

Diamond Head Block Buildings

The parcels that comprise the Diamond Head Block total approximately 103,000 square feet in area and are bounded by Lisbon Street, Lusitana Street, Alapai Street and South Beretania Street; they are identified by TMK numbers (1) 2-1-036:001 and (1) 2-1-036:004. The Diamond Head Block contains the Engineering Building, Beretania Pumping Station and Annex, Beretania Wells, monitor wells, appurtenance piping and other infrastructure for the wells and pumps. The parcel also holds parking areas for customers and employees. Under the parking area directly mauka of the Engineering Building is a World War II-era subterranean bomb shelter.

Built in 1927, the Beretania Pumping Station and Annex replaced the 1895 building, in nearly the same location. The earthquake and fireproof buildings were designed by the Honolulu architecture and engineering firm of Rothwell, Kanegter and Lester, in close collaboration with the Water Commission. The contractor was E.J. Lord.

The Annex, which is attached to the mauka side of the Pumping Station, is believed to have been completed first to enclose and protect the existing boilers. Although the construction of the two buildings is the same, concrete on a structural steel frame with stucco exterior finish, the Annex is a

[2] Local Section. Honolulu Advertiser. May 2, 1895, p.7 and May 13, 1895, p.7.
[3] A Number of Men to be Employed, Honolulu Advertiser. October 31, 1894, p.1.

simple, utilitarian, rectangular building with a flat roof. Original windows have been infilled and five skylights on the roof have been covered over. A 125-foot-tall concrete smoke stack from the 1895 building stood mauka of the building and remained in use for years, but is no longer extant. Currently, the siting of the Annex makes it nearly invisible from all vantage points – other than from within the inner courtyard of the U-shaped Engineering Building.

The Beaux Arts style Pumping Station building is a double-height rectangle with a green, barrel-tiled, hip roof. The roof has no overhangs and the intersection of wall and roof features a crenulated-arch corbel table. The base of the building has a concrete water table with canted top. The building follows a formal symmetry. It has a pedimented entry on the Diamond Head façade flanked by stacked metal awning windows and topped by a large, arched, fixed and awning transom. The Ewa façade is arranged the same but now holds a double aluminum storefront door and fixed glass transom; there is no pediment above the doors (assumed to have been removed), but the large arched transom is extant. The makai façade, along Beretania, is dominated by five very large, equally spaced arched windows that extend from the water table up the façade nearly to the corbel table. The Pumping Station was completed in 1927 but not put into full service until 1928, after multiple tests of the equipment, which included a new 10,000,000-gallon pump, a 4,000,000-gallon pump, three new 12-inch artesian wells, and additional boilers. Also completed in 1928 was the lawn and landscaping surrounding the Pumping Station.

According to Sanborn Fire Insurance Maps, the Engineering Building has had a similar footprint from as early as 1927, when it was a one-story reinforced-concrete auto garage. Over the years, portions of the garage were adapted into offices, laboratories, and maintenance shops. The present-day Engineering building is a concrete and steel-framed structure that varies in height from one to three stories with basement and mezzanine floor levels. The 1956 Sanborn Map shows the building to have been built in 1939, while the earliest available drawings (dated January 1939) show the expansion of the existing building to its current height and configuration.

The Engineering Building, designed by Hart Wood & Arthur J. Russell Architects, steps up along Lisbon Street with the mauka slope of the land. The building has no overhangs, giving it the appearance of a flat roof when viewed from street level, although the roofs are actually moderately-sloped hips. Other notable exterior features include horizontal bands of glass block at each floor level to admit daylight into the interior spaces interspersed at regular intervals with operable steel windows. The main entrance, at the first-floor mauka level, features an Art Deco-style, green slate, bas-relief carving designed by Honolulu artist Margaret Blasingame. The carved mural depicts the legend of how water was brought to the islands. Above the mural and entry is a cantilevered canopy with water-related inscriptions in Art Deco lettering. Also of note is the elevated pedestrian bridge that connects the Engineering Building with the Public Service Building located across Lisbon Street.

Located approximately 20 feet underground and accessed through a hatch inside the first floor of the Engineering Building are a series of bomb shelter tunnels that encompass an approximate 16,000 square foot area beneath the driveway adjacent to the north side of the Engineering Building.[4] A drawing from 1942 indicates that there are approximately 4,800 square feet of tunnels leading in multiple directions, including a branch that angles to the southeast and is labeled “Waikiki Escape Tunnel.” The rough-

[4] Precise location of tunnel system has not been mapped. See recommendations.

walled tunnels are shown on the drawing to be eight inches thick, presumably finished with gunite, varying in width and height, but all with barrel vault ceilings.

Ewa Block Buildings

The land parcels that comprise the Ewa Block are those bounded by Lauhala Street, Lusitana Street, Lisbon Street and South Beretania Street. They are identified by Tax Map Key (TMK) Numbers (1) 2-1-036:005 and (1) 2-1-036:006 and comprise approximately 171,000 square feet in land area. The Ewa Block contains the Public Service Building and parking areas for equipment, customers and employees.

The Public Services Building, constructed in 1958, is a three-story, concrete-framed structure with a basement and a steel-framed roof penthouse structure. Its design, also by Hart Wood, was finalized by 1950, but construction was delayed by funding. Wood died in 1957 so the construction was overseen by his firm, Wood, Weed & Kubala. The building combines quintessential Modernist design with Asian-influenced elements in an engaging and appropriate regional architectural expression, a synergy for which Hart Wood is well-known. It successfully employs the use of architecture, art, and landscape to convey the importance of water to community.

The most prominent exterior feature of the building is the vertical sun screen grille, perforated with an Asian-inspired decorative pattern. The grilles were constructed of aluminum and are bisected by horizontal concrete eyebrows. The dramatic main entrance canopy design harkens to a Japanese torii gate. The water fountain, located prominently at the entrance, bears the inscription, “Uwe Ka Lani Ola Ka Honua” which means “When the heavens weep, the earth lives.”

Public spaces occupy the center portion of the ground floor, with administrative offices located at either ends of the ground floor level. The second and third floors are administrative offices, while the basement is primarily used for building mechanical services, maintenance and storage. The roof top penthouse was designed with an employee lunchroom.

An elevated and curved pedestrian bridge connects the Public Services Building to the Engineering Building. It, too, features Asian-inspired decorative motifs along the railings and in the graceful concrete support pylons. The building’s landscaping and fountain were designed by the noted husband and wife landscape architecture firm of Thompson & Thompson.

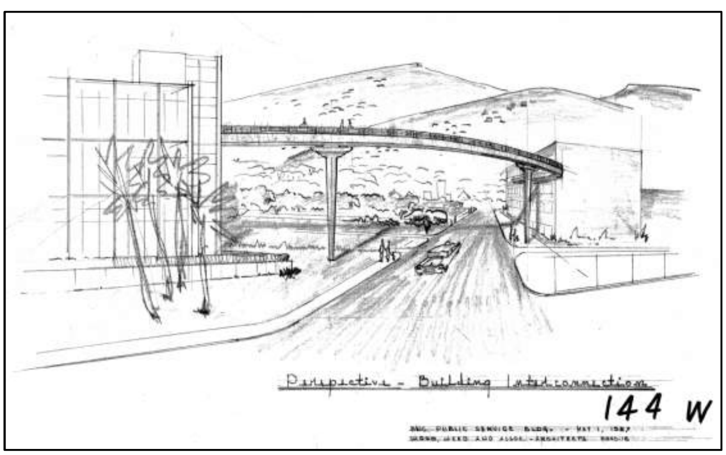

Figure 3: Perspective sketch by Wood, Weed & Assoc., showing the proposed pedestrian bridge with Punchbowl in the distance. Source: Honolulu BWS drawing archives.

Notable People

Hart Wood

Hart Wood (1880-1957) is one of Hawaii's foremost architects. He artfully melded classic western architectural styles with Asian and Hawaiian traditions to hone a unique Hawaiian regionalist design aesthetic that has had an enduring influence on architecture in Hawaii that includes both commercial buildings and private residences.

Among his most prominent works are the First Church of Christ Scientist (1923), the Gump Building (1929), the First Chinese Church of Christ (1929), the Alexander & Baldwin Building (1929), the Beretania Board of Water Supply Public Service Building (1957) and various iconic pumping stations (1933-1957).

The BWS, which was flush with Public Works money after the Depression, began its association with Wood in 1933 with four commissions for pumping stations around Oahu. In partnership with the landscape architecture firm of Thompson & Thompson, the meticulously detailed Board of Water Supply buildings and grounds elevated what was generally a utilitarian building form to thoughtfully designed buildings and landscapes that enhance the neighborhoods in which they were built. The designs earned Wood the American Association of Nurseryman's national award for institutional buildings. Also of note - the green exterior color of the BWS buildings that has become the trademark color of the BWS facilities and vehicles was selected by Hart Wood.

The Territory of Hawaii was booming after World War II, and so was Wood's business – designing many notable civic, religious, medical, and education buildings. The Board of Water Supply Public Service Building on Beretania was built during this period and remains one of his most recognizable works. Upon his death in October 1957, Hart Wood was referred to in multiple obituaries and editorial columns as "the dean of Hawaii architects." "He pioneered a design language that was unique to Hawaii and did so by looking not only at its benign weather but by using local materials in innovative ways and incorporating the cultures of the various people of Hawaii."[5]

Fred Ohrt

Fred Ohrt (1889-1957) was the first manager and chief engineer of the BWS from 1929-1952. A kamaʻāina resident and pioneer in the fields of water development and water conservation, Ohrt began his engineering career with the Honolulu Water Works in 1915 as assistant city engineer and later chief engineer for the Honolulu Sewer and Water Commission.

Over the years, the fledgling water system expanded, and in 1929, Ohrt became manager of the newly formed Board of Water Supply. The BWS was established to replace the mismanaged and scandal-ridden City Waterworks Department, which had brought the city to the verge of a water shortage. Ohrt's obituary said he "transformed the run-down politics-ridden Honolulu Waterworks into a highly efficient government department that won the respect of engineers everywhere. His vision anticipated every new demand for services and the system he built met the extraordinary increase in water consumption during World War II."[6]

His vision also extended to BWS facilities. He believed that thoughtful, sensitive designs could transform a utilitarian building into a community asset – and hence began a 20-year-long association with Hart

[5] Hibbard, Mason & Weitze, "Hart Wood: Architectural Regionalism In Hawaii," p.246.
[6] His Life Was Dedicated to Public Service, Honolulu Star Bulletin. March 14, 1957, p6.

Wood. Some of the lasting legacies under Ohrt's leadership include the Pacific Heights Reservoir (1933), the Makiki–Mānoa Pumping Station (1935), the Kalihi Uka Pumping Station (1935) and the Nuʻuanu Aerator (1936), which was designed to purify surface waters drawn from Nuʻuanu stream. His final collaboration with Wood was the Public Service Building fronting Beretania Street.

As the first head of the BWS, Ohrt was largely responsible for the development of a modernized water system for Honolulu. He became a nationally recognized water expert, both in development and conservation. As an architectural patron, Ohrt created a lasting legacy of exemplary architectural and landscape design in Honolulu.

Historic Districts

The BWS project site is located near, but outside of, two National Register of Historic Places historic districts. These include the Hawaii Capital Historic District, which was listed in 1978, and the Pūowaina (National Memorial Cemetery of the Pacific) historic district, which was listed on the National Register of Historic Places in 1975. In addition, the project is situated within, or near, two Special Districts, as discussed in the Special Districts section.

Proposed Action

Three scenarios are under consideration for the site. These include:

Scenario 1: Assisted Care Living Facility and Office Building

The main component of Scenario 1 is a 266-unit assisted living facility located in the northwest corner of the property. Parking for employees, residents, and guests of the assisted living facility would be provided in an adjacent 10-floor parking structure, which will include a total of 605 stalls.

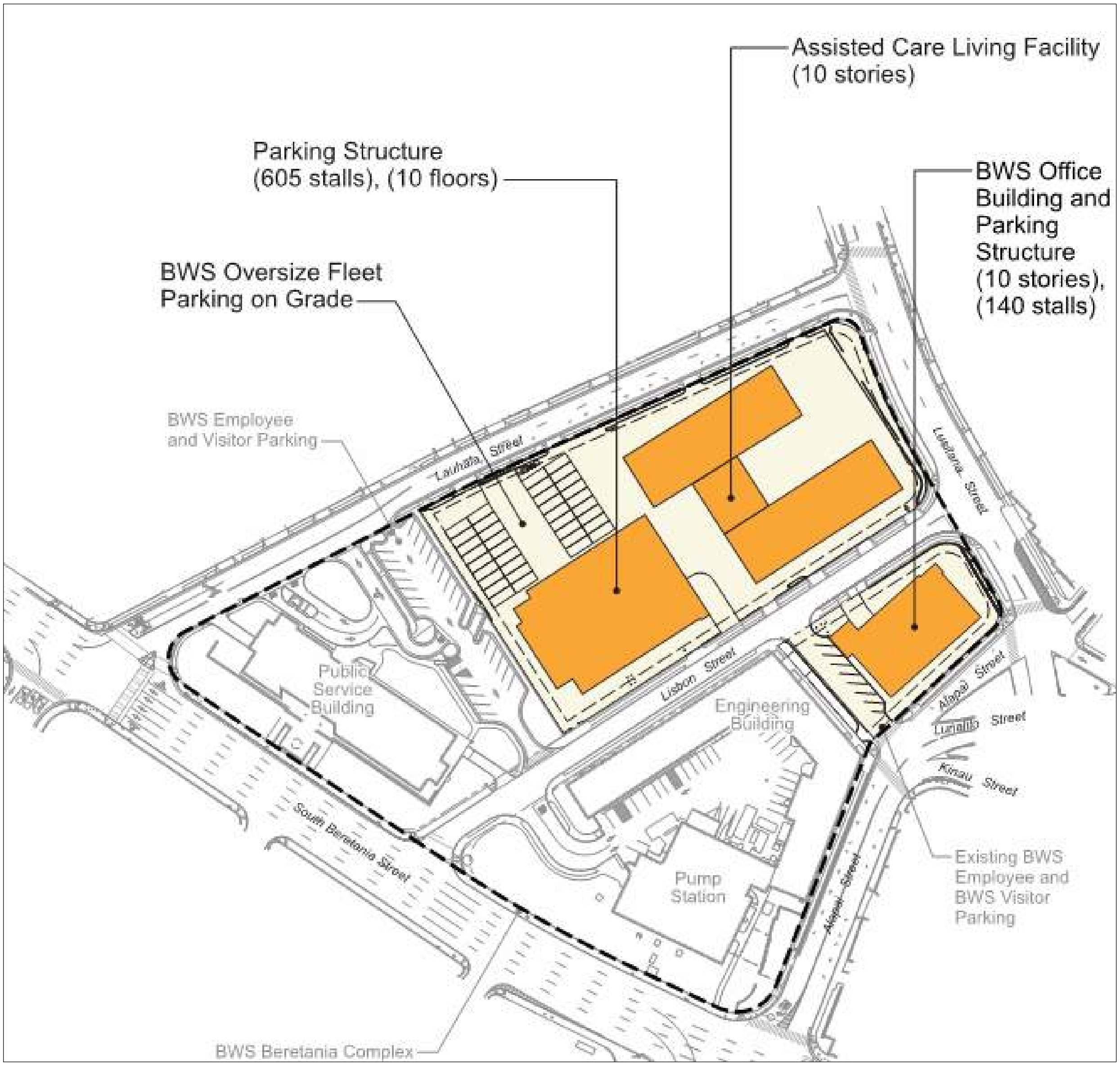

Figure 4: Proposed Action, Scenario 1. Source: AHL.

Scenario 2: Affordable Senior Rental Apartments and Office Building

Scenario 2 (Figure 5) includes the development of senior rental apartments in the northwestern corner of the Beretania Complex. The concept plan shows the building footprint for two 10-story apartments with 312 units, approximately 450 SF in size. Parking for residents and visitors would be provided in an adjacent 10-floor parking structure which will include a total of 605 stalls.

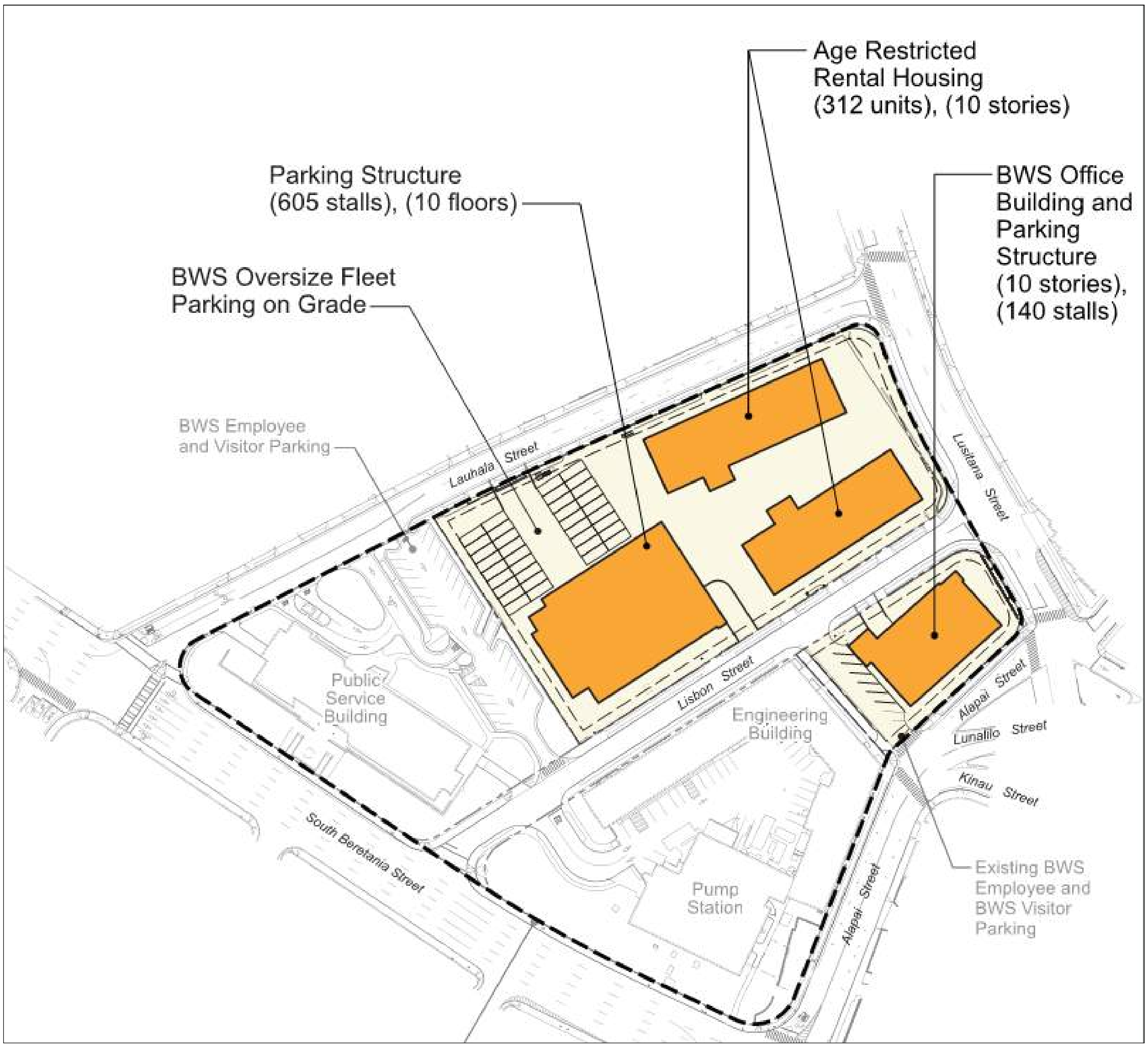

Figure 5: Proposed Action, Scenario 2. Source: AHL.

Scenario 3: Parking Structure and Office Building

Under Scenario 3 there would be no residential component on the property. The northwest corner of the property, near the intersection of Lauhala and Lusitana Streets, will remain as ground level parking. The proposed parking structure off Lauhala Street will be 10 floors but larger in footprint, with a total of 1,155 parking stalls. Approximately 178 stalls will be reserved for BWS use and the remainder will be available for lease.

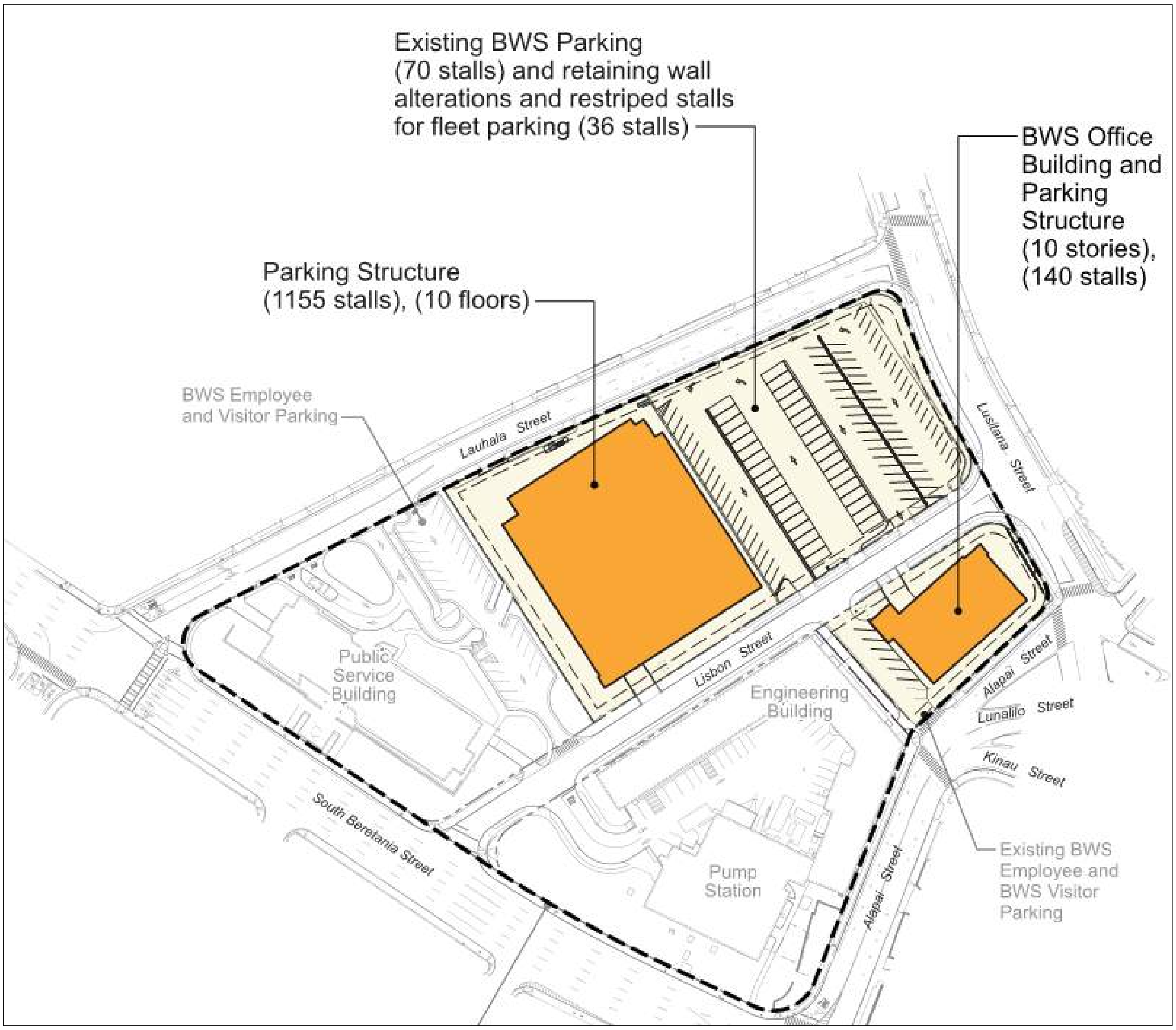

Figure 6: Proposed Action, Scenario 3. Source: AHL.

Evaluation of Effects on Historic Properties

Hawaii Administrative Rules chapter 13-275-7 (b) describes effects on historic properties as:

> Effects include, but are not limited to, partial or total destruction or alteration of the historic property, detrimental alteration of the properties' surrounding environment, detrimental visual, spatial, noise or atmospheric impingement, increasing access with the chances of resulting damage, and neglect resulting in deterioration or destruction.

Effects to historic properties are federally defined by 36 CFR 800.5(1), Assessment of Adverse Effect (See References) and include undertakings that impact the integrity of a historic resource's location, design, setting, materials, workmanship, feeling, or association. An adverse effect is found when an action alters, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register. Effects may include destruction, alteration, removal, change of use, change of setting - be that physical, visual or audible; neglect; or a transfer, sale or lease that could endanger long-term preservation of the resource.

With this in mind, each of the proposed three scenarios were evaluated for their effects on historic properties. These evaluations are presented on the following pages.

Figure 7: Present-day view of the BWS Complex showing the current open sky backdrop at the pedestrian bridge that spans the Public Services Building and the Engineering Building, as viewed from the Beretania Street corridor. Source: MASON.

Table 2: Evaluation of Effect of Scenario 1 on Historic Resources

Historic Resource	**Proposed Work**	**Evaluation of Effect**
Underground Bomb Shelter and Tunnel System	Construction of 10-story BWS Office Building and Parking Structure	If site work and construction of the 10-story BWS Office Building and Parking Structure damage or demolish any portion of the historic underground tunnel system, it would be an adverse effect. (Building location and design will be determined by selected contractor. Tunnel mapping should occur as part of the design phase.)
Historic structures within BWS Beretania Complex are: Pumping Station & Annex, Engineering Building, and the Public Services Building, historic landscape elements (fountain), and footbridge.	Construction of: ▪ 10-story parking structure ▪ 10-story assisted care living facility - two towers ▪ 10-story BWS Office Building and Parking Structure	Integrity of Location, Design, Materials, and Workmanship will retain intact, since the buildings will not be moved or modified. Integrity of setting, feeling, and association will be adversely affected as viewed from Beretania Street. The proposed 10-story parking structure would largely replace the open sky and palm tree backdrop that frames the low-rise BWS buildings and connecting bridge between the Engineering Building and the Public Service Building. The site's current open, low-rise character would be physically and visually changed.

Figure 8: Rendering showing conceptual view of Scenario 1 from Beretania Street. Source: HHF Planners.

Table 3: Evaluation of Effect of Scenario 2 on Historic Resources		
Historic Resource	**Proposed Work**	**Evaluation of Effect**
Underground Bomb Shelter and Tunnel System	Construction of 10-story BWS Office Building and Parking Structure	If site work and construction of the 10-story BWS Office Building and Parking Structure damage or demolish any portion of the historic underground tunnel system, it would be an adverse effect. (Building location and design will be determined by selected contractor. Tunnel mapping should occur as part of the design phase.)
Historic structures within BWS Beretania Complex are: Pumping Station & Annex, Engineering Building, and the Public Services Building, historic landscape elements (fountain), and footbridge.	Construction of: ▪ 10-story parking structure ▪ 10-story rental housing – two towers ▪ 10-story BWS Office Building and Parking Structure	Integrity of Location, Design, Materials, and Workmanship will retain intact, since the buildings will not be moved or modified. Integrity of setting, feeling, and association will be adversely affected as viewed from Beretania Street. The proposed 10-story parking structure would largely replace the open sky and palm tree backdrop that frames the low-rise BWS buildings and connecting bridge between the Engineering Building and the Public Service Building. The site's current open, low-rise character would be physically and visually changed.

Figure 9: Rendering showing conceptual view of Scenario 2 from Beretania Street. Source: HHF Planners.

Table 4: Evaluation of Effect of Scenario 3 on Historic Resources		
Historic Resource	**Proposed Work**	**Evaluation of Effect**
Underground Bomb Shelter and Tunnel System	Construction of 10-story BWS Office Building and Parking Structure	If site work and construction of the 10-story BWS Office Building and Parking Structure damage or demolish any portion of the historic underground tunnel system, it would be an adverse effect. (Building location and design will be determined by selected contractor. Tunnel mapping should occur as part of the design phase.)
Historic structures within BWS Beretania Complex are: Pumping Station & Annex, Engineering Building, and the Public Services Building, historic landscape elements (fountain), and footbridge.	Construction of: ▪ 10-story parking structure ▪ 10-story BWS Office Building and Parking Structure	Integrity of Location, Design, Materials, and Workmanship will retain intact, since the buildings will not be moved or modified. Integrity of setting, feeling, and association will be adversely affected as viewed from Beretania Street. The proposed 10-story parking structure would completely infill the open sky and palm tree backdrop that frames the low-rise BWS buildings and connecting bridge between the Engineering Building and the Public Service Building. The site's current open, low-rise character would be physically and visually changed.

Figure 10: Rendering showing conceptual view of Scenario 3 from Beretania Street. Source: HHF Planners.

Special Districts

The project is located within, or near, two Special Districts. Special Districts are recognized under Chapter 21, Article 9, of the Hawaii Land Use Ordinance. Undertakings within these, and other special districts, must adhere to design controls specific to them, and be reviewed by a Design Advisory Committee, and approved by the Director of the Department of Planning and Permitting. Special District Regulations are outlined in Chapter 21, Article 9 of the Land Use Ordinance (LUO), Revised Ordinances of Honolulu, ROH 21-9.30.

Hawaii Capital Special District

The BWS project is located within the Hawaii Capital Special District, which is the civic core of state and Honolulu County government, and contains many of Honolulu's landmark buildings. See Figure 11 map for boundaries.

The district includes regulations with limits on height, setbacks and open space, and protects identified views. It also includes design controls for landscaping, street trees, roof treatment, architectural components, open spaces, and visual impacts.

Per Section 21-9-30-1, the special district has two objectives;

a) To provide safeguards for the preservation and enhancement of buildings and landmarks within the Hawaii capital special district which represent or reflect elements of the state's civic, aesthetic, cultural, social, economic, political, and architectural heritage, and encourage new development which is compatible with and complements those buildings and sites.

b) *To preserve and enhance the park-like setting of the Hawaii capital special district, including its view from the Punchbowl lookout.*

As shown in Figure 13 on page 23, the addition of proposed new buildings within the site are nearly indistinguishable from the surrounding urban landscape. The views from the Punchbowl lookout over the Hawaii Capital Special District are thus largely preserved, since the three scenarios being considered for the BWS project only pose minor changes from that viewpoint and distance. Further, the proposed project does not impact the park-like setting of the Hawaii Capital Special District.

The Special District is divided into multiple precincts that include the Historic Precinct at its core, as well as the Perimeter Precincts, the Queen's Medical Center Precinct, and Tower Precinct. The proposed project site is located within the Queen's Medical Center Precinct, whose objective is, *to minimize any adverse impact of new medical facilities on the Historic Precinct*. The Queen's Medical Center Precinct has a 100-foot height limitation, and a 40% open space requirement. All three scenarios of the BWS project conform to the Queen's Medical Center height and open space requirements.

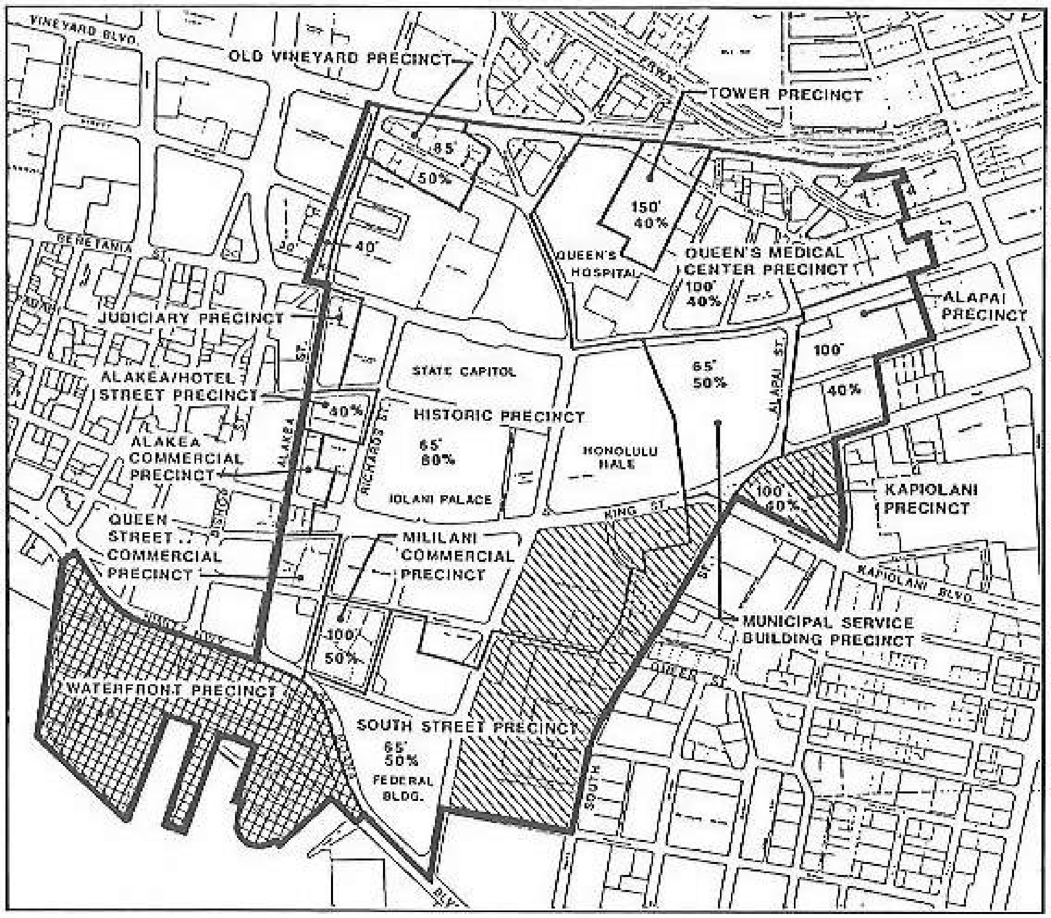

Figure 11: Map of Hawaii Capital Special District, showing precincts. Source: Hawaii Capital Special District Design Guidelines.

Punchbowl Special District

The BWS project site is located outside of the Punchbowl Special District boundaries, but is within its designated sightlines. Punchbowl is a volcanic crater and home to the National Memorial Cemetery of the Pacific. Its traditional name, Pūowaina, means "Hill of Sacrifice." Formed over 75,000 years ago, the dramatic crater has served as a ritual space for early Hawaiians, military defense (both for the early Hawaiians and later for World War II defenses), and now as a national cemetery. In 1942 the Territory of Hawaii donated the crater to the United States for use as a cemetery, and in 1948 the cemetery site was approved by Congress and construction began.

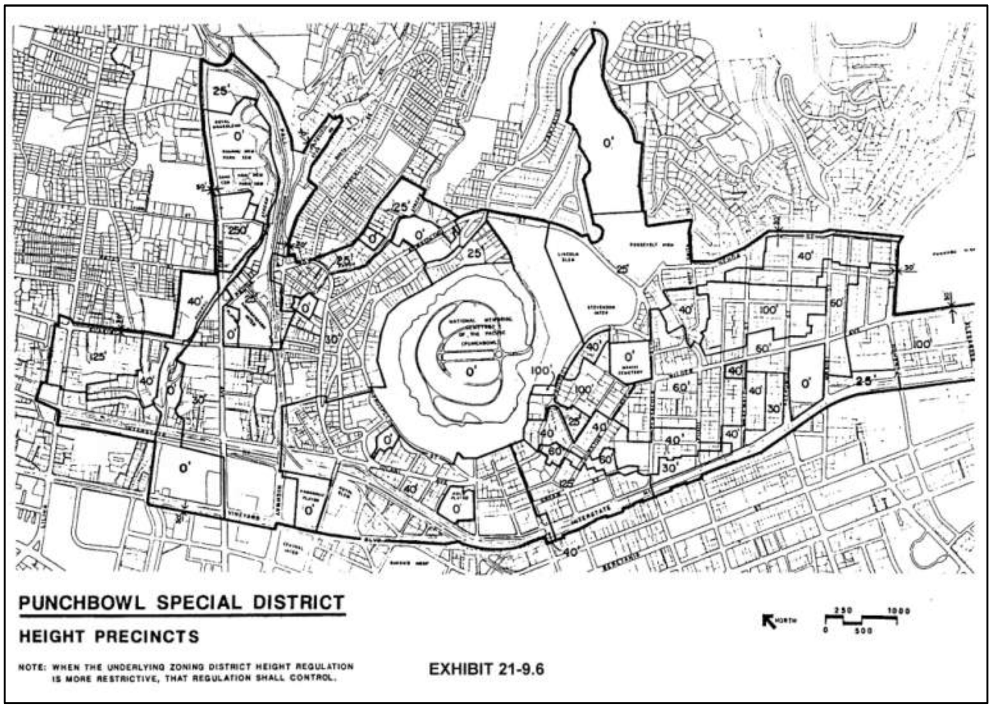

Figure 12: Map of Punchbowl Special District.

The Punchbowl Special District encompasses the National Memorial Cemetery of the Pacific within the crater, as well as portions of several neighborhoods located adjacent to the flanks of the crater. The map in Figure 12 shows these boundaries, as well as height limitations prescribed to maintain views to and from the Hawaii Capital Special District. However, since the project site is located outside these special district boundaries, the height restrictions do not apply.

The district's prime objective is to protect the Punchbowl monument as a dominant physical form within the island landscape. It calls to *preserve and enhance significant public views to and from Punchbowl, especially those from the Punchbowl lookouts and long-range views towards Punchbowl, by modifying construction projects that would diminish those views*.

The views from the Punchbowl lookout over the Hawaii Capital Special District are largely unaffected by the three scenarios being considered for the BWS project. As shown in Figure 13, the addition of proposed new buildings within the site are nearly indistinguishable from the surrounding urban landscape. The views from the Punchbowl lookout over the Hawaii Capital Special District are thus largely preserved, since the three scenarios being considered for the BWS project only pose a minor change from that viewpoint and distance.

Figure 13: View from Punchbowl Overlook of the Hawaii Capital Special District. Arrow points to conceptual rendering of Scenario 1 buildings inserted into the project site. (Conceptual views of Scenarios 2-3 are similar from this distance.) Source: HHF Planners.

Mitigation

Mitigation measures are required for adverse effects to historic resources. Appropriate mitigation commitments and detailed mitigation plans are developed in consultation with SHPD, and cannot be determined without SHPD involvement.

According to the Administrative Rules Chapter 13-275 (Rules Governing Procedures for Historic Preservation Review for Governmental Projects Covered Under Sections 6E-7 and 6E-8, HRS) mitigation for an architectural resource may take the form of one or more of the following:

> *A. Preservation. Preservation may include avoidance of the effect and protection, rehabilitation, restoration, or reconstruction.*
> *B. Architectural Recordation. Recordation involves the photographic documentation and possibly the measured drawing of a building, structure or object prior to its alteration. Architectural recordation plans and photos shall meet the minimal standards as provided by Historic American Building Survey (HABS).*
> *C. Historical Data Recovery. Data recovery involves researching historical source materials to document an adequate and reasonable amount of information about the property when a property will be altered or destroyed.*
> *D. Ethnographic Documentation. Ethnographic documentation consists of interviewing knowledgeable individuals and researching historical materials to document an adequate and reasonable amount of information about the property.*

Preservation

As outlined in item A above, “preservation” may include ‘avoidance of the effect’. For this project, it may be possible to undertake design modifications to minimize the adverse effects of Scenarios 1-3 shown in Tables 2, 3 and 4. However, it may be difficult to avoid an adverse effect determination altogether without significant project changes.

Changes to the placement of the proposed buildings within the site could reduce their perceived mass and height when viewed from the Beretania Street corridor. Further, designs for the new buildings could consider respecting the low-scale heights of the historic BWS buildings, by stepping back upper floors while leaving lower floors to reflect the adjacent historic buildings’ base heights. Paint colors for the new buildings should be different from, but compatible with, the iconic BWS green of the historic buildings. Landscaping may also soften adverse effects.

Architectural Recordation, Historical Data Recovery, Ethnographic Documentation

Architectural recordation, in the form of HABS/HAER/HALS recordation and large-scale photography, would be an appropriate method to document the site before it is modified with the addition of new buildings. Architectural Recordation, Historical Data Recovery and Ethnographic Documentation may take the form of a HABS report, National Register Nomination, or other context study.

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Appendix

Definitions: Assessment of Adverse Effects

As outlined in the Assessment of Adverse Effect 36 CFR 800.5(1),

> An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Consideration shall be given to all qualifying characteristics of a historic property, including those that may have been identified subsequent to the original evaluation of the property's eligibility for the National Register. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance or be cumulative.

Assessment of Adverse Effect 36 CFR 800.5 section (2) provides the following examples of adverse effects, stating that;

> "Adverse effects on historic properties include, but are not limited to:
>
> (i) Physical destruction of or damage to all or part of the property;
>
> (ii) Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation and provision of handicapped access, that is not consistent with the Secretary's Standards for the Treatment of Historic Properties (36 CFR part 68) and applicable guidelines;
>
> (iii) Removal of the property from its historic location;
>
> (iv) Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance;
>
> (v) Introduction of visual, atmospheric or audible elements that diminish the integrity of the property's significant historic features;
>
> (vi) Neglect of a property which causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an Indian tribe or Native Hawaiian organization; and
>
> (vii) Transfer, lease, or sale of property out of Federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance."

Appendix E

Market Assessment, Honolulu Board of Water Supply Beretania Campus Redevelopment, Avalon Development, July 2017

Market Assessment

HONOLULU BOARD OF WATER SUPPLY
BERETANIA CAMPUS REDEVELOPMENT
JULY 2017

Queens Court, Suite 501
800 Bethel Street
Honolulu, HI 96813
Phone | 808 587 7770
E-Mail | info@avalonhi.com

DISCLAIMER

The information contained herein has been obtained from sources both public and private for the purpose of determining market conditions for a variety of uses proposed for the redevelopment of the Honolulu Board of Water Supply Beretania Campus. Much of our research and analysis effort centers around the gathering of information from real estate owners, agents, and through other relationships. Although we deem such sources of information are being reliable, we recommend the reader to review our data and conclusions and determine if the reader agrees with our assessment. While every reasonable effort has been made to ensure this assessment's accuracy, we cannot guarantee it. No responsibility is assumed for any inaccuracies.

Executive Summary

Assignment

Avalon Development Company LLC ("Avalon") has been retained by Architects Hawaii Limited to undertake a market supply & demand assessment ("Assessment") for senior housing (affordable apartment rentals & assisted care living), office space, and parking facilities. These specific real estate uses ("Uses") are considered for the potential redevelopment of the Board of Water Supply Beretania Campus ("BWS Site") based on existing entitlements and proximity to Queens Medical Center.

Senior Housing Market

Due to the BWS Site's proximity to the Queens Medical Center and to some extent, the Straub Medical Clinic & Hospital, uses including affordable senior rentals and/or assisted care living are likely to be primary choices of potential development. The opportunity to create synergy between such uses and that of Queens Medical Center is logical, providing benefits for potential residents and for the medical center.

This part of the assessment intends to:

- Identify the local senior housing market (affordable senior rentals & assisted care living)
- Identify the housing mix and services desired by seniors;
- Determine what is affordable for seniors.

Office Space & Parking

As a possible extension of existing office uses on the BWS Site and the potential need for additional medical office space and parking by Queens Medical Center, office uses present a possible redevelopment opportunity for a potential developer.

This part of the assessment intends to:

- Identify the local office space leasing market;
- Determine Queens Medical Center's need for additional medical office space and parking;
- Determine the need for parking to help support local and state office facilities in the nearby area.

The purpose of these individual assessments is to not only answer the above questions specific to each potential use, but also forecast demand over the next several years. This executive summary provides a brief review of our key research findings and conclusions.

Report Findings

Affordable Senior Rentals

- On O'ahu, affordable senior apartments vacancy rates are currently below 1%. Absorption of newly delivered apartment product over the last twenty (20) years has been fairly quick, keeping the vacancy rates under 1% historically. For some facilities currently, prospective residents are on wait lists for as long as 3 years.
- Most affordable senior rentals feature 1 bedroom layouts in the range of 375 to 435 square feet.
- Avalon's survey of existing affordable senior rental properties yields current rents of $500 to $1,200 per month for properties qualifying in the range of 50-80% AMI.
- Most affordable senior rentals have experienced 1-3% annual increases in rent historically although most do not approach the maximum rents allowed under applicable LIHTC (Low Income Housing Tax Credit) rules and regulations for rent control.

Assisted Care Living

- On O'ahu, assisted care living vacancy rates are currently below 14% due in large part to the introduction of the 196-bed Kalakaua Gardens in 2016. Historically over the last 20 years, vacancy rates for these facilities have fluctuated between 7-10% due to the absorption of new inventory. Currently, some facilities have wait lists for prospective residents as long as 3 years.
- Nationally, the U.S. is experiencing a slight excess in the supply of assisted care living product. Some national assisted care living providers have been experiencing unprecedented availabilities in some key markets in the continental U.S., creating some heightened competitive pressure in those markets for 2017. National assisted care living providers are now focused on differentiating themselves to fill vacancies. One way of differentiating themselves is by providing assistance to seniors in their own homes before a transition to a senior community is both desired and necessary.
- Assisted care living options in Honolulu usually offer 1 bedroom units in the range of 400 to 510 square feet depending on the community. Such communities feature a wide variety of services ranging from independent living up to memory care.

Senior Demographics & Economics

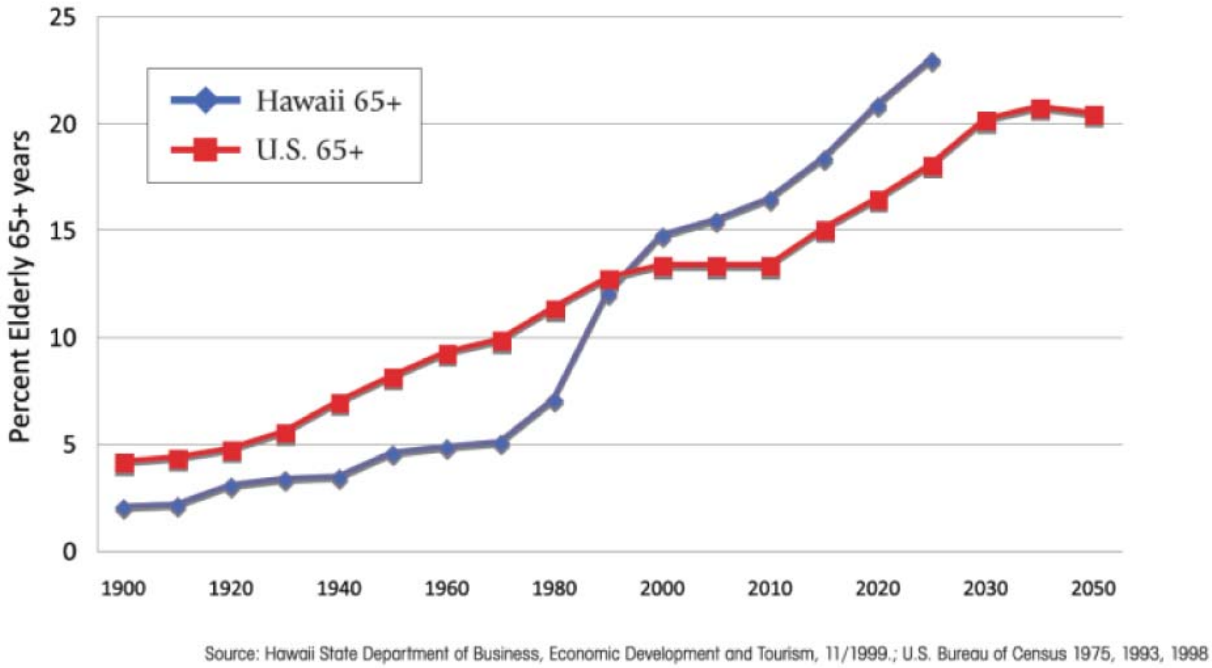
- Hawai`i is growing older at a faster pace than the rest of the nation. In 2030, 24% of Hawai`i's population will be aged 65 or older, compared to 21% nationally. In Honolulu, 27% of residents will be 65 years and older by 2040. Between 2010 and 2040, Hawai`i's population 65 years and older will increase 104%, compared with the total population increase of 28% over the same period.
- The state's cost of living is 16% higher than the national average. This is clearly evident in home ownership and rental costs. As of June 2017, the median price of a single-family house on O'ahu was $735,000, up 5.0% from the year before and up 16.7% from 10 years ago. The median price of a condominium was $390,000, up 8.3% from the year

before and up 25.8% from 10 years ago. The average cost of renting a two-bedroom apartment in Honolulu is currently $2,300 a month, about 42% higher than the national average.

Office Space & Parking Facilities

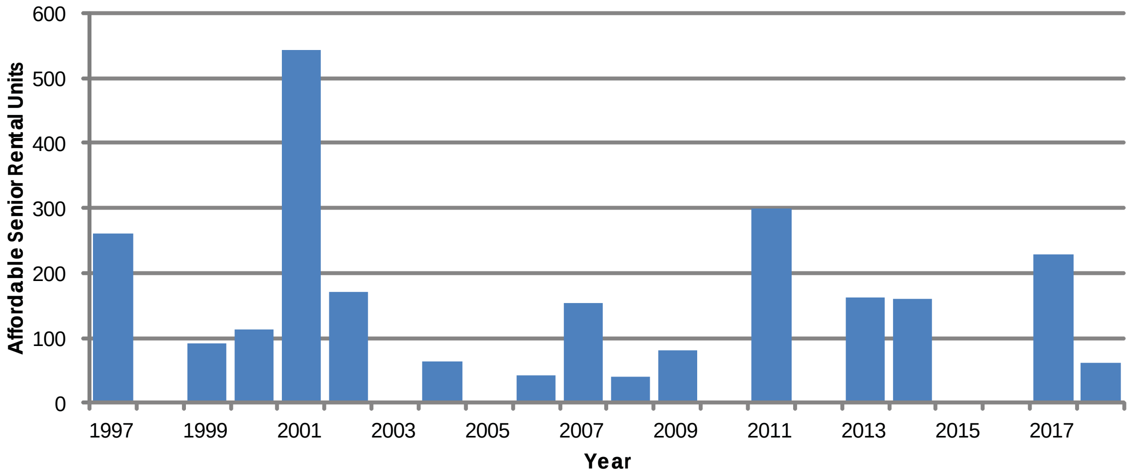
- The Honolulu office market saw a 54,000 sqft gain in office space from year end 2015 to 2016 dropping the vacancy rate from 13.5 percent down to 13.1 percent.
- Honolulu's Class-A market saw a vacancy drop from 14.3% down to 14.2% from year end 2015 to 2016. Gross asking rents have slightly increased from $3.29 per sqft per month to $3.32, mostly attributed to increases in operating expenses.
- 575 office spaces remain available at year end 2016 compared to the 582 in 2015.
- Office base rents in the range of $1.59-$1.69 per sqft per month and current vacancy rates fail to meet minimum income thresholds for the financing of new office product.
- At the height of the real estate boom in 2007, vacancy rates declined to single-digit percentage levels. After the crash of 2008, vacancy rates have been floating in the low to mid teen percentages. Rent growth seems to be stagnant as operating expense increases over the last 10 years have eaten up a considerable share of gross asking rents.
- New trends in "co-working" concepts whereas multiple companies and professionals work out of a single office environment with common office infrastructure is all the rage in technology and science office space users. This has impacted office leasing and vacancy rates.
- Parking availability in the Honolulu Downtown Central Business District is next to zero with most facilities having wait lists for availabilities. Parking rates range from $220-$290 per stall per month.

Hawaii Statewide Elderly (65+ years) Population Growth (% of Total Population)



Source: U.S. Census Bureau; Hawaii State Department of Business, Economic Development and Tourism

New Senior Affordable Rental Inventory Introduction to O'ahu Market



Source: HawaiiInformation.com & Hawaii Housing, Finance & Development Corporation.

Senior Housing & Assisted Care Living

Preface

Due to the Island of O'ahu's small scale and the limited market availability of senior rentals and assisted care living facilities, the following demographics analysis is focuses on entire the Island of O'ahu as the market area ("Market Area") in regard to individuals 60 years or older. Absent from this analysis are housing options involving owner-occupants, condominiums, and other market-centric units outside of the scope of affordable senior rentals and assisted care living facilities.

Demographics & Market Demand

Analyzing Hawai'i's demographic growth trends from 1980 to 2035, it is clearly evident that the overall population of Hawai'i is expected to grow by an estimated 65 percent. By comparison, those 60 years of age and older will increase 310 percent and those over 85 and older are expected to experience a hyper-growth rate of 1,158 percent during this same 55 year period. Numerous factors are contributing to this demographic change: lower mortality rates, and improved public health access, advances in medicine and pharmaceutical technology.

As the data demonstrates, the percent elderly over 65 has overshot the national average since the year 2000 and today, there are very few states in the Union with faster elderly population growth rates. Hawai'i is particularly challenged since as an ocean-locked state, all islands are required to create their entire aging network of services and delivery infrastructure and cannot share services or workers readily.

Based on these trends, Avalon anticipates:

- Fixed-income elderly people will not have sufficient affordable housing options and many may not find suitable housing to rent; and
- Those that seek residency in assisted care living facilities will likely shift their search to mainland options.

Senior Housing Options

There are 3 market segments for senior housing considered in this analysis:

- Senior Affordable Rental Apartments (Allowed under existing entitlements for the BWS Campus)
- Assisted Care Living Communities (Allowed under existing entitlements for the BWS Campus)
- Adult Resident Care Homes

Senior Affordable Rentals Apartments are simply rent-controlled apartments for individuals 60-65 years old and up. Assisted Care Living Communities serve as homes with significant common areas for activities while allowing to some extent, aging in-place. Adult Resident Care Homes are typically small-scale (4-24 residents served) offering intensive support for its residents.

Case for Senior Affordable Rentals

Demographics & Market

Since 1997 the demographic segment of people 60 years and older experienced an increase of 77,000 people or an average of 3,850 people per year. Over this same timeframe, the number of available senior affordable rentals built were 2,407 units (120 units per year) in 55 projects island-wide. Demand is outgrowing supply at a substantial rate.

Low Income Housing Tax Credit (LIHTC) Program

The challenge in building affordable rentals is the awarding of federal tax credits from the U.S. Treasury through the Low Income Housing Tax Credit (LIHTC) Program. As with all states, a fixed number of credits are allocated to each state based on population.

Senior Affordable Rental Forecast

Currently, there is a less than 1% vacancy rate for senior affordable rentals on O'ahu. This is primarily attributed to the turnover of units due to death or relocation. Historically, the less than 1% vacancy rate has been consistent and is projected to continue for the foreseeable future.

Future Consideration

Compared to assisted care living facilities, senior affordable rentals are less risky due to the ease of absorbing residents and stabilizing income. Senior affordable rentals would likely be the first choice of any developer as long as tax credits are available. The first development priority should be Senior affordable rentals.

O'ahu Elderly (60+ years) Population Growth

				Annualized Change			
				2000-2010		2010-2015	
	2000	2010	2015	% +/-	People +/-	% +/-	People +/-
O'ahu							
Total Population	894,564	936,984	984,178	0.47%	4,242	1.01%	9,439
Total Population - Male	449,966	469,004	498,129	0.42%	1,904	1.24%	5,825
Total Population - Female	444,598	467,980	486,049	0.53%	2,338	0.77%	3,614
Total - 60 years and over	155,994	184,565	207,372	1.83%	2,857	2.47%	4,561
Male - 60 years and over	70,568	82,545	93,150	1.70%	1,198	2.57%	2,121
Female - 60 years and over	85,426	102,020	114,222	1.94%	1,659	2.39%	2,440

Source: U.S. Census Bureau

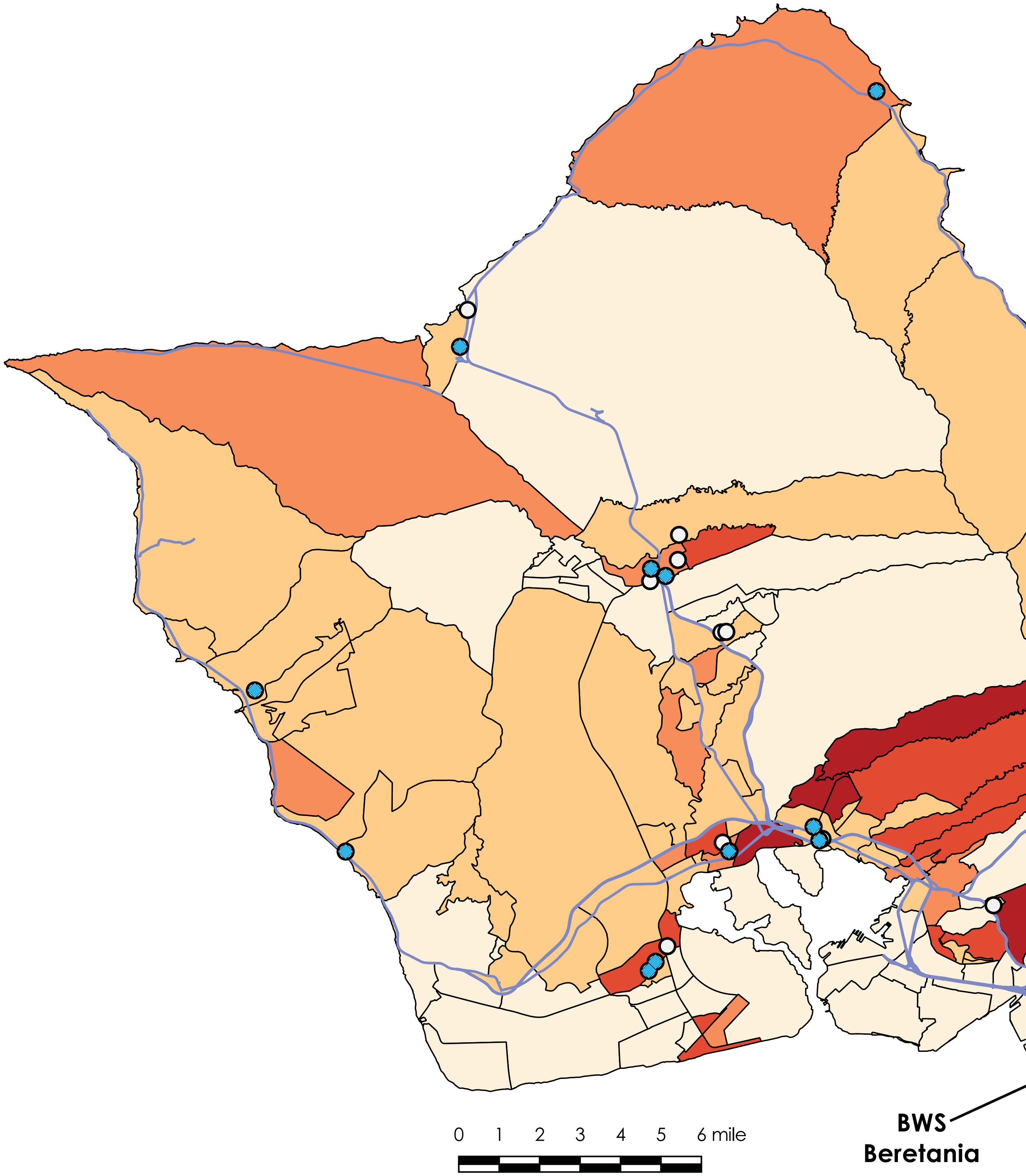
Select Senior Affordable Rental Facilities within Close Proximity to the BWS Campus

Building	Address	Units	Unit Type	SqFt	Monthly Rent	% of AMI	Vacancies	Wait List	Distance from BWS (mi)
Kinau Vista	1150 Kinau Street	62	1B	430	$575	30%	None	5 years	0.9
					$950	50%	None	6 Months	
					$1,150	60%	None	6 Months	
Piikoi Vista	1326 Piikoi Street	47	1B	420	$955	50%	None	6 Months	0.9
Wisteria Vista Senior Apartments	1239 South King Street	91	1B	384	$835	50%	1	6-12 Months	1.2
One Kalakaua Senior Living	1314 Kalakaua Avenue	166	1B	526	$4,200	n/a	None	12 Months	1.8
			2B	772	$4,300	n/a	None	12 Months	
Kalakaua Vista	1628 Kalakaua Avenue	80	1B	430	$575	30%	None	3-4 Years	1.9
					$950	50%	None	2 Years	
Kulana Hale Senior Apartment	1551 South Beretania Street	176	Studio	350	$1,386		None	Closed	2.0
			1B	530	$1,511		None	Closed	
			2B	600	$1,991		None	Closed	
Artesian Vista	1828 Young Street	53	1B	420	$575	30%	None	Unavail	2.0
			1B	420	$950	50%	None	Unavail	
Ainahau Vista	614 Kapahulu Avenue	106							4.5
		11	1B	403	$565	30%	None	6 Months	
		88	1B	403	$950	50%	None	6 Months	
		7	2B	607	$1,100	50%	None	6 Months	

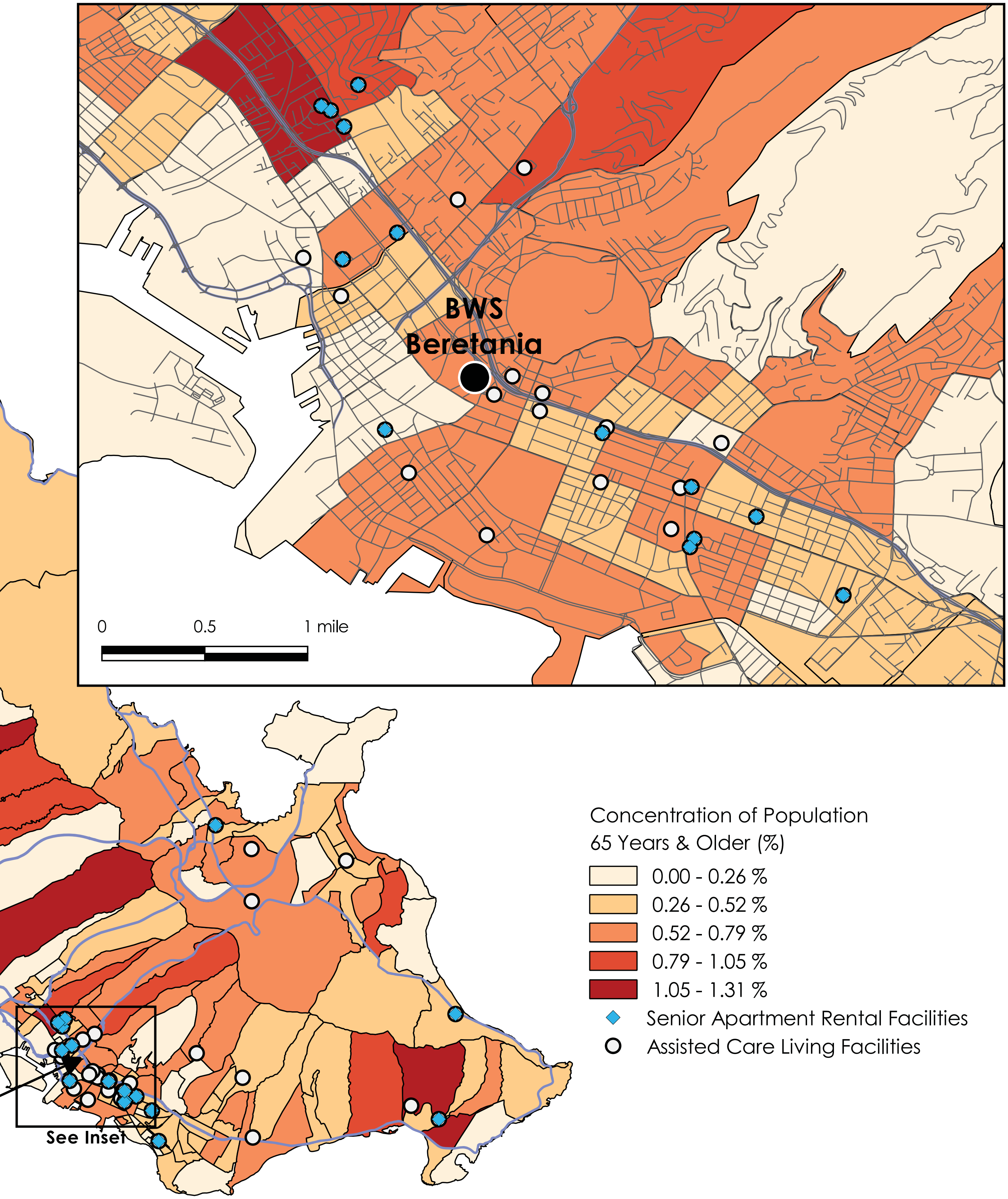
Note: Due to most senior affordable rental facilities being 100% occupied, some facilities within close proximity of the BWS campus were not included on this list since rents could not be verified at the time of this report. Water, sewer and electricity are included in the rents above.

Source: Avalon market research

O'ahu Existing (June 2017) Senior Affordable Rental & Assisted Care Living Facilities



Inset Map


BWS
Beretania
0
0.5
1 mile
See Inset
Concentration of Population
65 Years & Older (%)
0.00 - 0.26 %
0.26 - 0.52 %
0.52 - 0.79 %
0.79 - 1.05 %
1.05 - 1.31 %
Senior Apartment Rental Facilities
Assisted Care Living Facilities

O'ahu (June 2017)
Senior Affordable Rental Facilities & Projects

% AMI	Project Name	Street Address	City	Units	Year Built
Existing Inventory					
50	220 California	220 California Avenue	Wahiawa	42	2006
30/50	Ainahau Vista (fka Tusitala Vista)	2428 Tusitala Street	Honolulu	107	2007
30/50	Artesian Vista	1828 Young Street	Honolulu	54	2002
50	D. E. Thompson Village	91-1295 Renton Road	Ewa Beach	84	1991
60	Franciscan Vistas Ewa	41-1471 Miula Street	Ewa Beach	150	2011
60	Hale Mohalu	800 Third Street	Pearl City	210	1996
30/50/60	Hale Mohalu II Senior Housing	785 Kamehameha Hwy	Pearl City	163	2013
60	Hale O'Hauoli	950 Luehu Street	Pearl City	100	1980
80	Hale Po'ai	1001 N. School Street	Honolulu	206	2001
30	Haleiwa Senior Citizens	66-477 Paalaa Road	Haleiwa	60	1982
80	Halia Hale	851 N. School Street	Honolulu	41	1994
50	Harry & Jeanette Weinberg Nanaikeola	87-122 Nanaikeola Street	Waianae	40	2008
50	Harry & Jeanette Weinberg Philip St	1515 Philip Street	Honolulu	34	1993
50	Harry & Jeanette Weinberg Senior	1111 Hala Drive	Honolulu	40	1995
50	Harry & Jeanette Weinberg Silvercrest	520 Pine Avenue	Wahiawa	80	1993
50	Hausten Gardens	808 Hausten Street	Honolulu	50	1979
60	Honuakaha	545 Queen Street	Honolulu	150	1995
80	Ho'olulu	94-943 Kau'olu Place	Waipahu	112	2000
30	Kahuku Elderly Hauoli Hale	56-154 Pu'uluana Street	Kahuku	64	1979
60	Kalakaua Vista	1620 & 1628 Kalakaua Ave	Honolulu	81	2001
30/80	Kalanihuia	1220 Aala Street	Honolulu	151	1968
30/50	Kaluanui Senior Apartments	6950 Hawaii Kai Drive	Honolulu	31	2002
80	Kamalu	94-941 Kau'olu Place	Waipahu	109	1993
60	Kaneohe Elderly	45-457 Meli Place	Kaneohe	44	1982
60	Kapuna I Apartments	1015 N. School Street	Honolulu	162	1980
50	Keola Hoomalu Elderly	85-259 Plantation Road	Waianae	35	1983
80	Keola Hoonanea	1465 Aala Street	Honolulu	175	1971
30/60	Kinau Vista	1150 Kinau Street	Honolulu	63	2004
60	Kulana Hale	1551 S. Beretania Street	Honolulu	176	1997
60	Kulanakauhale Maluhia O Na Kupuna	41-209 Ilauhole Street	Waimanalo	86	2002
80	Kulaokahua	1311 Ward Avenue	Honolulu	30	1991
30/80	Kupuna Home O'Waialua	67-088 Goodale Avenue	Waialua	40	n/a
80	La'iola	1 & 15 Ihoiho Place	Wahiawa	108	1991
60	Lani Huli (Kailua Elderly)	25 Aulike Street	Kailua	82	1993
30/80	Makamae	21 S. Kuakini Street	Honolulu	124	1970
30/80	Makua Alii	1541 Kalakaua Avenue	Honolulu	211	2001

% AMI	Project Name	Street Address	City	Units	Year Built
80	Malulani Hale	114 N. Kuakini Street	Honolulu	150	1976
80	Manoa Gardens	2790 Kahaloa Drive	Honolulu	80	1990
60	Na Lei Hulu Kupuna	610 Cooke Street	Honolulu	76	1992
30/80	Paoakalani	1583 Kalakaua Avenue	Honolulu	151	na
50	Pauahi Elderly	167 N. Pauahi Street	Honolulu	48	na
50	Piikoi Vista	1326 Piikoi Street	Honolulu	47	2007
80/M	Pohulani Elderly	626 Coral Street	Honolulu	262	1991
30/80	Pumehana	1212 Kinau Street	Honolulu	139	1972
30/80	Punchbowl Homes	730 Captain Cooke Avenue	Honolulu	156	1960
60	Royal Kinau, The	728 Kinau Street	Honolulu	84	1997
50/60	Senior Residence at Iwilei	888 Iwilei Road	Honolulu	160	2014
50	Senior Residence at Kaneohe	45-705 Kamehameha Hwy	Kaneohe	44	2001
30/50	Senior Residence at Kapolei	91-1034 Namahoe Street	Kapolei	60	2009
30/50	Senior Residence at Kapolei 2	91-1098 Namahoe Street	Kapolei	20	2009
60	Waipahu Hall	94-1060 Waipahu Street	Waipahu	72	1981
60	West Loch Elderly Village	91-1472 Renton Road	Ewa	150	2011
50	Whitmore Circle Apartments	111 Circle Makai Street	Wahiawa	44	1990
60	Wilikina Park Elderly	298 Wilikina Drive	Wahiawa	64	1993
50	Wisteria Vista	1239 S. King Street	Honolulu	91	1999
Projects Under Development					
30-60	Ainahau Vista II	2428 Tusitala St	Honolulu	62	2018
30-60	Kulana Hale II	Kapolei	Kapolei	154	2017
n/a	Meheula Vista Senior I-IV	Meheula Pkwy	Mililani	75	2017

Source: Hawaii Housing Finance & Development Corporation, Avalon market research

Case for Assisted Care Living

Demographics & Market

With the elderly share of the Oahu population growing at a faster rate than other population segments and a large share of this population segment having wealth, Avalon concluded that the O'ahu market is currently significantly underserved. Accordingly, any likely developer of Assisted Care Living facilities will likely capture a considerable share of the unserved local market and some of the migrating seniors market (mainland U.S.).

At present, the 164 independent and assisted living suites comprising the recently introduced Kalakaua Gardens have bumped up the current vacancy rate for assisted care living facilities on O'ahu. Currently, the vacancy rate stands at 14.2%. Although Kalakaua Gardens declined to provide occupancy data, the facility has been open since March 2016 and has been offering incentives to new potential residents. Avalon does not believe this to be a sign of distress for the new product as most new assisted care living communities have experienced slow stabilization phases shortly after construction completion.

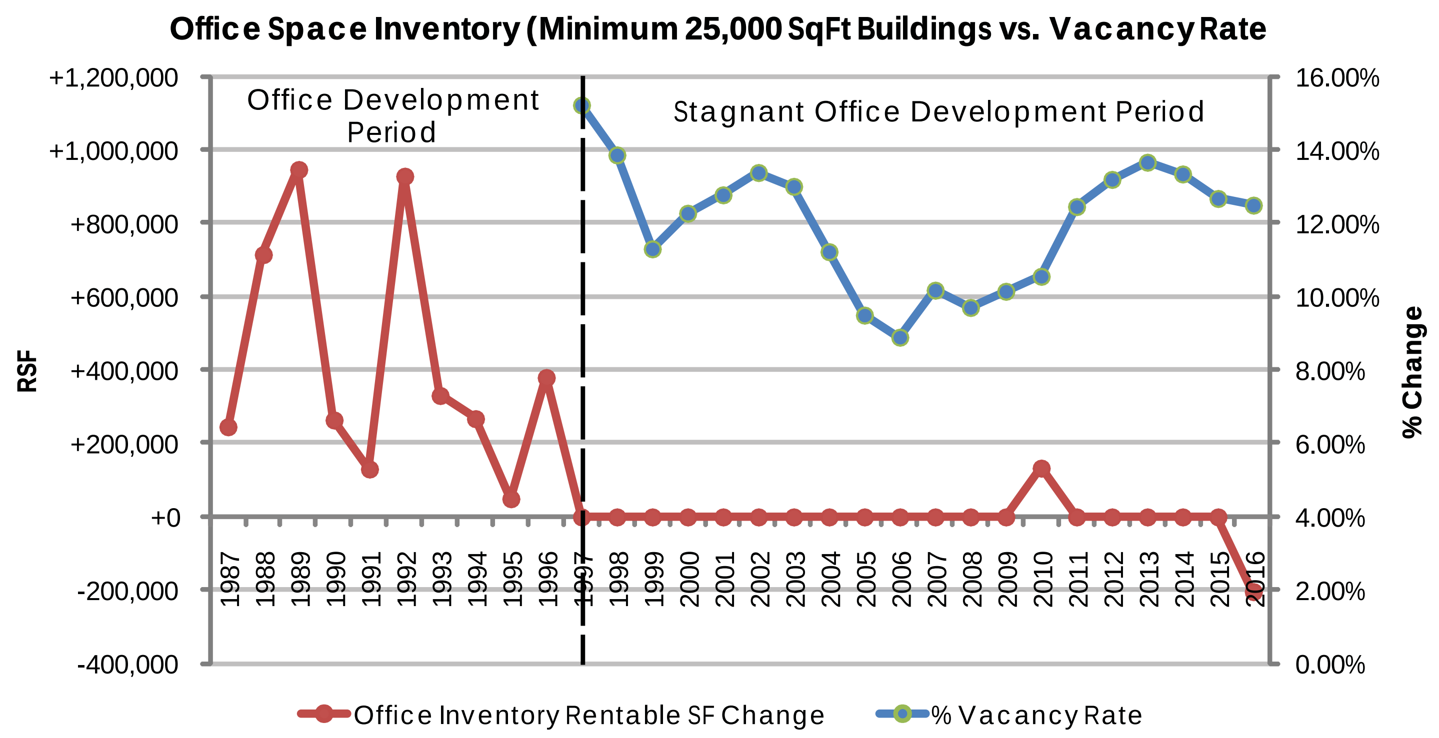
Historically, the O'ahu assisted care living vacancy rate has fluctuated between 7-10%. Some facilities in our survey have 100% occupancy with long waiting lists. Such facilities such as Kahala Nui have garnered significant traction with new potential residents by offering posh amenities and open low-rise environment. In comparison, Kalakaua Gardens is situated inside of a high-rise tower. Location qualities aside, amenities seem to be a key driving force in attracting new residents to a community.

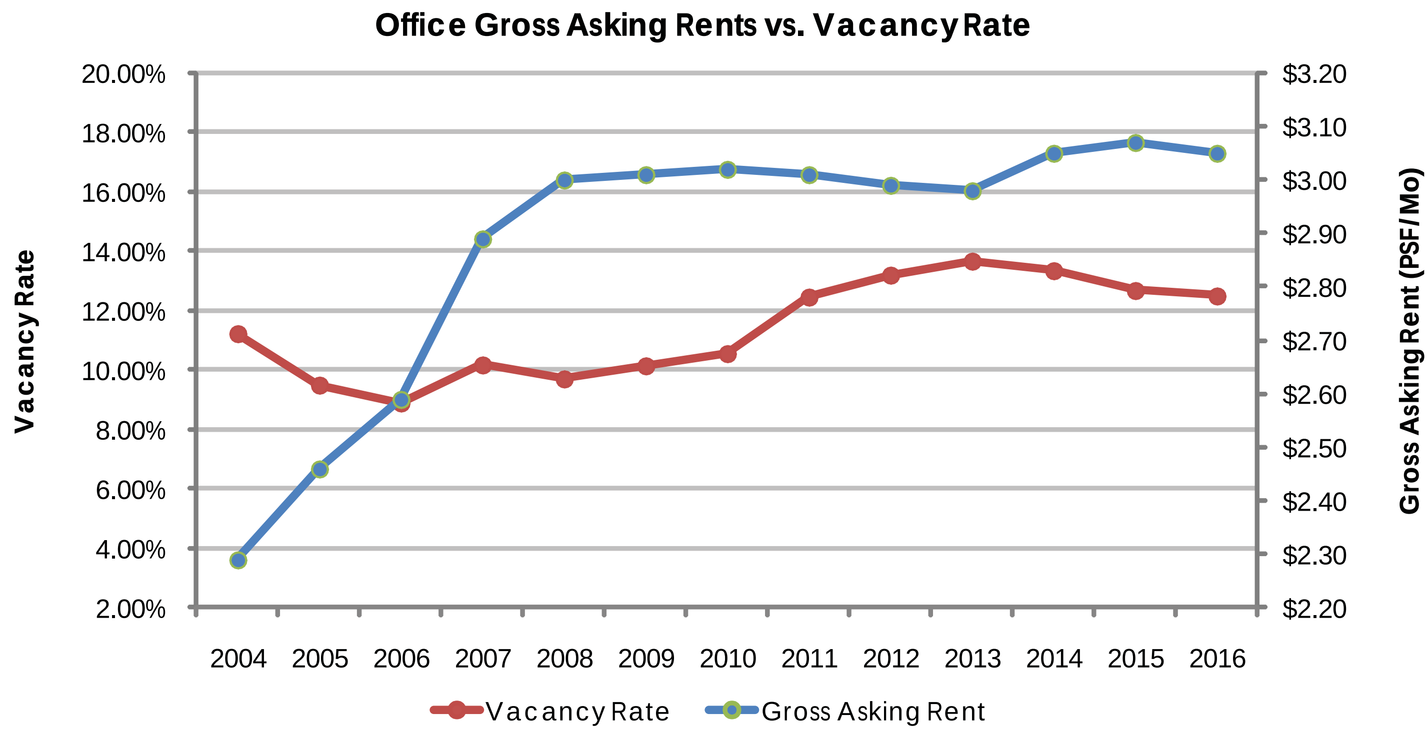
Assisted Care Living Forecast

This assessment has been consistent with its interpretation of demographic and market trends regarding the accelerated growth of the age 60+ population segment in Hawaii. It is clearly evident that there will be an increasing demand for assisted care living services in Hawaii. Based on our current projections, it appears that the demand is outpacing the supply by a 2 to 1 ratio. If this trend persists, there will be a very recognizable population segment that will seek opportunities to live in an assisted care living community.

Future Consideration

- Unlike senior affordable rental apartments, the absorption of newly introduced assisted care living units require more time to fill. In such event, any potential developer/operator may need to arrange for free ground rent and/or rent deferral until such facility is stabilized and refinanced out of a construction loan.
- Assisted care living tends to be susceptible to significant economic events.
- Changes in the state or federal regulatory environment could affect the feasibility of operating an assisted care living facility.


Office Space Inventory (Minimum 25,000 SqFt Buildings vs. Vacancy Rate
Office Development Period
Stagnant Office Development Period
RSF
% Change
+1,200,000
+1,000,000
+800,000
+600,000
+400,000
+200,000
+0
-200,000
-400,000
16.00%
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Office Inventory Rentable SF Change
% Vacancy Rate


Office Gross Asking Rents vs. Vacancy Rate
Vacancy Rate
Gross Asking Rent (PSF/Mo)
20.00%
18.00%
16.00%
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
$3.20
$3.10
$3.00
$2.90
$2.80
$2.70
$2.60
$2.50
$2.40
$2.30
$2.20
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Vacancy Rate
Gross Asking Rent

Office Space

Stagnant Office Market

The Oahu office market as of year-end 2016 has experienced a 4th consecutive year of slight increases in occupancy rates and gross asking rents. Although vacancy rates are still well above the sub-10% days of 2008, most office properties continue to advertise slightly higher gross asking rents. Compared to gross asking rents of 10 years ago, rents today are a mere 6% higher.

At the root of this stagnation are several factors:

- Rent growth seems to be stagnant as operating expense increases over the last 10 years have eaten up a considerable share of gross asking rents.
- New trends in "co-working" concepts whereas multiple companies and professionals work out of a single office environment with common office infrastructure is all the rage in technology and science office space users. Less office space is typically desired to implement this concept.
- In 2010, the average office space per employee nationwide was 225 sqft. In 2012, the average was 176 sqft. Today, this ratio is somewhere between 100 to 150 sqft per employee. This downward shift in space demand has significantly impacted the market locally as many law and financial firms have given back space to their landlords over the last 10 years.

Office Forecast

It has been nearly 21 years since the last office building (100,000 sqft or larger) was built (1996), ending a 10 year phase where an aggregate 4.3 million sqft of office space was delivered to the O'ahu market. Since then, the market has experienced a slight decrease in inventory with the addition of the 133,000 sqft medical office building Hale Pawa'a and the conversion of the 204,000 sqft Waikiki Trade Center from office to Hotel in 2016.

Avalon Development Company projects continued stagnation in the office market with small minute gains in gross asking rents and a seesawing of occupancy and vacancy for the foreseeable future.

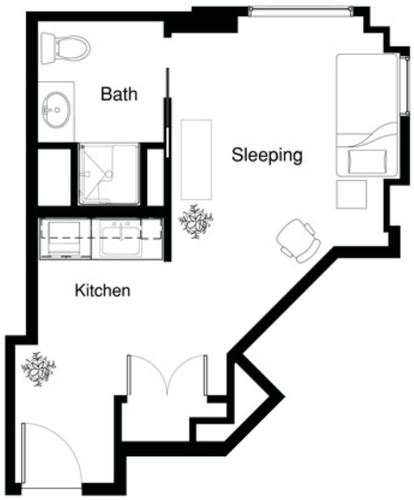
Recommendation

In the event the Honolulu Board of Water Supply requires additional office space at its Beretania campus, Avalon recommends:

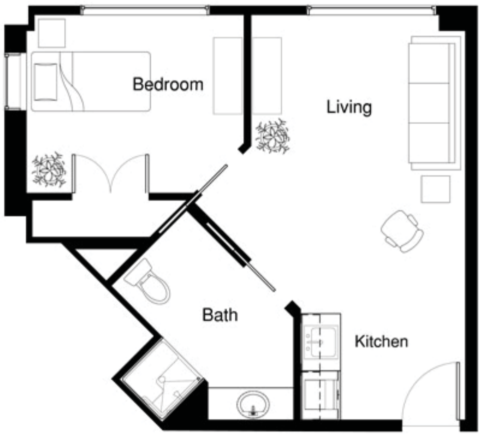
- Consider the purchase of a nearby office building in lieu of building ground up on a new facility. Most recent sale comparables of office buildings come in at a lower dollar figure than to build/develop something new. Perhaps BWS can pickup where the State left off in the attempt to acquire 1099 Alakea St (Ali'i Place).
- If BWS elects to have a new facility built at the BWS campus, Avalon recommends the development of an extensive space plan that eliminates inefficient uses for space to minimize the cost burden on the department.

Sample Senior Housing Unit Design

Plaza at Waikiki
Assisted Care Living Floor Plans

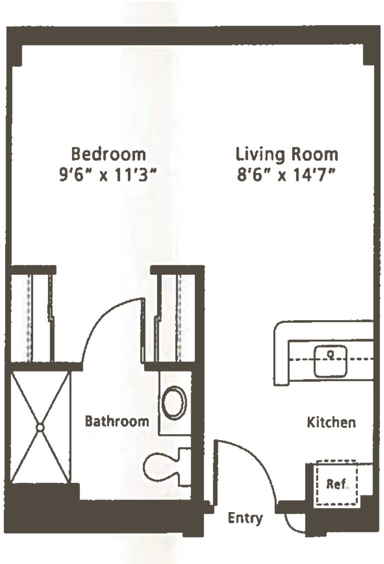


Studio Unit

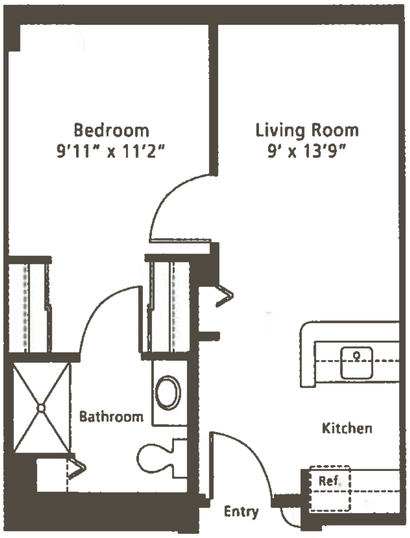


1 Bedroom Unit

Hi'Olani Care Center at Kahala Nui
Assisted Care Living Floor Plans



Studio Unit



1 Bedroom Unit


Porte Cochere

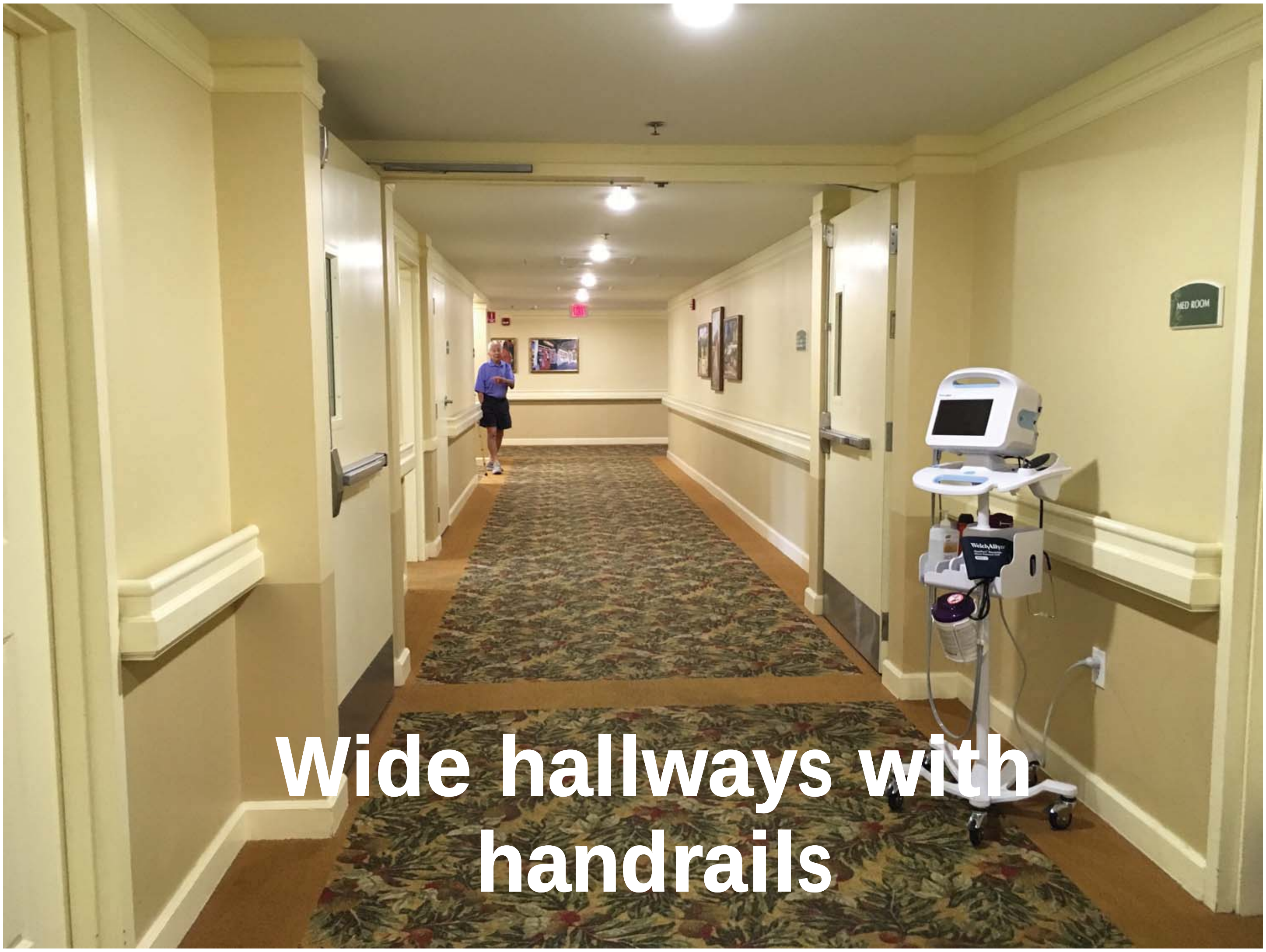
Hi'Olani Care Center at Kahala Nui


Dining


Dining


Recreation Room


Recreation Room



Wide hallways with handrails


Outdoor Sitting Areas

Outdoor Sitting Areas


Library & Business Center


Library & Business Center

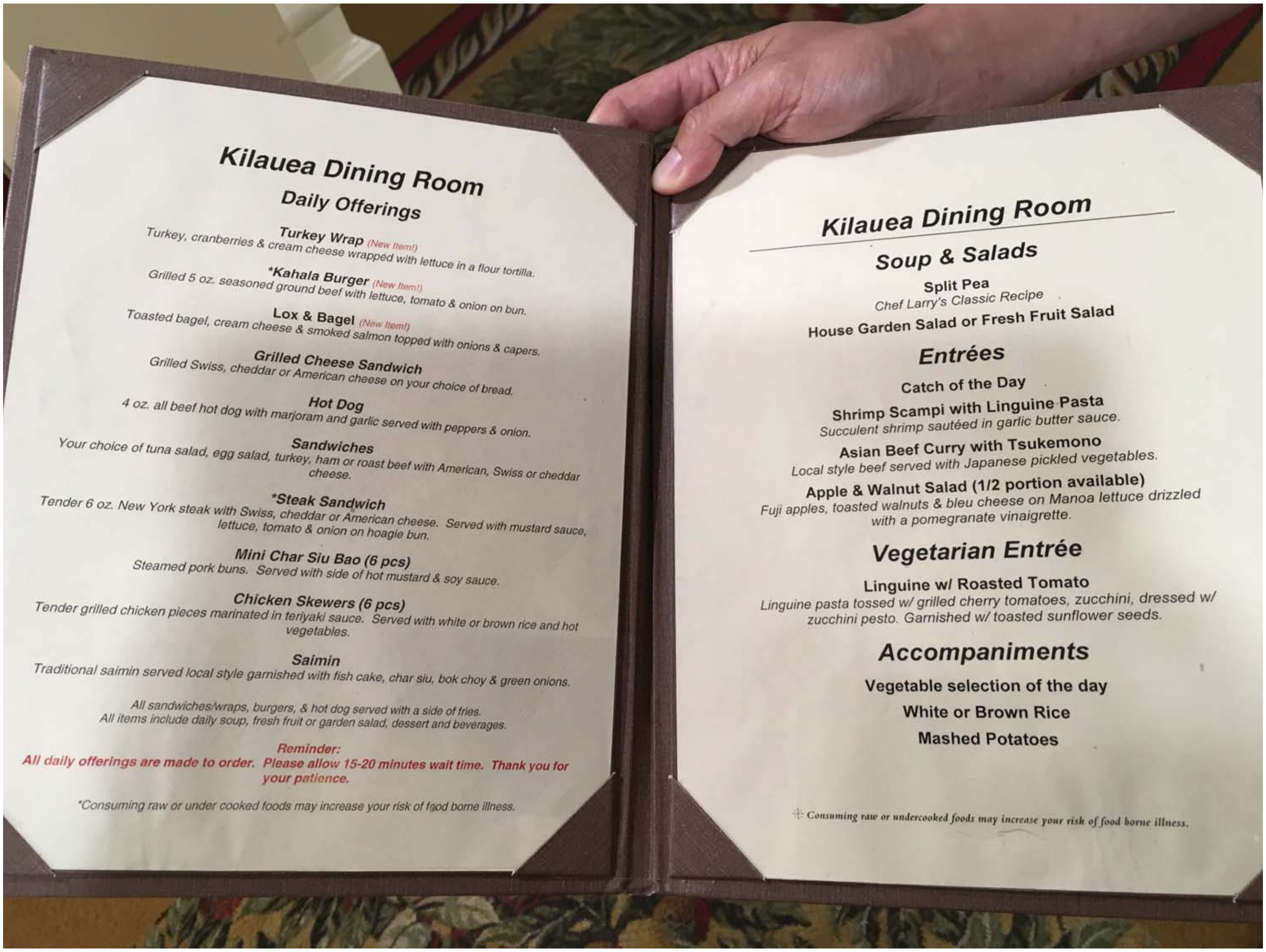
Food Bar


Indoor Sitting Area


Dining


Dining

Dining


Kilauea Dining Room
Daily Offerings
Turkey Wrap (New Item!)
Turkey, cranberries & cream cheese wrapped with lettuce in a flour tortilla.
*Kahala Burger (New Item!)
Grilled 5 oz. seasoned ground beef with lettuce, tomato & onion on bun.
Lox & Bagel (New Item!)
Toasted bagel, cream cheese & smoked salmon topped with onions & capers.
Grilled Cheese Sandwich
Grilled Swiss, cheddar or American cheese on your choice of bread.
Hot Dog
4 oz. all beef hot dog with marjoram and garlic served with peppers & onion.
Sandwiches
Your choice of tuna salad, egg salad, turkey, ham or roast beef with American, Swiss or cheddar cheese.
*Steak Sandwich
Tender 6 oz. New York steak with Swiss, cheddar or American cheese. Served with mustard sauce, lettuce, tomato & onion on hoagie bun.
Mini Char Siu Bao (6 pcs)
Steamed pork buns. Served with side of hot mustard & soy sauce.
Chicken Skewers (6 pcs)
Tender grilled chicken pieces marinated in teriyaki sauce. Served with white or brown rice and hot vegetables.
Saimin
Traditional saimin served local style garnished with fish cake, char siu, bok choy & green onions.
All sandwiches/wraps, burgers, & hot dog served with a side of fries.
All items include daily soup, fresh fruit or garden salad, dessert and beverages.
Reminder:
All daily offerings are made to order. Please allow 15-20 minutes wait time. Thank you for your patience.
*Consuming raw or under cooked foods may increase your risk of food borne illness.
Kilauea Dining Room
Soup & Salads
Split Pea
Chef Larry's Classic Recipe
House Garden Salad or Fresh Fruit Salad
Entrées
Catch of the Day
Shrimp Scampi with Linguine Pasta
Succulent shrimp sautéed in garlic butter sauce.
Asian Beef Curry with Tsukemono
Local style beef served with Japanese pickled vegetables.
Apple & Walnut Salad (1/2 portion available)
Fuji apples, toasted walnuts & bleu cheese on Manoa lettuce drizzled with a pomegranate vinaigrette.
Vegetarian Entrée
Linguine w/ Roasted Tomato
Linguine pasta tossed w/ grilled cherry tomatoes, zucchini, dressed w/ zucchini pesto. Garnished w/ toasted sunflower seeds.
Accompaniments
Vegetable selection of the day
White or Brown Rice
Mashed Potatoes
Consuming raw or undercooked foods may increase your risk of food borne illness.

Market Assessment

HONOLULU BOARD OF WATER SUPPLY
BERETANIA CAMPUS REDEVELOPMENT
JULY 2017

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Appendix F

Economic and Fiscal Impact Assessment
Avalon Development, June 24, 2019

Honolulu Board of Water Supply

Economic & Fiscal Impact Assessment

DRAFT REPORT

Prepared by

AVALON DEVELOPMENT

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June 24, 2019

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1. INTRODUCTION & STUDY OVERVIEW

Document Structure

This document is organized as follows:

1. Introduction & Study Overview – Study background, objectives and approach.
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Project & Study Background

The Honolulu Board of Water Supply ("HBWS") will be issuing a Request for Proposal(s) to redevelop a portion of its Beretania Complex in an effort to create a revenue stream, offsetting a portion of its operating and capital improvements costs. Although the redeveloped portion of the Beretania Complex will vary in size depending on the actual redeveloped use, the redeveloped portion can range in size from ____ to ____ acres.

For the purposes of this study, three (3) scenarios for redeveloping a portion of the Beretania Complex were considered. Each of these scenarios are based on uses permitted under the Revised Ordinances of Honolulu, Chapter 21, Land Use Ordinance. The scenarios are described as follows:

Table 1: Scenario Summary

	Scenario 1 Assisted Care Living (ACL)	Scenario 2 Age-Restricted Low-Income Senior Apartment Rentals (SAR)	Scenario 3 Parking Structure (PS)
Possible Use[1]	Conditional Use Permit Major Required	Permitted	Permitted
Unit Count	266 ACL Units 605 Parking Stalls	312 Apartments 490 Parking Stalls	1,155 Parking Stalls

In order to maintain HBWS' current level of parking, all redevelopment scenarios assume the inclusion of or a portion of a parking structure to replace any displaced HBWS parking stalls.

[1] "Possible Use" includes all uses of the Project regardless of a Conditional Use Permit (CUP) being required under the Revised Ordinances of Honolulu, Chapter 21, Land Use Ordinance.

Subject Property

The Beretania Complex currently consists of three (3) Tax Map Key (TMK) parcels, each improved with commercial facilities that are now in operations. The TMK parcels are identified as follows:

- (1) 2-1-036-001 – 22,980 sqft, currently owned fee simple by the Board of Water Supply
- (1) 2-1-036-004 – 1.83 acres, currently owned fee simple by the Board of Water Supply
- (1) 2-1-036-005 – 3.92 acres, currently owned fee simple by the Board of Water Supply

Of these, the 3.92 acres comprising parcel 005 represents the Subject Property ("Subject Property") to be redeveloped per the Scenarios specified earlier.

Study Objectives

HHF Planners engaged Avalon Development Company LLC to prepare this assessment of the economic and fiscal impacts of the Project within the State of Hawaii ("State") and the City and County of Honolulu ("County"). Factors evaluated include:

- **Economic Impacts:**
  - Development-related employment;
  - Operations-related employment;
  - Personal income deriving from development and operations; and
  - General economic impacts on surrounding property values.
- **Population Impacts:**
  - Residential utilization patterns;
  - Average daily visitor population; and
  - In-migrant resident population
- **Fiscal Impacts:**
  - Property tax and other county government revenues and benefits;
  - General excise tax, income tax, transient accommodations tax and other State government revenues;

Monetary Value Basis

Unless otherwise stated, all monetary amounts in this report are stated in 2019 US Dollars.

Analysis Timeframes

This analysis is presented with respect to three time periods for each of the three scenarios:

Table 2: Project Timelines By Scenario

	Scenario 1 Assisted Care Living (ACL)	Scenario 2 Age-Restricted Low-Income Senior Apartment Rentals (SAR)	Scenario 3 Parking Structure (PS)
Development	2020-2023 A four-year period of Project planning, design, financing, construction, and pre-leasing	2020-2023 A four-year period of Project planning, design, financing, construction, and pre-leasing	2020-2022 A three-year period of Project planning, design, financing, construction, and pre-leasing
Operations to Stabilization	2024-2026 Leasing of units are projected to commence by mid to late-2024 with operations stabilizing by the end of 2027.	2024 Leasing of units are projected to commence by early to mid-2024 with operations stabilizing by the end of 2024.	2023 Absorption of parking stalls are projected to commence by early 2023 with operations stabilizing by the end of 2023.
Project Stabilization	2027+ Long-term impacts of the initial development after Project has been stabilized	2025+ Long-term impacts of the initial development after Project has been stabilized	2024+ Long-term impacts of the initial development after Project has been stabilized

2. EXECUTIVE SUMMARY

Project Elements & Costs

The Key Project components, by scenario, evaluated in this assessment include the following:

Table 3: Key Project Elements and Costs in 2019 Dollars by Scenario

	Scenario 1 Assisted Care Living (ACL)	Scenario 2 Age-Restricted Low-Income Senior Apartment Rentals (SAR)	Scenario 3 Parking Structure (PS)
Residential Unit Count	266 one-bedroom units	312 one-bedroom units	n/a
Parking Structure Stalls	605 total stalls (390 for BWS)	490 total stalls (390 for BWS)	1,155 total stalls (320 for BWS)
Description	Assisted-care living facility with tiered services from independent to memory care.	Low-income age-restricted housing for seniors 65 years and older. Funded in part by Low Income Housing Tax Credits (LIHTC)	Parking structure for use by surrounding area government offices and adjacent Queens Medical Center.
Project Timeframe	2020-2026	2020-2024	2020-2023
Estimated Total Project Costs	$168,847,000	$158,211,000	$53,498,000
Project Costs to Directly Impact the Hawaii Economy ("Direct Impact)[2]	$132,645,000	$127,610,000	$44,395,000
Project Costs Attributed to Consultants	$9,000,000	$7,700,000	$3,350,000

[2] Project costs that directly impact the Hawaii economy do not include due diligence, permitting, financing, and developer profit.

Although the project costs for each scenario includes all costs associated with the development of each scenario, this study focuses on the project costs that directly impact the Hawaii economy. It is assumed that the developer of each scenario would employ locally-based architects, engineers and other key consultants ("Consultants") in the development of each scenario.

Overview of Impacts

The three (3) scenarios will generate varying levels of on-going economic and fiscal benefits for residents of Hawaii, as well as for the County and State governments. The scenarios would generate spending, employment and consequent income and taxes. This economic activity is expected to support long-term impacts, including additional consumer expenditures, employment opportunities, personal income and government revenue enhancement.

A summary of the Project impacts is provided in the below table and discussed in the sections that follow. Study methodology and definition of key terms as "direct", "indirect" and "induced" are provided under Chapter 3 Study Conditions & Terminology.

Table 4: Scenario 1 Overview of Economic & Fiscal Impacts
Average annual figures

Assisted Care Living (ACL)	Development 2020-2023	Operations to Stabilization 2024-2026	Stabilization 2027+
FTE Employment[3]			
Development-related	400	0	0
Operations-related on-site	0	25	43
Total Personal Earnings[4]			
Development-related ($mil)	$22.5	$0.0	$0.0
Operations-related ($mil)	$0.0	$2.1	$3.8
Average earnings per FTE job[4]			
Development-related ($)	$75,600	n/a	n/a
Operations-related ($)	0	$84,500	$88,000
In-migration resident population			
To the County	10	3[5]	0
To the State	10	3[6]	0
Net additional taxes ($mil)			
To the County	$0.1	$0.1	$0.1
To the State	$1.9	$0.2	$0.2

[3] FTE = Full-time equivalent, defined as 40 hours per week or 2,080 hours per year.
[4] Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance.
[5] The likely low supply of licensed nurses will lead to the recruitment of talent from out of County and State.
[6] The likely low supply of licensed nurses will lead to the recruitment of talent from out of County and State.

Table 5: Scenario 2 Overview of Economic & Fiscal Impacts
Average annual figures

Senior Apartment Rentals (SAR)	Development 2020-2023	Operations to Stabilization 2024	Stabilization 2025+
FTE Employment[7]			
Development-related	400	0	0
Operations-related on-site	0	1	0
Total Personal Earnings[8]			
Development-related ($mil)	$22.5	$0.0	$0.0
Operations-related ($mil)	$0.0	$0.1	$0.0
Average earnings per FTE job[4]			
Development-related ($)	$75,600	n/a	n/a
Operations-related ($)	0	$73,100	$76.500
In-migration resident population			
To the County	10	0[9]	0[9]
To the State	10	0[9]	0[9]
Net additional taxes ($mil)			
To the County	$0.1	$0.0[10]	$0.0[10]
To the State	$1.9	$0.0[10]	$0.0[10]

[7] FTE = Full-time equivalent, defined as 40 hours per week or 2,080 hours per year.
[8] Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance.
[9] Senior apartment rentals are not human-resource intensive. Pool of potential employees is abundant.
[10] Limited growth in employment yields negligible tax revenue from employee compensation.

Table 6: Scenario 3 Overview of Economic & Fiscal Impacts
Average annual figures

Parking Structure (PS)	Development 2020-2022	Operations to Stabilization 2023	Stabilization 2024+
FTE Employment[11]			
Development-related	200	0	0
Operations-related on-site	0	5[12]	0
Total Personal Earnings[13]			
Development-related ($mil)	$11.3	$0.0	$0.0
Operations-related ($mil)	$0.0	$0.3	$0.0
Average earnings per FTE job[4]			
Development-related ($)	$75,600	n/a	n/a
Operations-related ($)	0	$51,100	$52,300
In-migration resident population			
To the County	5	0[14]	0[14]
To the State	5	0[14]	0[14]
Net additional taxes ($mil)			
To the County	$0.1	$0.0[15]	$0.0[15]
To the State	$0.9	$0.0[15]	$0.0[15]

[11] FTE = Full-time equivalent, defined as 40 hours per week or 2,080 hours per year.
[12] Full staff of parking attendants and manager are required upon start of operations.
[13] Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance.
[14] Parking structures are not human-resource intensive. Pool of potential employees is abundant.
[15] Limited growth in employment yields negligible tax revenue.

Development Employment

- **FTE Employment** – The development of each scenario is estimated to generate 200-400 full-time equivalent (FTE) jobs annually, including positions created directly and indirectly by the development activities. Such jobs are expected to be located primarily on Oahu.
- **Personal Earnings** – New development-related positions are expected to be associated with total personal earnings of some $11.3-$22.5 million per year during design and construction. These earnings represent an average of $75,600 per FTE job, including direct construction-related jobs as well as the indirect and induced opportunities created throughout the economy. The many jobs created directly by the development are expected to enjoy higher salaries than these averages.

Operational Employment

- **On-Site Jobs** – Operationally-speaking, there is a stark difference between the scenarios in terms of employment. Scenario 1's Assisted Care Living concept will likely require up to 43 direct FTE's until stabilization. Scenarios 2 & 3 have little in terms of human resource needs as both concepts represent real estate assets that are managed by a small group of people. The direct impact of these individuals are negligible.
- **FTE Employment** - Considering the Project's direct, indirect and induced impacts statewide, only Scenario 1 has the potential of generating possible additional employment state-wide. These "net new" jobs could include vendor services such as food delivery; however it is generally assumed that such positions generated throughout the economy via indirect and induced economic factors is minimal and negligible due to the all-inclusive employment nature of the Assisted Care Living model.
- **Personal Earnings** - The evaluation of personal earnings is based on the island- wide net new jobs explained above. Net new personal earnings for local employees for Scenario 1 are projected at about $2.2 million by the time doors open to the public. By 2027 and thereafter, with ACL operations stabilized, net new personal earnings for local residents are projected to total about $3.8 million per year.

  On average, these net new FTE positions are expected to earn about $84,500 each between 2024 and 2026 during the lease-up of available units and the operations of the Project, and about $88,000 per year thereafter, when all activities have been stabilized.

  Scenarios 2 & 3 yield negligible earnings for the purpose of calculating tax revenue.

Table 7: Employment Breakdown by Scenario

	Scenario 1 Assisted Care Living (ACL)	Scenario 2 Age-Restricted Low-Income Senior Apartment Rentals (SAR)	Scenario 3 Parking Structure (PS)
Residential Unit Count	266 one-bedroom units	312 one-bedroom units	n/a
Employee Counts	605 total stalls (390 for BWS)	490 total stalls (390 for BWS)	1,155 total stalls (320 for BWS)
Description	Assisted-care living facility with tiered services from independent to memory care.	Low-income age-restricted housing for seniors 65 years and older. Funded in part by Low Income Housing Tax Credits (LIHTC)	Parking structure for use by surrounding area government offices and adjacent Queens Medical Center.

Population Movements

Employment opportunities created by the Scenarios are likely to create incentives for some out-of-state residents, including former Hawaii residents, to move to Oahu. Thus, up to 5% of the construction labor force, and a small share of the operations-related positions are projected to be filled by persons moving from out-of-state.

Together, the above factors are estimated to result in up to 10 persons moving to Hawaii because of the Project during its development and initial leasing, stabilizing at most 10 persons.

The population impact to the County is assumed for projection purposes to be the same as to the state. While some may move between islands because of employment or residential opportunities created by the Project, representing a population impact to Oahu but not to the state, such impacts are assumed to be nominal.

Fiscal & Other Public Impacts

The three (3) scenarios present different opportunities in filling the need for housing and parking. Considering the ideal location of the Beretania Campus next to Queens Medical Center, Scenario 1 (Assisted Care Living) and Scenario 2 (Senior Apartment Rentals) are ideal fits as complimentary uses to the medical care services provided across the street. Scenario 3 (Parking Structure) fulfills a major need for additional parking in the area considering the mass of government offices and medical services (Queens Medical Center).

All three (3) scenarios will certainly generate more real property tax and gross excise taxes. Income taxes on the other hand would only see significant gains in Scenario 1 (Assisted Care Living) with its significant human resource need.

The Project is also expected to generate these fiscal and other public benefits:

- **County** - Increased real property taxes will be the major driver of fiscal impacts for the County. The scenarios are expected to generate the following revenues starting within a year after the commencement of operations for each scenario:

Table 8: Real Property Tax Calculation

	Scenario 1 Assisted Care Living (ACL)	Scenario 2 Age-Restricted Low-Income Senior Apartment Rentals (SAR)	Scenario 3 Parking Structure (PS)
First Full Real Property Tax Year	2025	2025	2024
First Full Real Property Assessed Value	$120,000,000	$118,550,000	$40,000,000
Assessed Value Adjustment for HBWS Stalls (390)	($10,815,000)	($10,815,000)	($10,815,000)
Net Assessed Value	$109,185,000	$107,735,000	$29,185,000
C&C of Honolulu Real Property Tax Rate (Per $1,000 Value) – Fiscal Year 2018	$3.50	$3.50	$12.40
Estimated Real Property Tax	$382,000	$377,000[16]	$362,000

[16] If tax credits are used to secure capital for the construction of Scenario 2, the real property tax will be waived by the City & County of Honolulu.

- **State** - For the State, net additional operating revenues generated by the Scenarios are generated primarily through employment income tax. Although Scenario 1 (Assisted Care Living) is assumed to reach an estimated 43 employees at stabilization with $3.8 million per year, Scenario 2 (Senior Apartment Rentals) and Scenario 3 (Parking Structure) have minimal need for human resource and thus generate minimal if any income tax revenue for the State. Since the scenarios do not involve the sale of any real estate product, no conveyance tax income is generated.

3. STUDY CONDITIONS & TERMINOLOGY

Special considerations and terminology for the analyses on which the preceding results rely are presented in this chapter.

Special Study Considerations

- **Start of Project –** It is assumed for this report that each of the Scenarios would begin planning & permitting by the 2^{nd} quarter of 2020.
- **Target Markets for Scenarios**
  - Scenario 1 (Assisted Care Living) is expected to attract some elderly residents who live out-of-state. However, based on our polling of 291 elderly residents in various assisted care living facilities in Hawaii, we determined that 96% have been residents of Hawaii prior to their residency at their respective facilities.
  - Scenario 2 (Senior Apartment Rentals) is expected to quickly fill its entire capacity of available units with qualified elderly individuals as there is currently a strong demand for such affordable housing. Based on our polling of 9 senior age-restricted low income housing properties in Hawaii, we determined that every facility had a waiting list of individuals seeking occupancy. The average wait time in gaining occupancy is 19 months.
  - Scenario 3 (Parking Structure) is expected to be a welcome addition to the community as the nearby city and state office buildings and Queens Medical Center are fighting parking challenges.
- **Government Revenues** - Government revenues and rates are largely derived from government sources. County real property tax revenues are based on rates that were in effect during the fiscal year ending June 30, 2019. State income tax revenues are based on 2019 rates, as applicable to married taxpayers filing jointly, in the income brackets considered. This was the latest income tax schedule available at the time of preparation of this report.

Definition of Key Terms

- **Direct Impacts** - Those economic, population or other impacts attributable to persons or activities that are a direct result of the proposed development. For instance, direct employment impacts are expected to include those involved in building the proposed facilities, such as construction workers, and those who would later work at them in their operations.

  Many, but not all direct impacts can be expected to occur on-site. For instance, a portion of the construction budget is for architects and engineers. While such persons' employment might be temporarily dependent on contracts related to the Scenarios, many such professionals may do most of their work from offices in downtown Honolulu, or elsewhere. Likewise, administrative and managerial staff located off-site would support construction professionals working on-site.
- **Indirect Impacts** - Indirect impacts occur when the businesses or persons who are directly affected make expenditures for additional supplies or services. For instance, some of the additional retail spending by those newly attracted to Hawaii by the Project could be spent on eating out. These elevated dining out expenditures could indirectly increase demand for produce, seafood and meats from Hawaii farms, fishermen and/or ranching enterprises. The Scenarios would have thus indirectly supported new business opportunities for area providers of such goods and services.
- **Induced Impacts** - Induced impacts occur throughout the community when those persons or companies that have benefited from the direct or indirect impacts of the Project spend their associated earnings on consumer goods and services. For instance, a construction worker may spend her earned wages to buy a new pair of shoes, or to pay for her child's day care. The farmer who sells produce to say Scenario 1's Assisted Care Living may use some of his profit to take his family out to the movies. The businesses and individuals impacted by such re-spending are said to enjoy induced economic impacts from the Project.
- **Total Impacts** - Total impacts are defined as the sum of direct, indirect and induced impacts for any given variable.
- **Resident Population** - Resident population refers to all those persons who habitually reside in a given area, whether or not they are temporarily away.
- **Full-Time Equivalent** -This study measures employment opportunities in full-time equivalent (FTE) units. One full-time equivalent position is defined herein as 2,080 hours of employment, including paid vacation and sick leave, per year. This is equivalent to 40 hours per week, and may also be referred to as a "person-year" of employment. Two half-time jobs would be considered to together represent one FTE job.
- **Other** - Other special terms used in this analysis are defined on the exhibits where they are used.

Report Conditions

Assumptions regarding the scale, nature and timing of the Project are made in order to assess its economic and fiscal impacts. This study relies on physical parameters, layouts, timelines, budgets, development programs and other inputs provided by Avalon and other sources as noted.

This assessment also incorporates information provided by government agencies, developers, brokers, landowners, and other sources as cited in the exhibits. While attempts have been made to verify such information via multiple sources, it is not always possible to do so. Avalon Development Company LLC cannot guarantee the accuracy of all information upon which its assessments may be based.

This report is for the planning purposes of HBWS and consultants, as well as for public disclosure of the nature of the Project pursuant to seeking land entitlements. It is not intended to be used for solicitation of investment.

Appendix G

Preliminary Engineering Report, Electrical and Telecommunications Utility Infrastructure
ECS Inc., May 2019

ECS, INC.
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PRELIMINARY ENGINEERING REPORT

ELECTRICAL AND TELECOMMUNICATIONS UTILITY INFRASTRUCTURE

Board of Water Supply Beretania Complex Redevelopment Project

May 2019

General

This Preliminary Engineering Report for the electrical and telecommunications utility infrastructure addresses off-site commercial electrical and telecommunications utility systems and identifies potential modifications/upgrades to the utility systems which may be required to support the proposed redevelopment of the Board of Water Supply (BWS) Beretania Street Complex. Utility systems include, but are not limited to electrical (power), telecommunications (telephone, cable television and internet/data), and City and County of Honolulu street lighting systems.

The initial engineering assessment of the electrical and telecommunications utilities is based on the anticipated maximum utility service requirements for the following proposed conceptual development options:

- Assisted Care Living Development
  - 10 floor, 251,000 square foot assisted care living facility with 266 units
  - 10 floor, 605 stall parking structure
  - 11 story, BWS office building consisting of 35,500 square feet of office space and 140 stall parking structure

- Affordable Senior Rental Development
  - 10 floor, 248,300 square foot senior rental development with 312 units
  - 10 floor, 605 stall parking structure
  - 11 story, BWS office building consisting of 35,500 square feet of office space and 140 stall parking structure

- Parking Structure Development
  - 10 floor, 1,155 stall parking structure
  - 11 story, BWS office building consisting of 35,500 square feet of office space and 140 stall parking structure

Existing Electrical (Power) Utility Systems

Electrical (power) service to customers in the project area is provided by Hawaiian Electric (HECO) and is either distributed overhead on joint use utility poles or underground via ductline and manhole/handhole systems. HECO distribution systems are located within road rights-of-way or utility easements.

The HECO distribution system along Beretania Street, between, Alapai Street and Lauhala Street, consists of three (3) underground 11.5 kV circuits, utilizing 750 kcmil copper conductors. Two (2) of the three (3) underground 11.5 kV circuits along Beretania Street extend underground, along the Alapai Street frontage of the BWS complex. These 11.5 kV circuits utilize #4/0 copper conductors. The two (2) underground 11.5 kV circuits along Alapai Street are used to serve the outdoor HECO substation located along the Alapai Street side of the BWS Pump Building. This substation consists of 3 – 500 kVA transformers which supply 4.16/2.14 kV power to support the Pump Building pump station process equipment.

Two (2) of the three (3) underground 11.5 kV circuits along Beretania Street are tapped and extend underground along Lauhala Street and extend through to Lusitana Street. These 11.5 kV circuits utilize #4/0 copper conductors. HECO records indicate that the existing 11.5 kV ductline appears to consist of transite conduits. The two (2) underground 11.5 kV circuits along Lauhala Street are tapped to serve various customers along Lauhala Street, including the BWS Public Service Building. The 11.5 kV circuits terminate at indoor switchgear located in the basement of the Public Service Building. Dual 11.5 kV feeders extend from the switchgear to serve the BWS Engineering Building and Pump Station building.

HECO customers along Lusitana Street are served from the overhead joint use pole line which runs along Lusitana Street. The poleline consists of one 12.47 kV, 336 AL circuit and secondary lines. Pole mounted transformers are utilized to step the 12.47 kV distribution voltage down to secondary utilization voltages. The joint use poles support overhead or underground secondary circuits which distribute power from the pole mounted transformers to various customers. For larger customers, a primary 12.47 kV feeder is extended underground to their properties for use with a HECO pad-mounted transformer. This 12.47 kV circuit also extends overhead along Alapai Street and Lauhala Street.

HECO has no distribution circuits along Lisbon Street.

Proposed Electrical (Power) Utility Improvements

Electrical (power) utility connection points for the proposed BWS redevelopment will likely be from underground circuits along Lauhala and Alapai Streets. However HECO cannot provide information regarding future circuiting requirements at the preliminary engineering stage of the project. HECO has preliminarily indicated that extension of new circuits into the area or upgrade of existing circuits may be necessary to support the proposed development. The extension/upgrade of HECO circuits may also require the construction of new underground infrastructure (ductlines and manholes/handholes), particularly along Lauhala Street where the existing transite ductline may need to be replaced if existing cables are upgraded or replaced.

HECO will require additional information regarding specific development plans before confirming the adequacy of the existing circuits and the extent of any upgrades to HECO's distribution system. A detailed evaluation of circuit capacity will be performed when service request(s) for the development are submitted to HECO during the design phase.

For purposes of this report, assume that new HECO pad mounted transformers will be utilized to support the project loads associated with the various buildings and facilities proposed for the development. HECO may also require pad mounted primary switches for the transformers. Locations of the transformers and primary switches will be determined as site development plans are further refined.

The PER does not address undergrounding of the existing HECO cables along Alapai Street and Lusitana Street. If the selected developer would like to pursue the feasibility of placing the Alapai Street and Lusitana Street utility systems underground, significant coordination and discussion with HECO will be required to identify infrastructure requirements and HECO design and construction costs associated with such undergrounding work. Although HECO will perform the actual removal of overhead circuits and installation of underground conductors, the cost for undergrounding of existing overhead circuits will be charged to the customer.

Existing Telecommunications Utility Systems

Telephone, cable television and related telecommunications services are provided to customers in the project area by Hawaiian Telcom (HT) and Spectrum. Customers have the option to contract with HT, Spectrum, or both for their telecommunications services. Both HT and Spectrum are capable of providing voice, internet and other telecommunications services to their customers.

The existing Hawaiian Telcom and Spectrum telecommunications cables are generally run underground and follow the path of the HECO underground distribution system along Beretania Street, Alapai Street and Lauhala Street. In addition, HT and Spectrum have telecommunications cables that are run overhead on the portion of the joint pole line along Lusitana Street and Alapai Street. HT also has smaller underground distribution cables along Lisbon Street.

Hawaiian Telcom's overhead and underground distribution systems consist of a combination of fiber optic and copper cables. Similarly, Spectrum's overhead and underground distribution systems consist of fiber and coaxial cables.

The existing customers within the project area have a combination of overhead and underground services from HT and Spectrum. Existing telephone service is provided to the current BWS facility from HT's distribution system along Beretania Street. High speed data service is provided via fiber optic cabling from HT's infrastructure along Lisbon Street and terminates within the existing BWS data center in the Pump Building. Secondary high speed data service is provided from Spectrum, terminates at the BWS Engineering Building, and is then routed to the BWS data center in the Pump Building. Cable television service is obtained from Spectrum infrastructure along Lisbon Street and provided to select executive offices on the third floor of the BWS Public Service Building.

Proposed Telecommunications Utility Improvements

Possible telecommunications utility connection points for the proposed BWS redevelopment will likely be from underground circuits along Lauhala and Alapai Streets. Hawaiian Telcom and Spectrum have not yet confirmed that their existing fiber optic facilities in the project area have sufficient capacity to support the development, and further input from both HT and Spectrum is needed to verify available capacity and to identify the extent of upgrades to existing HT and Spectrum facilities.

It is anticipated that new underground infrastructure consisting of ductline, manholes and/or handholes will be extended from the existing HT and Spectrum underground distribution systems along Lauhala Street to support telecommunications services for the proposed development bounded by Lauhala and Lisbon Streets. It is assumed that telecommunications services to the proposed BWS office building will be extended from the BWS data center at the Pump Building to the proposed office building via new underground infrastructure. If additional commercial telecommunications services are desired for the office building, it is expected that new underground infrastructure can be extended from HT and Spectrum's existing underground distribution systems along Lisbon Street or Alapai Street. Specific service points of connection to the HT and Spectrum underground distribution systems will be confirmed as site development plans are further refined and the types of telecommunications services desired by the developer and BWS are identified.

The PER does not address undergrounding of the existing HT and Spectrum cables along Alapai Street and Lusitana Street. If the selected developer would like to pursue the feasibility of placing the Alapai Street and Lusitana Street utility systems underground, significant coordination and discussion with HT and Spectrum will be required to identify infrastructure requirements and utility company design and construction costs associated with such undergrounding work. Although HT and Spectrum will perform the actual removal of overhead circuits and installation of underground conductors, the cost for undergrounding of existing overhead circuits will be charged to the customer.

Street Lighting System

The City and County of Honolulu street lighting systems along Beretania Street, Lauhala Street and portion of Lusitana Street (Ewa of Lisbon Street) consist of full-cutoff, "cobra head" type luminaires with LED lamps and metal street light standards. Power for the street lights is distributed via an underground street lighting distribution system.

The City and County of Honolulu street lighting systems along Alapai Street and Lusitana Street, between Lisbon Street and Alapai Street, consists of full-cutoff, “cobra head” type luminaires with mast arms mounted to joint use wood poles. The street lights utilize LED lamps. Power for these street lights originate directly from the HECO secondary lines. There are no street lights along Lisbon Street.

Assume no work or upgrade to the existing street lighting system along Beretania Street, as street frontages along the proposed development do not have direct access to Beretania Street. Modifications to the existing street lighting systems along Alapai Street, Lauhala Street and/or Lusitana Streets may be required to accommodate new driveways to the proposed facilities with frontages along these roadways.

Construction of new driveway entrances to the proposed facilities along Lisbon Street, and the expectation that there will be an increase in vehicular and/or pedestrian traffic in the area, may require the provision of a street lighting system for Lisbon Street. New street lighting systems will consist of metal street light standards which conform to City and County of Honolulu standards. The typical City street light standard consists of a galvanized steel light pole with transformer base, galvanized steel bracket arm, “cobra head” street light luminaires with full cutoff reflectors, LED lamps and networked wireless lighting control nodes. Power for the street lighting system will need to be supplied by new underground secondary lighting circuits which will consist of ductline, pullboxes and conductors.

If undergrounding of the utility poleline along Alapai Street or Lusitana Street is pursued, the existing street light luminaires mounted on the wood poles will be removed, and metal street light standards which conform to City and County of Honolulu standards will need to be provided along with a new underground street lighting distribution system.

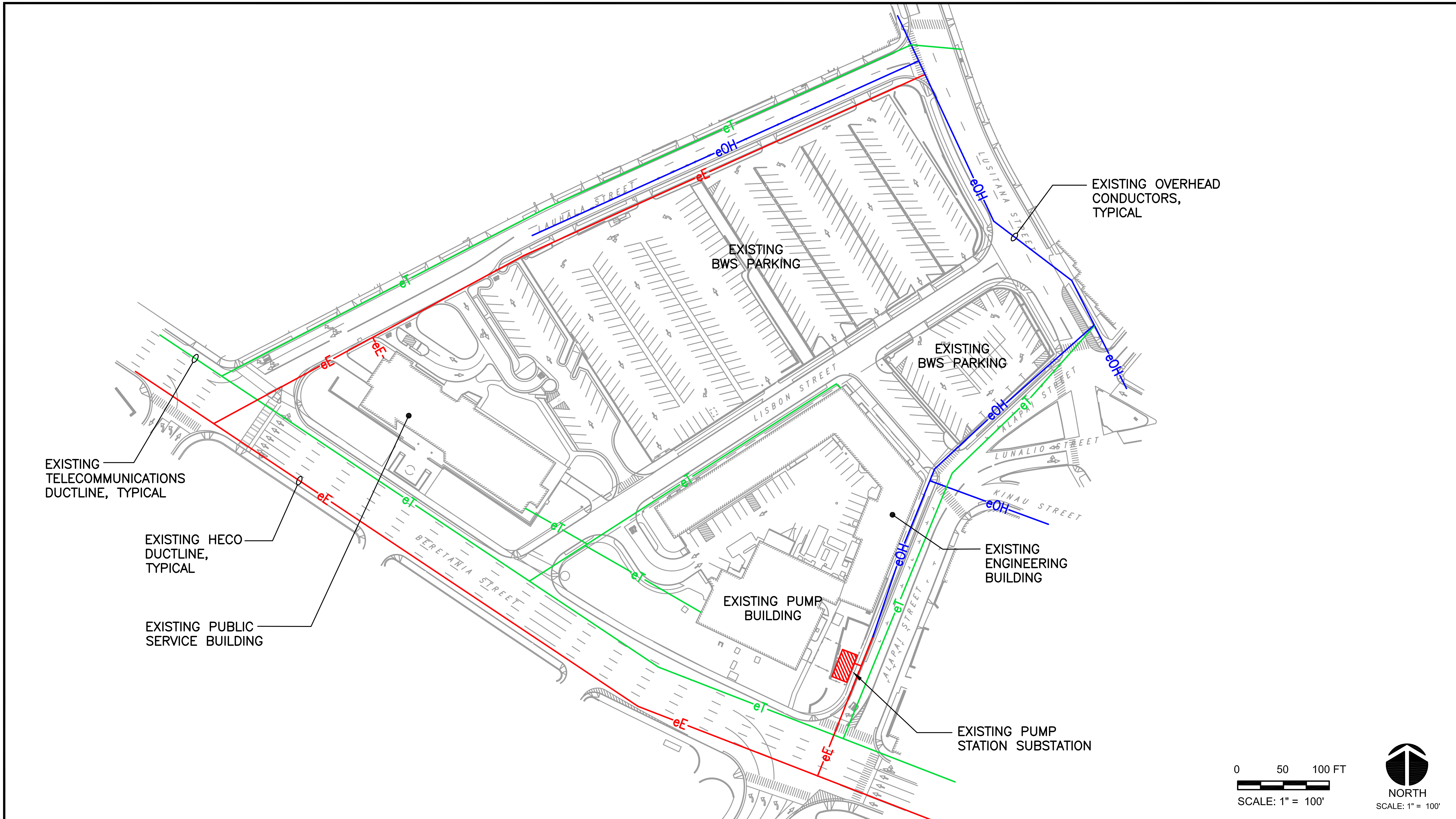

FIGURE E-1

EXISTING ELECTRICAL AND TELECOMMUNICATIONS UTILITY SYSTEM

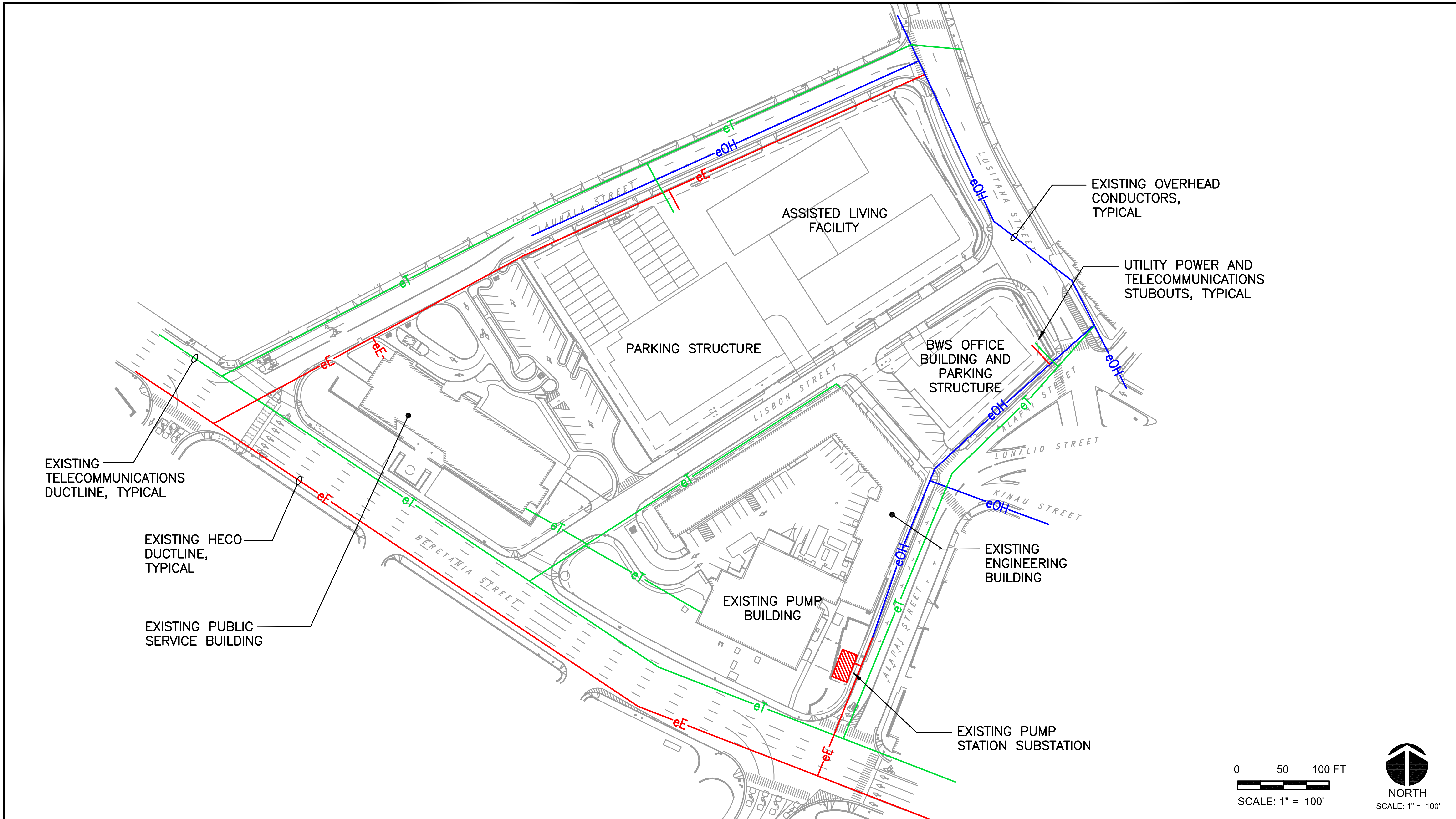

FIGURE E-2

ASSISTED LIVING OPTION ELECTRICAL AND TELECOMMUNICATIONS UTILITY SYSTEM

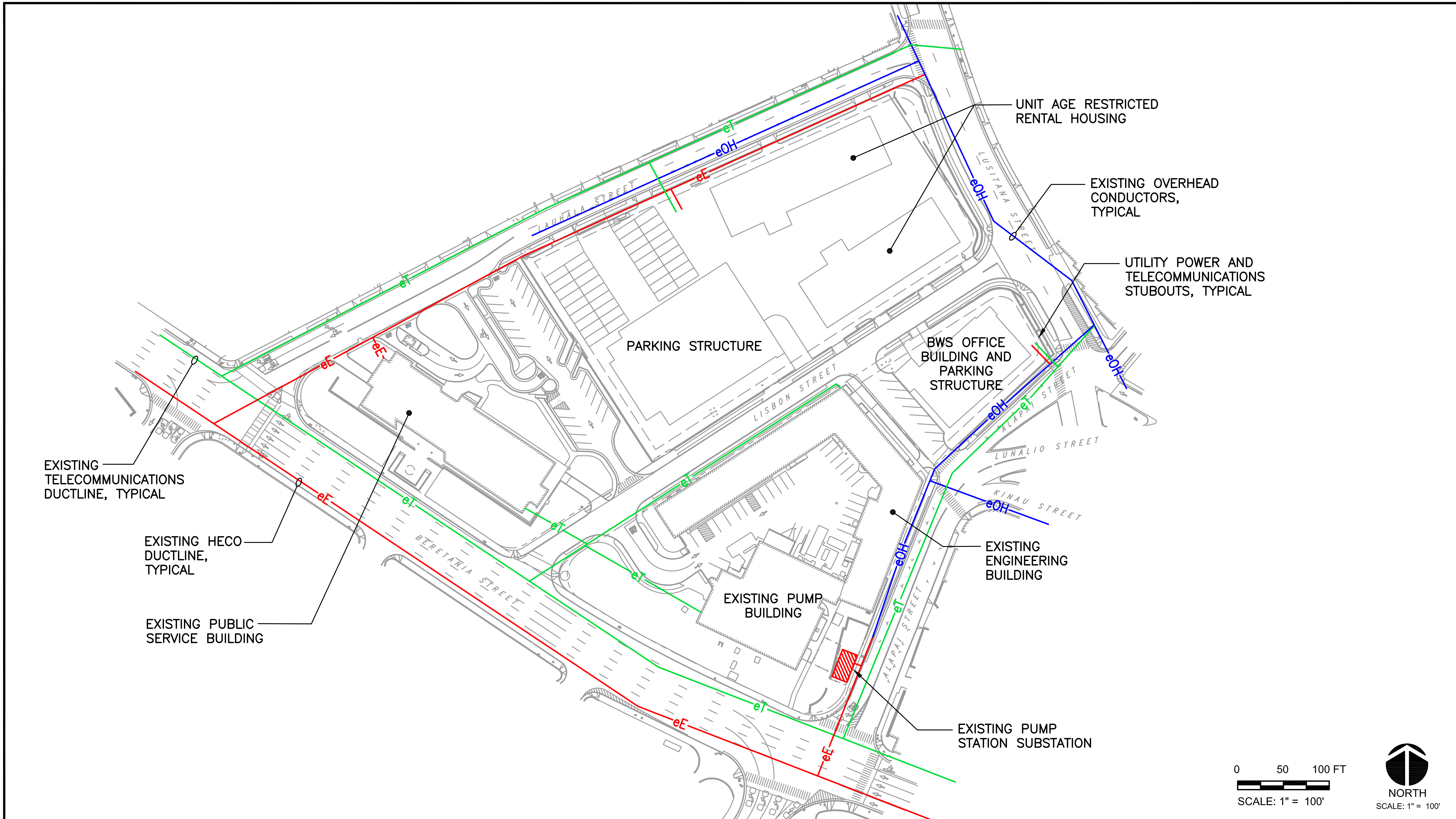

FIGURE E-3

SENIOR RENTALS OPTION ELECTRICAL AND TELECOMMUNICATIONS UTILITY SYSTEM

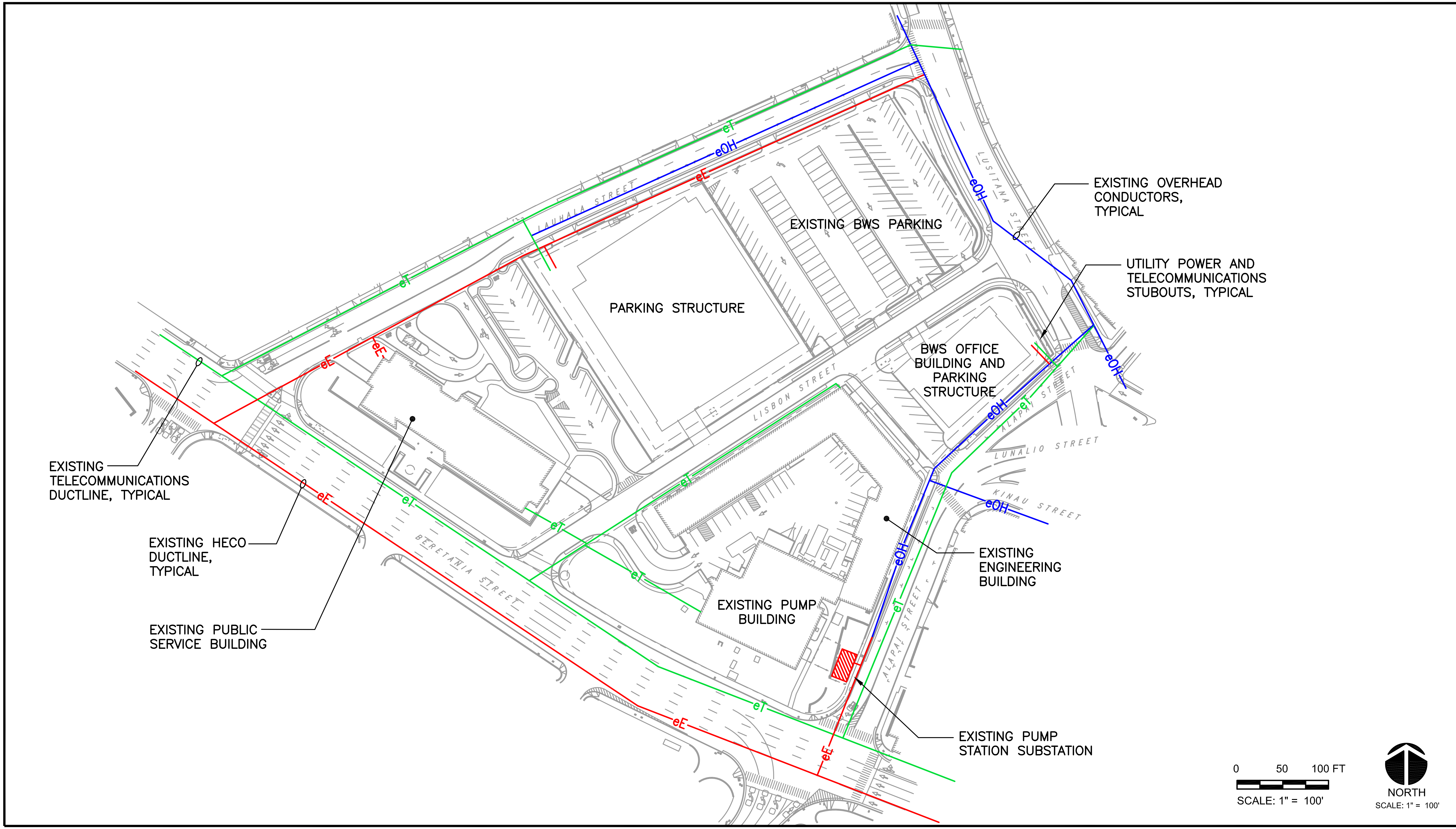

FIGURE E-4

PARKING STRUCTURE OPTION ELECTRICAL AND TELECOMMUNICATIONS UTILITY SYSTEM

Appendix H

Preliminary Engineering Report, Civil Infrastructure
Wilson Okamoto Corporation, May 2019

DRAFT
PRELIMINARY ENGINEERING REPORT
CIVIL INFRASTRUCTURE

BOARD OF WATER SUPPLY
BERETANIA COMPLEX REDEVELOPMENT

Honolulu, Oahu, Hawaii
TMK: (1) 2-1-036: 001 & 005 (por.)

Prepared For:

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May 2019

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APPENDICES

EXECUTIVE SUMMARY

The City and County of Honolulu Board of Water Supply (BWS) intends to issue a Request for Proposal (RFP) to redevelop up to 128,100-square feet (sf) of its 6.3-acre Beretania Complex property located at 630 South Beretania Street in Honolulu on the island of Oahu. The area designated for redevelopment is currently being used as ground level parking and is identified by Tax Map Keys 2-1-036:001 and 2-1-036:005 (por.). Through redevelopment, BWS intends to maximize the use of the underutilized property and provide a revenue stream to help offset rising water rates and reduce costs to BWS customers.

BWS will enter into a development contract and ground lease with selected Offeror for the use of all or a portion of the property for a maximum term not to exceed sixty-five (65) years. Future development of the site will be determined by the developer.

The three (3) possible development scenarios under consideration for the redevelopment are identified as follows:

- 266-unit assisted care living facility
- 312-unit affordable senior rental housing complex; and
- 10-story parking structure.

Each scenario would include construction of a BWS office building within the parcel TMK: 2-1-036:001.

This preliminary engineering assessment was conducted to provide a detailed evaluation of the three (3) development scenarios related to the civil infrastructure and utility systems for the Beretania Complex redevelopment. The objective of the report is to review the existing site infrastructure improvements, determine the project requirements related to the roadway and parking facilities, site grading, storm drainage system, sanitary sewer system, water system, and, based on the project requirements, determine required improvements, and identify possible opportunities and constraints for the Beretania Complex Redevelopment. An Environmental Impact Statement is being prepared to assess each development scenario and confirm if any proposed action will have a significant effect on the environment.

1. INTRODUCTION

1.1 Background

The proposed project site is composed of two parcels (*Ewa and Diamond Head*) within the Board of Water Supply's (BWS) 6.3-acre Beretania Complex in Honolulu (See Figure 1-1). The two parcels, TMK 2-1-036:001 and 005 (por.), are approximately 0.53 and 3.92-acres, respectively (See Figure 1-2). The parcels are separated by Lisbon Street and bounded by Lusitana Street on the *mauka* side, S. Beretania Street on the *makai* side, Lauhala Street on the *Ewa* side, and Alapai Street on the *Diamond Head* side. All of these streets are owned and maintained by the City and County of Honolulu.

The parcels currently contain paved parking lots for the BWS fleet and employee vehicles (See Figure 1-3).

1.2 Proposed Project

BWS desires to issue a Request for Proposal (RFP) to redevelop the subject portion of the Beretania Complex. BWS intends to enter into a development contract with a qualified Offeror to issue a ground lease for the use of all or a portion of the property to a maximum term not to exceed sixty-five (65) years. Full ownership and control over property and improvements to be constructed under the accepted proposal shall revert to BWS at the end of the lease term.

Development scenarios include:

1. Assisted care living facility with 266 units, 10-story parking structure with 605 stalls, and BWS office building with 140 stall parking structure (See Figure 1-4).

2. Affordable senior rental housing complex with 312 units, 10-story parking structure with 605 stalls, and BWS office building with 140 stall parking structure (See Figure 1-5).

3. 10-story parking structure with 1,155 stalls, and BWS office building with 140 stall parking structure (See Figure 1-6).

1.3 Purpose

This Preliminary Engineering Report presents a detailed evaluation of the three (3) development scenarios related to the civil infrastructure and utility systems for the BWS Beretania Complex Redevelopment project. The objective of the report is to review the existing site infrastructure improvements, evaluate the project requirements, and, based on the project requirements, determine required improvements, and identify possible opportunities and constraints for the following:

- Roadway, parking, and access
- Site grading and flood hazard
- Storm drainage system
- Sanitary sewer system
- Water supply system
- Natural gas

The assessment of the site characteristics and utilities for each project site is based on available data obtained from the City's Honolulu Land Information System (HoLIS) database, record information, as-built plans, and a combination of aerial and street level photography obtained from the Google Earth database. In addition, site visits were conducted to gather information, verify conditions, and analyze development opportunities and constraints. Further, letters were sent to appropriate City agencies, and other service agencies, with the proposed project requirements for each development scenario to determine capacities and the agency's ability to serve the redevelopment demands.

The proposed improvements are conceptual and subject to change based on further development of plans and availability of additional information.

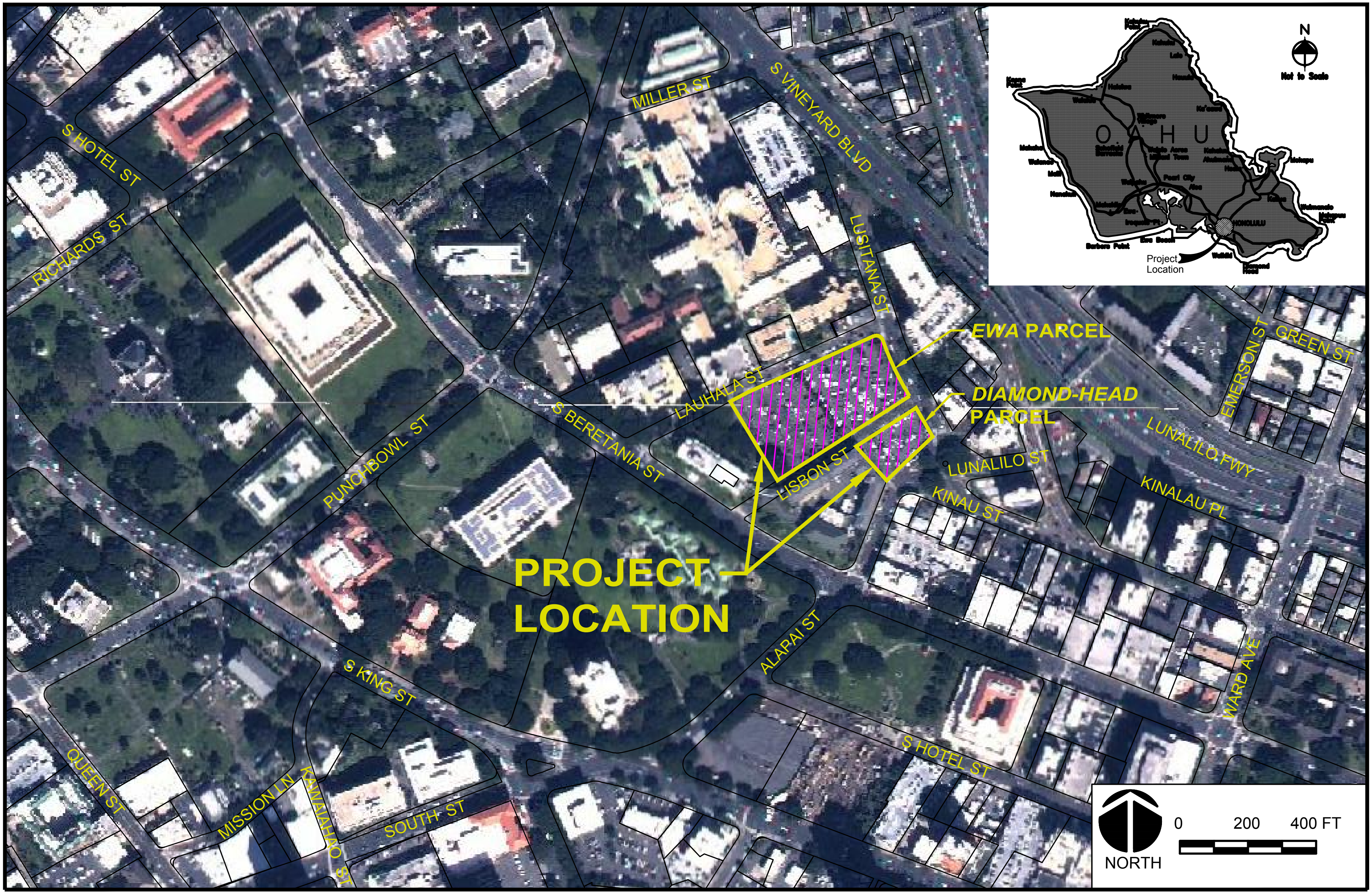

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FIGURE 1-1
PROJECT LOCATION AND VICINITY MAP

BOARD OF WATER SUPPLY - BERETANIA COMPLEX REDEVELOPMENT | HONOLULU, HAWAII

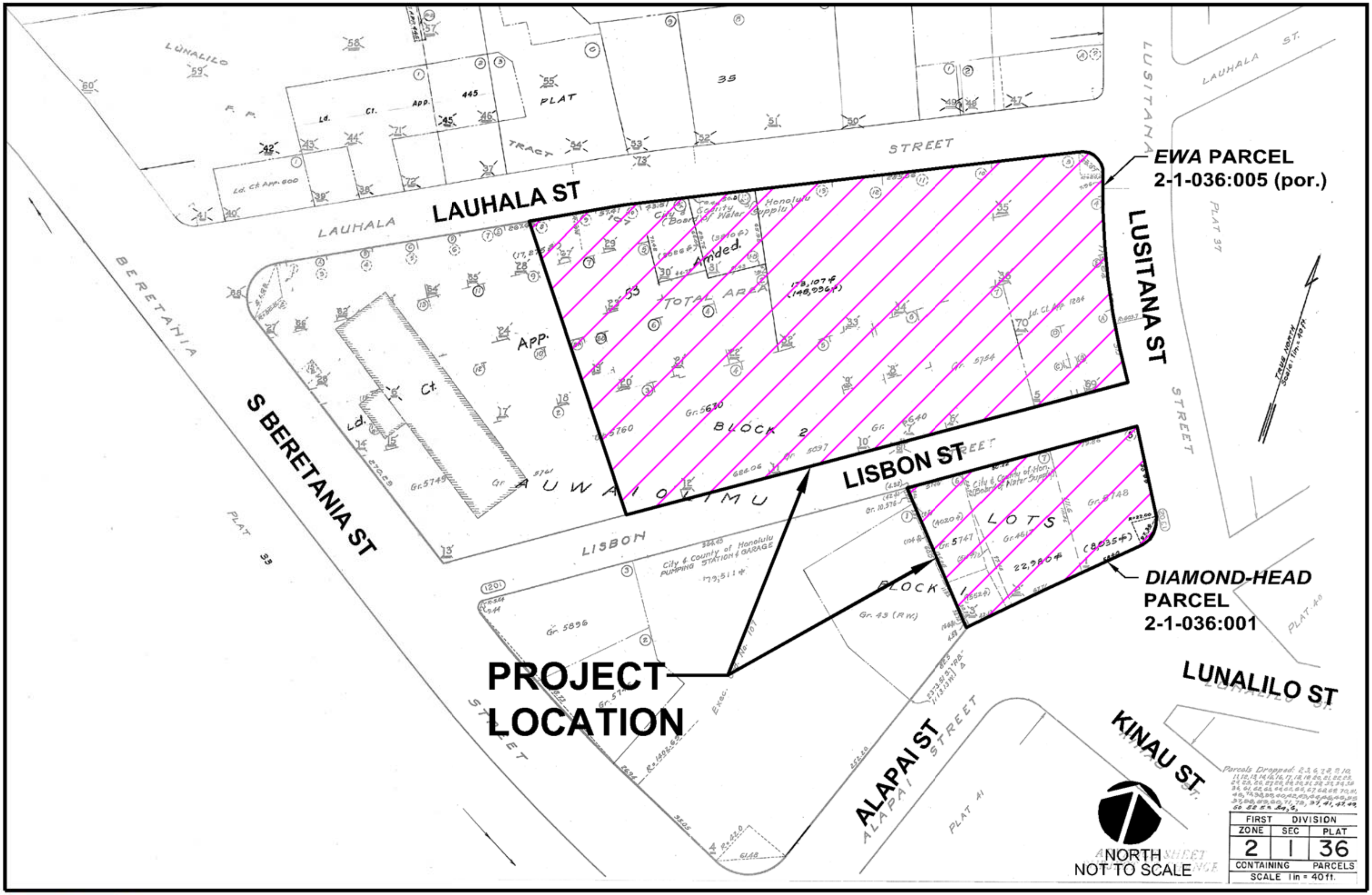

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FIGURE 1-2

TAX MAP KEY: 2-1-036:001 & 005 (por.)

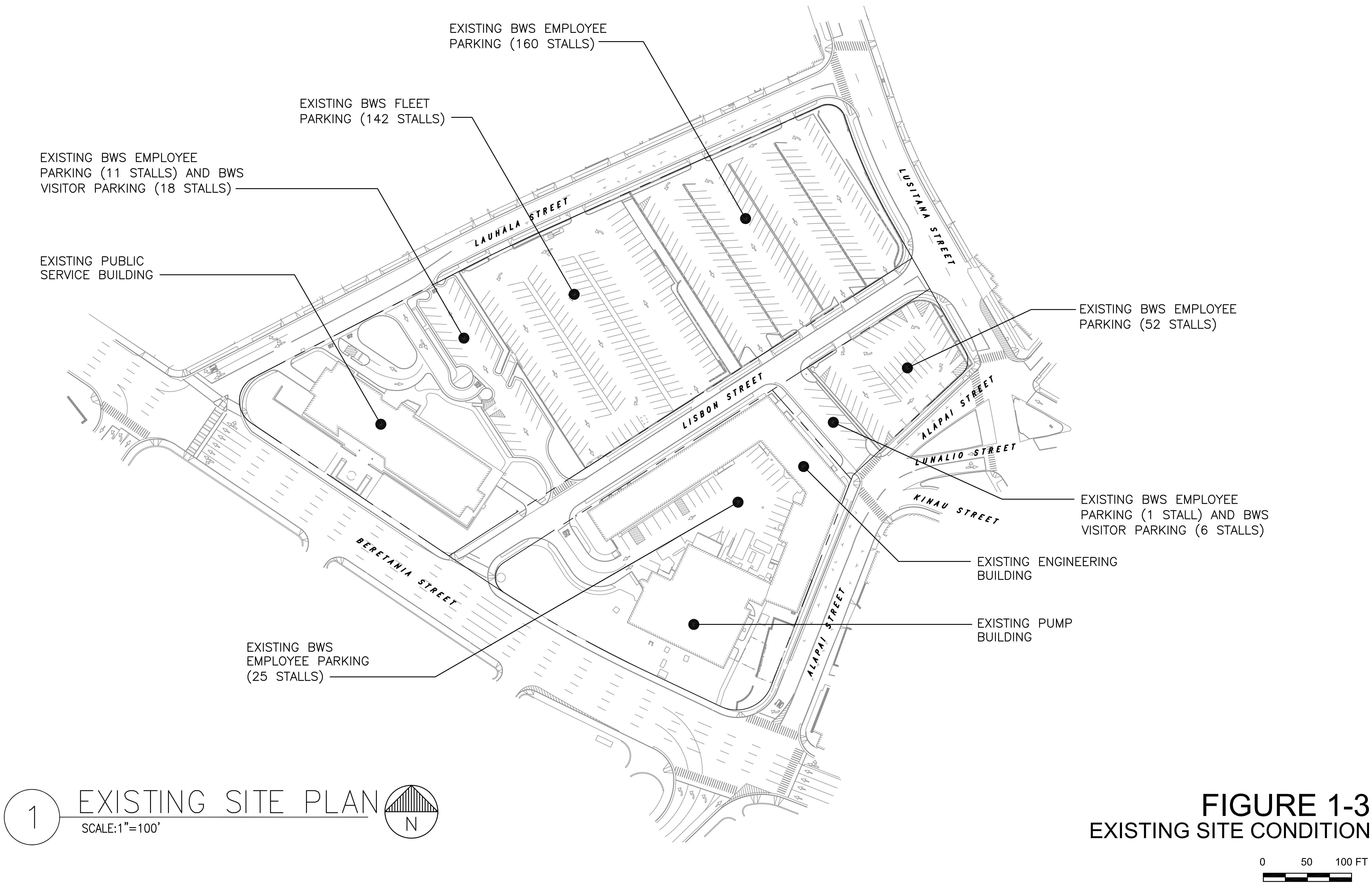
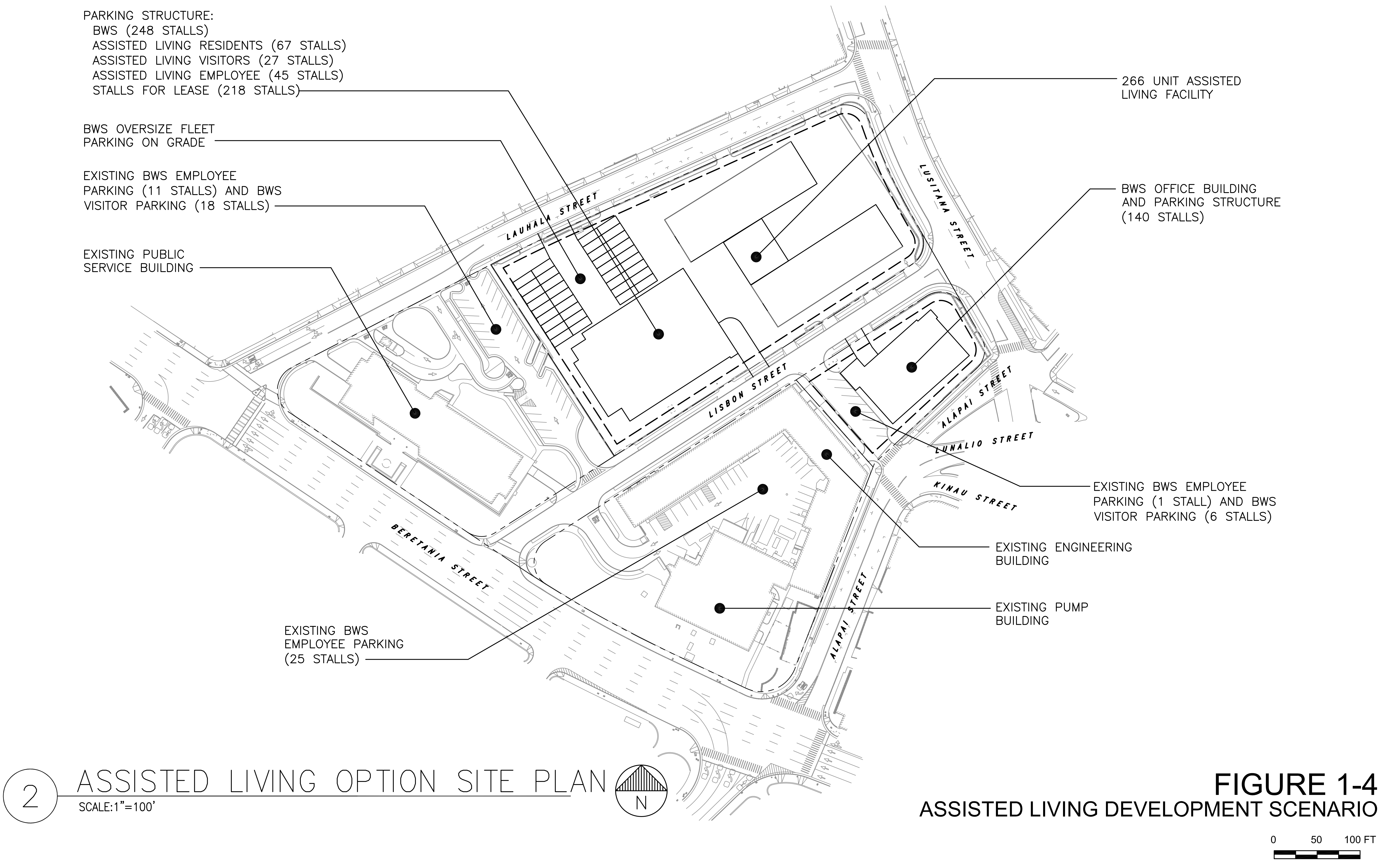


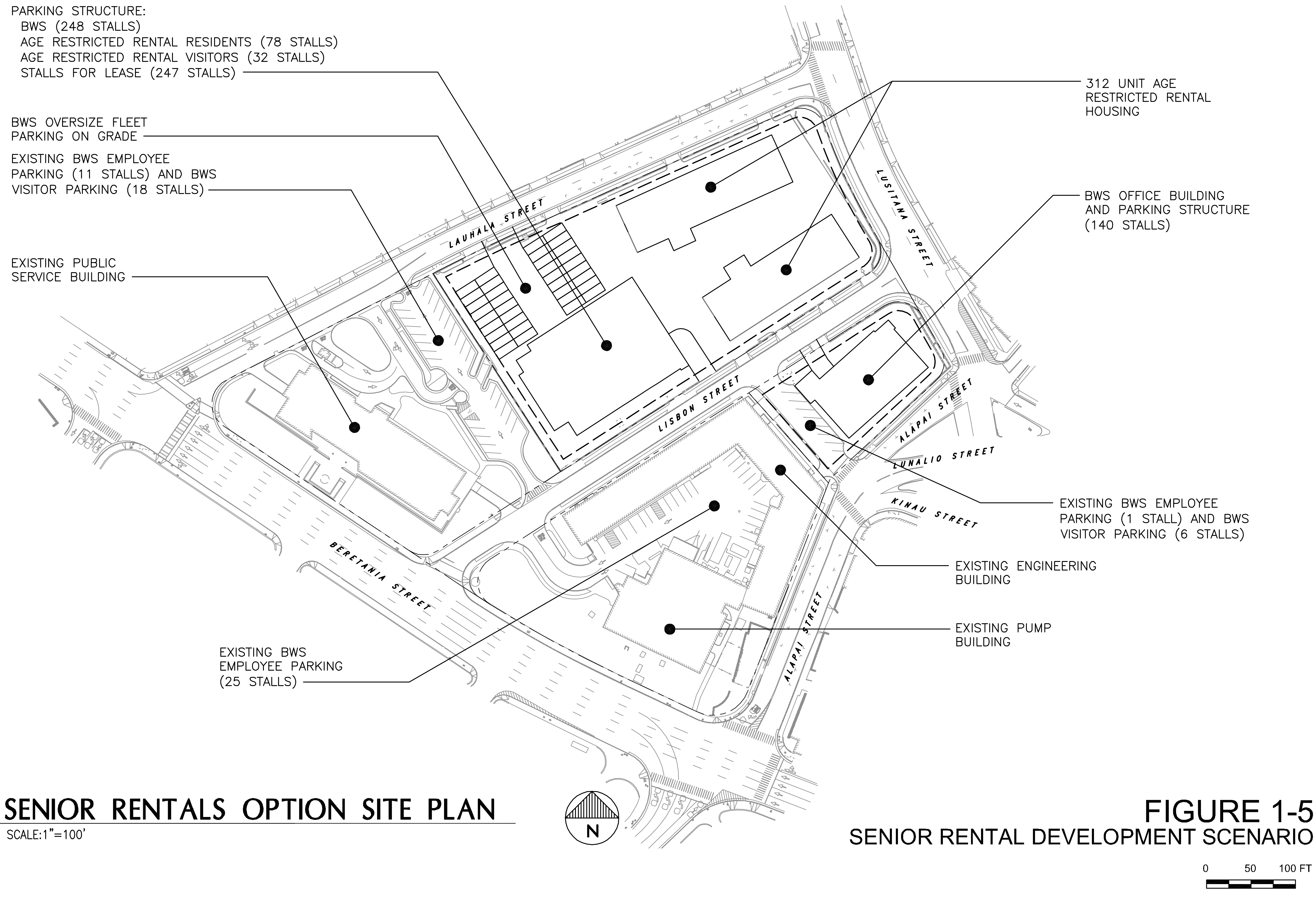
FIGURE 1-3
EXISTING SITE CONDITION



2 ASSISTED LIVING OPTION SITE PLAN

SCALE:1"=100'

FIGURE 1-4
ASSISTED LIVING DEVELOPMENT SCENARIO



3 SENIOR RENTALS OPTION SITE PLAN

SCALE:1"=100'

FIGURE 1-5
SENIOR RENTAL DEVELOPMENT SCENARIO

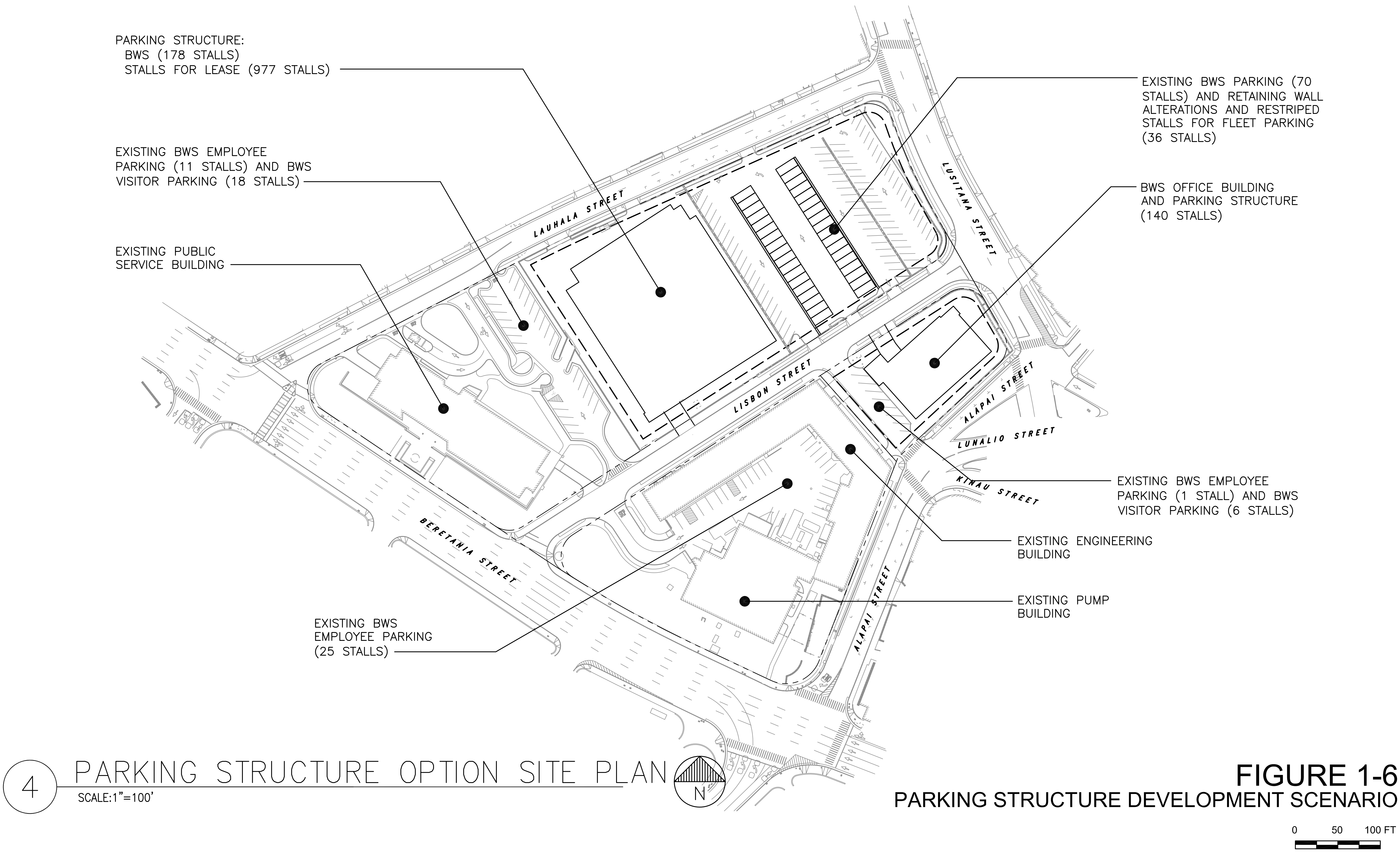


FIGURE 1-6
PARKING STRUCTURE DEVELOPMENT SCENARIO

2. ROADWAY, PARKING, AND ACCESS

2.1 Existing Conditions

The BWS Beretania Street Complex is bordered by Lauhala Street to the north, Lusitana Street to the east, Alapai Street to the south and S. Beretania Street to the west. Lisbon Street runs *mauka-makai* and bisects the property. S. Beretania Street on the *makai* side of the property is a one-way, six-lane roadway and contains traffic signals at the Alapai and Lauhala Street intersections. Alapai, Lusitana, Lauhala, and Lisbon Streets are all two-way, two-lane roads with concrete curbs and sidewalk. In addition, metered, on-street parking is provided on Alapai and Lauhala Streets. All adjacent streets are owned and maintained by the City and County of Honolulu (See Figure 2-1).

Primary vehicular access to both the *Ewa* and *Diamond Head* parcels where parking lots for BWS fleet and employee parking are located is provided along Lisbon Street. There are four existing driveway aprons along Lauhala Street which are currently gated and are not used under normal BWS fleet/employee parking circulation. A summary of existing driveway access to the project area is listed in the table below:

Location	TMK	Existing Driveway Access (#)
Ewa Parcel	2-1-036:005 (por.)	Lauhala Street (4) Lisbon Street (6)
Diamond Head Parcel	2-1-036:001	Lisbon Street (2) Alapai Street

(#) indicates the number of driveway access points at each street frontage

City bus routes service S. Beretania Street and Alapai Streets. Pedestrian walkways are in-place along both sides of all adjacent streets. Paved walkways are provided throughout the Beretania Complex.

2.2 Proposed Improvements

Vehicular and pedestrian access to the project site is expected to continue to be provided from Lauhala and Lisbon Streets where ADA compliant driveway aprons and curb ramps will be installed at all new driveway locations. The existing Engineering Building parking lot is expected to remain. Figures A-1 through A-3 in Appendix A show the proposed improvements for the various development scenarios.

Per discussion with the City and County of Honolulu's Department of Planning and Permitting (DPP) Traffic Review Branch (TRB), there are no road widening setbacks on the adjacent streets surrounding the project except for the 30' property line radius at all corner lots. The corners affected would be:

- Lauhala & Lusitana Streets
- Lisbon & Lusitana Streets
- South Beretania & Lisbon Streets
- Lusitana & Alapai Streets

Internal access roads and parking lot layouts for the proposed project will be designed to meet applicable State and City requirements. Geometrics and pavement structure for proposed driveways, fire lanes, and parking lots will need to be designed based on the appropriate design vehicles. Proposed pavement structures will follow the Soils Engineer's recommendations. Perimeter walkways and parking layouts, dimensions, longitudinal and cross slopes will comply with Americans with Disabilities Act (ADA) Accessibility Guidelines to the maximum extent practicable.

As the redevelopment progresses and site plans are developed, consultation with the appropriate jurisdictions will be needed to confirm vehicular driveway and crosswalk locations, pedestrian sidewalk widths, bicycle facilities, and emergency vehicle access lanes.

Evaluation of the traffic impacts associated with the proposed redevelopment are documented in the "Traffic Impact Report for the Board of Water Supply Beretania Complex Redevelopment".

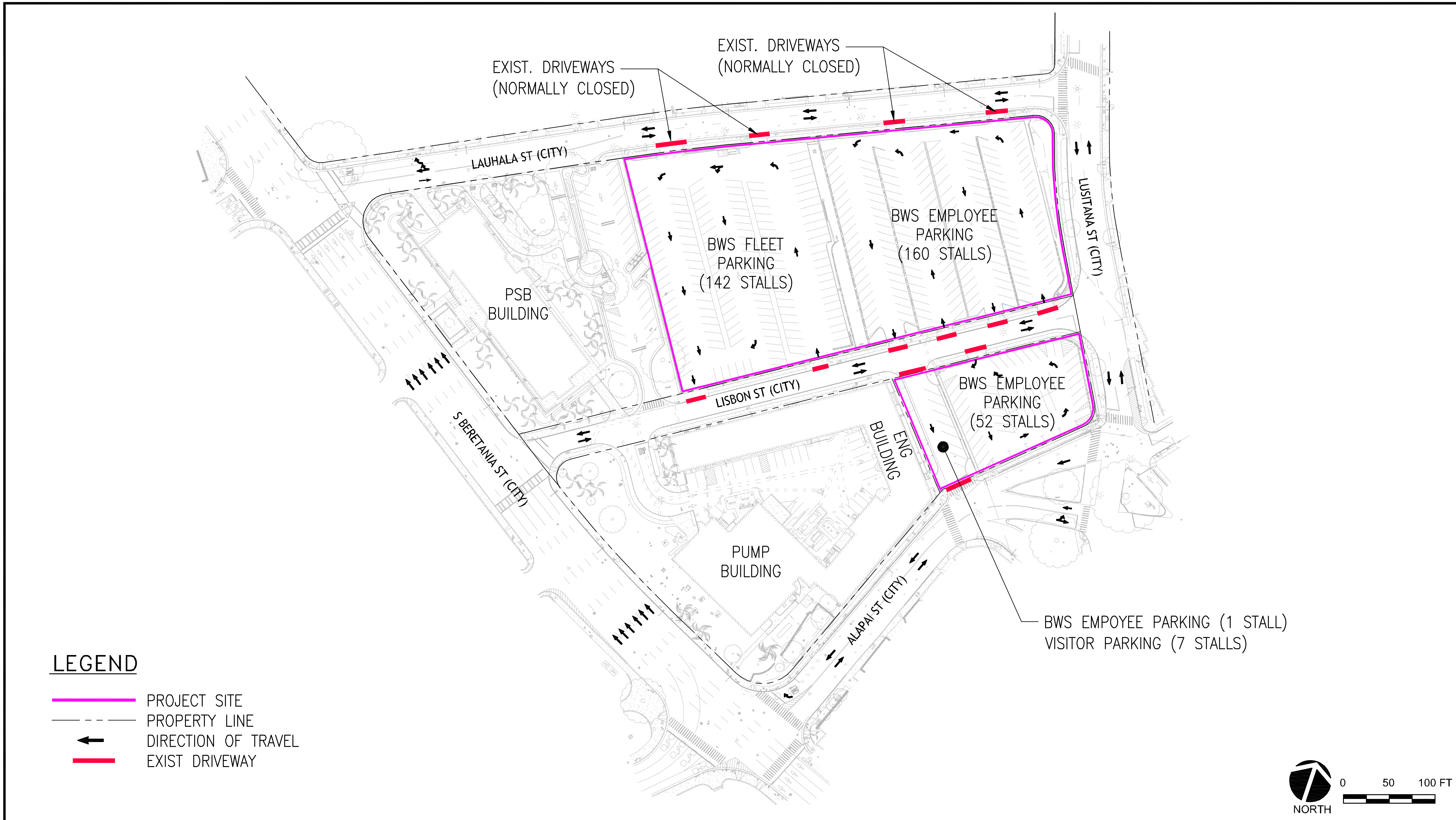


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FIGURE 2-1
EXISTING ROADWAY SYSTEM

BOARD OF WATER SUPPLY - BERETANIA COMPLEX REDEVELOPMENT | HONOLULU,HAWAII

3. SITE GRADING AND FLOOD HAZARD

3.1 Existing Conditions

Both the *Ewa* and *Diamond Head* parcels are relatively steep has been built up with paved parking stalls and retaining walls and generally slopes in the *makai* direction towards S. Beretania Street. Elevations within *Ewa* parcel range from 56 feet mean sea level (MSL) at the back of sidewalk along Lusitana Street to 18 feet MSL along the *makai* project boundary. The elevation difference between the bottom of the BWS Employee parking lot and the top of the BWS fleet parking lot is approximately 5-feet. *Diamond Head* parcel elevations range from 55 feet msl at the back of sidewalk along Lusitana Street to 41-feet at the along the *makai* property boundary. Runoff generated onsite sheet flows across the paved parking lots to the adjacent roadway drainage systems.

Soil series and mapping units for the island of Oahu are found in maps in the "Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii" dated August 1972, prepared by the U.S. Department of Agriculture, Soil Conservation Service (currently Natural Resources Conservation Services). As shown in Figure 3-1, the underlying soil within the project site consists of Makiki clay loam (MkA) and Tantalus silty clay loam (TCC). The soil has characteristics described below:

<u>Makiki clay loam, 0 to 2 percent slopes (MkA):</u> This soil is on smooth fans and terraces. Included in mapping were small, stony areas and small areas of Kaena soils. Permeability is moderately rapid. Runoff is slow, and the erosion hazard is no more than slight.

<u>Tantalus silty clay loam, 8 to 15 percent slopes (TCC):</u> On this soil, runoff is slow and the erosion hazard is slight. Included in mapping were small areas of stony soils in the drainageways. This soil is used for homesites, water supply, and recreation.

Flood hazard assessment was based on The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Community Panel No: 15003C0362G dated January 19, 2011 (see Figure 3-2). According to FEMA, the project site is located in the Zone X limits. Zone X is defined as "Areas determined to be outside the 0.2% annual chance (500 year) floodplain. No base flood elevations or depths are established for this zone.

The parcel is not located in the tsunami evacuation zone as established by the Oahu Civil Defense.

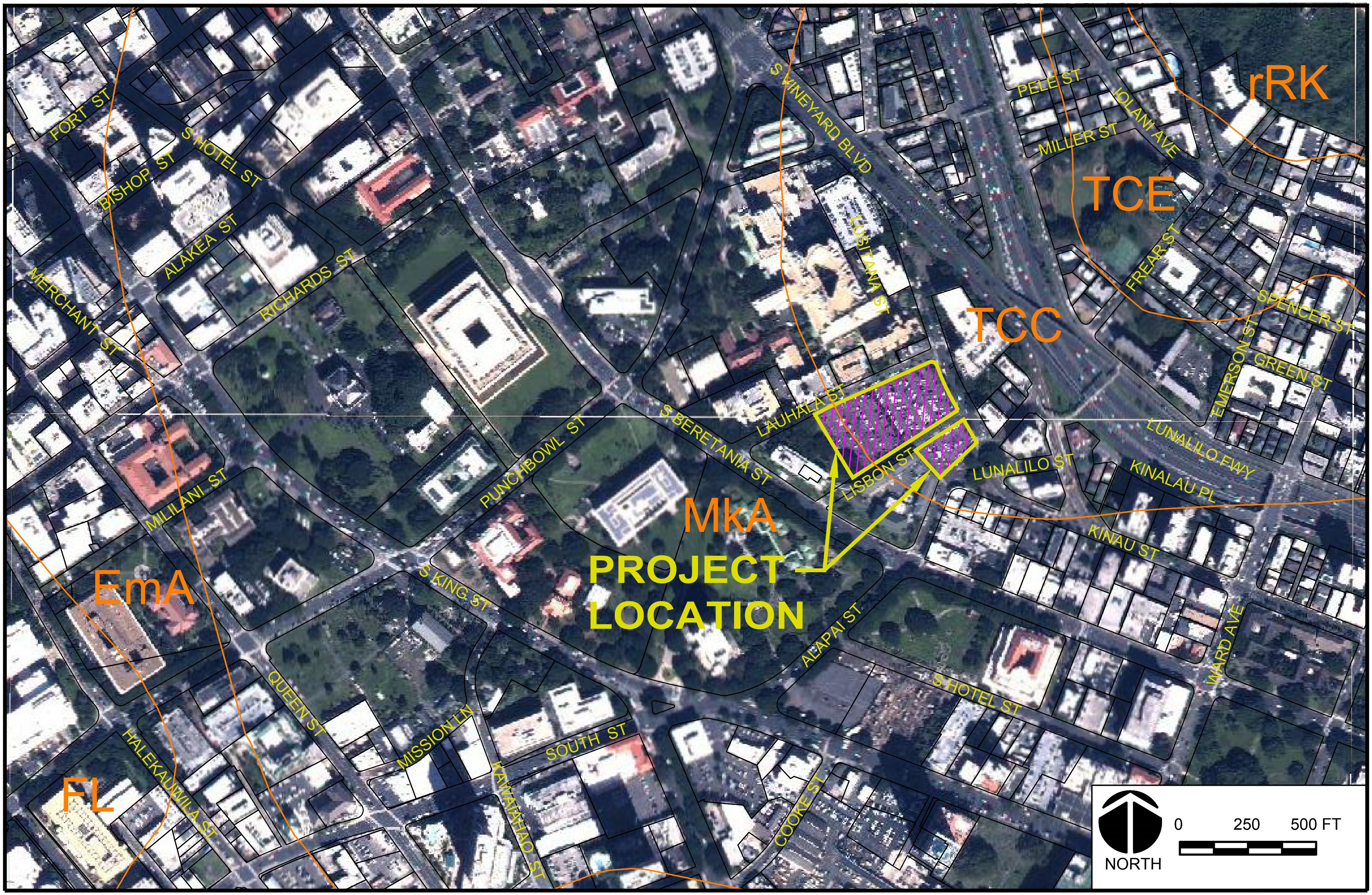

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FIGURE 3-1
SOIL CLASSIFICATION MAP

BOARD OF WATER SUPPLY - BERETANIA COMPLEX REDEVELOPMENT | HONOLULU, HAWAII

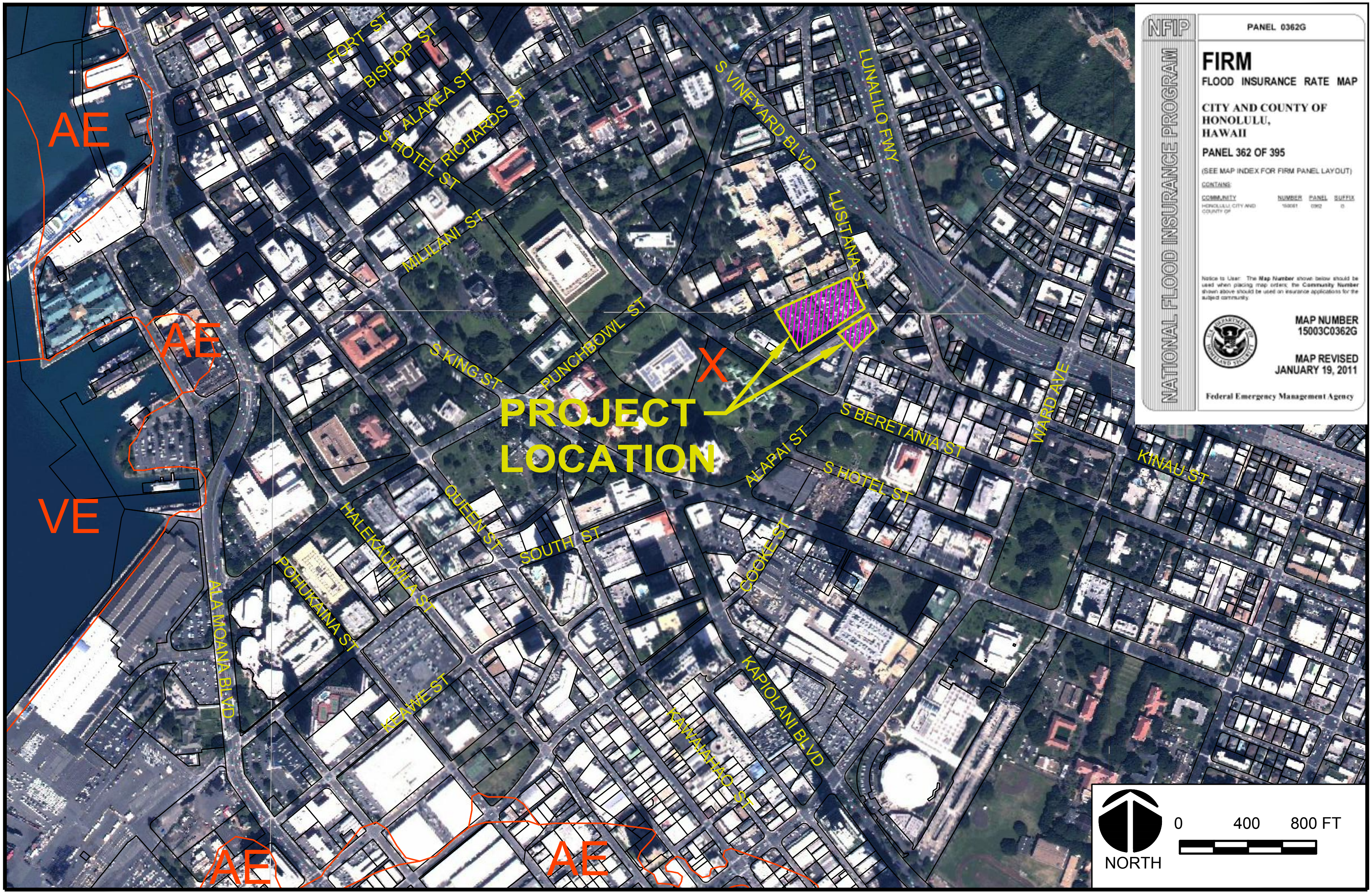

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FIGURE 3-2
FLOOD INSURANCE RATE MAP

3.2 Proposed Improvements

The project site will be graded to provide positive drainage for storm water runoff to be directed away from the proposed buildings. On-site grading and the new building finish floor elevations will need to consider the storm drainage patterns with reference to the existing drainage system. Storm water runoff in excess of existing conditions will need to be retained, reused, or disposed by percolation on site. Accessible walkway layouts, dimensions, and slopes shall comply with ADA Accessibility Guidelines.

Based on the existing site topography and the proposed conceptual layouts, grade adjustment or retaining structures may be required. This will be verified during the design phase.

Site grading shall follow the Soils Engineer's recommendations and conforming to Chapter 14, Article 15 of the Revised Ordinances of Honolulu "Grading, Grubbing and Stockpiling" as amended. All grading and construction work shall comply with the Rules Relating to Water Quality, Department of Planning and Permitting, City and County of Honolulu, amended September 17, 2018, to control soil erosion and ensure that the discharge of pollutants from the construction site will be reduced to the maximum extent practicable (MEP).

Temporary erosion control measures shall be installed prior to any demolition and/or construction activities. Recommended Structural Best Management Practices (BMPs) include silt fence, filter sock, stabilized construction ingress/egress, concrete wash-out area, and sediment control filters at drain inlets and catch basins as required.

4. STORM DRAINAGE SYSTEM

4.1 Existing Conditions

Runoff generated within the *Ewa* parcel sheet flows across the paved parking lots to an opening in the CRM wall at the southwest corner of the parking lot where runoff is discharged to an existing catch basin along Lauhala Street. Runoff generated within the *Diamond Head* parcel sheet flows across the paved parking lot to a drain inlet located in the southwest corner of the parking area which discharges via a sidewalk culvert to Lisbon Street. Runoff from Lisbon street sheet flows to the South Beretania Street drainage system. There is also a catch basin along Alapai Street near the southeast corner of the *Diamond Head* parcel, however, it does not receive runoff from the BWS site. The adjacent underground roadway storm drainage systems on are owned and maintained by the City and County of Honolulu and consist of a network of drain lines, catch basins, and drain manholes.

The existing storm drainage system within the project vicinity is shown on Figure 4-1. A summary of existing roadway storm drainage systems fronting the subject parcels are in the table below:

Location	TMK	Existing Adjacent Drainage System
Ewa Parcel	2-1-036:005 (por.)	18-inch drain along Lauhala Street
Diamond Head Parcel	2-1-036:001	18-inch drain along Alapai Street

4.2 Project Requirements

Drainage run off rates and improvements for the proposed improvements will be determined based on the City and County of Honolulu Department of Planning and Permitting, Storm Drainage Standards, dated August 2017. Any increase in runoff due to the proposed improvements will need to be retained on-site to ensure that the project will not have any adverse effects on downstream properties.

In addition, the proposed drainage improvements will also be required to comply with the City’s Rules Relating to Water Quality amended September 2018. Under these rules, projects that disturb over one (1) acre of land are classified as Priority A projects.

Priority A projects are required (unless determined to be infeasible) to:

- Incorporate appropriate Low Impact Development (LID) site design strategies to the “maximum extent practicable” (MEP).

- Incorporate appropriate Source Control Best Management Practices (BMPs) to the MEP.

- Retain on-site by infiltration, evapotranspiration, or harvest/reuse as much of the water quality volume (WQV) as feasible with appropriate LID Retention Post-Construction Treatment Control BMP's.

- Biofilter any portion of the WQV that is not retained on-site with appropriate LID Biofiltration Post-Construction Treatment Control BMPs.

If it is determined to be infeasible to retain and/or biofilter the Water Quality Volume, the City rules require the project to:

- Treat (by detention, filtration, settling, or vortex separation) and discharge with appropriate Alternative Compliance Post-Construction Treatment Control BMPs, any portion of the WQV that is not retained on-site or biofiltered.

- Retain or biofilter at an offsite location, the volume of runoff from a non-tributary drainage area equivalent to the difference between the project's WQV and the amount retained on-site or biofiltered.

Appropriate BMP measures include: infiltration basins and trenches, subsurface infiltration systems, dry wells, bioretention basins, permeable pavement, green roofs, vegetated bio-filters, enhanced swales, detention basins, sand filters, vegetated swales and buffer strips.

4.3 Proposed Improvements

The area identified for the proposed improvements is currently fully developed with impervious surfaces. Thus, it is expected that any increase in the storm water runoff peak discharge rate will be minimal compared to the existing conditions. Any increase in flow to the City system due to the proposed project will need to be retained, reused, or disposed of by percolation on site.

The onsite drainage system will consist of underground piping, manholes, and drain inlets and would maintain the existing discharge points to Lauhala and Lisbon Streets for the *Ewa* and *Diamond Head* parcels respectively. As required by the Storm Drainage Standards, Department of Planning and Permitting, City and County of Honolulu, dated August 2017, storm water quality measures shall be installed to treat the water quality volume. Figures A-1 through A-3 in Appendix A show the proposed improvements for the various development scenarios.

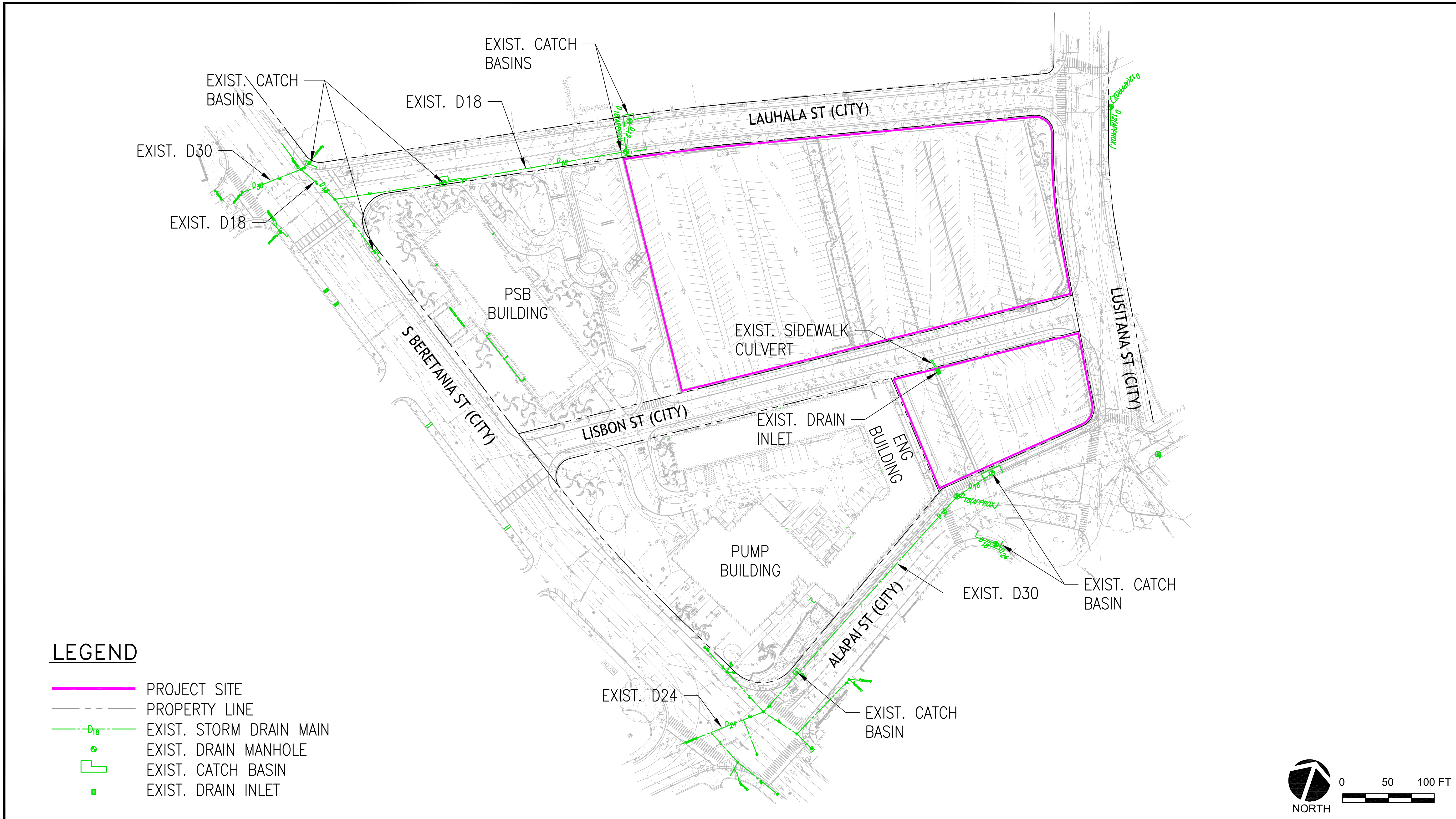

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FIGURE 4-1
EXISTING STORM DRAINAGE SYSTEM

BOARD OF WATER SUPPLY - BERETANIA COMPLEX REDEVELOPMENT | HONOLULU,HAWAII

5. SANITARY SEWER SYSTEM

5.1 Existing Conditions

The sanitary sewer system within the project vicinity is part of the City's Ala Moana collection system which is operated and maintained by the Department of Environmental Services (ENV). Record drawings indicate that there are existing 6-inch sewer laterals within Lisbon Street and Lauhala Street which currently provide service to the project site. These laterals discharge to an 8-inch sewer line within South Beretania Street (See Figure 5-1). The City's sewer system collects and transports sewage from the project site to the Sand Island Wastewater Treatment Plant for treatment and disposal. A summary of the existing sewer lines serving the project site are in the table below:

Location	TMK	Existing Adjacent Sewer System
Ewa Parcel	2-1-036:005 (por.)	4'x5' sewer tunnel along Lusitania Street 6-inch sewer along Lisbon Street 6-inch sewer along Lauhala Street Dual 4-inch force main along Lauhala Street
Diamond Head Parcel	2-1-036:001	4'x5' sewer tunnel along Lusitania Street 8-inch sewer along Alapai Street 6-inch sewer along Lisbon Street

5.2 Connection to the City and County Sewer System

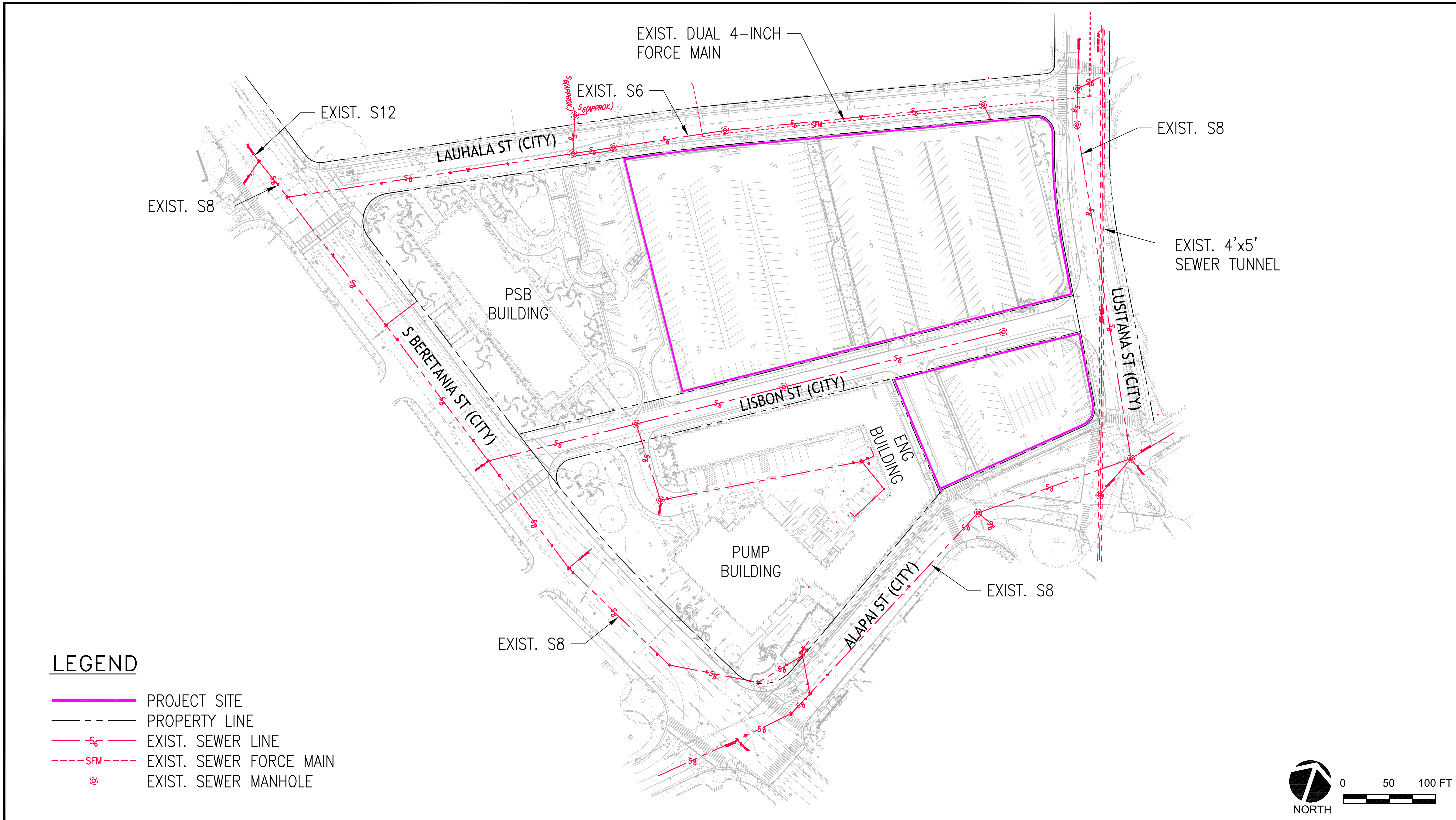
The Department of Planning and Permitting's (DPP) Wastewater Branch (WWB) reviews and authorizes sewer connection applications for developments which require sanitary sewer service. On February 1, 2019, preliminary sewer connection applications based on the various development scenarios were approved by WWB, indicating that the existing City sewer system is adequate to support the proposed project (See Appendix B).

The expiration date of the approved application is January 30, 2021. Construction plans shall be completed and approved within this 2-year period. Construction shall commence within 1-year after approval of plans. The application can be renewed by submitting a revised SCA, however its approval is not guaranteed.

5.3 Proposed Improvements

The proposed on-site sewer improvements will consist of new sewer manholes, cleanouts, and underground piping to provide lateral connections to the new buildings. Proposed sewer connections for both the *Ewa* and *Diamond Head* parcels will be to the existing 6-inch sewer lateral within Lisbon Street. Figures A-1 through A-3 in Appendix A show the proposed improvements for the various development scenarios.

New sewer lateral locations and sizes will be verified during the design phase. Trenching and backfilling of proposed sewer lines will follow CCH standards and the Soils Engineer's recommendations. Upon City approvals of the SCA(s) and construction plans, along with payment of the sewer facilities charges, the proposed system can be connected to the City sewer system.



WILSON OKAMOTO CORPORATION

FIGURE 5-1
EXISTING SANITARY SEWER SYSTEM

BOARD OF WATER SUPPLY - BERETANIA COMPLEX REDEVELOPMENT | HONOLULU,HAWAII

6. WATER SUPPLY SYSTEM

6.1 Existing Conditions

Water for domestic use and fire protection is provided to the project site and surrounding vicinity through the CCH Board of Water Supply (BWS) municipal water system. The BWS water system in the vicinity of the project site consists of a system of distribution mains and fire hydrants. BWS record drawings and facility maps indicate an existing 8-inch water line and four existing fire hydrants on Lauhala Street, a 12-inch and 42-inch water line and two hydrants on Lusitana Street, an 18-inch and 20-inch waterline and one hydrant along Alapai Street, and an 8-inch waterline that crosses through the *Diamond Head* parcel which connects to a hydrant on Lisbon Street. A table summarizing the existing water mains serving the project area is below:

Location	TMK	Existing Adjacent Sewer System
Ewa Parcel	2-1-036:005 (por.)	8-inch water along Lauhala Street 42-inch water along Lusitania Street 12-inch water along Lusitania Street 8-inch water along Lisbon Street 20-inch water along Alapai Street 18-inch water along Alapai Street
Diamond Head Parcel	2-1-036:001	20-inch water along Alapai Street 18-inch water along Alapai Street 8-inch water through Eng. Bldg. parking lot.

BWS records show three existing water meters servicing the *Ewa* parcel: a 1-1/2" meter on S. Beretania Street, a 3/4" meter on Lauhala Street, and a 2" meter on Lisbon Street. There are no existing water meters currently servicing the *Diamond Head* parcel.

6.2 Connection to Board of Water Supply System

On September 14, 2017, a letter was submitted to the BWS requesting information on the availability of water for the project and water pressure information for fire hydrants in the vicinity of the project site. This initial letter was based on programming for the various development scenarios and the estimated average daily water demand shown below (See Appendix C for supporting calculations).

Assisted Living Scenario - Proposed Program Information

Facility	Area	Avg. Daily Water Demand (gpd)
Assisted Living Facility	266 beds	29,260
BWS Office Building	36,000 sf	2,480
	Total:	**31,740 gpd**

Senior Rental Scenario - Proposed Program Information

Facility	Area	Avg. Daily Water Demand (gpd)
Senior Rentals	312 units	93,600
BWS Office Building	36,000 sf	2,480
	Total	**96,080 gpd**

Parking Structure Scenario - Proposed Program Information

Facility	Area	Avg. Daily Water Demand (gpd)
BWS Office Building	36,000 sf	2,480
	Total	2,480 gpd

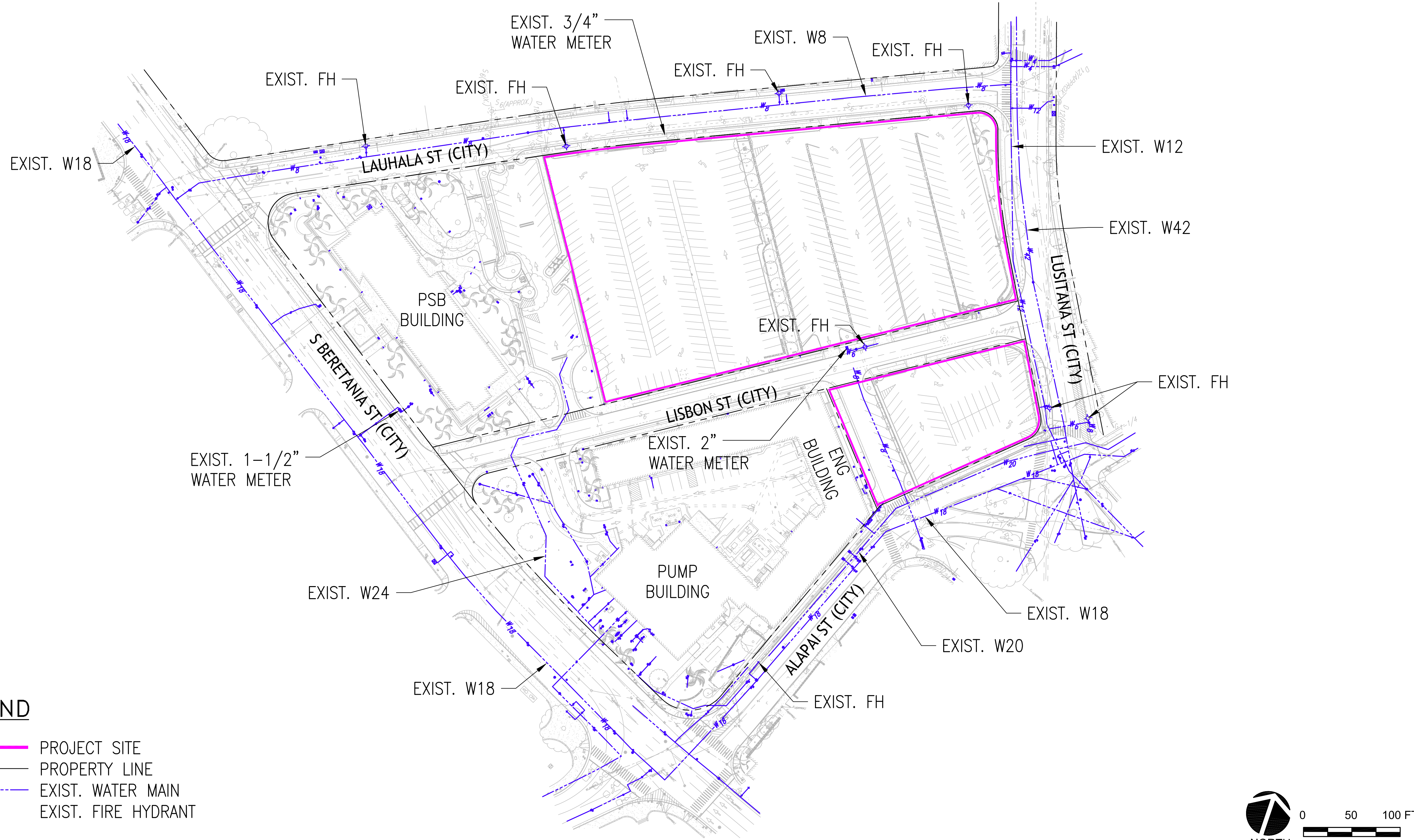
On October 2, 2017, the BWS responded stating that based on current data, the existing water system is adequate to accommodate the proposed development scenarios (See Appendix C). BWS record information indicates the water supply system has a calculated fire flow capacity of 4,000 gallons per minute. The final decision on the availability of water will be made when the building permit application is submitted for approval.

6.3 Proposed Improvements

On-site water system improvements will be required to accommodate the proposed redevelopment consisting of new water meters, backflow preventers, valves and underground piping. Proposed connection to the BWS system will be to the existing 8-inch water line located within Lauhala Street for the *Ewa* parcel and the 8-inch lateral *mauka* of the Engineering Building for the *Diamond Head* parcel. Figures A-1 through A-3 in Appendix A show the proposed improvements for the various development scenarios.

The final line sizes, meter, and backflow locations will be determined during the design phase of the project. Proposed connections and improvements will be confirmed when construction drawings for the proposed project are developed and submitted to BWS for review and approval. Trenching and backfilling of proposed water lines will follow BWS standards and the Soils Engineer’s recommendations.

New on-site fire hydrants and fire access roads will be provided as required to ensure adequate fire protection for the proposed buildings.



LEGEND

- PROJECT SITE
- PROPERTY LINE
- EXIST. WATER MAIN
- EXIST. FIRE HYDRANT

WILSON OKAMOTO CORPORATION

FIGURE 6-1
EXISTING WATER SUPPLY SYSTEM

BOARD OF WATER SUPPLY - BERETANIA COMPLEX REDEVELOPMENT | HONOLULU,HAWAII

7. NATURAL GAS

7.1 Existing Conditions

Synthetic natural gas (SNG) service is provided by Hawaii Gas (HG). Record drawings obtained through email correspondence with HG indicate that the Beretania Complex is not served by HG. However, 2” and 1” gas lines are located on Lauhala and Lisbon Streets, respectively (See Figure 7-1).

7.2 Proposed Improvements

If the proposed redevelopment requires gas service, further coordination with HG by the project’s mechanical engineer will be required during the design phase to confirm fuel system service connections. The proposed natural gas demand load required by the project will be needed at that time.

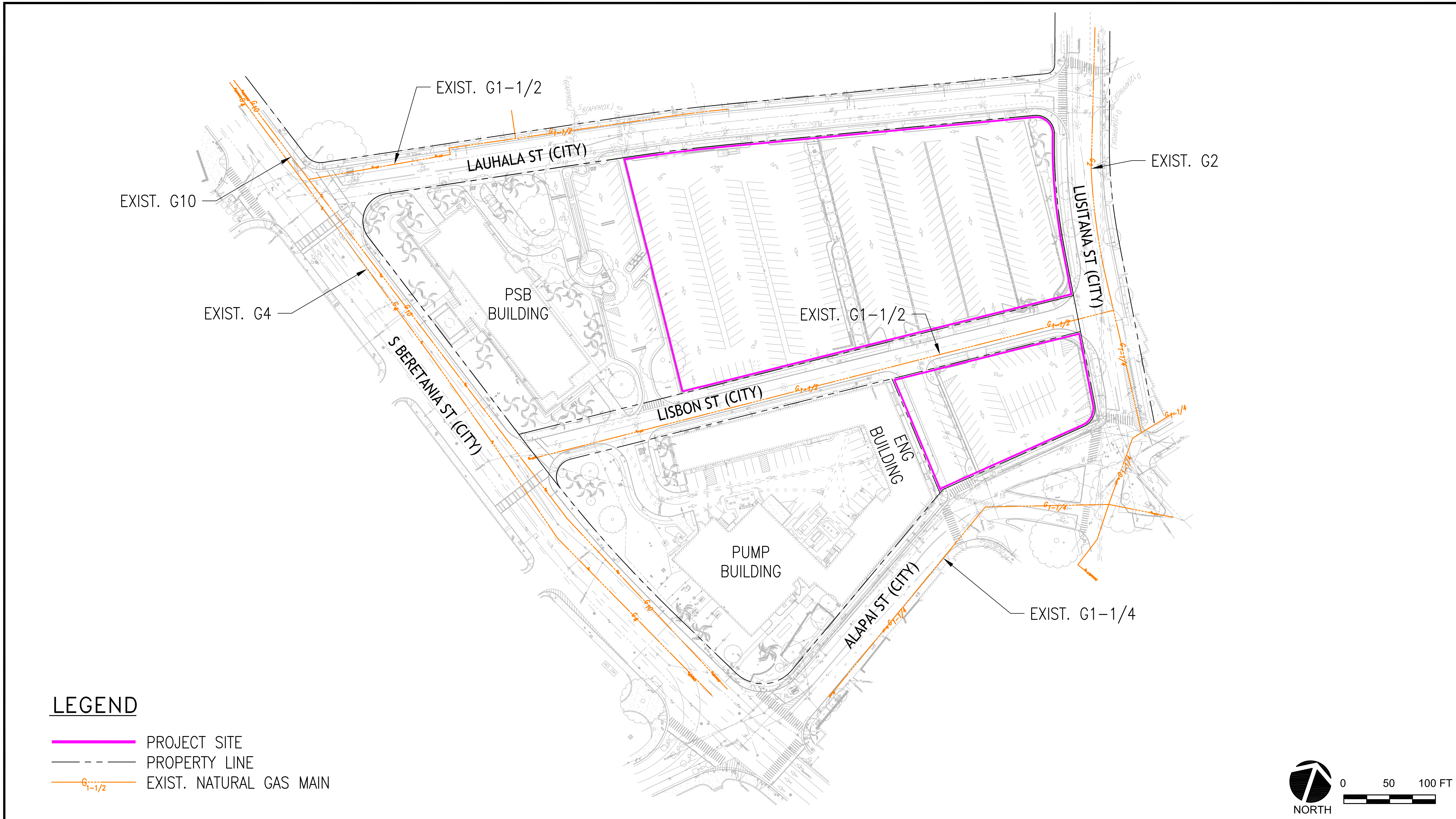


FIGURE 7-1
EXISTING NATURAL GAS SYSTEM

WILSON OKAMOTO CORPORATION

8. REFERENCES

1. Flood Insurance Rate Map, City and County of Honolulu, Hawaii, Community Panel Number 15003 C0362 G," Federal Emergency Management Agency, Federal Insurance Administration, January 19, 2011.

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

3. "Storm Drainage Standards", Department of Planning and Permitting, City and County of Honolulu, August 2017.

4. "Rules Relating to Water Quality of the Administrative Rules, Title 20," Department of Planning and Permitting, City and County of Honolulu, December 24, 2018.

5. "Water System Standards", Board of Water Supply, City and County of Honolulu, State of Hawaii, 2002.

6. "Wastewater System Design Standards, Volume 1 Wastewater Collection Systems," Department of Environmental Services, City and County of Honolulu, July 2017.

7. "Traffic Impact Report for the Board of Water Supply Beretania Complex Redevelopment", Wilson Okamoto Corporation, May 2019.

8. Topographic Survey Map "BWS-Planning Study Phase II Beretania Property" by Control Point Surveying, Inc. dated September 8, 2005.

APPENDICES

Appendix A

Proposed Site Improvement Figures

LEGEND

- PROJECT SITE
- PROPERTY LINE
- EXIST. WATER MAIN
- EXIST. SEWER MAIN
- EXIST. SEWER FORCE MAIN
- EXIST. STORM DRAIN MAIN
- EXIST. NATURAL GAS MAIN
- EXIST. DRAIN MANHOLE
- EXIST. SEWER MANHOLE
- EXIST. FIRE HYDRANT
- EXIST. CATCH BASIN
- PROPOSED WATER LATERAL
- PROPOSED SEWER LATERAL
- PROPOSED DRAIN LINE
- PROPOSED BUILDING

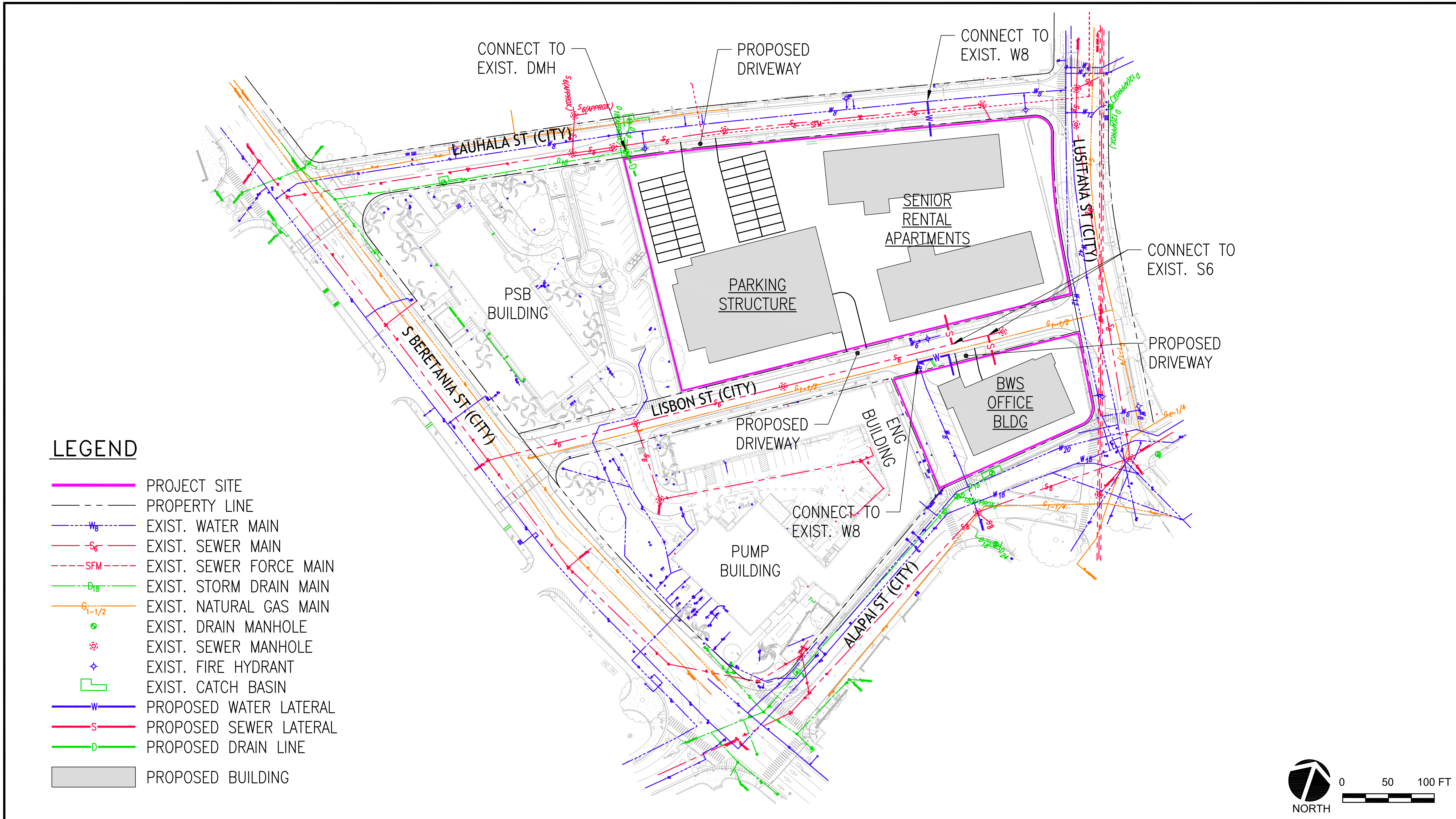
WILSON OKAMOTO CORPORATION

FIGURE A-1

ASSISTED LIVING SCENARIO - PROPOSED SITE IMPROVEMENTS

BOARD OF WATER SUPPLY - BERETANIA COMPLEX REDEVELOPMENT | HONOLULU,HAWAII

Path: W:\10233-01\Civil\Reports-Calcs\Figures\D Filename: Figure A-2 Senior Rental Scenario - Proposed Site Improvements Plot date: May 17, 2019-02:49:04pm CAD User: ckanekuni. Xref Filename: | bdr11x17 | 05015-5A | EXISTING SITE PLAN | 05015-5BNDY |

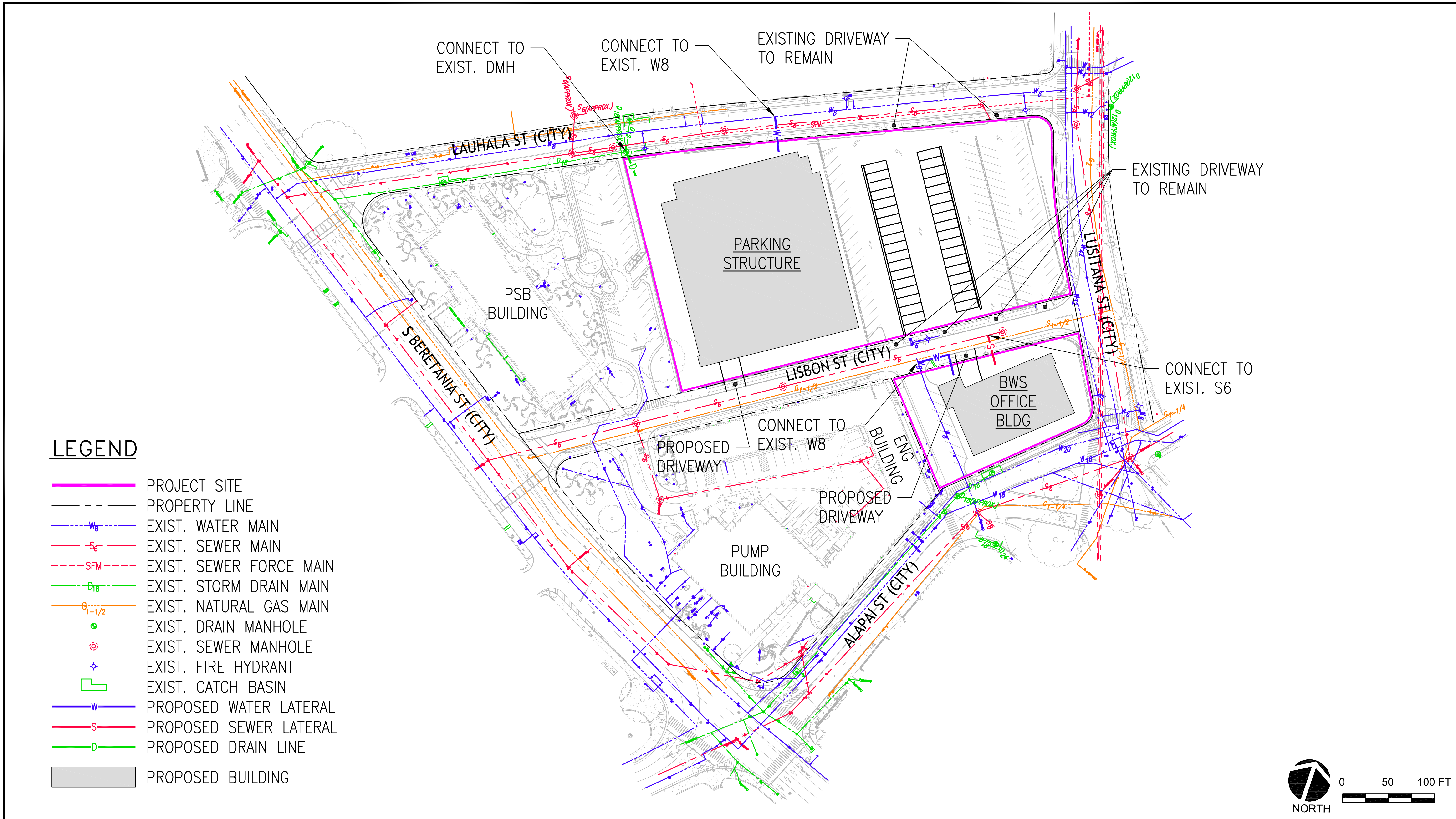


WILSON OKAMOTO CORPORATION

FIGURE A-2

SENIOR RENTAL SCENARIO - PROPOSED SITE IMPROVEMENTS

BOARD OF WATER SUPPLY - BERETANIA COMPLEX REDEVELOPMENT | HONOLULU,HAWAII



WILSON OKAMOTO CORPORATION

FIGURE A-3

PARKING STRUCTURE SCENARIO - PROPOSED SITE IMPROVEMENTS

BOARD OF WATER SUPPLY - BERETANIA COMPLEX REDEVELOPMENT | HONOLULU,HAWAII

Appendix B

Sewer System Information

Sewer Connection Applications submitted January 30, 2019

Approved Sewer Connection Applications dated February 1, 2019

CITY AND COUNTY OF HONOLULU
DEPARTMENT OF PLANNING & PERMITTING
650 South King Street, Honolulu, Hawaii 96813

SITE DEVELOPMENT DIVISION MASTER APPLICATION FORM

All required documents and fees must accompany this application form. Please visit www.honoluludpp.org for applicable procedures and fees under the menu heading Application & Forms, Site Engineering and Subdivision Permits. Electronic submittal of permit applications and other permit-related documents constitutes agreement by the applicant or authorized representative to transact business electronically with this department, in accordance with HRS Chapter 489E.

I. PERMIT — VARIANCE — APPROVAL

Check one or more as appropriate:

PERMIT		VARIANCE	APPROVAL
☐ Grading	☑ Sewer Connection	☐ Flood Hazard Variance	☐ Subdivision, Easement Consolidation
☐ Grubbing		☐ Flood Determination	☐ Park Dedication
☐ Stockpiling		☐ Floodway Permit	☐ Lot Determination
☐ Trenching		☐ Flood Map Revision	☐ Ag. Site Development

Complete Sections I, II, III and all other sections as possible

II. LOT AND LAND USE INFORMATION

TAX MAP KEY(S): 2-1-036:001 and 005 (por.) Lot Area: 128,100 sq.ft./ac.

Zoning District: A-2 - Apartment Development Plan Designation: Institutional State Land Use District: Urban

Street Address/Location of Property: 630 South Beretania Street, Honolulu, HI 96843

Present Use of Property/Building: Surface parking lots

Project Name (if any): Board of Water Supply Beretania Complex Redevelopment

Request/Proposal (describe the nature of the request, proposed activity or project): Sewer Connection Application for redevelopment Scenario 1

III. APPLICANT INFORMATION

	Owner/Developer	Engineer/Architect	Contractor (or Agent for Subdivision apps only)
Name (& title)	Board of Water Supply	Wilson Okamoto Corporation	TBD
Mailing Address	630 South Beretania Street	1907 S. Beretania St, Suite 400	
City / State / Zip	Honolulu HI 96843	Honolulu HI 96826	
Phone Number(s)	(808)748-5951	(808)946-2277	
Email Address	mmatsuo@hbws.org	msuga@wilsonokamoto.com	

APPLICANT: Mason M. M. Suga (Print NAME of applicant) — Project Manager (Print TITLE of applicant) — Mn M M Suga (Signature of applicant)

IV. FOR GRADING/GRUBBING/STOCKPILING INFORMATION ONLY

Estimated Dates: Start: ______ Completion: ______ Borrow Material: ______

Area of work (sf or acres): ______ Borrow Site: ______

Disturbed area (sf or acres): ______ Disposal Material: ______

Estimated Quantity (cy): Cut: ______ Fill: ______ Disposal Site: ______

V. DESIGNATED ESCP COORDINATOR OR CWPPP

Complete the **Authorization Letter to Designate ESCP coordinator and/or CWPPP**

ESCP: Erosion and Sediment Control Plan; CWPPP: Certified Water Pollution Plan Preparer

AUTHORIZATION CLEARANCE

This statement of authorization is used in reference to the information provided for in sections I, II and III above.

I/We, ______ (Print NAME and TITLE of person **giving authority**), hereby authorize ______ (Print NAME of person **receiving authority**) to act in my/our behalf in obtaining/closing the Grading/Grubbing/Stockpiling/Trenching permit for the project.

Signature of Owner/Developer giving authority **Date**

FOR DIVISION USE ONLY:

Grading Permit No.: ______ Application No.: ______

Trenching Permit No.: ______ Date of Application: ______

Received By: ______

SEE REVERSE FOR APPLICATIONS FOR TRENCHING AND SEWER CONNECTION *rev. 05/2018*

SITE DEVELOPMENT DIVISION MASTER APPLICATION FORM

(REVERSE SIDE)

VI. FOR TRENCHING INFORMATION ONLY

Work to be performed for: ______ Work to be done: ☐ Service Connection ☐ Repair ☐ Borings

Estimated Dates: Start: ______ Completion: ______ Other: ______

Estimated Value of work: $ ______ Dimensions: ______ ft/in (length) ______ ft/in (width) ______ ft/in (depth)

in the City right-of-way

AGENCY CLEARANCES	SIGNATURE	DATE	ADDRESS	PHONE NO.
DPP, Wastewater Branch			650 So. King St., FMB, 1st Flr.	768-8210
DTS, Traffic Signal			650 So. King St., FMB, 2nd Flr.	768-8388
DDC, Street Lightning			650 So. King St., FMB, 9th Flr.	768-8431
BWS, Customer Care			630 So. Beretania St., 1st Flr.	748-5460
Hawaiian Electric, Construction Installation			820 Ward Avenue, 4th Flr.	543-5654
Hawaiian Telcom, Excavation			1177 Bishop St.,Security Entrance Adams Lane	546-7746
Gasco., Inc., Maps & Records			515 Kamakee St., 1st Flr.	594-5575
Oceanic Cablevision, Engineering & Constr			200 Akamainui St.	625-8443
DFM, Division of Road Maintenance (if trenching 250 lineal feet or more)			99-999 Iwaena Street, #214	484-7695

DPP: Dept. of Planning and Permitting DTS: Dept. of Transportation Services DDC: Dept. of Design and Construction BWS: Board of Water Supply DFM: Dept. of Facility Maintenance

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Note to the applicants receiving clearances: The utilities listed above may not represent all underground utilities located within City rights-of-ways, nor do their utility clearances relieve the permittee from complying with all other applicable codes, rules, regulations, and/or permit procedures including, but not limited to, additional clearances and requirements for other utilities (i.e. irrigation, data transmission, etc.) located within City rights-of-ways. Pursuant to ROH 1990, Section 14-17.6, the permittee shall indemnify and save harmless the city for any injuries or damages to any person or property received or sustained by any person as a consequence of any act or acts of the permitee on work done under the trenching permit.

VII. FOR SEWER CONNECTION INFORMATION ONLY

To receive a response via e-mail,provide email address below and check box here: ☑

☐ Residential: No. of Proposed Units ______ (Provide breakdown below)

______ Studios ______ 1 Bedroom ______ 2 Bedrooms ______ 3 Bedrooms ______ 4 Bedrooms ______ Other

☑ Non-Residential: (See attached sewer table for required category and quantity and provide any additional information in the remarks)

CATEGORY(IES)	QUANTITY(IES)	NEW WATER METER SIZE(S)
Assisted Care Living Facility	251,000 SF / 266 Beds	TBD
BWS Office Building	35,500 SF	TBD

Date of Connection: 2024 (approximate)

Connection Work Desired: ☑ Use Existing Lateral ☐ Other

Dimensions: ______ ft. (length) ______ in. (size) ______ ft. (depth)

Existing Structures/Dwellings on Property: (Provide breakdown below)

TYPE (i.e. Single Family)	QUANTITY(IES)	REMAIN	DEMOLISH
N/A			

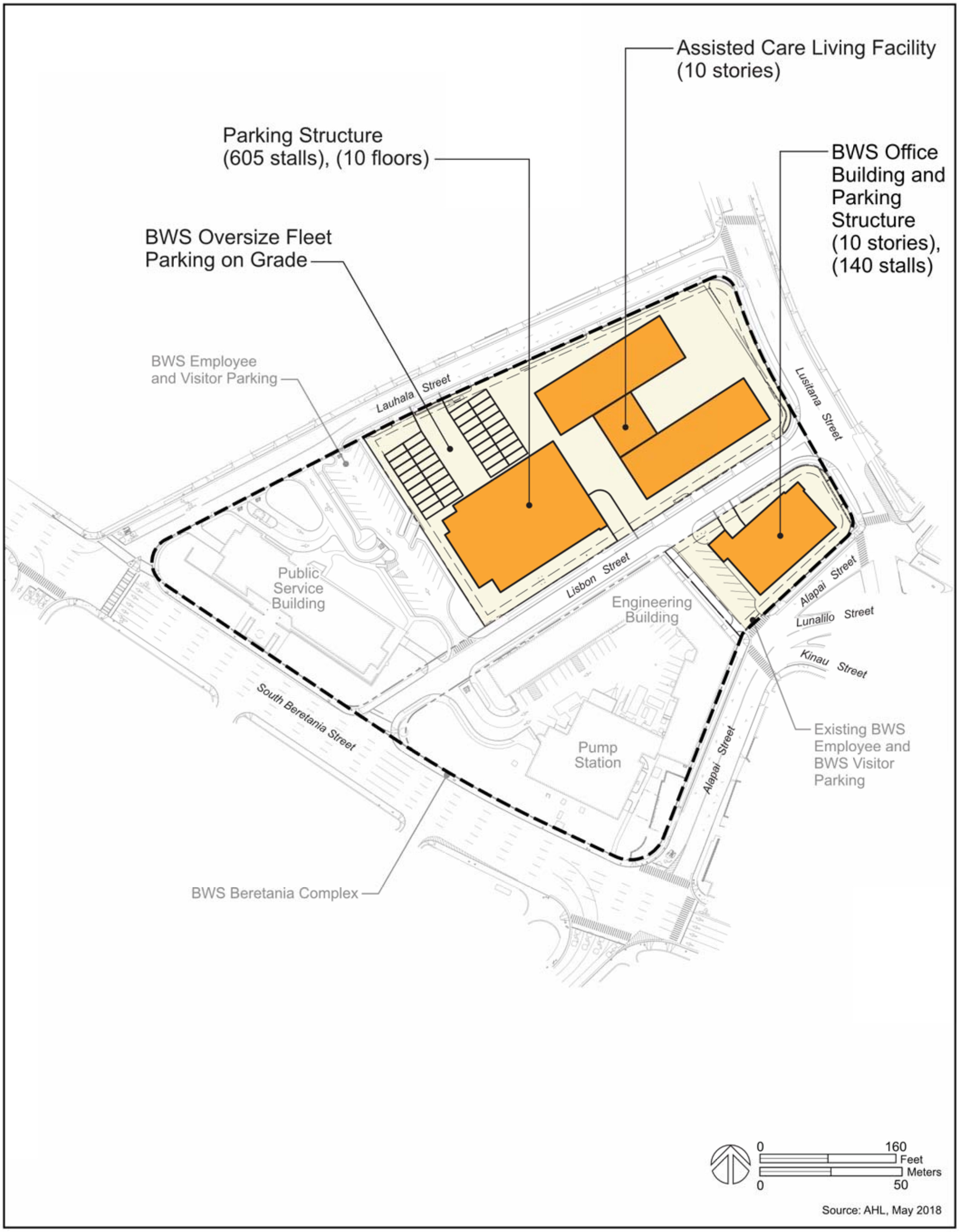
Remarks: (Provide any additional information on the lines provided) *To receive a response via e-mail,provide email address below and check box here:* ☑

The proposed project is evaluating three development scenarios: 1) 266 bed Assisted Care Facility w/35,500 sf Office Space, 2) 312 Unit Senior Rentals w/35,500 sf Office Space 3) Parking Structure w/ 35,500 sf Office Space. Separate SCA's will be submitted for each scenario for WWB review/approval. See attached figure for conceptual site layout.

Please email any questions/correspondence to msuga@wilsonokamoto.com.

FOR DIVISION USE ONLY:

Date of Application: ______ Received By: ______ Application No.: ______



Scenario 1: Assisted Care Living Facility and Office Building **Figure 4**

Board of Water Supply Beretania Complex Redevelopment

Environmental Impact Statement Preparation Notice

Board of Water Supply

CITY AND COUNTY OF HONOLULU
DEPARTMENT OF PLANNING & PERMITTING
650 South King Street, Honolulu, Hawaii 96813

SITE DEVELOPMENT DIVISION MASTER APPLICATION FORM

All required documents and fees must accompany this application form. Please visit www.honoluludpp.org for applicable procedures and fees under the menu heading Application & Forms, Site Engineering and Subdivision Permits. Electronic submittal of permit applications and other permit-related documents constitutes agreement by the applicant or authorized representative to transact business electronically with this department, in accordance with HRS Chapter 489E.

I. PERMIT — VARIANCE — APPROVAL

Check one or more as appropriate:

PERMIT		VARIANCE	APPROVAL
☐ Grading	☑ Sewer Connection	☐ Flood Hazard Variance	☐ Subdivision, Easement Consolidation
☐ Grubbing		☐ Flood Determination	☐ Park Dedication
☐ Stockpiling		☐ Floodway Permit	☐ Lot Determination
☐ Trenching		☐ Flood Map Revision	☐ Ag. Site Development

Complete Sections I, II, III and all other sections as possible

II. LOT AND LAND USE INFORMATION

TAX MAP KEY(S): 2-1-036:001 and 005 (por.) Lot Area: 128,100 sq.ft./ac.

Zoning District: A-2 - Apartment Development Plan Designation: Institutional State Land Use District: Urban

Street Address/Location of Property: 630 South Beretania Street, Honolulu, HI 96843

Present Use of Property/Building: Surface parking lots

Project Name (if any): Board of Water Supply Beretania Complex Redevelopment

Request/Proposal (describe the nature of the request, proposed activity or project): Sewer Connection Application for redevelopment Scenario 2

III. APPLICANT INFORMATION

	Owner/Developer	Engineer/Architect	Contractor (or Agent for Subdivision apps only)
Name (& title)	Board of Water Supply	Wilson Okamoto Corporation	TBD
Mailing Address	630 South Beretania Street	1907 S. Beretania St, Suite 400	
City / State / Zip	Honolulu HI 96843	Honolulu HI 96826	
Phone Number(s)	(808)748-5951	(808)946-2277	
Email Address	mmatsuo@hbws.org	msuga@wilsonokamoto.com	

APPLICANT: Mason M. M. Suga — Print NAME of applicant; Project Manager — Print TITLE of applicant; [signature] — **Signature of applicant**

IV. FOR GRADING/GRUBBING/STOCKPILING INFORMATION ONLY

Estimated Dates: Start: ______ Completion: ______ Borrow Material: ______

Area of work (sf or acres): ______ Borrow Site: ______

Disturbed area (sf or acres): ______ Disposal Material: ______

Estimated Quantity (cy): Cut: ______ Fill: ______ Disposal Site: ______

V. DESIGNATED ESCP COORDINATOR OR CWPPP

Complete the **Authorization Letter to Designate ESCP coordinator and/or CWPPP**

ESCP: Erosion and Sediment Control Plan; CWPPP: Certified Water Pollution Plan Preparer

AUTHORIZATION CLEARANCE

This statement of authorization is used in reference to the information provided for in sections I, II and III above.

I/We, ______________ (Print NAME and TITLE of person **giving authority**), hereby authorize ______________ (Print NAME of person **receiving authority**) to act in my/our behalf in obtaining/closing the Grading/Grubbing/Stockpiling/Trenching permit for the project.

Signature of Owner/Developer giving authority **Date**

FOR DIVISION USE ONLY:

Grading Permit No.: ______ Application No.: ______

Trenching Permit No.: ______ Date of Application: ______

Received By: ______

SEE REVERSE FOR APPLICATIONS FOR TRENCHING AND SEWER CONNECTION *rev. 05/2018*

SITE DEVELOPMENT DIVISION MASTER APPLICATION FORM

(REVERSE SIDE)

VI. FOR TRENCHING INFORMATION ONLY

Work to be performed for: ______________________ Work to be done: ☐ Service Connection ☐ Repair ☐ Borings

Estimated Dates: Start: __________ Completion: __________ Other: ______________________

Estimated Value of work: $ ______________________ Dimensions: ________ ft/in (length) ________ ft/in (width) ________ ft/in (depth)

in the City right-of-way

AGENCY CLEARANCES	SIGNATURE	DATE	ADDRESS	PHONE NO.
DPP, Wastewater Branch			650 So. King St., FMB, 1st Flr.	768-8210
DTS, Traffic Signal			650 So. King St., FMB, 2nd Flr.	768-8388
DDC, Street Lightning			650 So. King St., FMB, 9th Flr.	768-8431
BWS, Customer Care			630 So. Beretania St., 1st Flr.	748-5460
Hawaiian Electric, Construction Installation			820 Ward Avenue, 4th Flr.	543-5654
Hawaiian Telcom, Excavation			1177 Bishop St.,Security Entrance Adams Lane	546-7746
Gasco., Inc., Maps & Records			515 Kamakee St., 1st Flr.	594-5575
Oceanic Cablevision, Engineering & Constr			200 Akamainui St.	625-8443
DFM, Division of Road Maintenance (if trenching 250 lineal feet or more)			99-999 Iwaena Street, #214	484-7695

DPP: Dept. of Planning and Permitting DTS: Dept. of Transportation Services DDC: Dept. of Design and Construction BWS: Board of Water Supply DFM: Dept. of Facility Maintenance

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VII. FOR SEWER CONNECTION INFORMATION ONLY

To receive a response via e-mail,provide email address below and check box here: ☑

☐ Residential: No. of Proposed Units__________ (Provide breakdown below)

______ Studios ______ 1 Bedroom ______ 2 Bedrooms ______ 3 Bedrooms ______ 4 Bedrooms ______ Other

☑ Non-Residential: (See attached sewer table for required category and quantity and provide any additional information in the remarks)

CATEGORY(IES)	QUANTITY(IES)	NEW WATER METER SIZE(S)
Senior Rental	248,300 SF / 312 units	TBD
BWS Office Building	35,500 SF	TBD

Date of Connection: 2024 (approximate)

Connection Work Desired: ☑ Use Existing Lateral ☐ Other

Dimensions: ________ ft. (length) ________ in. (size) ________ ft. (depth)

Existing Structures/Dwellings on Property: (Provide breakdown below)

TYPE (i.e. Single Family)	QUANTITY(IES)	REMAIN	DEMOLISH
N/A			

Remarks: (Provide any additional information on the lines provided) *To receive a response via e-mail,provide email address below and check box here:* ☑

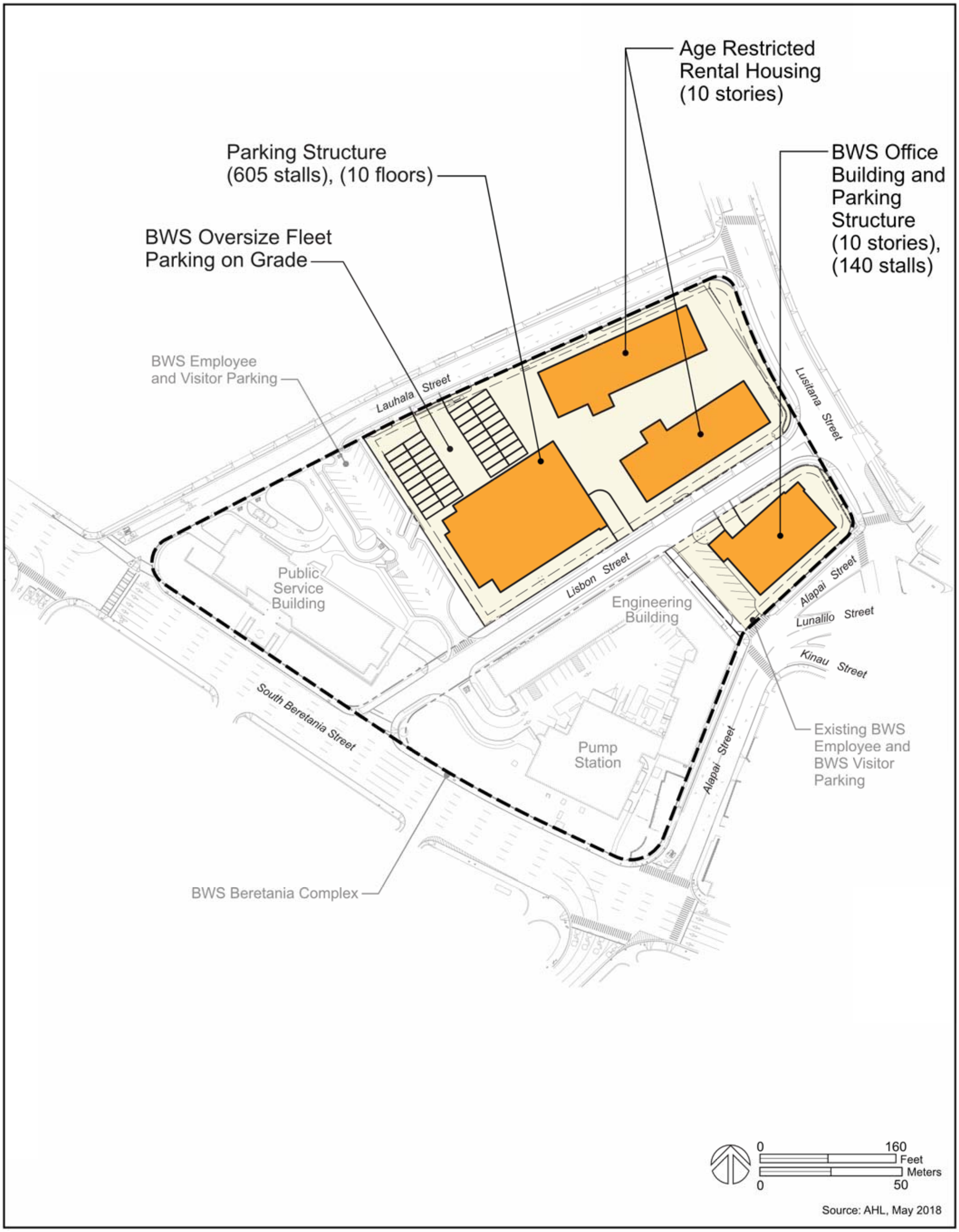
The proposed project is evaluating three development scenarios: 1) 266 bed Assisted Care Facility w/35,500 sf Office Space, 2) 312 Unit Senior Rentals w/35,500 sf Office Space 3) Parking Structure w/ 35,500 sf Office Space. Separate SCA's will be submitted for each scenario for WWB review/approval. See attached figure for conceptual site layout.

Please email any questions/correspondence to msuga@wilsonokamoto.com.

FOR DIVISION USE ONLY:

Date of Application: __________ Received By: __________ Application No.: __________

rev. 05/2018



Scenario 2: Affordable Senior Rental Apartments and Office Building **Figure 5**

Board of Water Supply Beretania Complex Redevelopment

Environmental Impact Statement Preparation Notice

Board of Water Supply

CITY AND COUNTY OF HONOLULU
DEPARTMENT OF PLANNING & PERMITTING
650 South King Street, Honolulu, Hawaii 96813

SITE DEVELOPMENT DIVISION MASTER APPLICATION FORM

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I. PERMIT — VARIANCE — APPROVAL

Check one or more as appropriate:

- ☐ Grading
- ☐ Grubbing
- ☐ Stockpiling
- ☐ Trenching
- ☑ Sewer Connection
- ☐ Flood Hazard Variance
- ☐ Flood Determination
- ☐ Floodway Permit
- ☐ Flood Map Revision
- ☐ Subdivision, Easement Consolidation
- ☐ Park Dedication
- ☐ Lot Determination
- ☐ Ag. Site Development

Complete Sections I, II, III and all other sections as possible

II. LOT AND LAND USE INFORMATION

TAX MAP KEY(S): 2-1-036:001 and 005 (por.)　Lot Area: 128,100 sq.ft / ac.

Zoning District: A-2 - Apartment　Development Plan Designation: Institutional　State Land Use District: Urban

Street Address/Location of Property: 630 South Beretania Street, Honolulu, HI 96843

Present Use of Property/Building: Surface parking lots

Project Name (if any): Board of Water Supply Beretania Complex Redevelopment

Request/Proposal (describe the nature of the request, proposed activity or project): Sewer Connection Application for redevelopment Scenario 3

III. APPLICANT INFORMATION

	Owner/Developer	**Engineer**/Architect	**Contractor** (or **Agent for Subdivision apps only**)
Name (& title)	Board of Water Supply	Wilson Okamoto Corporation	TBD
Mailing Address	630 South Beretania Street	1907 S. Beretania St, Suite 400	
City / State / Zip	Honolulu / HI / 96843	Honolulu / HI / 96826	
Phone Number(s)	(808)748-5951	(808)946-2277	
Email Address	mmatsuo@hbws.org	msuga@wilsonokamoto.com	

APPLICANT	Mason M. M. Suga	Project Manager	[signature]
	Print NAME of applicant	Print TITLE of applicant	**Signature of applicant**

IV. FOR GRADING/GRUBBING/STOCKPILING INFORMATION ONLY

Estimated Dates: Start: ______ Completion: ______　Borrow Material: ______

Area of work (sf or acres): ______　Borrow Site: ______

Disturbed area (sf or acres): ______　Disposal Material: ______

Estimated Quantity (cy): Cut: ______ Fill: ______　Disposal Site: ______

V. DESIGNATED ESCP COORDINATOR OR CWPPP

Complete the **Authorization Letter to Designate ESCP coordinator and/or CWPPP**

ESCP: Erosion and Sediment Control Plan; CWPPP: Certified Water Pollution Plan Preparer

AUTHORIZATION CLEARANCE

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I/We, ______ (Print NAME and TITLE of person **giving authority**), hereby authorize ______ (Print NAME of person **receiving authority**) to act in my/our behalf in obtaining/closing the Grading/Grubbing/Stockpiling/Trenching permit for the project.

Signature of Owner/Developer giving authority　**Date**

FOR DIVISION USE ONLY:

Grading Permit No.: ______　Application No.: ______

Trenching Permit No.: ______　Date of Application: ______

Received By: ______

SEE REVERSE FOR APPLICATIONS FOR TRENCHING AND SEWER CONNECTION

SITE DEVELOPMENT DIVISION MASTER APPLICATION FORM

(REVERSE SIDE)

VI. FOR TRENCHING INFORMATION ONLY

Work to be performed for: ______________________ Work to be done: ☐ Service Connection ☐ Repair ☐ Borings

Estimated Dates: Start: __________ Completion: __________ Other: ______________________

Estimated Value of work: $ ______________________ Dimensions: ________ ft/in (length) ________ ft/in (width) ________ ft/in (depth)

in the City right-of-way

AGENCY CLEARANCES	SIGNATURE	DATE	ADDRESS	PHONE NO.
DPP, Wastewater Branch			650 So. King St., FMB, 1st Flr.	768-8210
DTS, Traffic Signal			650 So. King St., FMB, 2nd Flr.	768-8388
DDC, Street Lightning			650 So. King St., FMB, 9th Flr.	768-8431
BWS, Customer Care			630 So. Beretania St., 1st Flr.	748-5460
Hawaiian Electric, Construction Installation			820 Ward Avenue, 4th Flr.	543-5654
Hawaiian Telcom, Excavation			1177 Bishop St.,Security Entrance Adams Lane	546-7746
Gasco., Inc., Maps & Records			515 Kamakee St., 1st Flr.	594-5575
Oceanic Cablevision, Engineering & Constr			200 Akamainui St.	625-8443
DFM, Division of Road Maintenance (if trenching 250 lineal feet or more)			99-999 Iwaena Street, #214	484-7695

DPP: Dept. of Planning and Permitting DTS: Dept. of Transportation Services DDC: Dept. of Design and Construction BWS: Board of Water Supply DFM: Dept. of Facility Maintenance

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VII. FOR SEWER CONNECTION INFORMATION ONLY

To receive a response via e-mail,provide email address below and check box here: ☑

☐ Residential: No. of Proposed Units__________ (Provide breakdown below)

______ Studios ______ 1 Bedroom ______ 2 Bedrooms ______ 3 Bedrooms ______ 4 Bedrooms ______ Other

☑ Non-Residential: (See attached sewer table for required category and quantity and provide any additional information in the remarks)

CATEGORY(IES)	QUANTITY(IES)	NEW WATER METER SIZE(S)
BWS Office Building	35,500 SF	TBD

Date of Connection: 2024 (approximate)

Connection Work Desired: ☑ Use Existing Lateral ☐ Other

Dimensions: ________ ft. (length) ________ in. (size) ________ ft. (depth)

Existing Structures/Dwellings on Property: (Provide breakdown below)

TYPE (i.e. Single Family)	QUANTITY(IES)	REMAIN	DEMOLISH
N/A			

Remarks: (Provide any additional information on the lines provided) *To receive a response via e-mail,provide email address below and check box here:* ☑

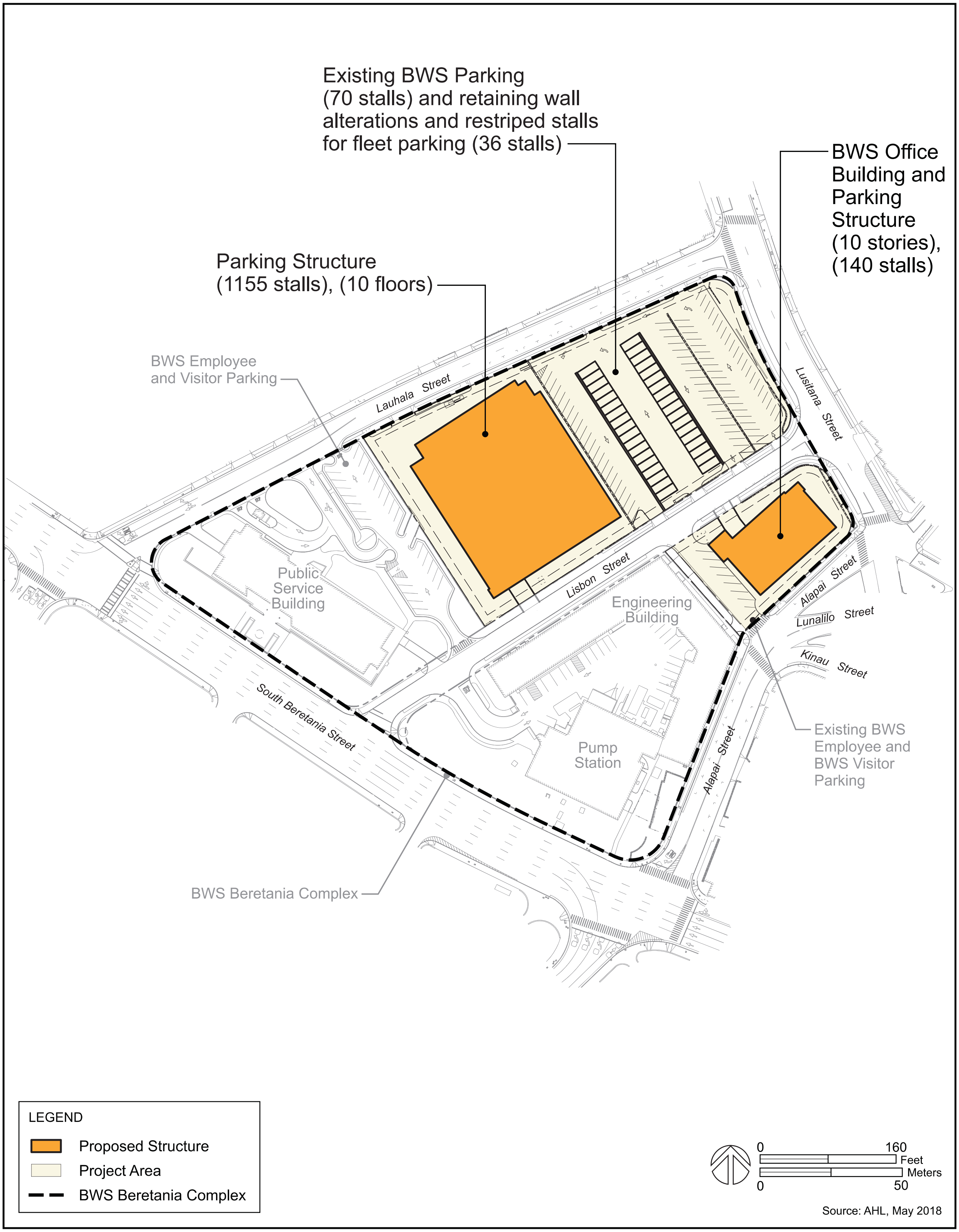
The proposed project is evaluating three development scenarios: 1) 266 bed Assisted Care Facility w/35,500 sf Office Space, 2) 312 Unit Senior Rentals w/35,500 sf Office Space 3) Parking Structure w/ 35,500 sf Office Space. Separate SCA's will be submitted for each scenario for WWB review/approval. See attached figure for conceptual site layout.

Please email any questions/correspondence to msuga@wilsonokamoto.com.

FOR DIVISION USE ONLY:

Date of Application: __________ Received By: __________ Application No.: __________

rev. 05/2018



Scenario 3: Parking Structure and Office Building **Figure 6**

Board of Water Supply Beretania Complex Redevelopment

Environmental Impact Statement Preparation Notice

Board of Water Supply

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET * HONOLULU, HAWAII 96813
Phone: (808) 768-8209 * Fax: (808) 768-4210

SEWER CONNECTION APPLICATION

APPLICATION NO.: **2019/SCA-0125** STATUS: **Approved**
DATE RECEIVED: **01/30/2019** IWDP APP. NO.:
PROJECT NAME: **2019/SCA-0125 BWS Beretania Complex Redevelopment Scenario 1 - Assisted care Living Facility and BWS Office Building**

LOCATION:

Zone	Section	Plat	Parcel
2	1	036	001

22,980 Sq. Ft.

Zone	Section	Plat	Parcel
2	1	036	005

630 S BERETANIA ST HONOLULU /

SPECIFIC LOCATION: **630 South Beretania Street**

APPLICANT: **Wilson Okamoto Corporation**
ATTN. Mason Suga
1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826

DEVELOPMENT TYPE: **Nursing, Convalescent Home** SEWER CONNECTION WORK DESIRED:

OTHER USES: **Assisted Care Living Facility - 266 Beds**
Office Building - 35,500 SF

NON-RESIDENTIAL AREA: s.f. APPROXIMATE DATE OF CONNECTION:

PROPOSED UNITS	EXISTING UNITS	UNITS TO BE DEMOLISHED
No. of New Units: **0**	No. of Existing Units: **0**	No. of Units to be Demolished: **0**
Studios:	Studios:	Studios:
1-Bedroom:	1-Bedroom:	1-Bedroom:
2-Bedroom:	2-Bedroom:	2-Bedroom:
3-Bedroom:	3-Bedroom:	3-Bedroom:
4-Bedroom:	4-Bedroom:	4-Bedroom:
5-Bedroom:	5-Bedroom:	5-Bedroom:
6-Bedroom:	6-Bedroom:	6-Bedroom:

REMARKS

APPROVAL DATE: **02/01/2019**

EXPIRATION DATE: **01/30/2021**

Valid 2-years after approval date. Construction plans shall be completed and approved within this 2-year period. Construction shall commence within 1-year after approval of plans.
**Applicable WSFC shall be collected at the prevailing rate in accordance with ROH 1990, Chapter 14, Sections 14-10.3, 14-10.4, 14-10.5 and Appendix 14-D.*

REVIEWED BY: ***Keith Miyashiro***

Site Development Division, Wastewater Branch

ExternalID: 064594895-001 JobId: 64594895

DEPARTMENT OF PLANNING AND PERMITTING

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET * HONOLULU, HAWAII 96813
Phone: (808) 768-8209 * Fax: (808) 768-4210

SEWER CONNECTION APPLICATION

APPLICATION NO.: **2019/SCA-0126** STATUS: **Approved**

DATE RECEIVED: **01/30/2019** IWDP APP. NO.:

PROJECT NAME: **2019/SCA-0126 BWS Beretania Complex Redevelopment Scenario 2- Senior Rental Units and BWS Office**

$1,444,934.40
Estimated Wastewater System Facility Charge*

LOCATION:

Zone	Section	Plat	Parcel		
2	**1**	**036**	**001**		**22,980** Sq. Ft.
2	**1**	**036**	**005**	**630 S BERETANIA ST Honolulu / D(**	**170,947** Sq. Ft.

SPECIFIC LOCATION: **630 South Beretania Street**

APPLICANT: **Wilson Okamoto Corporation**
ATTN. Mason Suga
1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826

DEVELOPMENT TYPE: **Dwelling, Multi-family**

SEWER CONNECTION WORK DESIRED:

OTHER USES: **Office Building**

NON-RESIDENTIAL AREA: **35,500.00** s.f.

APPROXIMATE DATE OF CONNECTION:

PROPOSED UNITS	EXISTING UNITS	UNITS TO BE DEMOLISHED
No. of New Units: **312**	No. of Existing Units: **0**	No. of Units to be Demolished: **0**
Studios:	Studios:	Studios:
1-Bedroom:	1-Bedroom:	1-Bedroom:
2-Bedroom:	2-Bedroom:	2-Bedroom:
3-Bedroom:	3-Bedroom:	3-Bedroom:
4-Bedroom:	4-Bedroom:	4-Bedroom:
5-Bedroom:	5-Bedroom:	5-Bedroom:
6-Bedroom:	6-Bedroom:	6-Bedroom:

REMARKS

APPROVAL DATE: **02/01/2019**

EXPIRATION DATE: **01/31/2021**

Valid 2-years after approval date. Construction plans shall be completed and approved within this 2-year period. Construction shall commence within 1-year after approval of plans.
** Applicable WSFC shall be collected at the prevailing rate in accordance with ROH 1990, Chapter 14, Sections 14-10.3, 14-10.4, 14-10.5 and Appendix 14-D.*

REVIEWED BY: ***Keith Miyashiro***

Site Development Division, Wastewater Branch

ExternalID: **064594916-001** JobId: **64594916**

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET * HONOLULU, HAWAII 96813
Phone: (808) 768-8209 * Fax: (808) 768-4210

SEWER CONNECTION APPLICATION

APPLICATION NO.: **2019/SCA-0127** STATUS: **Approved**
DATE RECEIVED: **01/30/2019** IWDP APP. NO.:
PROJECT NAME: **2019/SCA-0127 BWS Beretania Complex Redevelopment Scenario 3 - BWS Office Building**

LOCATION:

Zone	Section	Plat	Parcel		
2	1	036	001		**22,980** Sq. Ft.
2	1	036	005	**630 S BERETANIA ST Honolulu / D(**	**170,947** Sq. Ft.

SPECIFIC LOCATION: **630 South Beretania Street**

APPLICANT: **Wilson Okamoto Corporation**
ATTN. Mason Suga
1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826

DEVELOPMENT TYPE: **Office Building** SEWER CONNECTION WORK DESIRED:
OTHER USES:
NON-RESIDENTIAL AREA: **35,500.00** s.f. APPROXIMATE DATE OF CONNECTION:

PROPOSED UNITS	EXISTING UNITS	UNITS TO BE DEMOLISHED
No. of New Units: **0**	No. of Existing Units: **0**	No. of Units to be Demolished: **0**
Studios:	Studios:	Studios:
1-Bedroom:	1-Bedroom:	1-Bedroom:
2-Bedroom:	2-Bedroom:	2-Bedroom:
3-Bedroom:	3-Bedroom:	3-Bedroom:
4-Bedroom:	4-Bedroom:	4-Bedroom:
5-Bedroom:	5-Bedroom:	5-Bedroom:
6-Bedroom:	6-Bedroom:	6-Bedroom:

REMARKS

APPROVAL DATE: **02/01/2019**

EXPIRATION DATE: **01/31/2021**

Valid 2-years after approval date. Construction plans shall be completed and approved within this 2-year period. Construction shall commence within 1-year after approval of plans.
**Applicable WSFC shall be collected at the prevailing rate in accordance with ROH 1990, Chapter 14, Sections 14-10.3, 14-10.4, 14-10.5 and Appendix 14-D.*

REVIEWED BY: ***Keith Miyashiro***

Site Development Division, Wastewater Branch

ExternalID: **064594920-001** JobId: **64594920**

Initial Print Date: Friday February 1, 2019 9:26 am

Appendix C

Water Supply System Information

Water Demand Calculations

Request Letter for Adequacy Inquiry and Pressure Data submitted Sept. 14, 2017

Water Availability Response Letter from BWS dated Oct. 2, 2017

BWS RFP - ASSISTED LIVING OPTION
Proposed Water Design Flow Calculations

Type of Use	Zoning Designation	Average Daily Demand	
Assisted Living	N/A	110	gpd/bed
Office	Commercial Only	3,000	gpd/acre

Proposed Average Daily Water Demand Calculations

Facility	Zoning Designation	Count		Average Daily Demand (gallons per day per unit)		Average Daily Flow (gallons per day)	Peak Hour Demand (gallons per minute)
Assisted Living	N/A	266	beds	110	gpd/bed	29,260	31
BWS Office Building	Commercial Only	36,000	sf	3,000	gpd/acre	2,480	3
					Total	**31,740**	**34**

The proposed total Average Daily Water flow for the BWS RFP - Assisted Living Option is approximately 31,740 gallons per day.

BWS RFP - SENIOR RENTALS OPTION
Proposed Water Design Flow Calculations

Type of Use	Zoning Designation	Average Daily Demand	
Senior Rentals	Multi-Family High Rise	300	gpd/unit
Office	Commercial Only	3,000	gpd/acre

Proposed Average Daily Water Demand Calculations

Facility	Zoning Designation	Count		Average Daily Demand (gallons per day per unit)		Average Daily Flow (gallons per day)
Senior Rentals	MFHR	312	units	300	gpd/unit	93,600
BWS Office Building	Commercial Only	36,000	sf	3,000	gpd/acre	2,480
					Total	**96,080**

The proposed total Average Daily Water Flow for the BWS RFP - Senior Rentals Option is approximately 96,080 gallons per day.

BWS RFP - PARKING STRUCTURE OPTION
Proposed Water Design Flow Calculations

Type of Use	**Zoning Designation**	**Average Daily Demand**
Office	Commercial Only	3,000 gpd/acre

Proposed Average Daily Water Demand Calculations

Facility	Zoning Designation	Count		Average Daily Demand (gallons per day per unit)		Average Daily Flow (gallons per day)
BWS Office Building	Commercial Only	36,000	sf	3,000	gpd/acre	2,480
					Total	**2,480**

The proposed total Average Daily Water Flow for the BWS RFP - Parking Structure Option is approximately 2,480 gallons per day.

WILSON OKAMOTO CORPORATION
INNOVATORS • PLANNERS • ENGINEERS

10233-01
September 14, 2017

City and County of Honolulu
Board of Water Supply
Customer Care Division
630 South Beretania Street
Honolulu, HI 96813

Attention: Mr. Robert Chun

Subject: BWS Beretania Street Complex RFP

Dear Mr. Chun:

Wilson Okamoto Corporation is the civil engineering consultant performing a due diligence study for the redevelopment of the existing BWS Beretania Street Complex. The project site is approximately 4.50 acres and is bordered by Lusitana Street to the north, Alapai Street to the east, South Beretania Street to the south, and Lauhala Street to the west. The project site is identified by Tax Map Key(s): 2-1-036:001 & 005 (See attached TMK).

At this time we would like to get your assistance in determining the adequacy of the existing BWS storage and water distribution system in the vicinity of the project site to support the proposed project. Three options are being considered for the redevelopment of the property. Descriptions of the three options and projected average daily water demand are as follows:

Proposed Program – Parking Structure Option

Facility	Zoning Designation	Area	Gal/day/unit	Avg. Daily Demand (gpd)
BWS Office Building	Commercial Only	36,000 sf	3,000 gpd/acre	2,480 gpd
			Total:	2,480 gpd

Proposed Program – Senior Rental Option

Facility	Zoning Designation	Area	Gal/day/unit	Avg. Daily Demand (gpd)
Senior Rentals	MFHR	312 units	300 gpd/unit	93,600 gpd
BWS Office Building	Commercial Only	36,000 sf	3,000 gpd/acre	2,480 gpd
			Total:	96,080 gpd

Proposed Program – Assisted Living Option

Facility	Zoning Designation	Area	Gal/day/unit	Avg. Daily Demand (gpd)
Assisted Living Facility	N/A	266 beds	110 gpd / bed*	29,260 gpd
BWS Office Building	Commercial Only	36,000 sf	3,000 gpd/acre	2,480 gpd
			Total:	31,740 gpd

*110 gpd/bed based on record information from a similar assisted living development.

In addition to your review of the existing water system adequacy, we would like to obtain pressure and flow information for the existing fire hydrants located in the vicinity of the project site. The hydrant numbers are (See attached BWS System Map).

M00092	M00187	M00793	M05166	M15168
M00182	M00188	M02113	M05167	M05169

Please call 946-2277 should you have any questions or require additional information.

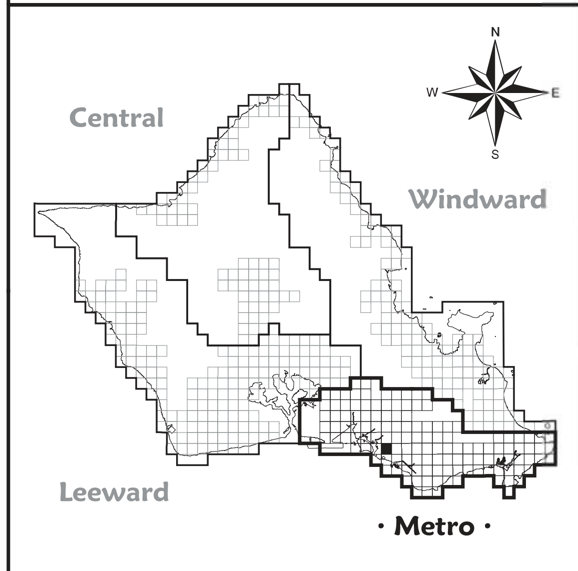
Sincerely,

Mason M. M. Suga, P.E.
Associate Project Manager

Enclosures: TMK map
BWS System Map


LUNALILO
F. P.
Ld. Ct. App. 445
Ld. Ct. App. 600
PLAT
TRACT
35
STREET
LAUHALA
LUSITANA
LAUHALA ST.
BERETANIA
Ld. Ct. App. 1284
City & County of Honolulu (Board of Water Supply)
Amded.
TOTAL AREA
173,107# (148,996#)
App. 53
Ld. Ct.
Gr. 5754
Gr. 5630
Gr. 5760
Gr. 6640
Gr. 5637
Gr. 5749
Gr. 5761
BLOCK 2
AUWAIOLIMU STREET
LISBON
City & County of Honolulu PUMPING STATION & GARAGE
City & County of Hon. (Board of Water Supply)
LOTS
Gr. 5748
Gr. 5747
Gr. 4617
22,980#
(8,035#)
(4020#)
(1552#)
Gr. 10.576
BLOCK 1
Gr. 43 (R.W.)
Gr. 5896
Gr. 5746
Exec. Ord. No. 107
STREET
ALAPAI STREET
LUNALILO ST.
KINAU ST.
PLAT 33
PLAT 37
PLAT 40
PLAT 41
TRUE NORTH Scale: 1 in. = 40 ft.
Parcels Dropped: 2, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 51, 48, 73, 38, 39, 40, 42, 43, 44, 45, 46, 55, 57, 58, 59, 60, 71, 72, 37, 41, 47, 49, 50, 52, 53, 54, 56
Dwg. No. 240
By T.A.-D.S.C.
Source: Tax Maps Bureau
ADVANCE SHEET SUBJECT TO CHANGE
FIRST DIVISION
ZONE 2 SEC 1 PLAT 36
CONTAINING PARCELS
SCALE 1 in. = 40 ft.

Tile: R36C44 (Metro)



LEGEND

WATER MAIN TYPES
- Service
- Bypass
- Distribution
- Lateral
- Maintenance
- Transmission
- Private
- Non-Potable

PIPE CASINGS
- Concrete Jacket over DI pipe
- Pipeline Tunnel

MISCELLANEOUS
- Building Footprint
- Facility
- Inset Frame
- Stream Centerline

MATERIALS

AC	ASBESTOS CEMENT
AC-JM	AC-JOHNS MANSVILLE
AC-KM	AC-KEASBEY MATTISON
CC	CONCRETE CYLINDER
CC-A	CC-AMERICAN
CC-H	CC-HAWAII
CC-S	CC-SOUTHERN
CI	CAST IRON
CU	COPPER
DI	DUCTILE IRON
GI	GALVANIZED IRON
PVC	POLYVINYL CHLORIDE
STL	STEEL
CP	CATHODIC PROTECTION
NP	NON-POTABLE

BILLING METERS
- CM Compound
- DC Detector Check
- FM FM
- Unknown

FITTINGS
- Cut & Plug
- Emergency Connection
- Flow Tube
- Reducer
- Transition Coupling

FIRE HYDRANT
- Fire Hydrant
- 99 No Fire Hydrant Number

OPERATIONAL METERS
- FL Flow
- MS Master
- TUR Turbine
- Unknown
- Venturi

PUMPS
- Lift
- Line
- Source

RESERVOIR
- Reservoir

SOURCES
- Shaft
- Source Well
- Spring
- Tunnel
- Unknown

VALVES
- Air Release
- Air Release BFV
- Air Release BGGV
- Air Release Gate
- Altitude
- Backflow Preventor
- Bevel Gear Gate
- Butterfly
- Check
- Closed
- Control
- English
- Flap
- Float
- Gate
- Pressure Reducing
- Pressure Relief
- Pressure Sustaining
- Solenoid Control
- Spur Gear Gate
- Square Bottom Bevel Gear
- Stopcock
- Tapping
- Unknown

WATER TREATMENT PLANTS

Coupling

drant Number

This repr distr feat exa & r

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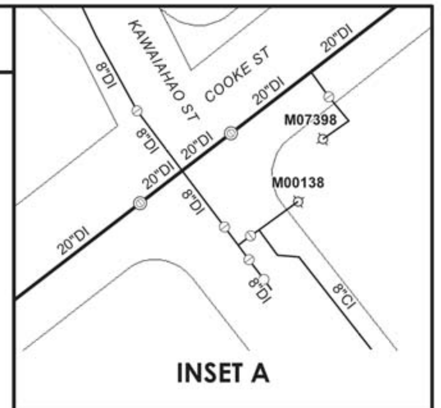
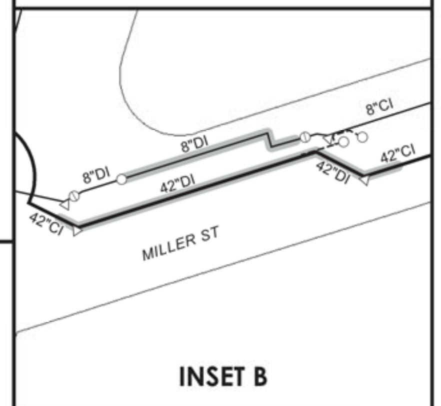
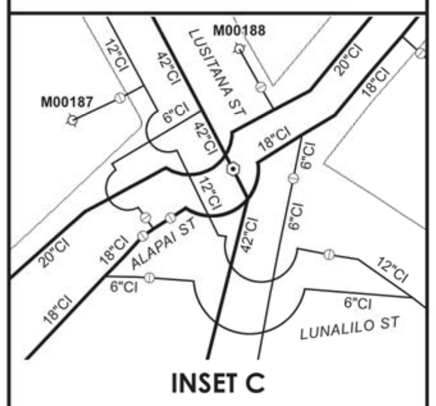
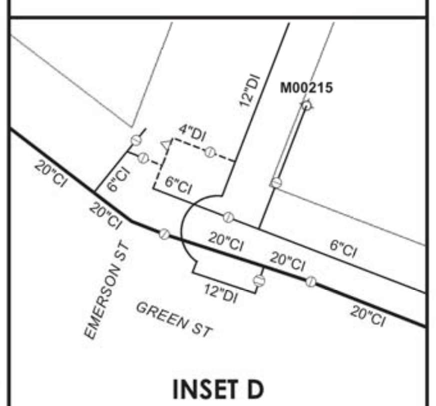
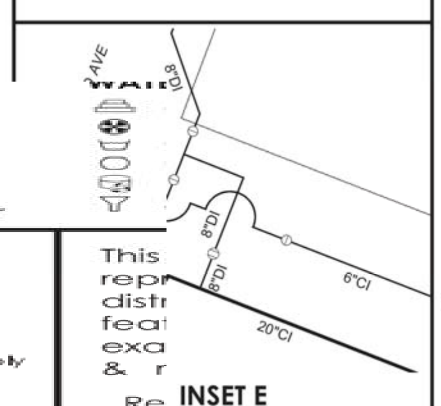
of Honolulu
Reserved

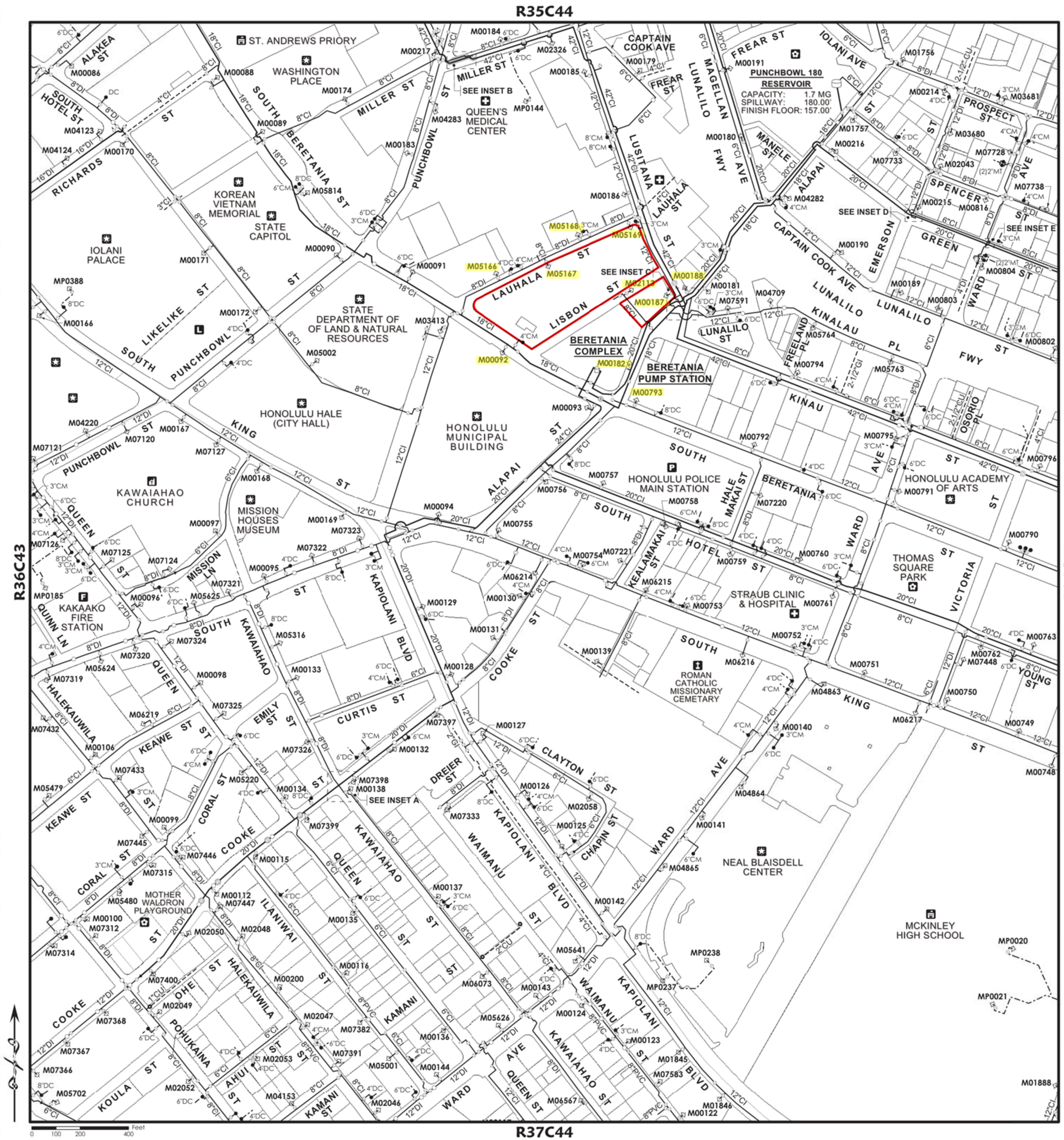












BOARD OF WATER SUPPLY

CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HI 96843
www.boardofwatersupply.com

October 2, 2017

Mr. Mason M. M. Suga
Wilson Okamoto Corporation
1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826

Dear Mr. Mason:

Subject: Your Letter Dated September 14, 2017 Requesting the Availability of Water and Fire Flow and Pressure Data for the Board of Water Supply Beretania Street Complex RFP – Tax Map Key: 2-1-036: 001 & 005

Thank you for your letter regarding the proposed redevelopment of the Board of Water Supply (BWS) Beretania Street Complex.

The existing water system is adequate to provide domestic and off-site fire protection to the proposed redevelopment. However, please be advised that this information is based upon current data, and therefore, the BWS reserves the right to change any position or information stated herein up until the final approval of the building permit application. The final decision on the availability of water will be confirmed when the building permit application is submitted for approval.

Water conservation measures are recommended for all proposed developments. These measures include utilization of non-potable water for irrigation using rain catchment, drought tolerant plants, xeriscape landscaping, efficient irrigation systems, such as a drip system and moisture sensors and the use of water sense labeled ultra-low-flow water fixtures and toilets.

High-rise buildings with booster pumps will be required to install water hammer arrestors or expansion tanks to reduce pressure spikes and potential main breaks in our water system.

When water is made available, the applicant will be required to pay our Water System Facilities Charges for resource development, transmission and daily storage.

The BWS has suspended fire flow tests on fire hydrants as a water conservation measure. However, you may use the following calculated flow data for Fire Hydrant No. M00092, M00182, M00187, M00188, M00793, M02113, M05166, M05167, M05168, and M05169:

Fire Hydrant Number	Location	Static Pressure (psi)	Residual Pressure (psi)	Flow (gpm)
M00092	Beretania Street	73	70	4000
M00182	Alapai Street	164	157	4000
M00187	Lusitania Street	57	47	4000
M00188	Alapai Street	152	146	4000
M00793	Beretania Street	68	65	4000
M02113	Lisbon Street	62	30	4000
M05166	Lauhala Street	72	56	4000
M05167	Lauhala Street	69	49	4000
M05168	Lauhala Street	64	45	4000
M05169	Lauhala Street	58	47	4000

The data are based on the existing water system, and the static pressure represents the theoretical pressure at the point of calculation with the reservoir full and no demands on the water system. The static pressure is not indicative of the actual pressure in the field. Therefore, in order to determine the flows that are available to the site, you will have to determine the actual field pressure by taking on-site pressure readings at various times of the day and correlating that field data with the above hydraulic design data.

The map showing the location of the fire hydrants is attached.

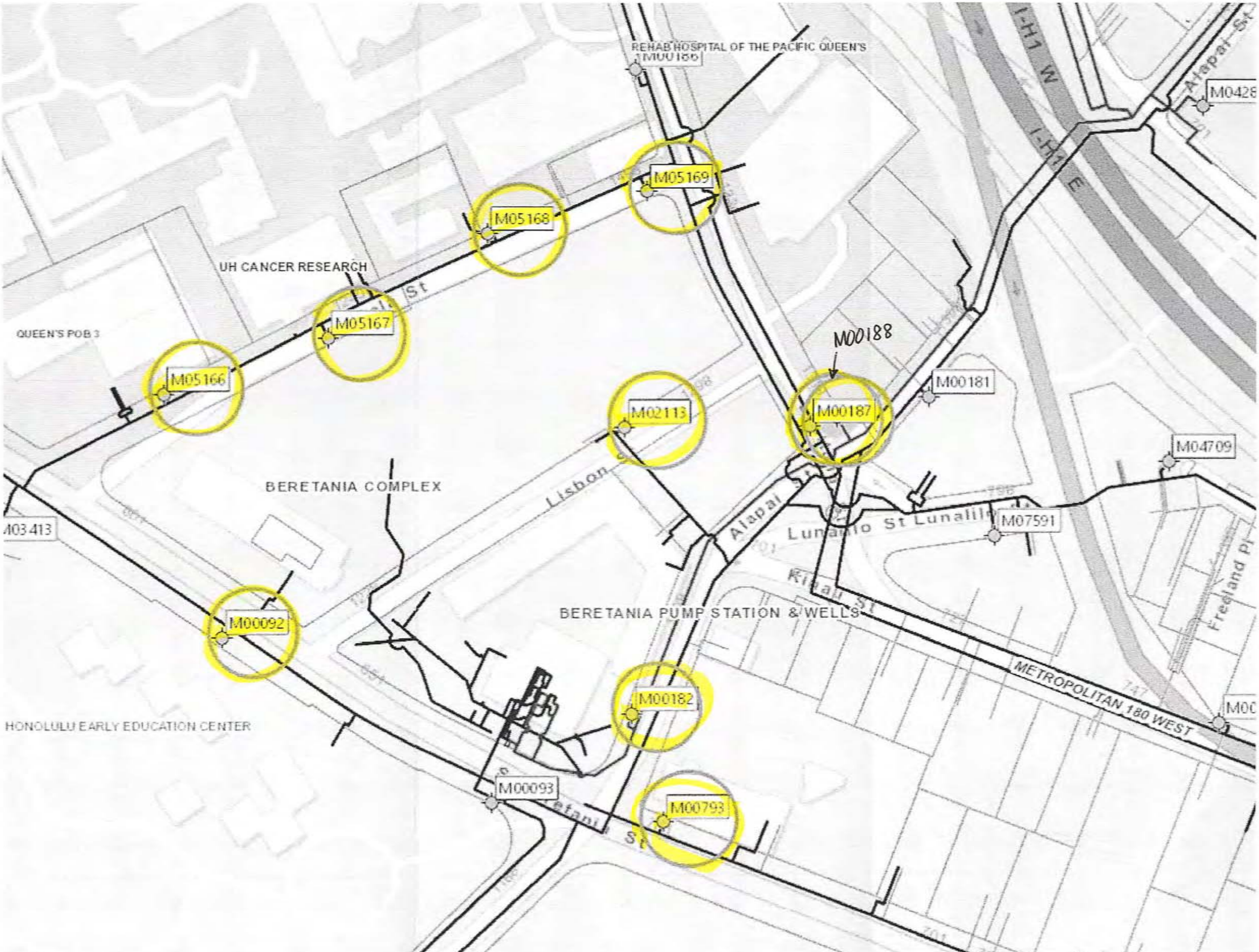
The on-site fire protection requirements should be coordinated with the Fire Prevention Bureau of the Honolulu Fire Department.

If you have any questions, please contact Robert Chun, Project Review Branch of our Water Resources Division at 748-5443.

Very truly yours,

ERNEST Y. W. LAU, P.E.
Manager and Chief Engineer

Attachment



REHAB HOSPITAL OF THE PACIFIC QUEEN'S
I-H1 W
I-H1 E
Alapai St
M0428
M05169
M05168
UH CANCER RESEARCH
St
M05167
QUEEN'S POB 3
M05166
M00188
M00181
M02113
M00187
M04709
BERETANIA COMPLEX
Lisbon
M03413
Alapai
Lunalilo St
M07591
Freeland Pl
Kinau St
BERETANIA PUMP STATION & WELLS
M00092
METROPOLITAN 180 WEST
M00182
HONOLULU EARLY EDUCATION CENTER
M00093
M00793
St

Appendix I

Traffic Impact Report, Board of Water Supply Beretania Complex Redevelopment
Wilson Okamoto Corporation, May 2019

Traffic Impact Report

Board of Water Supply Beretania Complex Redevelopment

Prepared for:
HHF Planners

Prepared by:
Wilson Okamoto Corporation

May 2019

TRAFFIC IMPACT REPORT

FOR THE

BOARD OF WATER SUPPLY
BERETANIA COMPLEX REDEVELOPMENT

Prepared for:

HHF Planners
Pacific Guardian Center, Makai Tower
733 Bishop Street, Suite 2590
Honolulu, HI 96813

Prepared by:

Wilson Okamoto Corporation
1907 S. Beretania Street, Suite 400
Honolulu, Hawaii 96826
WOC Ref #10233-03

May 2019

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

I. INTRODUCTION

A. Purpose of Study

The purpose of this study is to identify and assess the traffic impacts resulting from the proposed redevelopment of the existing Board of Water Supply Complex in Honolulu on the island of Oahu. The proposed project entails the replacement of a portion of the existing site with three alternative development plans currently under consideration.

B. Scope of Study

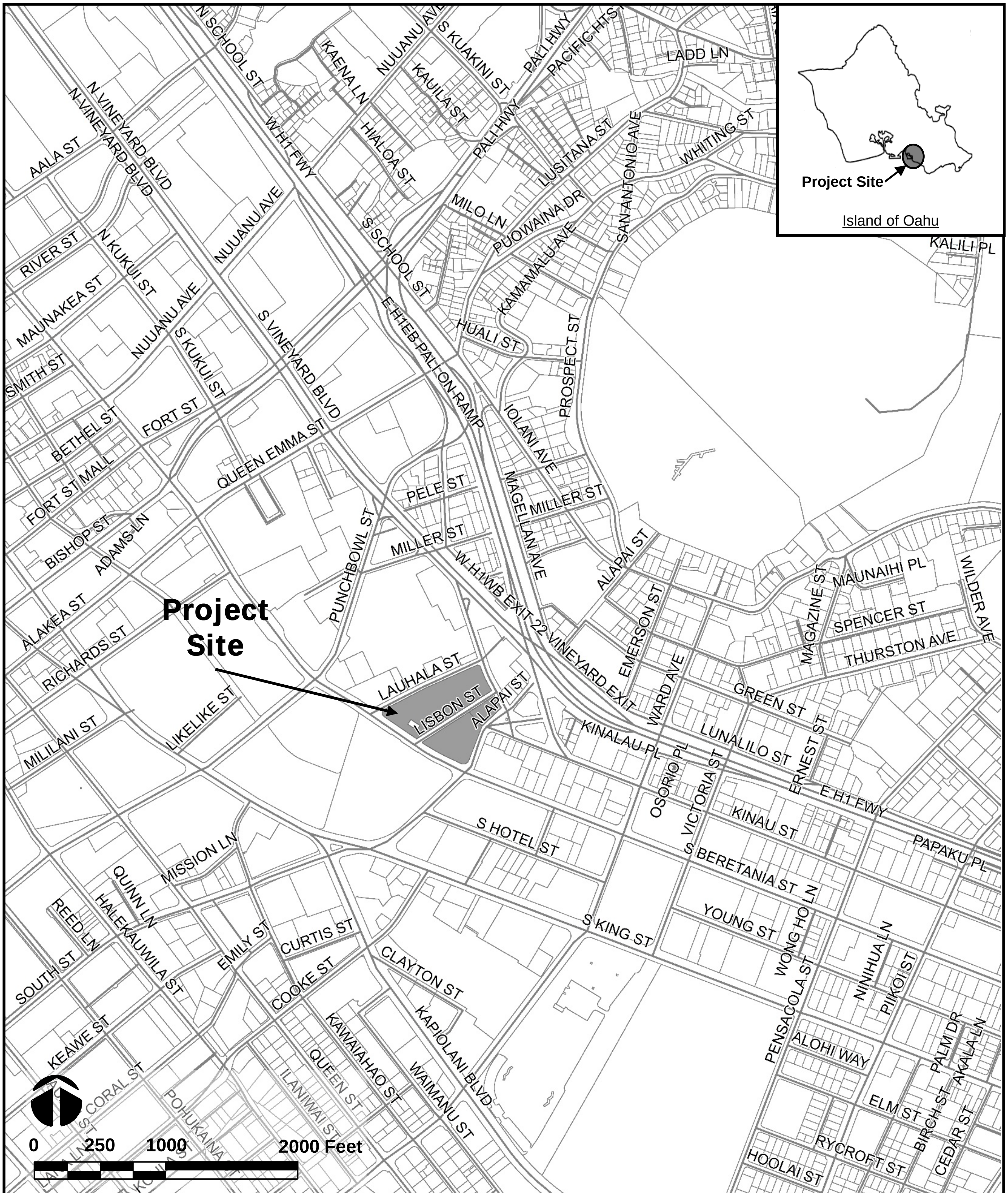
This report presents the findings and conclusions of the traffic study, the scope of which includes:

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 Board of Water Supply complex is located adjacent to South Beretania Street in Honolulu on the island of Oahu (see Figure 1). The existing site is bounded by South Beretania Street to the south, Lusitana Street to the north, Alapai Street to the east, and Lauhala Street to the west. The project site is further identified as Tax Map Keys (TMKs): (1) 2-1-036 parcels 001, 004, and 005. Access to the existing Board of Water Supply is currently provided via driveways off Lauhala Street and Lisbon Street. It should be noted that although there are several driveways located along Lauhala Street, the driveways leading to the adjacent parking lots are gated and are currently not used.



WILSON OKAMOTO CORPORATION

BOARD OF WATER SUPPLY BERETANIA COMPLEX

LOCATION MAP AND VICINITY MAP

FIGURE 1

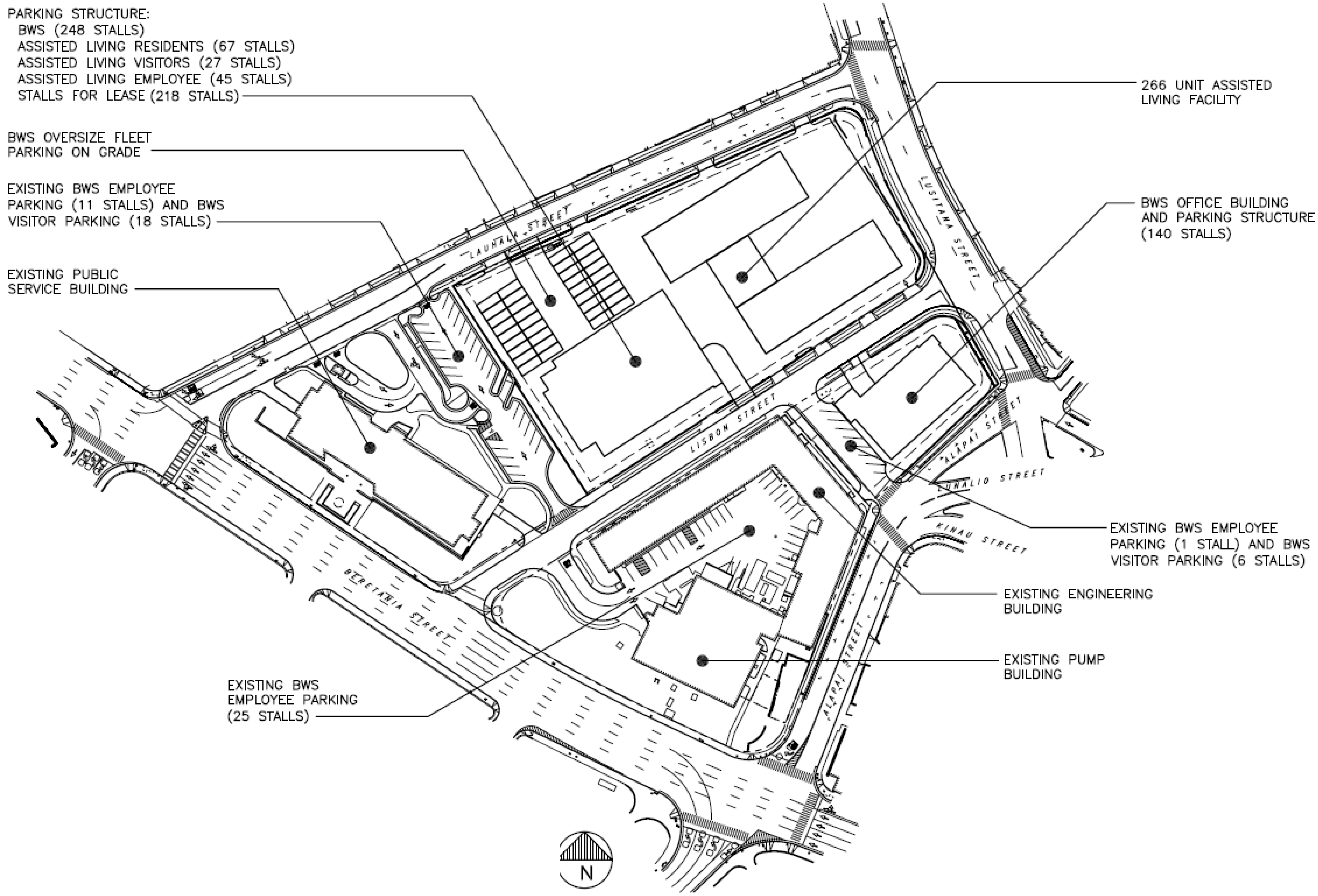
B. Project Characteristics

The site for the existing Board of Water Supply (BWS) complex is comprised of three parcels that include office and maintenance buildings and at-grade parking areas for the agency's employees and fleet vehicles. The proposed project entails the redevelopment of portions of the existing site currently used for at-grade parking to create an additional source of revenue for the agency to offset their operating and capital improvements costs, as well as to construct additional office space to accommodate anticipated growth of the BWS's existing operations. Three development alternatives are currently under consideration as detailed below. The proposed project under all alternatives is expected to be completed and occupied by Year 2026.

Alternative 1

Under Alternative 1, the northwest portion of the existing site is expected to be replaced with a new assisted living care facility that accommodates approximately 266 beds. Parking for the new assisted living care facility will be provided within a new parking structure that is also expected to house replacement parking for the BWS to offset the parking stalls displaced by the proposed project, as well as 218 additional parking stalls that are intended to be leased to the surrounding uses. The existing driveways off Lisbon Street that are currently serving the northwest parking areas will be consolidated into a new two-way driveway that will provide access to the new living care facility and parking garage. A secondary driveway is also proposed off Lauhala Street with access restricted to BWS's oversize fleet vehicles only.

In addition, Alternative 1 also entails the redevelopment of the northeast portion of the existing site to include a new BWS building with approximately 35,500 square feet (sf) of office uses, as well as an additional new parking garage for its employees. Access to the new office building is expected to be provided via an existing two-way driveway off Lisbon Street. See Figure 2 for the proposed site plan for Alternative 1.



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PROJECT SITE PLAN ALTERNATIVE 1

FIGURE 2

Alternative 2

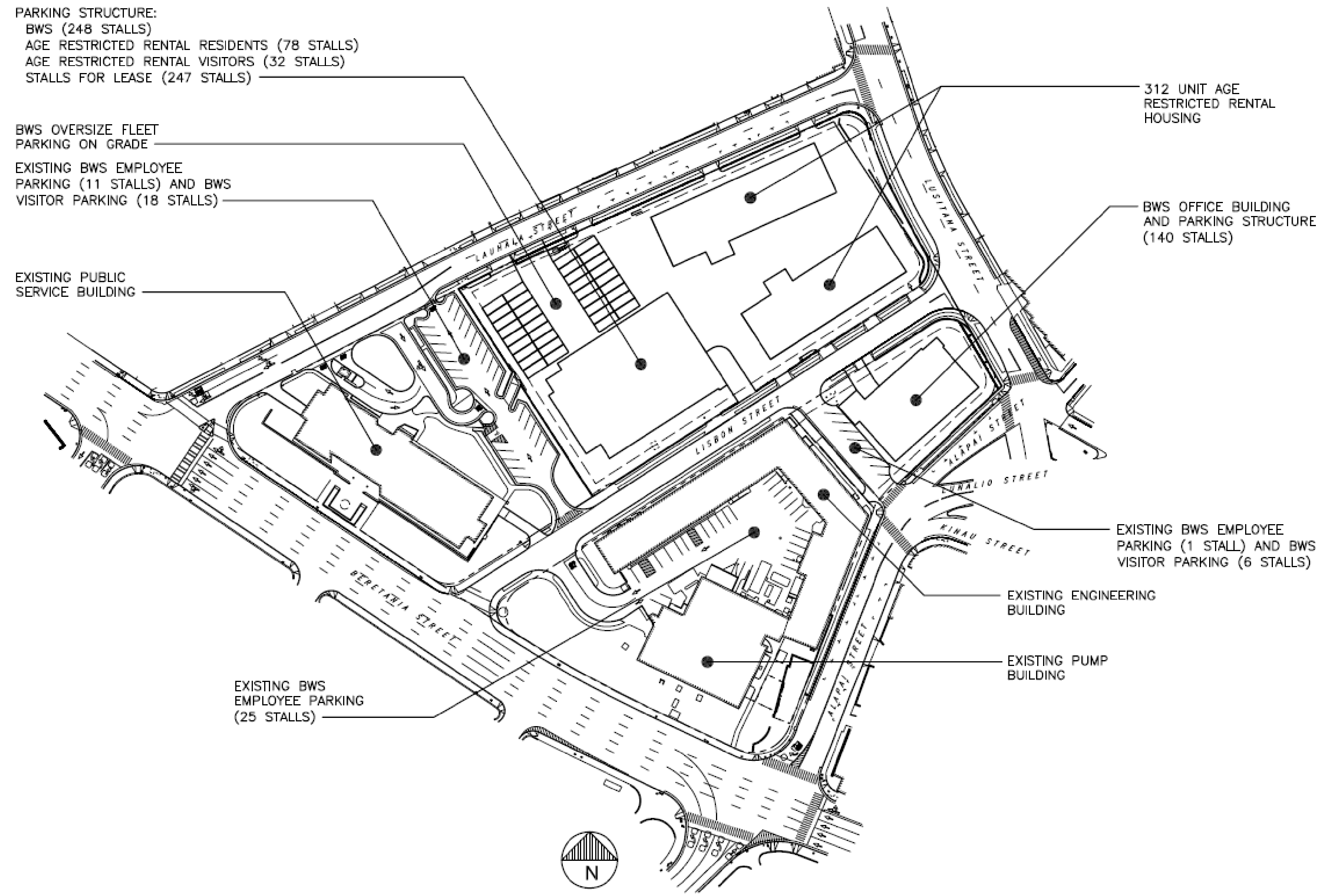
Under Alternative 2, the northwest portion of the existing site is expected to be replaced with a new senior living facility with approximately 312 units. Parking for the new senior living facility will be provided within a new parking structure that is also expected to house replacement parking for the BWS to offset the parking stalls displaced by the proposed project, as well as 247 additional parking stalls that are intended to be leased to the surrounding uses. The existing driveways off Lisbon Street that are currently serving the northwest parking areas will be consolidated into a new two-way driveway that will provide access to the new senior living facility and parking garage. A secondary driveway is also proposed off Lauhala Street with access restricted to BWS's oversize fleet vehicles only.

In addition, Alternative 2 also entails the redevelopment of the northeast portion of the existing site to include a new BWS building with approximately 35,500 sf for office uses, as well as an additional new parking garage for its employees. Access to the new office building is expected to be provided via an existing two-way driveway off Lisbon Street. See Figure 3 for the proposed site plan for Alternative 2.

Alternative 3:

Under Alternative 3, the northwest portion of the existing site is expected to be replaced with a new parking structure. The new parking structure is expected to house replacement parking for the BWS to offset parking stalls displaced by the proposed project, as well as 977 additional parking stalls that are intended to be leased to the surrounding uses. The existing driveways off Lisbon Street that are currently serving the northwest parking areas will be consolidated into a new two-way driveway that will provide access to the parking garage. A secondary driveway is also proposed off Lauhala Street with access restricted to BWS's oversize fleet vehicles only.

In addition, Alternative 3 also entails the redevelopment of the northeast portion of the existing site to include a new BWS building with approximately 35,500 sf for office uses as well as an additional new parking garage for its employees.



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BOARD OF WATER SUPPLY BERETANIA COMPLEX

PROJECT SITE PLAN ALTERNATIVE 2

FIGURE 3

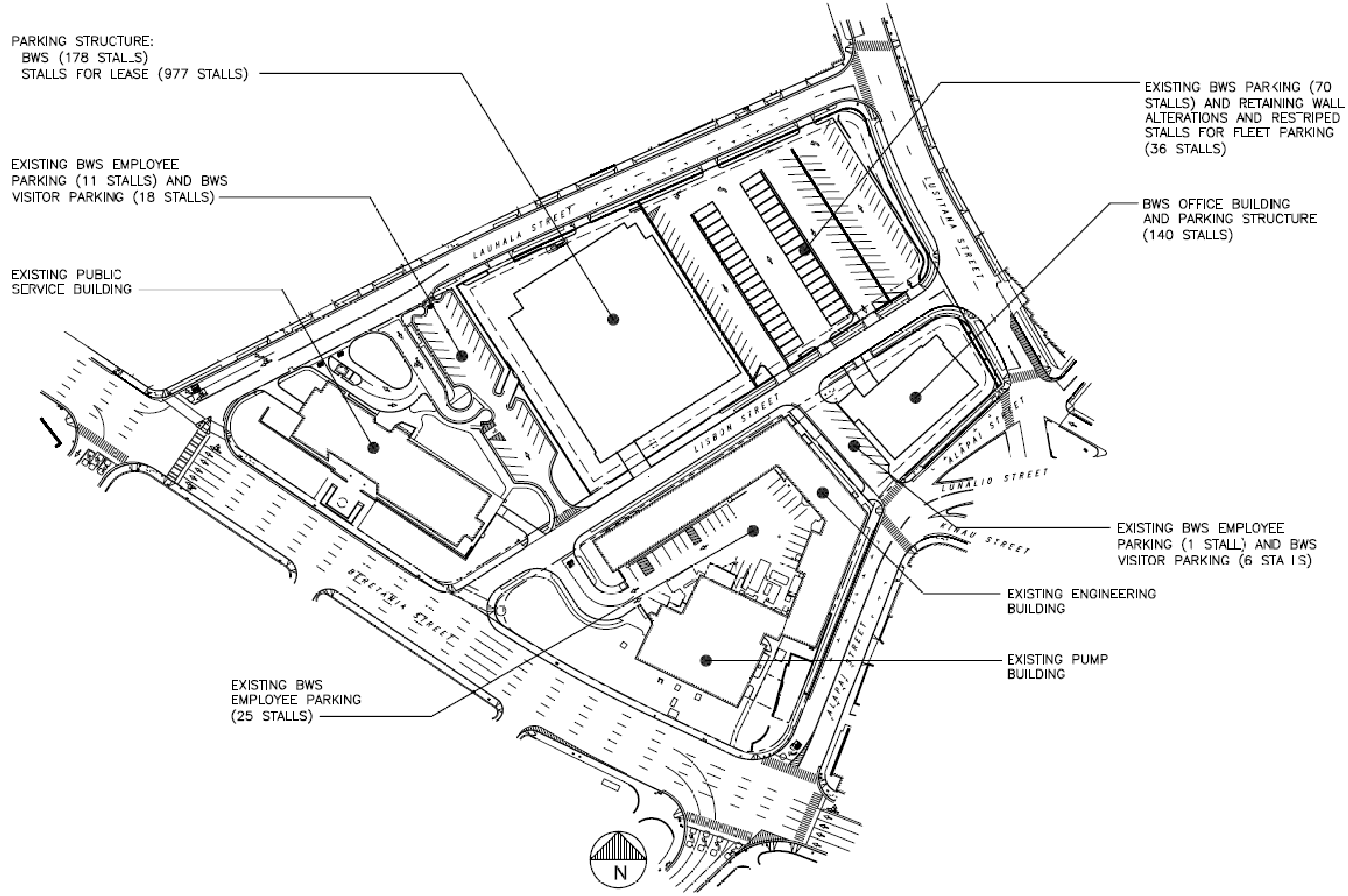
Access to the new office building is expected to be provided via an existing two-way driveway off Lisbon Street. See Figure 4 for the proposed site plan for Alternative 3.

III. EXISTING TRAFFIC CONDITIONS

A. Area Roadway System

Northwest of the project site, Punchbowl Street intersects Vineyard Boulevard. Vineyard Boulevard is a predominantly six-lane, two-way divided roadway that runs parallel to the Interstate H-1 Freeway through downtown Honolulu. At the intersection with Punchbowl Street, the eastbound approach on Vineyard Boulevard has an exclusive left-turn lane, two through lanes, and a shared through and right-turn lane while the westbound approach has an exclusive left-turn lane, a shared left-turn and through lane, two through lanes, and a shared through and right-turn lane. It should be noted that during the AM peak period, the curbside eastbound lane is converted from a shared through and right-turn lane to a right-turn only lane with temporary coning. At the signalized intersection with Vineyard Boulevard, the northbound approach of Punchbowl Street has an exclusive left-turn lane, one through lane, and exclusive shared through and right-turn lane while the southbound approach has one through lane and a shared through and right-turn lane.

East of the Vineyard Boulevard and Punchbowl Street intersection, Lusitana Street intersects Lauhala Street. Lusitana Street is a predominantly two-lane, two way roadway generally oriented in the east-west direction that serves as a connector roadway between Vineyard Boulevard and Kinau Street. At the intersection with Lauhala Street, the eastbound approach of Lusitana Street has one lane that serves through and right-turn movements while the westbound approach has one lane that serves left-turn and through movements. Lauhala Street is a predominantly two-lane, two-way roadway generally oriented in the north-south direction that serves as a connector roadway between Lusitana Street and South Beretania Street. At the unsignalized T-intersection with Lusitana Street, the northbound approach of Lauhala Street has one stop-controlled lane that serves left-turn and right-turning movements. It should be noted that there is a midblock crosswalk across Lusitana Street located



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BOARD OF WATER SUPPLY BERETANIA COMPLEX

PROJECT SITE PLAN ALTERNATIVE 3

FIGURE 4

approximately 130 feet west of this intersection that connects the Physicians Office Buildings of the nearby Queen's Medical Center on either side of Lusitana Street.

Further east of the intersection with Lauhala Street, Lusitana Street intersects Lisbon Street. At this unsignalized intersection, the eastbound and westbound approaches of Lusitana Street have one lane that serves all traffic movements. Lisbon Street is a predominantly two-lane, two-way roadway generally oriented in the north-south direction that serves as a connector roadway between South Beretania Street and Lusitana Street. At the intersection with Lusitana Street, the northbound approach of Lisbon Street has one stop-controlled lane that serves all traffic movements. The north leg of the intersection is comprised of an entrance driveway for the adjacent Physicians Office Building of the Queen's Medical Center.

At the east end of the study area, Lusitana Street intersects Alapai Street, Lunalilo Street, and Kinau Street. At this 5-way intersection, the eastbound approach of Lusitana Street has one lane that serves all traffic movements. Alapai Street originates at South King Street as four-lane, one-way (northbound) roadway that transitions to a two-lane, two-way roadway north of South Beretania Street with the exception of a short segment between Lunalilo Street and Lusitana Street where Alapai Street is a one-way (southbound) roadway. At the intersection with Lusitana Street, Lunalilo Street, and Kinau Street, the southbound approach of Alapai Street has one stop-controlled lane that serves all traffic movements. The westbound approach of the intersection is comprised of a short segment of Kinau Street which provides access from the Interstate H-1 Freeway to Lusitana Street. At this intersection, the Kinau Street approach has one stop-controlled lane that serves all traffic movements. The remaining approaches of this intersection are comprised of Lunalilo Street, a two-lane, two-way roadway generally oriented in the north-south direction. At the intersection with Lusitana Street, Alapai Street, and Kinau Street, both approaches of Lunalilo Street have one lane that serves all traffic movements.

South of the intersection with Lusitana Street, Alapai Street intersects South Beretania Street. South Beretania Street is a predominantly five-lane, one-way (westbound) roadway that with South King Street forms a couplet that runs parallel to the Interstate H-1 Freeway and Vineyard Boulevard through downtown Honolulu. The northbound approach of Alapai Street has three left-turn lanes and a through lane, while the southbound approach has a right-turn only lane. At this signalized intersection the westbound approach of South Beretania Street has four through lanes and a shared through and right-turn lane.

West of the intersection with Alapai Street, South Beretania Street intersects Lisbon Street. At this unsignalized T-intersection, the westbound approach of South Beretania Street has five through lanes and a shared through and right-turn lane. The southbound approach of Lisbon Street has one stop-controlled that serves right-turn movements.

Further west, South Beretania Street intersects Lauhala Street. The westbound approach of South Beretania Street has six lanes that serve all traffic movements while the southbound approach of Lauhala Street has a shared through and right-turn lane and an exclusive right-turn lane. The northbound approach of this signalized intersection is comprised of a driveway for the adjacent State of Hawaii Kalanimoku Building which includes two left-turn lanes and a through lane.

Southwest of the project site, South Beretania Street intersects Punchbowl Street. At this signalized intersection, the westbound approach of South Beretania Street has an exclusive left-turn lane, a shared left-turn and through lane, three through lanes, and an exclusive right-turn lane. At the intersection with South Beretania Street, Punchbowl Street is generally a four-lane, two-way roadway generally oriented in the north-south direction. The northbound approach of Punchbowl Street has one through lane while the southbound approach has two through lanes and a shared through and right-turn lane.

B. Traffic Volumes and Conditions

1. General

a. Field Investigation

Field investigations were conducted on November 2017 and April 2018 which consisted of manual turning movement count surveys during the morning peak hours between 5:00 AM and 8:00

AM and during the afternoon peak hours between 3:00 PM and 6:00 PM at the following intersections:

- Vineyard Boulevard and Punchbowl Street
- Vineyard Boulevard and Lusitana Street
- Lusitana Street and Lauhala Street
- Lusitana Street and Lisbon Street
- Lusitana Street, Alapai Street, Lunalilo Street, and Kinau Street
- South Beretania Street and Alapai Street
- South Beretania Street and Lisbon Street
- South Beretania Street and Lauhala Street
- South Beretania Street and Punchbowl Street

Appendix A includes the existing traffic count data.

b. Capacity Analysis Methodology

The highway capacity analyses performed in this study is based upon procedures presented in the "Highway Capacity Manual", Transportation Research Board, 2000, and the "Synchro" software, developed by Trafficware. It should be noted that the HCM 2010 methodology is available with the Synchro software; however, analysis conducted using that methodology is unable to accommodate all of the exclusive and shared-use lane configurations in the study area. As such, for the purpose of this report, the HCM 2000 methodology output was used. The analysis is based on the concept of Level of Service (LOS) to identify the traffic impacts associated with traffic demands during the peak periods of traffic.

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" unacceptable or potentially congested traffic operating conditions.

"Volume-to-Capacity" (v/c) ratio is another measure indicating the relative traffic demand to the road 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 indicates that the traffic demand exceeds the road's carrying capacity. The LOS definitions are included in Appendix B.

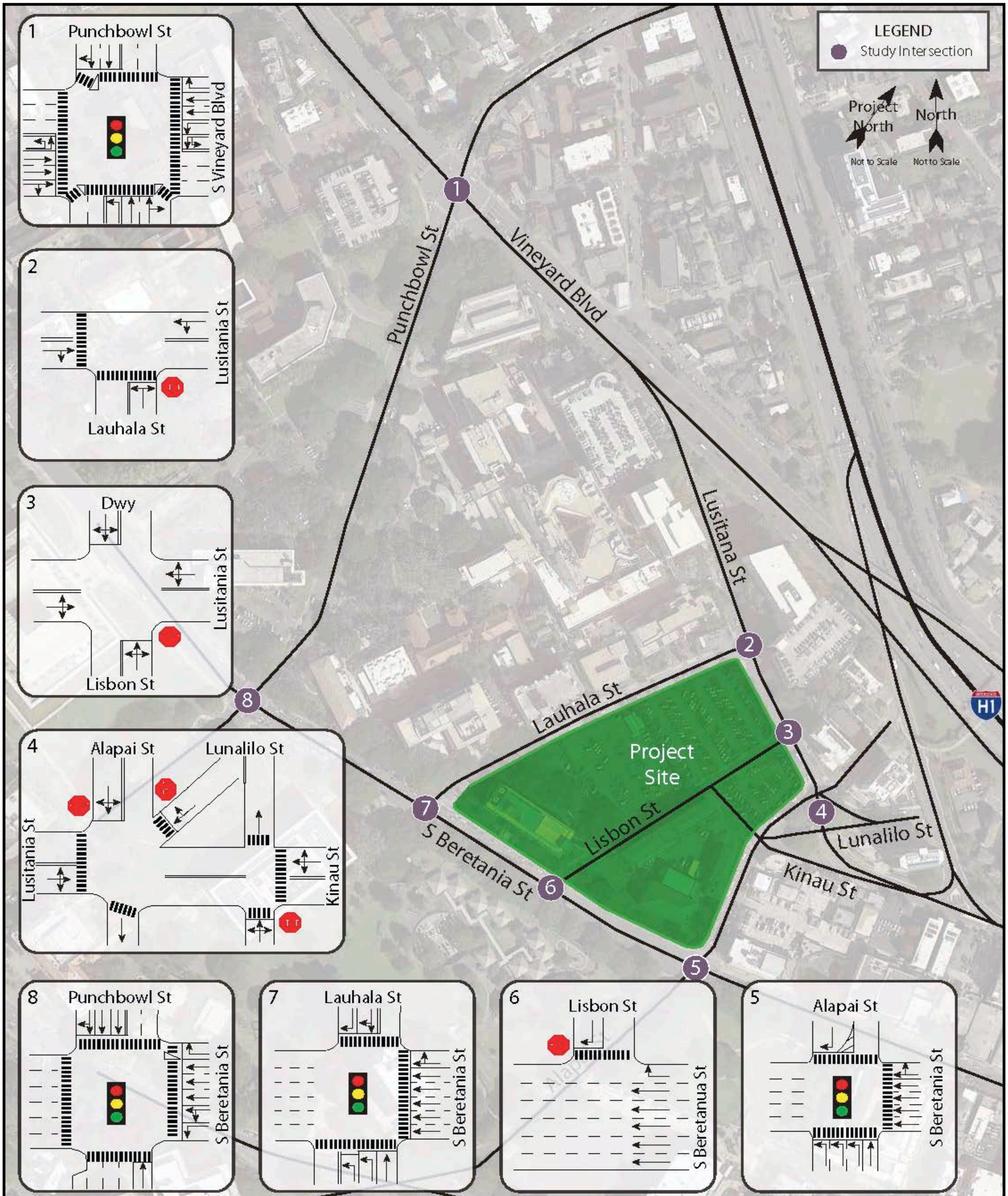
2. Existing Peak Hour Traffic

a. General

Figures 5 and 6 shows the existing lane uses and peak hour traffic volumes. The AM peak hour of traffic generally occurs between 7:00AM and 8:00 AM while the PM peak hour of traffic generally occurs between 4:15 PM and 5:15 PM. The analysis is based on these peak hour time periods for each study intersection to identify the traffic impacts resulting from the proposed project.

b. Vineyard Boulevard and Punchbowl Street

At the intersection with Punchbowl Street, Vineyard Boulevard carries 1,718 vehicles eastbound and 1,434 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume is less with 1,944 vehicles traveling eastbound and 791 vehicles traveling westbound. The eastbound approach operates at LOS "D" during both peak periods, while the westbound approach operates at LOS "D" and LOS "E" during the AM and PM peak periods, respectively. The Punchbowl Street approach of the intersection carries 947 vehicles northbound and 677 vehicles southbound during the AM peak period. During the PM peak period, the overall traffic volume increased with 1,263 vehicles traveling northbound and 443 vehicles traveling southbound. The northbound approach operates at LOS "E" during both peak periods while the southbound approach operates at LOS "D" during both periods. Vehicular queues periodically formed on all approaches of the intersection with the most significant queuing occurring along the northbound approach of Punchbowl Street during the PM peak period. During this period, queues typically extended through the upstream



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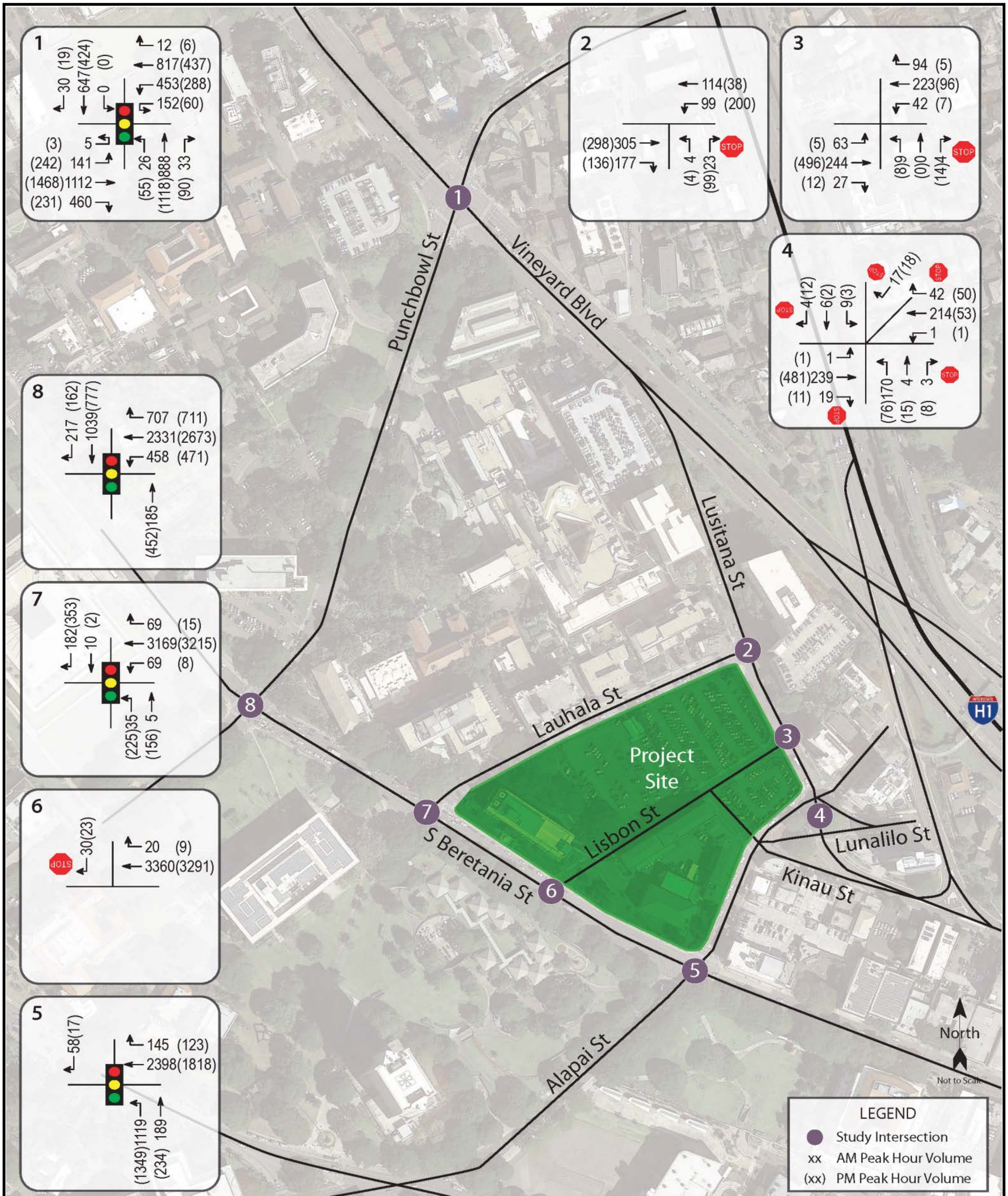
EXISTING LANE CONFIGURATIONS

FIGURE 5



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EXISTING PEAK HOURS OF TRAFFIC

FIGURE 6

intersection with Miller Street and occasionally to the upstream intersection with South Beretania Street. Most of these queues were observed to clear the intersection after each traffic signal cycle change, but occasionally vehicles had to wait for more than one traffic signal cycle to clear the intersection.

Crosswalks are provided across Vineyard Boulevard on the east and west sides of the intersection, as well as across Punchbowl Street on the north and south sides of the intersection. During the AM peak period, 70 pedestrians and 11 pedestrians were observed crossing Vineyard Boulevard on the east and west sides of the intersection, respectively, while 87 pedestrians and 11 pedestrians were observed crossing Punchbowl Street on the north and south sides of the intersection, respectively. During the PM peak period, 22 pedestrians and 19 pedestrians were observed crossing Vineyard Boulevard on the east and west sides of the intersection, respectively, while 7 pedestrians and 32 pedestrians were observed crossing Punchbowl Street on the north and south sides of the intersection, respectively.

c. Lusitana Street and Lauhala Street

At the intersection with Lauhala Street, Lusitana Street carries 482 vehicles eastbound and 213 vehicles westbound during the AM peak period. During the PM peak period traffic volumes remained approximately the same with 434 vehicles traveling eastbound and 238 vehicles traveling westbound. The westbound left-turn traffic movement operates at LOS "A" during both peak periods.

The Lauhala Street approach of the intersection carries 27 vehicles and 103 vehicles northbound during the AM and PM peak periods, respectively. The northbound approach of Lauhala Street operates at LOS "B" during both peak periods.

Crosswalks are provided across Lusitana Street on the west side of the intersection and across Lauhala Street on the south side of the intersection. During the AM peak period, 88 pedestrians were observed crossing Lusitana Street on the west side of the intersection and 66 pedestrians were observed crossing Lauhala Street on the south side of the intersection. During the PM peak period, 69 pedestrians were observed crossing Lusitana Street on the west side of the intersection and 42 pedestrians were observed crossing Lauhala Street on the south side of the intersection. At the adjacent midblock crossing between the two Physicians Office Buildings, 61 pedestrians and 41pedestrians were observed crossing Lusitana Street during the AM and PM peak periods, respectively.

d. Lusitana Street and Lisbon Street

At the intersection with Lisbon Street, Lusitana Street carries 334 vehicles eastbound and 359 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume was approximately the same with 513 vehicles traveling eastbound and 108 vehicles traveling westbound. The left-turn traffic movements at both approaches of Lusitana Street operate at LOS "A" during both peak periods.

The Lisbon Street approach of the intersection carries 13 vehicles and 22 vehicles northbound during the AM and PM peak periods, respectively. The northbound approach on Lisbon Street operates at LOS "C" and LOS "B" during the AM and PM peak periods, respectively.

Although there are no marked crosswalks at this intersection, 80 pedestrians and 35 pedestrians were observed crossing Lisbon Street during the AM and PM peak periods, respectively.

e. Lusitana Street, Alapai Street, Lunalilo Street, and Kinau Street

At the intersection with Alapai Street, Lunalilo Street, and Kinau Street, the Lusitana Street approach carries 258 vehicles and 494 vehicles eastbound during the AM and PM peak periods, respectively, while the Kinau Street approach carries 216 vehicles and 58 vehicles westbound during the AM and PM peak periods, respectively. The Alapai Street approach of the intersection carries 19 vehicles and 9 vehicles southbound during the AM and PM peak periods, respectively, while the Lunalilo Street approaches carry 177 vehicles northbound and 17 vehicles southbound during the AM peak period, and 99 vehicles northbound and 18 vehicles southbound during the PM peak period. The northbound approach from Lunalilo Street operates at a LOS "C" during both peak periods while the southbound approach of that roadway operates at LOS "A" during both peak periods. The southbound approach of Alapai Street operates at LOS "C" and LOS "B" during the AM and PM peak periods, respectively.

Crosswalks are provided across the Lusitana Street, Kinau Street, and Lunalilo Street approaches of the intersection, as well as Alapai Street on the south side of the intersection. During the AM peak period, 41 pedestrians were observed crossing Lusitana Street on the west side of the intersection while 35 pedestrians were observed crossing Alapai Street and Lunalilo Street on the south side of the intersection. In addition, 5 pedestrians were observed crossing Lunalilo Street and Kinau Street on the north and east sides of the intersection, respectively. During the PM peak period 36 pedestrians were observed crossing Lusitana Street while 32 pedestrians were observed crossing Alapai Street and Lunalilo Street on the south side of the intersection. In addition, 8 pedestrians were observed crossing Lunalilo on the north side of the intersection while 11 pedestrians were observed crossing Kinau Street on the east side of the intersection.

f. South Beretania Street and Alapai Street

At the intersection with Alapai Street, South Beretania Street carries 2,441 vehicles and 1,941 vehicles westbound during the AM and PM peak periods, respectively. This approach operates at LOS

"B" during both peak periods. The Alapai Street approach carries 1,260 vehicles northbound and 56 vehicles southbound during the AM peak period. During the PM peak period, the overall traffic volume is higher with 1,583 vehicles traveling northbound and 17 vehicles traveling southbound. The northbound approach on Alapai Street operates at LOS "C" during both peak periods while the southbound approach operates at LOS "C" and LOS "B" during the AM and PM peak periods, respectively. Vehicular queues periodically formed on the approaches of the intersection with the most significant queuing occurring along South Beretania Street during the PM peak period. During this peak period, westbound queues, primarily in the two lanes on the north side of the roadway, extended from the downstream intersection with Punchbowl Street through this intersection and the upstream intersection with Hale Makai Street.

Crosswalks are provided across South Beretania Street on the east side of the intersection, as well as across Alapai Street on the north and south sides of the intersection. During the AM peak period, 97 pedestrians were observed crossing South Beretania Street while 50 pedestrians and 59 pedestrians were observed crossing Alapai Street on the north and south sides of the intersection, respectively. During the PM peak period, 108 pedestrians were observed crossing South Beretania Street while 34 pedestrians and 70 pedestrians were observed crossing Alapai Street on the north and south sides of the intersection, respectively.

g. South Beretania Street and Lisbon Street

At the intersection with Lisbon Street, South Beretania Street carries 3,380 vehicles and 3,300 vehicles westbound during the AM and PM peak periods, respectively. The Lisbon Street approach carries 30 vehicles and 23 vehicles southbound during the AM and PM peak periods, respectively. The southbound approach of Lisbon Street operates at a LOS "B" during the AM and PM peak periods. As previously noted, queues formed along South Beretania Street during the PM peak period with westbound queues from the downstream intersection with Punchbowl Street extending through this intersection during that period.

A crosswalk is provided across the Lisbon Street approach of the intersection. During the AM peak period, 38 pedestrians were observed crossing Lisbon Street on the north side of the intersection. During the PM peak period, 23 pedestrians were observed crossing Lisbon Street on the north side of the intersection.

h. South Beretania Street and Lauhala Street

At the intersection with Lauhala Street, South Beretania Street carries 3,307 vehicles and 3,238 vehicles westbound during the AM and PM peak periods, respectively. This approach operates at LOS "A" during both peak periods. The southbound approach of Lauhala Street carries192 vehicles and 355 vehicles during the AM and PM peak periods, respectively. The southbound approach on Lauhala Street operates at LOS "D" during both peak periods. The northbound approach is comprised of the driveway that serves the adjacent Kalanimoku Building. This approach carries 40 vehicles and 381 vehicles northbound during the AM and PM peak periods, respectively. As previously noted, queues formed along South Beretania Street during the PM peak period with westbound queues from the downstream intersection with Punchbowl Street extending through this intersection during that period.

Crosswalks are provided across South Beretania Street on the east side of the intersection, as well as across Lauhala Street on the north side, and the driveway approach on the south side of the intersection. During the AM peak period, 110 pedestrians were observed crossing South Beretania Street on the east side of the intersection while 71 pedestrians and 25 pedestrians were observed crossing on the north and south sides of the intersection, respectively. During the PM peak period, 119 pedestrians were observed crossing South Beretania Street on the east side of the intersection while 68 pedestrians and 40 pedestrians were observed crossing Lauhala Street on the north and south sides of the intersection, respectively.

i. South Beretania Street and Punchbowl Street

At the intersection with Punchbowl Street, South Beretania Street carries 3,496 vehicles and 3,911 vehicles westbound during the AM and PM peak periods, respectively. This approach operates at LOS "B" during the AM and PM peak periods. The Punchbowl Street approaches carry 185 vehicles northbound and 1,256 vehicles southbound during the AM peak period. During the PM peak period, the overall traffic volume is slightly less with 460 vehicles traveling northbound and 939 vehicles traveling southbound. The northbound approach operates at LOS "C" and LOS "D" during the AM and PM peak periods, respectively, while the southbound approach operates at LOS "C" during both peak periods. Vehicular traffic queues periodically formed on the approaches of the intersection with the most significant queuing occurring on the South Beretania Street approach of the intersection during the PM peak period. During this period, westbound queues extended through the upstream intersections with Lauhala Street, Lisbon Street, and Alapai Street. In addition, vehicular queues along Punchbowl Street from the intersection with Vineyard Boulevard occasionally extended to this intersection.

Crosswalks are provided across South Beretania Street on the east and west sides of the intersection, as well as across Punchbowl Street on the north and south sides of the intersection. During the AM peak period, 126 pedestrians and 44 pedestrians were observed crossing South Beretania Street on the east and west sides of the intersection, respectively, while 135 pedestrians and 87 pedestrians were observed crossing Punchbowl Street on the north and south sides of the intersection, respectively. During the PM peak period, 111 pedestrians and 97 pedestrians were observed crossing South Beretania Street on the east and west sides of the intersection, respectively, while 133 pedestrians and 124 pedestrians were observed crossing Punchbowl Street on the north and south sides of the intersection, respectively.

3. Other Modes of Travel

a. Pedestrian Facilities

Pedestrian circulation in the vicinity of the Board of Water Supply is currently facilitated by improved facilities along the adjacent roadways including sidewalks and marked crosswalks. On the south side of the project site, South Beretania Street includes sidewalks and street lighting with crosswalks and curb ramps provided at the intersections with Alapai Street, Lisbon Street, Lauhala Street, and Punchbowl Street and pedestrian crossing facilitated at the Alapai Street, Lauhala Street, and Punchbowl Street intersections through pedestrian phasing at those signalized intersections. On the north, east, and west sides of the project site, Lusitana Street, Lauhala Street, and Alapai Street, have sidewalks and street lighting with trees along Lusitana Street providing intermittent shade on the north side of the roadway.

b. Bicycle Facilities

Bicycle facilities generally consist of shared-use paths, bicycle lanes, or shared roadways with pavement markings called sharrows. In the vicinity of the Board of Water Supply, bike lanes are provided along Lusitana Street, Alapai Street, and South Beretania Street. To the west, connections to Hotel Street which has been designated for transit and bicycles is provided via paths through the adjacent State

Capitol grounds, while south of the project site is the cycle track along South King Street. In addition, there are three Biki bikeshare stations located within a block of the Board of Water Supply site including stations located midblock along Lauhala Street, near the intersection of South Beretania Street and Lauhala Street, and the intersection of Punchbowl Street and South Beretania Street.

c. **Transit Facilities**

Public transit facilities are provided in the vicinity of the Board of Water Supply along South Beretania Street, Punchbowl Street, South King Street, and Alapai Street. Bus stops servicing westbound routes are located within a block along South Beretania Street and Punchbowl Street with stops servicing eastbound routes located along South King Street approximately two blocks away. Two of the closest bus stops along South Beretania Street are located west of the intersection with Punchbowl Street and east of the intersection with Alapai Street. The bus stop near Punchbowl Street is served by approximately 40 routes while the bus stop near Alapai Street is served by 4 routes. In addition, the Alapai Transit Center is also located in close proximity to the Board of Water Supply site along Alapai Street. The transit center is served by approximately 31 bus routes. It should also be noted that the City and County of Honolulu is currently developing a fixed guideway transit system that will extend from Kapolei to the central Honolulu area thereby providing an alternate mode of travel. In the vicinity of the project site, the guideway alignment is expected to run along Halekauwila Street with the Civic Center Station approximately half a mile south of the Board of Water Supply.

III. PROJECTED TRAFFIC CONDITIONS

A. Without Project

1. Through Traffic Forecasting Methodology

The travel forecast is based upon historical traffic count data obtained from the State DOT, Highways Division at survey stations located along South Beretania Street, Punchbowl Street, and Vineyard Boulevard in the vicinity of the proposed project site. The historical data indicates relatively stable traffic volumes along the study corridors and as such, an annual traffic growth rate of approximately 1.0 % was conservatively assumed in the project vicinity. Using 2017 as the Base Year, a growth rate factor of 1.09 was applied to the existing traffic demands along South Beretania Street, Punchbowl Street, and Vineyard Boulevard to achieve the projected Year 2026 traffic demands.

2. Other Considerations

West of the project site is Queen Medical Center which has previously prepared a 15-year Master Plan that outlined development plans for the campus to modernize existing spaces and expand its current services. The Queen Medical Center Master Plan was expected to be implemented in three phases with completion of the third phase expected by Year 2025. To date, Queen's Medical Center has completed some of the planned campus improvements; however, as stated in the "Traffic Assessment Report for the Queen's Medical Center" dated July 2018, the medical complex does not plan on initiating any of the remaining improvements included in the Master Plan at this time. As such, this project was not incorporated into to the without project conditions.

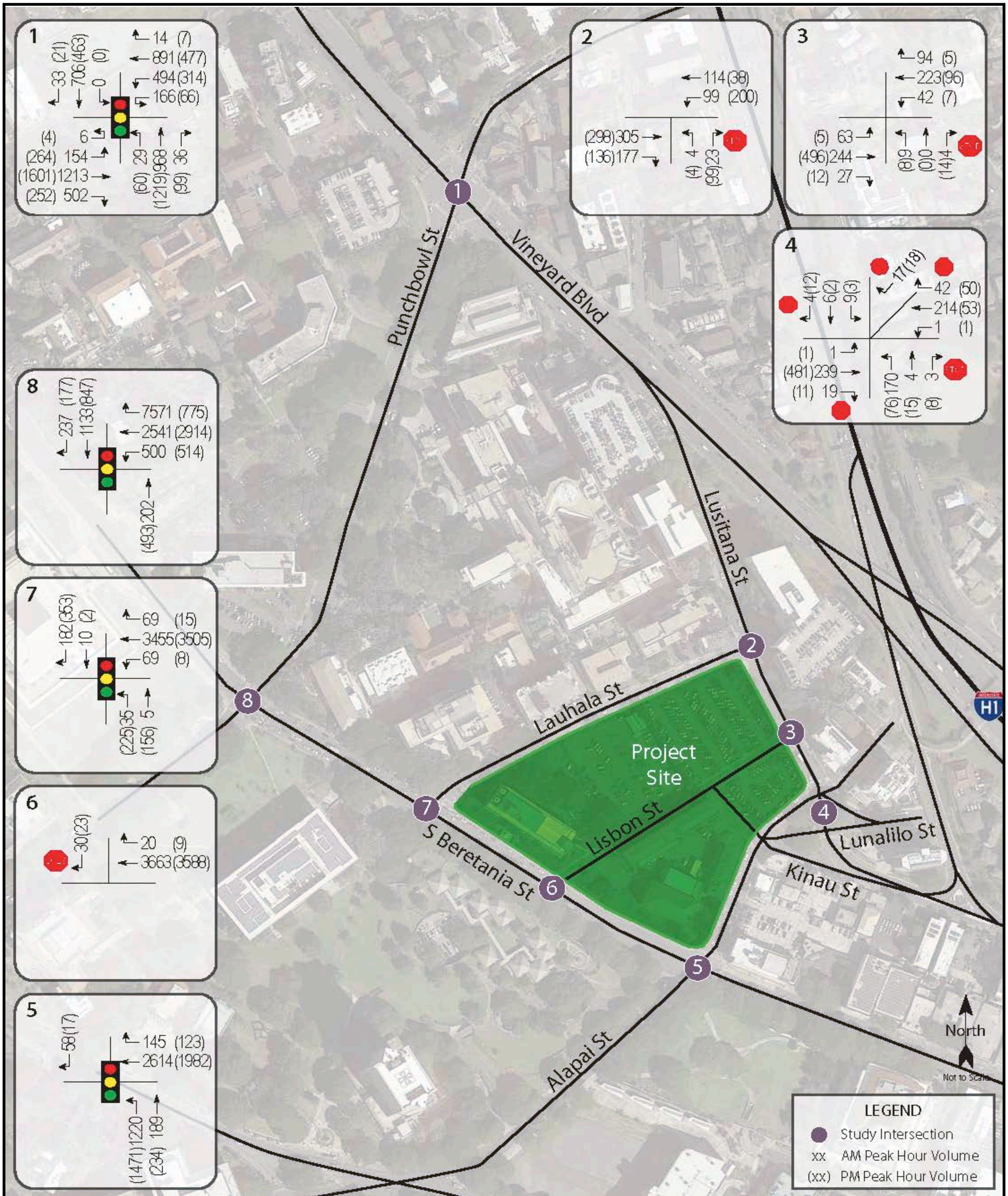
3. Year 2026 Total Traffic Volumes Without Project

The projected Year 2026 AM and PM peak period traffic volumes and operating conditions without the implementation of the proposed project are shown in Figure 7 and summarized in Table 2. The analysis incorporates the anticipated ambient growth in traffic in the vicinity. The existing levels of service are provided for comparison purposes. LOS calculations are included in Appendix D.

Table 1: Existing and Projected Year 2026 (Without Project) LOS Traffic Operating Conditions

Intersection	Approach/ Critical Movement	AM		PM	
		Exist	Year 2026 w/out Proj	Exist	Year 2026 w/out Proj
Vineyard Blvd/ Punchbowl St	Eastbound	D	E	D	E
	Westbound	D	E	E	E
	Northbound	E	F	E	E
	Southbound	D	D	D	D
Lusitana St/ Lauhala St	Westbound (LT*)	A	A	A	A
	Northbound	B	B	B	B
Lusitana St/ Lisbon St	Westbound (LT*)	A	A	A	A
	Northbound	C	C	B	B
Lusitana St/ Alapai St/ Lunalilo St/ Kinau St	Eastbound (LT*)	A	A	A	A
	Westbound (LT*)	A	A	A	A
	Northbound	C	C	C	C
	Southbound	B	B	B	B
South Beretania St/ Alapai St	Westbound	B	B	B	B
	Northbound	C	C	C	C
	Southbound	B	B	B	B
South Beretania St/ Lisbon St	Southbound	B	B	B	B
South Beretania St/ Lauhala St	Westbound	A	A	A	A
	Southbound	D	D	D	D

*LT = Left-Turn



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BOARD OF WATER SUPPLY BERETANIA COMPLEX

YEAR 2026 PEAK HOURS OF TRAFFIC WITHOUT PROJECT

FIGURE 7

Table 1: Existing and Projected Year 2026 (Without Project) LOS Traffic Operating Conditions (Cont'd)

Intersection	Approach/ Critical Movement	AM		PM	
		Exist	Year 2026 w/out Proj	Exist	Year 2026 w/out Proj
South Beretania St/ Punchbowl St	Westbound	B	C	B	B
	Northbound	C	C	D	D
	Southbound	C	D	C	C

*LT = Left-Turn

Under Year 2026 without project conditions, traffic operations during the AM peak period are expected to deteriorate slightly from existing conditions due to ambient growth in traffic. Along Punchbowl Street, traffic operations at the intersection with South Beretania Street are expected to deteriorate from LOS "C" or better to LOS "D" or better during the AM peak period while those at the intersection with Vineyard Boulevard are expected to deteriorate from LOS "E" or better to LOS "F" or better during the same peak period. The low levels of service at the intersection of Vineyard Boulevard and Punchbowl Street are influenced by the high volume of conflicting traffic movements at this intersection. Along Lusitana Street, traffic operations at the intersections with Lisbon Street and Alapai Street, Lunalilo Street, and Kinau Street are expected to continue operating at LOS "C" or better during both peak periods, while those at the intersection with Lauhala Street are expected to continue operating at LOS "B" or better during both peak periods. Traffic operations at the remaining intersections along South Beretania Street are also expected to remain similar to without project conditions.

B. With Project

1. Site-Generated Traffic

a. 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, 10th Edition," 2017. 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 square foot of development, per number of beds, or per number of residential units.

Typically, parking garages are not directly linked to the generation of new trips. Rather, trip generation is related to the generation characteristics of associated land uses. However, since the proposed parking garage is intended to include parking stalls to be leased to surrounding existing land uses, a direct correlation cannot be drawn between those land uses and the generation of new trips in the vicinity. As such, for the purpose of this report, the methodology used in this study to determine the trips associated with these parking stalls is based upon the procedures developed by ITE and published in "Parking Generation, 4th Edition," 2010. Similar to the trip generation rates, the ITE parking generation rates are developed empirically by correlating parking demand ratios over the course of a typical day with various land uses and building types. Using parking distribution ratios over the course of a typical day for land uses similar to those in the surrounding area, trip generation characteristics for the AM and PM peak period were determined using the number of available parking stalls as the independent variable. The applied daily distribution of trips is included in Appendix E.

Tables 2-4 summarizes the trip generation characteristics related to the redevelopment of the Board of Water Supply under Alternative 1, 2, and 3 applied to the AM and PM peak hours of traffic.

Table 2: Peak Hour Trip Generation Alternative 1

ASSISTED LIVING		
INDEPENDENT VARIABLE:		# of Beds = 266
		PROJECTED TRIP ENDS
AM PEAK	ENTER	32
	EXIT	19
	TOTAL	51
PM PEAK	ENTER	26
	EXIT	43
	TOTAL	69
OFFICE (GENERAL OFFICE BUILDING)		
INDEPENDENT VARIABLE:		1,000 sf of development = 35.5
		PROJECTED TRIP ENDS
AM PEAK	ENTER	35
	EXIT	6
	TOTAL	41
PM PEAK	ENTER	7
	EXIT	34
	TOTAL	41
LEASABLE PARKING STALLS		
INDEPENDENT VARIABLE:		# of Parking Stalls= 218
		PROJECTED TRIP ENDS
AM PEAK	ENTER	86
	EXIT	14
	TOTAL	99
PM PEAK	ENTER	12
	EXIT	59
	TOTAL	71
TOTALS		
AM PEAK	ENTER	153
	EXIT	39
	TOTAL	192
PM PEAK	ENTER	45
	EXIT	136
	TOTAL	181

Table 3: Peak Hour Trip Generation Alternative 2

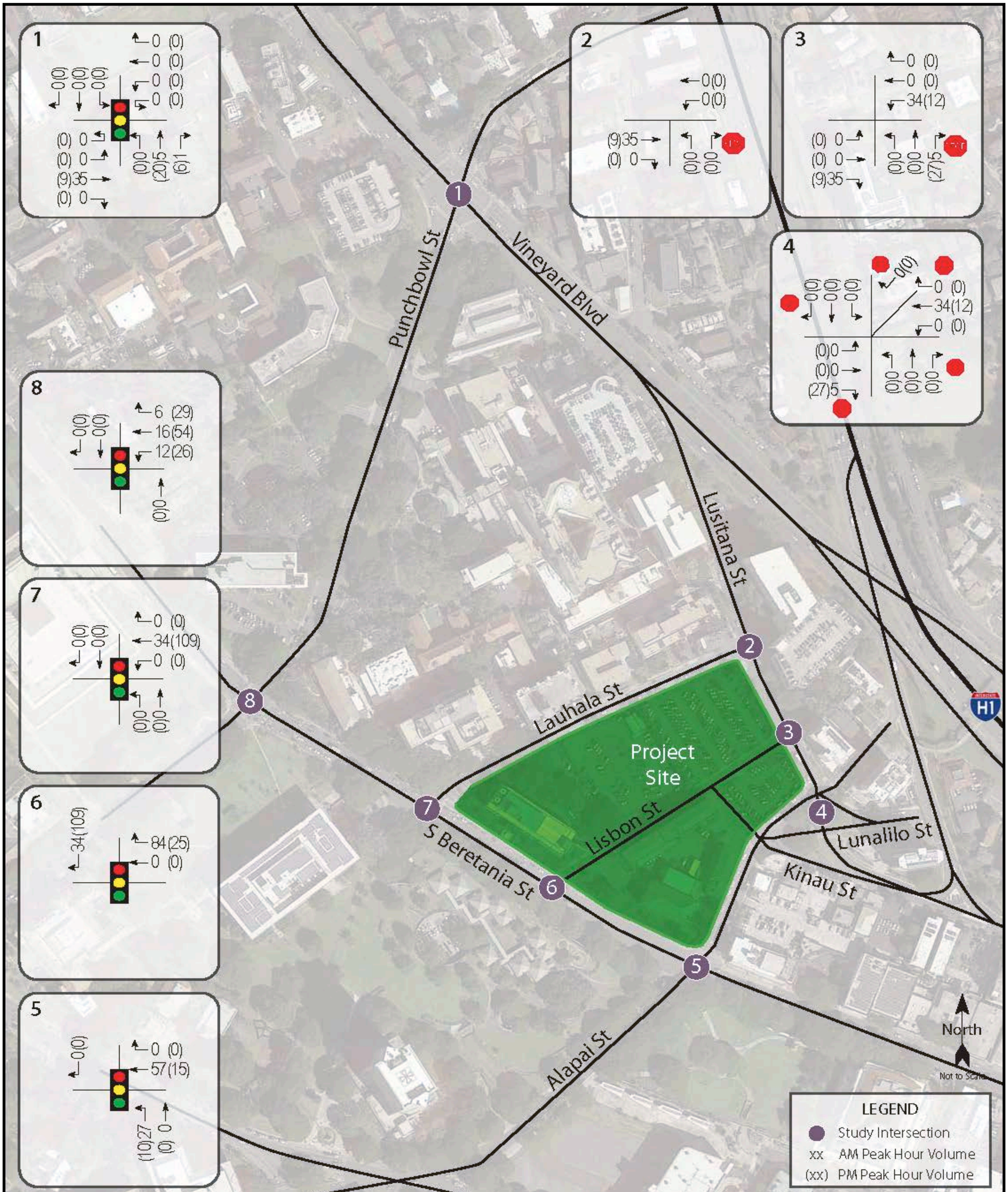
SENIOR ADULT HOUSING INDEPENDENT VARIABLE:		# of Units = 312
		PROJECTED TRIP ENDS
AM PEAK	ENTER	22
	EXIT	40
	TOTAL	62
PM PEAK	ENTER	45
	EXIT	36
	TOTAL	81
OFFICE (GENERAL OFFICE BUILDING) INDEPENDENT VARIABLE:		1,000 sf of development = 35.5
		PROJECTED TRIP ENDS
AM PEAK	ENTER	35
	EXIT	6
	TOTAL	41
PM PEAK	ENTER	7
	EXIT	34
	TOTAL	41
LEASABLE PARKING STALLS INDEPENDENT VARIABLE:		# of Parking Stalls= 247
		PROJECTED TRIP ENDS
AM PEAK	ENTER	97
	EXIT	16
	TOTAL	113
PM PEAK	ENTER	13
	EXIT	68
	TOTAL	81
TOTALS		
AM PEAK	ENTER	154
	EXIT	62
	TOTAL	215
PM PEAK	ENTER	65
	EXIT	138
	TOTAL	203

Table 4: Peak Hour Trip Generation Alternative 3

OFFICE (GENERAL OFFICE BUILDING)		
INDEPENDENT VARIABLE:		1,000 sf of development = 35.5
		PROJECTED TRIP ENDS
AM PEAK	ENTER	35
	EXIT	6
	TOTAL	41
PM PEAK	ENTER	7
	EXIT	34
	TOTAL	41
LEASABLE PARKING STALLS		
INDEPENDENT VARIABLE:		# of Parking Stalls= 977
		PROJECTED TRIP ENDS
AM PEAK	ENTER	379
	EXIT	62
	TOTAL	441
PM PEAK	ENTER	51
	EXIT	263
	TOTAL	314
TOTALS		
AM PEAK	ENTER	414
	EXIT	68
	TOTAL	482
PM PEAK	ENTER	58
	EXIT	297
	TOTAL	354

b. Trip Distribution

Figures 8-10 show the distribution of site-generated traffic during the AM and PM peak periods under Alternatives 1-3, respectively. Primary access to the proposed project under the three alternatives will be provided via driveways off Lisbon Street. The directional distribution of site-generated vehicles was based upon historical traffic data along the regional roadways in the vicinity of the project including South Beretania Street and South King Street which indicate the relative distribution of traffic. As such, 55% of site-generated trips were assumed to travel to/from the west while 45% were to travel to/from the east during the AM and PM peak hours of traffic. The directional distribution of all site generated vehicles at the



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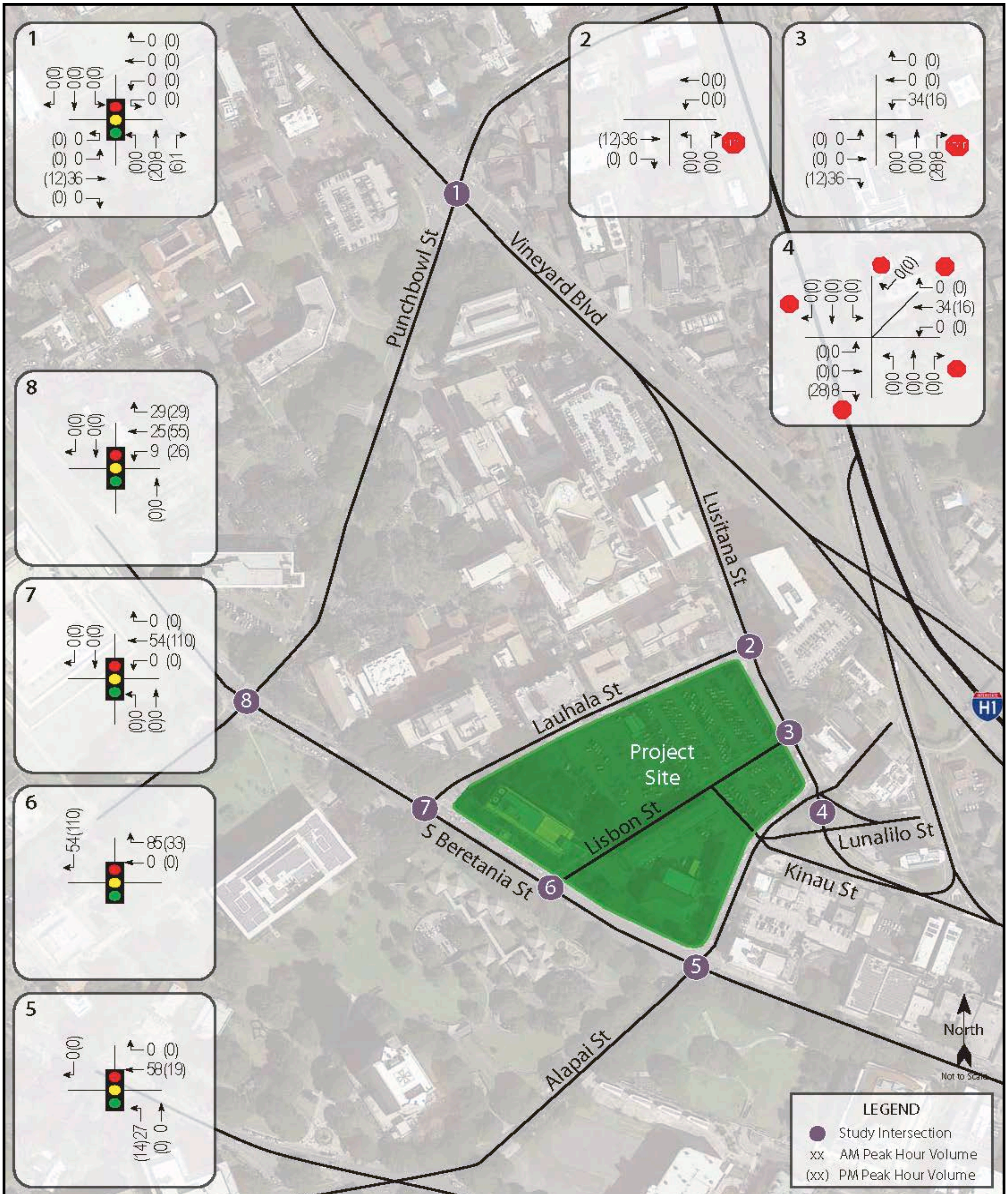
BOARD OF WATER SUPPLY BERETANIA COMPLEX

DISTRIBUTION OF SITE-GENERATED VEHICLES WITH ALTERNATIVE 1

FIGURE 8



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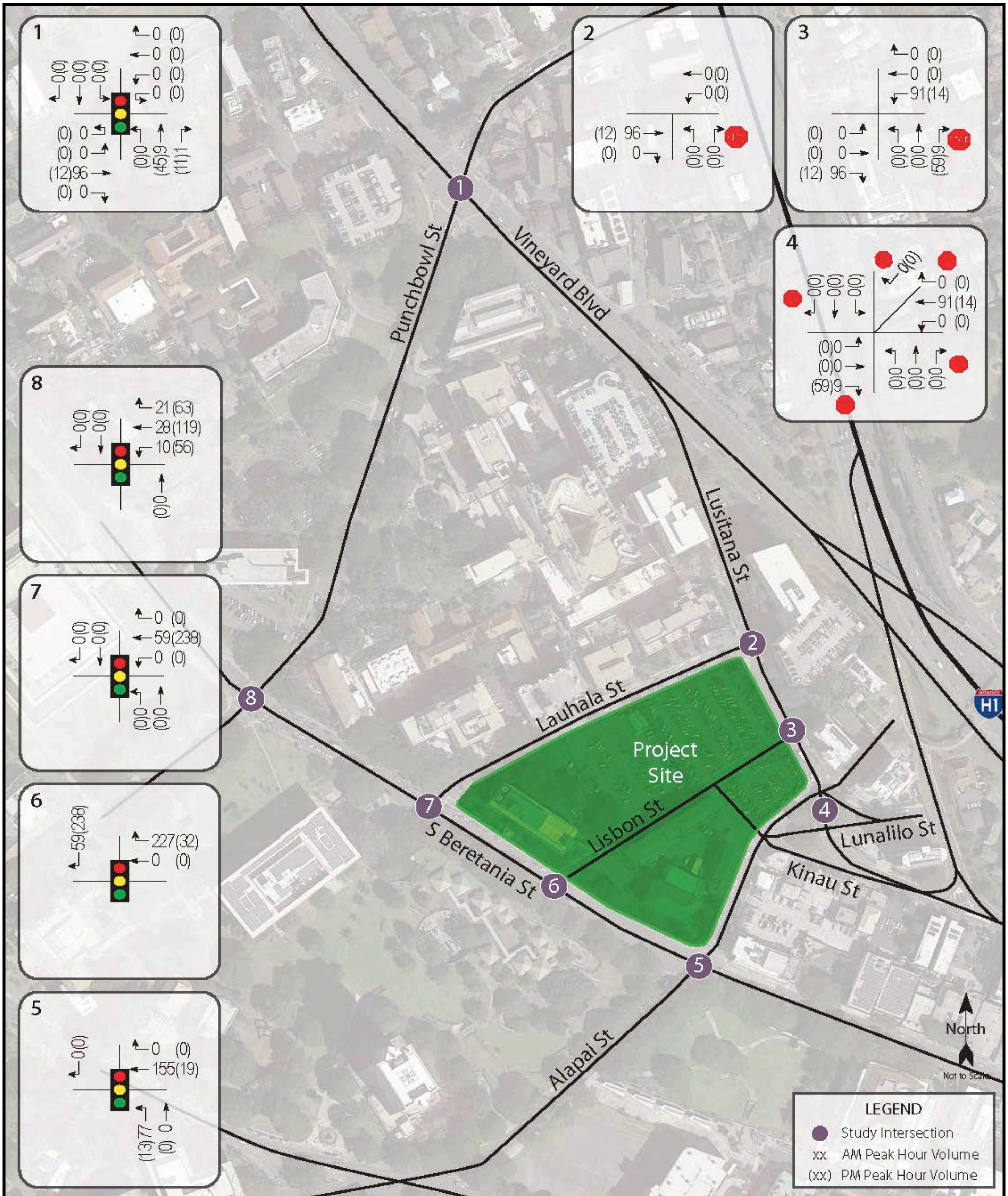
BOARD OF WATER SUPPLY BERETANIA COMPLEX

DISTRIBUTION OF SITE-GENERATED VEHICLES WITH ALTERNATIVE 2

FIGURE 9



BOARD OF WATER SUPPLY BERETANIA COMPLEX

DISTRIBUTION OF SITE-GENERATED VEHICLES WITH ALTERNATIVE 3

FIGURE 10

WILSON OKAMOTO CORPORATION

study intersections was based on their assumed origin/destination, allowed turning movements, and the relative convenience of the available routes.

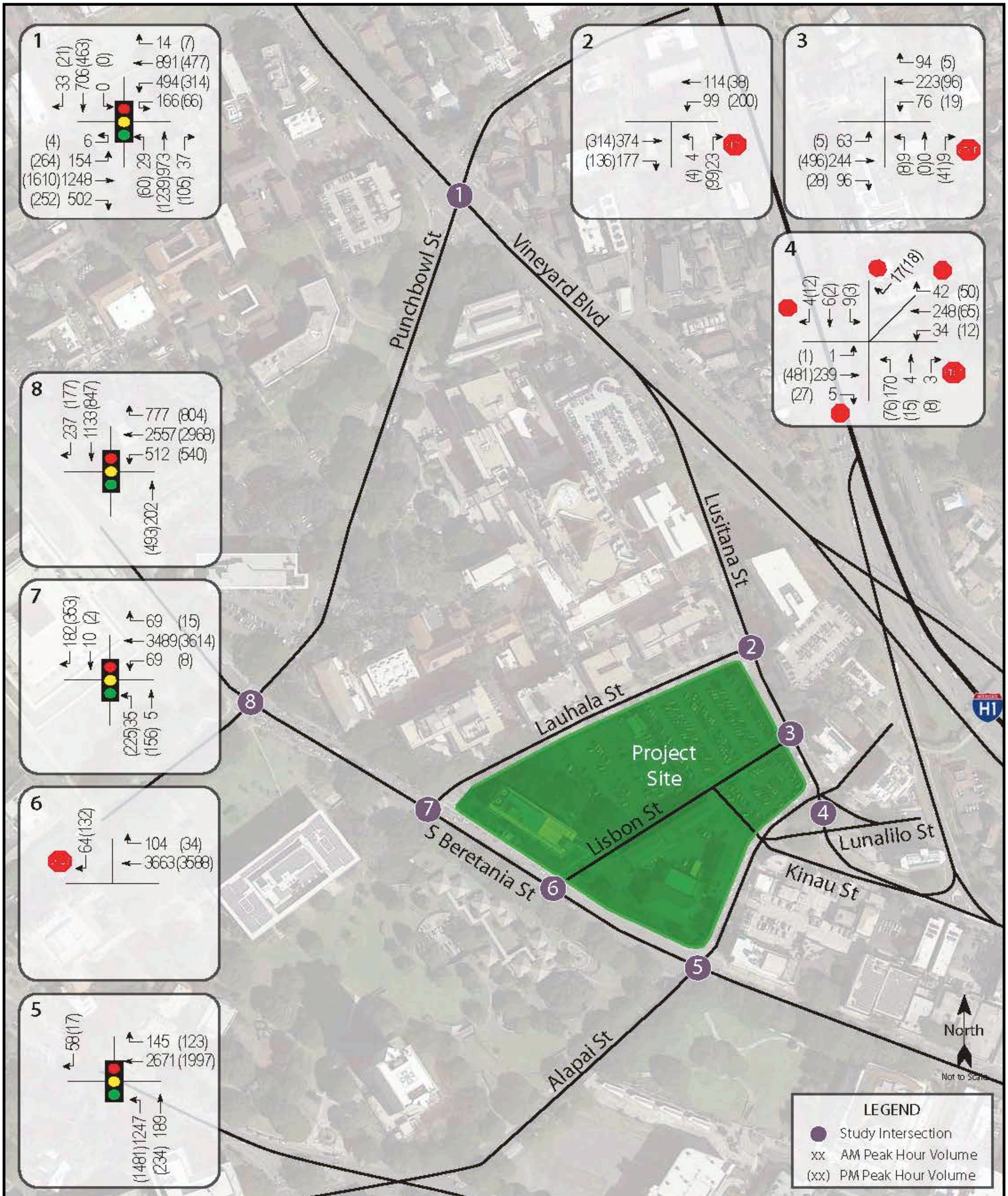
2. Year 2026 Total Traffic Volumes with Alternative 1

The Year 2026 cumulative AM and PM peak hour traffic conditions with the implementation of Alternative 1 are shown on Figure 11 and summarized in Table 5. The cumulative volumes consist of site-generated traffic superimposed over the Year 2026 projected traffic demands. The projected Year 2026 (Without Project) operating conditions are provided for comparison purposes. LOS calculations are included in Appendix F.

Table 5: Projected Year 2026 (Without and With Alternative 1) LOS Traffic Operating Conditions

Intersection	Approach/ Critical Movement	AM		PM	
		Year 2026		Year 2026	
		w/out Proj	w/ Alt 1	w/out Proj	w/ Alt 1
Vineyard Blvd/ Punchbowl St	Eastbound	E	E	E	E
	Westbound	E	E	E	E
	Northbound	F	F	E	E
	Southbound	D	D	D	D
Lusitana St/ Lauhala St	Westbound (LT*)	A	A	A	A
	Northbound	B	B	B	B
Lusitana St/ Lisbon St	Westbound (LT*)	A	A	A	A
	Northbound	C	C	B	B
Lusitana St/ Alapai St/ Lunalilo St/ Kinau St	Eastbound (LT*)	A	A	A	A
	Westbound (LT*)	A	A	A	A
	Northbound	C	C	C	C
	Southbound	B	B	B	B
South Beretania St/ Alapai St	Westbound	B	B	B	B
	Northbound	C	C	C	C
	Southbound	B	B	B	B
South Beretania St/ Lisbon St	Southbound	B	B	B	B

*LT = Left-Turn



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BOARD OF WATER SUPPLY BERETANIA COMPLEX

YEAR 2026 PEAK HOURS OF TRAFFIC WITH ALTERNATIVE 1

FIGURE 11

Table 5: Projected Year 2026 (Without and With Alternative 1) LOS Traffic Operating Conditions (Cont'd)

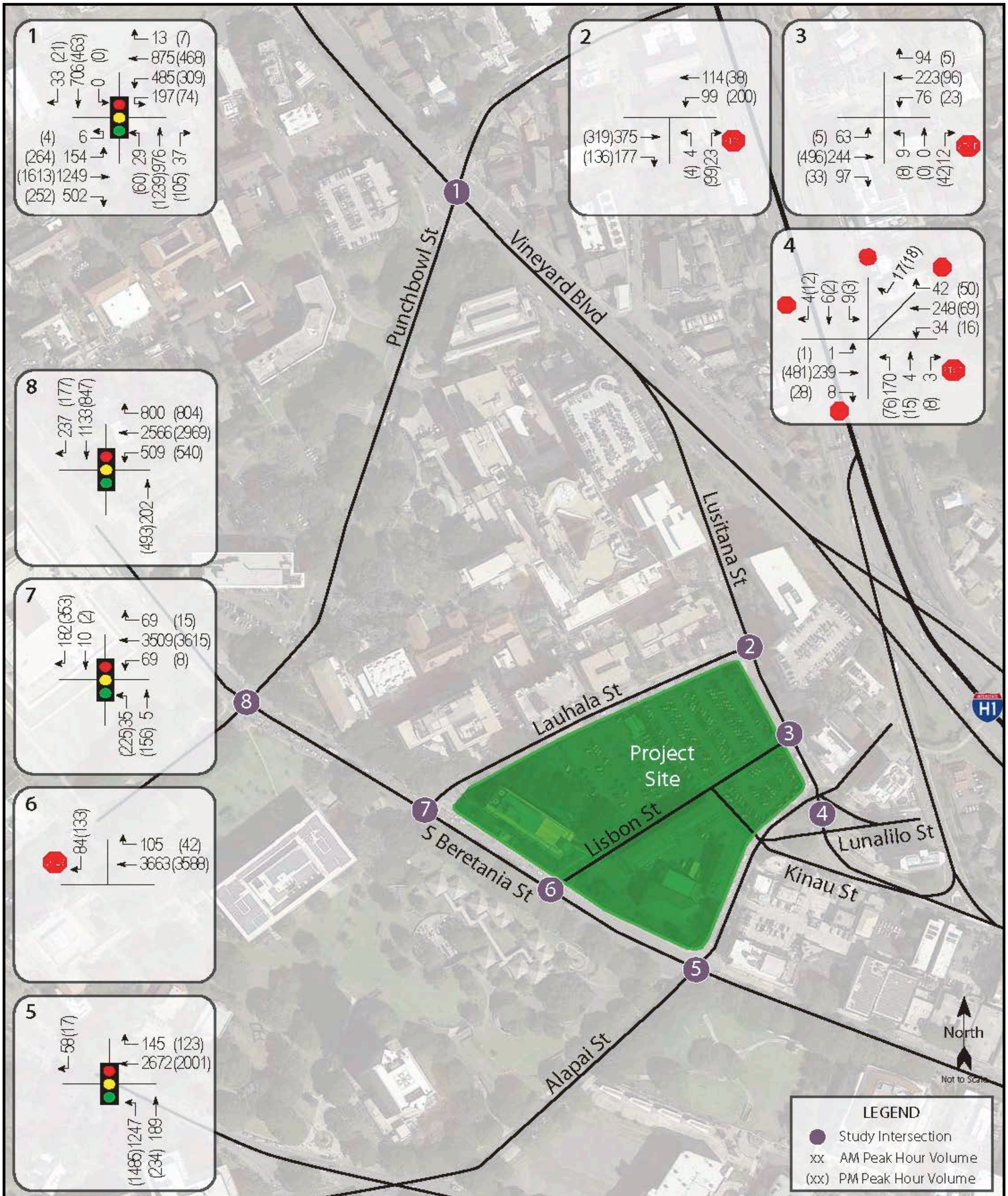
Intersection	Approach/ Critical Movement	AM		PM	
		Year 2026		Year 2026	
		w/out Proj	w/ Alt 1	w/out Proj	w/ Alt 1
South Beretania St/ Lauhala St	Westbound	A	A	A	A
	Southbound	D	D	D	D
South Beretania St/ Punchbowl St	Westbound	C	C	B	B
	Northbound	C	C	D	D
	Southbound	D	D	C	C

*LT = Left-Turn

Traffic operations with the implementation of Alternative 1 are generally expected to remain similar to without project conditions. Along South Beretania Street, traffic operations at the intersections with Punchbowl Street and Lauhala Street are expected to continue operating at LOS "D" or better during both peak periods while those at the intersection with Alapai Street are anticipated to continue operating at LOS "C" or better during both peak periods. At the intersection with Lisbon Street, the traffic operations are expected to continue operating at LOS "B" or better during both peak periods. Along Lusitana Street, the approaches at the intersections with Lauhala Street are expected to continue operating at LOS "B" or better during both peak periods while those at the intersection with Lisbon Street and Alapai Street, Lunalilo Street, and Kinau Street are expected to continue operating at LOS "C" or better during the AM peak period and LOS "B" or better during the PM peak period. The remaining study intersection along Punchbowl Street is also anticipated to continue operating similar to without project conditions.

3. Year 2026 Total Traffic Volumes With Alternative 2

The Year 2026 cumulative AM and PM peak hour traffic conditions with the implementation of Alternative 2 are shown on Figures 12 and summarized in Table 6. The projected Year 2026 (Without Project) operating



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BOARD OF WATER SUPPLY BERETANIA COMPLEX

YEAR 2026 PEAK HOURS OF TRAFFIC WITH ALTERNATIVE 2

FIGURE 12

conditions are provided for comparison purposes. LOS calculations are included in Appendix G.

Table 6: Projected Year 2026 (Without and With Alternative 2)
LOS Traffic Operating Conditions

Intersection	Approach/ Critical Movement	AM		PM	
		Year 2026		Year 2026	
		w/out Proj	w/ Alt 2	w/out Proj	w/ Alt 2
Vineyard Blvd/ Punchbowl St	Eastbound	E	E	E	E
	Westbound	E	E	E	E
	Northbound	F	F	E	E
	Southbound	D	D	D	D
Lusitana St/ Lauhala St	Westbound (LT*)	A	A	A	A
	Northbound	B	B	B	B
Lusitana St/ Lisbon St	Westbound (LT*)	A	A	A	A
	Northbound	C	C	B	B
Lusitana St/ Alapai St/ Lunalilo St/ Kinau St	Eastbound (LT*)	A	A	A	A
	Westbound (LT*)	A	A	A	A
	Northbound	C	C	C	C
	Southbound	B	B	B	B
South Beretania St/ Alapai St	Westbound	B	B	B	B
	Northbound	C	C	C	C
	Southbound	B	B	B	B
South Beretania St/ Lisbon St	Southbound	B	B	B	B
South Beretania St/ Lauhala St	Westbound	A	A	A	A
	Southbound	D	D	D	D
South Beretania St/ Punchbowl St	Westbound	C	C	B	B
	Northbound	C	C	D	D
	Southbound	D	D	C	C

*LT = Left-Turn

Traffic operations with the implementation of Alternative 2 are generally expected to remain similar to without project conditions. Along Punchbowl Street, traffic operations at the intersection with South Beretania Street are expected to continue operating at LOS "D" or better during both peak periods while those at the intersection with Vineyard Boulevard are expected to continue operating at LOS "F" or better during the AM peak period and LOS "E" or better during the PM peak period. As previously discussed, the low levels of service at that intersection are influenced by the high volume of conflicting movements at that intersection. Along Lusitana Street, traffic operations at the intersection with Lauhala Street are expected to continue operating at LOS "B" or better during both peak periods while those at the intersections with Lisbon Street and Alapai Street, Kinau Street, and Lunalilo Street are expected to continue operating at LOS "C" or better during both peak periods. The remaining intersections along South Beretania Street are expected to continue operating similar to without project conditions.

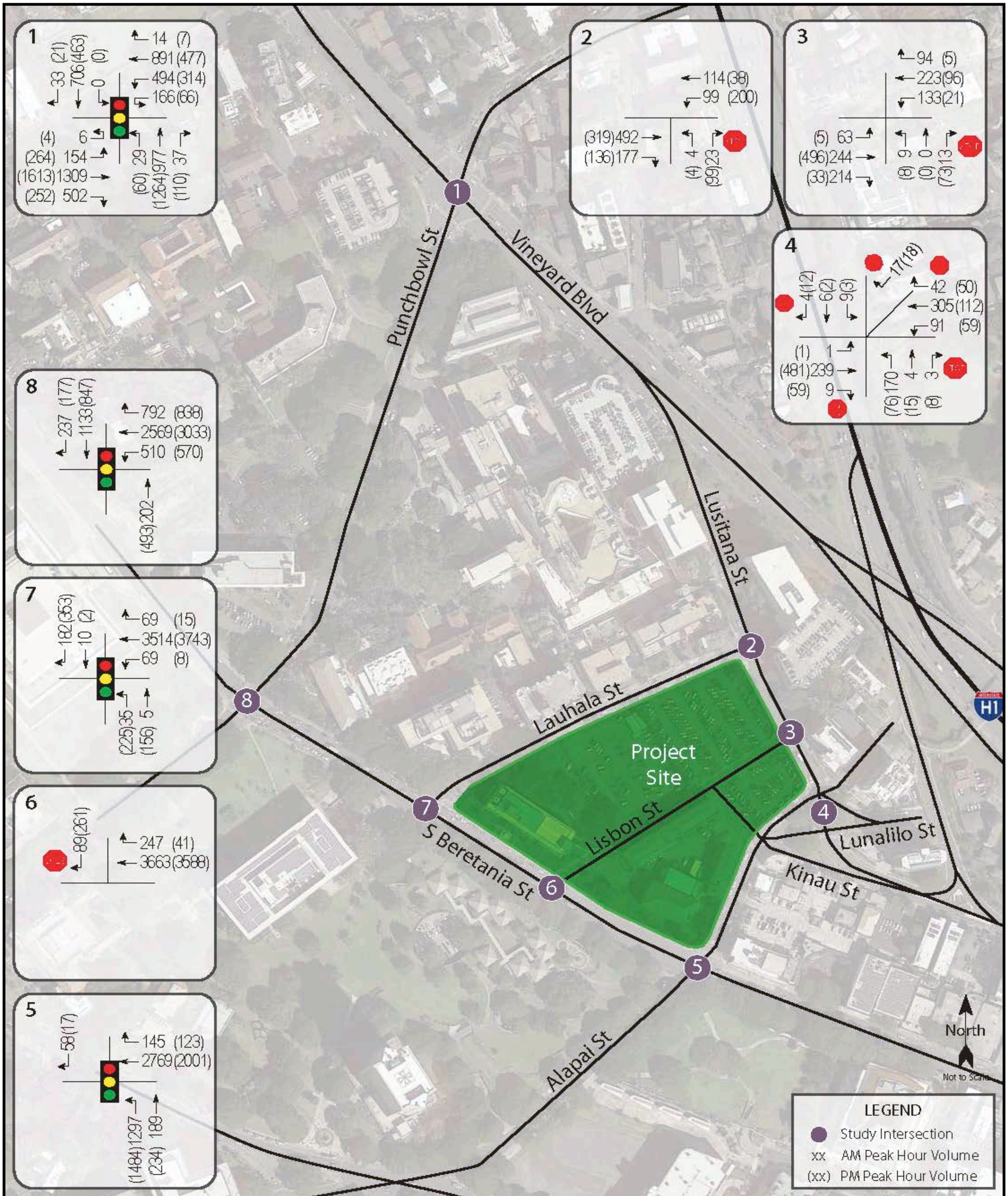
4. Year 2026 Total Traffic Volumes With Alternative 3

The Year 2026 cumulative AM and PM peak hour traffic conditions with the implementation of Alternative 3 are shown on Figure 13 and summarized in Table 7. The projected Year 2026 (3Without Project) operating conditions are provided for comparison purposes. LOS calculations are included in Appendix H.

Table 7: Projected Year 2026 (Without and With Alternative 3) LOS Traffic Operating Conditions

Intersection	Approach/ Critical Movement	AM		PM	
		Year 2026		Year 2026	
		w/out Proj	w/ Alt 3	w/out Proj	w/ Alt 3
Vineyard Blvd/ Punchbowl St.	Eastbound	E	E	E	E
	Westbound	E	E	E	E
	Northbound	F	F	E	E
	Southbound	D	D	D	D
Lusitana St/ Lauhala St	Westbound (LT*)	A	A	A	A
	Northbound	B	B	B	B
Lusitana St./ Lisbon St.	Westbound (LT*)	A	A	A	A
	Northbound	C	C	B	B

*LT = Left-Turn



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BOARD OF WATER SUPPLY BERETANIA COMPLEX

YEAR 2026 PEAK HOURS OF TRAFFIC WITH ALTERNATIVE 3

FIGURE 13

Table 7: Projected Year 2026 (Without and With Alternative 3) LOS Traffic Operating Conditions (Cont'd)

Intersection	Approach/ Critical Movement	AM Year 2026 w/out Proj	AM Year 2026 w/ Alt 3	PM Year 2026 w/out Proj	PM Year 2026 w/ Alt 3
Lusitana St/ Alapai St/ Lunalilo St/ Kinau St	Eastbound (LT*)	A	A	A	A
	Westbound (LT*)	A	A	A	A
	Northbound	C	C	C	C
	Southbound	C	C	B	B
South Beretania St/ Alapai St	Westbound	B	B	B	B
	Northbound	C	C	C	C
	Southbound	B	B	B	B
South Beretania St/ Lisbon St	Southbound	B	C	B	C
South Beretania St/ Lauhala St	Westbound	A	A	A	A
	Southbound	D	D	D	D
South Beretania St/ Punchbowl St	Westbound	C	C	B	B
	Northbound	C	C	D	D
	Southbound	D	D	C	C

*LT = Left-Turn

Traffic operations with the implementation of Alternative 3 are generally expected to remain similar to without project conditions. Along Lusitana Street, the approaches at the intersection with Lauhala Street are expected to continue operating at LOS "B" or better during both peak periods while those at the intersections with Lisbon Street and Alapai Street, Lunalilo Street, and Kinau Street are expected to continue operating at LOS "C" or better during the AM peak period and LOS "B" or better during the PM peak period. The approaches at the study intersections along South Beretania Street are generally expected to continue operating similar to without project conditions except at the intersection with Lisbon Street. At that intersection, the southbound approach is expected to operate slightly lower from LOS "B" to LOS "C" during both peak periods. The remaining study intersections along Vineyard Boulevard are expected to continue operating similar to without project conditions.

V. RECOMMENDATIONS

Based on the analysis of the traffic data, the following are the recommendations of this study to be incorporated in the project design under each alternative.

1. Maintain 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 public roadways.

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

5. If access to the parking garage is controlled, provide sufficient storage for entering vehicles at the parking area access controls (i.e., automatic gate, etc.) to ensure that queues do not extend onto the adjacent public roadways.

6. Under Alternatives 1 and 2, align the proposed parking garage driveway off the west side of Lisbon Street with the east driveway for the proposed BWS office building or provide larger separation between the two driveways to minimize conflicting turning movements.

7. Provide sufficient width along Lisbon Street to accommodate two-way traffic. In addition, prohibit on-street parking unless parking can be accommodated while allowing two-way traffic.

8. Provide pedestrian connections between the project site and the adjacent public roadways in locations that facilitate pedestrian movement to the existing pedestrian facilities and minimize unprotected midblock crossings.

9. Consider incorporation of complete street principles, if possible, to include features that encourage walking, bicycling, and use of public transit.

10. Prepare a Construction Management Plan (CMP) for the development which includes discussions regarding the anticipated construction schedule and phasing, as well as traffic circulation, traffic control, and parking during the construction period.

11. Prepare a Traffic Management Plan (TMP) for the development which includes traffic circulation, parking, loading, and traffic demand management strategies.

VI. CONCLUSION

The proposed project entails the redevelopment of a portion of the existing Board of Water Supply site with three alternatives currently under consideration. Alternative 1 entails a new assisted living care facility with a parking structure that includes 218 parking stalls intended to be leased to the surrounding uses while Alternative 2 entails a new senior living facility with a parking garage that includes 247 parking stalls intended to be leased to the surrounding uses and Alternative 3 includes a new parking structure to include 977 parking stalls intended to be leased to the surrounding uses. In addition, all three alternatives also entail the construction of a new building to include 35,000 sf of office uses to support Board of Water Supply's existing operations. The selected alternative is expected to be completed by Year 2026. Under the proposed three alternatives, traffic operations are generally expected to remain similar to without project conditions. As such, with the implementation of the aforementioned recommendations, the proposed project is not expected to have a significant impact on traffic operations in the vicinity.

APPENDIX A

EXISTING TRAFFIC COUNT DATA

Wilson Okamoto Corporation

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

Counted By: DY, BE
Counters: D4-3889, D4-3890
Weather: CLEAR

File Name : VIN PUN AM
Site Code : 00000001
Start Date : 11/2/2017
Page No : 1

Groups Printed- Unshifted

	Punchbowl Street Southbound					South Vineyard Boulevard Westbound					Punchbowl Street Northbound					South Vineyard Boulevard 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
05:00 AM	0	74	6	0	80	22	35	0	0	57	0	44	4	0	48	5	28	10	2	45	230
05:15 AM	0	90	2	1	93	29	49	1	0	79	5	57	2	2	66	14	38	19	0	71	309
05:30 AM	0	130	6	2	138	44	55	2	7	108	2	85	2	1	90	9	43	19	3	74	410
05:45 AM	0	188	7	4	199	62	71	2	9	144	0	113	5	2	120	15	75	26	0	116	579
Total	0	482	21	7	510	157	210	5	16	388	7	299	13	5	324	43	184	74	5	306	1528
06:00 AM	0	128	4	3	135	76	97	1	14	188	1	97	7	1	106	31	95	36	2	164	593
06:15 AM	0	208	9	5	222	117	121	19	21	278	2	142	6	5	155	26	100	52	5	183	838
06:30 AM	0	187	11	5	203	84	93	0	24	201	2	172	6	7	187	16	174	55	10	255	846
06:45 AM	0	134	11	10	155	121	152	2	22	297	4	196	2	4	206	25	234	96	6	361	1019
Total	0	657	35	23	715	398	463	22	81	964	9	607	21	17	654	98	603	239	23	963	3296
07:00 AM	0	158	5	15	178	123	178	1	19	321	10	210	8	0	228	34	237	86	3	360	1087
07:15 AM	0	162	6	19	187	110	180	4	18	312	3	215	9	3	230	30	307	117	5	459	1188
07:30 AM	0	161	9	25	195	109	214	2	17	342	6	224	4	6	240	35	271	123	0	429	1206
07:45 AM	0	166	10	28	204	111	245	5	16	377	7	239	12	2	260	42	297	134	3	476	1317
Total	0	647	30	87	764	453	817	12	70	1352	26	888	33	11	958	141	1112	460	11	1724	4798
Grand Total	0	1786	86	117	1989	1008	1490	39	167	2704	42	1794	67	33	1936	282	1899	773	39	2993	9622
Apprch %	0	89.8	4.3	5.9		37.3	55.1	1.4	6.2		2.2	92.7	3.5	1.7		9.4	63.4	25.8	1.3		
Total %	0	18.6	0.9	1.2	20.7	10.5	15.5	0.4	1.7	28.1	0.4	18.6	0.7	0.3	20.1	2.9	19.7	8	0.4	31.1	

	Punchbowl Street Southbound				South Vineyard Boulevard Westbound				Punchbowl Street Northbound				South Vineyard Boulevard 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 05:00 AM to 07:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:00 AM																	
07:00 AM	0	158	5	163	123	178	1	302	10	210	8	228	34	237	86	357	1050
07:15 AM	0	162	6	168	110	180	4	294	3	215	9	227	30	307	117	454	1143
07:30 AM	0	161	9	170	109	214	2	325	6	224	4	234	35	271	123	429	1158
07:45 AM	0	166	10	176	111	245	5	361	7	239	12	258	42	297	134	473	1268
Total Volume	0	647	30	677	453	817	12	1282	26	888	33	947	141	1112	460	1713	4619
% App. Total	0	95.6	4.4		35.3	63.7	0.9		2.7	93.8	3.5		8.2	64.9	26.9		
PHF	.000	.974	.750	.962	.921	.834	.600	.888	.650	.929	.688	.918	.839	.906	.858	.905	.911

Wilson Okamoto Corporation
1907 S. Beretania Street, Suite 400
Honolulu, HI 96826

Counted By: DY, BE
Counters: D4-3889, D4-3890
Weather: CLEAR

File Name : VIN PUN U TURN AM
Site Code : 00000001
Start Date : 11/2/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	South Vineyard Boulevard Westbound					Northbound	South Vineyard Boulevard Eastbound					
Start Time	App. Total	U-Turn	Thru	Right	Peds	App. Total	App. Total	U-Turn	Thru	Right	Peds	App. Total	Int. Total
05:00 AM	0	3	0	0	0	3	0	0	0	0	0	0	3
05:15 AM	0	8	0	0	0	8	0	1	0	0	0	1	9
05:30 AM	0	9	0	0	0	9	0	0	0	0	0	0	9
05:45 AM	0	26	0	0	0	26	0	0	0	0	0	0	26
Total	0	46	0	0	0	46	0	1	0	0	0	1	47
06:00 AM	0	24	0	0	0	24	0	2	0	0	0	2	26
06:15 AM	0	39	0	0	0	39	0	2	0	0	0	2	41
06:30 AM	0	34	0	0	0	34	0	0	0	0	0	0	34
06:45 AM	0	56	0	0	0	56	0	3	0	0	0	3	59
Total	0	153	0	0	0	153	0	7	0	0	0	7	160
07:00 AM	0	41	0	0	0	41	0	2	0	0	0	2	43
07:15 AM	0	30	0	0	0	30	0	2	0	0	0	2	32
07:30 AM	0	39	0	0	0	39	0	0	0	0	0	0	39
07:45 AM	0	42	0	0	0	42	0	1	0	0	0	1	43
Total	0	152	0	0	0	152	0	5	0	0	0	5	157
Grand Total	0	351	0	0	0	351	0	13	0	0	0	13	364
Apprch %		100	0	0	0			100	0	0	0		
Total %	0	96.4	0	0	0	96.4	0	3.6	0	0	0	3.6	

	Southbound	South Vineyard Boulevard Westbound				Northbound	South Vineyard Boulevard Eastbound				
Start Time	App. Total	U-Turn	Thru	Right	App. Total	App. Total	U-Turn	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 05:00 AM to 07:45 AM - Peak 1 of 1											
Peak Hour for Entire Intersection Begins at 06:15 AM											
06:15 AM	0	39	0	0	39	0	2	0	0	2	41
06:30 AM	0	34	0	0	34	0	0	0	0	0	34
06:45 AM	0	56	0	0	56	0	3	0	0	3	59
07:00 AM	0	41	0	0	41	0	2	0	0	2	43
Total Volume	0	170	0	0	170	0	7	0	0	7	177
% App. Total		100	0	0			100	0	0		
PHF	.000	.759	.000	.000	.759	.000	.583	.000	.000	.583	.750

Wilson Okamoto Corporation

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

Counted By: DY, BE
Counters: D4-3889, D4-3890
Weather: CLEAR

File Name : VIN PUN PM
Site Code : 00000001
Start Date : 11/2/2017
Page No : 1

Groups Printed- Unshifted

	Punchbowl Street Southbound					South Vineyard Boulevard Westbound					Punchbowl Street Northbound					South Vineyard Boulevard 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	130	10	4	144	56	125	2	13	196	15	229	18	4	266	84	295	80	1	460	1066
03:15 PM	0	154	14	0	168	61	119	3	5	188	13	275	17	2	307	83	217	62	3	365	1028
03:30 PM	0	121	3	2	126	61	115	3	8	187	17	270	21	8	316	61	349	67	6	483	1112
03:45 PM	0	127	7	3	137	67	93	2	3	165	13	237	16	10	276	57	343	65	4	469	1047
Total	0	532	34	9	575	245	452	10	29	736	58	1011	72	24	1165	285	1204	274	14	1777	4253
04:00 PM	0	97	7	0	104	61	91	1	6	159	20	254	20	8	302	42	335	76	4	457	1022
04:15 PM	0	127	4	0	131	72	103	1	3	179	11	282	26	5	324	57	374	59	4	494	1128
04:30 PM	0	90	3	3	96	85	102	4	3	194	10	266	25	14	315	63	345	67	9	484	1089
04:45 PM	0	102	8	0	110	55	105	1	8	169	26	309	16	7	358	56	350	50	1	457	1094
Total	0	416	22	3	441	273	401	7	20	701	67	1111	87	34	1299	218	1404	252	18	1892	4333
05:00 PM	0	105	4	4	113	76	127	0	8	211	8	261	23	6	298	66	399	55	5	525	1147
05:15 PM	0	96	3	5	104	70	94	1	5	170	9	269	18	4	300	40	336	76	3	455	1029
05:30 PM	0	67	3	9	79	54	126	3	7	190	12	292	17	4	325	54	376	65	2	497	1091
05:45 PM	0	90	3	4	97	65	103	0	1	169	9	247	19	4	279	62	409	48	1	520	1065
Total	0	358	13	22	393	265	450	4	21	740	38	1069	77	18	1202	222	1520	244	11	1997	4332
Grand Total	0	1306	69	34	1409	783	1303	21	70	2177	163	3191	236	76	3666	725	4128	770	43	5666	12918
Apprch %	0	92.7	4.9	2.4		36	59.9	1	3.2		4.4	87	6.4	2.1		12.8	72.9	13.6	0.8		
Total %	0	10.1	0.5	0.3	10.9	6.1	10.1	0.2	0.5	16.9	1.3	24.7	1.8	0.6	28.4	5.6	32	6	0.3	43.9	

	Punchbowl Street Southbound				South Vineyard Boulevard Westbound				Punchbowl Street Northbound				South Vineyard Boulevard 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 04:15 PM																	
04:15 PM	0	127	4	131	72	103	1	176	11	282	26	319	57	374	59	490	1116
04:30 PM	0	90	3	93	85	102	4	191	10	266	25	301	63	345	67	475	1060
04:45 PM	0	102	8	110	55	105	1	161	26	309	16	351	56	350	50	456	1078
05:00 PM	0	105	4	109	76	127	0	203	8	261	23	292	66	399	55	520	1124
Total Volume	0	424	19	443	288	437	6	731	55	1118	90	1263	242	1468	231	1941	4378
% App. Total	0	95.7	4.3		39.4	59.8	0.8		4.4	88.5	7.1		12.5	75.6	11.9		
PHF	.000	.835	.594	.845	.847	.860	.375	.900	.529	.905	.865	.900	.917	.920	.862	.933	.974

Wilson Okamoto Corporation

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

Counted By: DY, BE
Counters: D4-3889, D4-3890
Weather: CLEAR

File Name : VIN PUN U TURN PM
Site Code : 00000001
Start Date : 11/2/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	South Vineyard Boulevard Westbound					Northbound	South Vineyard Boulevard Eastbound					
Start Time	App. Total	U-Turn	Thru	Right	Peds	App. Total	App. Total	U-Turn	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	0	29	0	0	0	29	0	0	0	0	0	0	29
03:15 PM	0	17	0	0	0	17	0	2	0	0	0	2	19
03:30 PM	0	20	0	0	0	20	0	1	0	0	0	1	21
03:45 PM	0	15	0	0	0	15	0	1	0	0	0	1	16
Total	0	81	0	0	0	81	0	4	0	0	0	4	85
04:00 PM	0	7	0	0	0	7	0	1	0	0	0	1	8
04:15 PM	0	17	0	0	0	17	0	0	0	0	0	0	17
04:30 PM	0	15	0	0	0	15	0	2	0	0	0	2	17
04:45 PM	0	16	0	0	0	16	0	1	0	0	0	1	17
Total	0	55	0	0	0	55	0	4	0	0	0	4	59
05:00 PM	0	12	0	0	0	12	0	0	0	0	0	0	12
05:15 PM	0	16	0	0	0	16	0	2	0	0	0	2	18
05:30 PM	0	14	0	0	0	14	0	0	0	0	0	0	14
05:45 PM	0	19	0	0	0	19	0	0	0	0	0	0	19
Total	0	61	0	0	0	61	0	2	0	0	0	2	63
Grand Total	0	197	0	0	0	197	0	10	0	0	0	10	207
Apprch %		100	0	0	0			100	0	0	0		
Total %	0	95.2	0	0	0	95.2	0	4.8	0	0	0	4.8	

	Southbound	South Vineyard Boulevard Westbound				Northbound	South Vineyard Boulevard Eastbound				
Start Time	App. Total	U-Turn	Thru	Right	App. Total	App. Total	U-Turn	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 03:00 PM											
03:00 PM	0	29	0	0	29	0	0	0	0	0	29
03:15 PM	0	17	0	0	17	0	2	0	0	2	19
03:30 PM	0	20	0	0	20	0	1	0	0	1	21
03:45 PM	0	15	0	0	15	0	1	0	0	1	16
Total Volume	0	81	0	0	81	0	4	0	0	4	85
% App. Total		100	0	0			100	0	0		
PHF	.000	.698	.000	.000	.698	.000	.500	.000	.000	.500	.733

Wilson Okamoto Corporation

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

Counted By: TB
Counters: D4-5671
Weather: CLEAR

File Name : LUS VIN AM
Site Code : 00000000
Start Date : 11/2/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Westbound	Northbound	South Vineyard Boulevard Eastbound		
Start Time	App. Total	App. Total	App. Total	Lusitana Exit	App. Total	Int. Total
05:00 AM	0	0	0	14	14	14
05:15 AM	0	0	0	24	24	24
05:30 AM	0	0	0	21	21	21
05:45 AM	0	0	0	35	35	35
Total	0	0	0	94	94	94
06:00 AM	0	0	0	59	59	59
06:15 AM	0	0	0	89	89	89
06:30 AM	0	0	0	95	95	95
06:45 AM	0	0	0	124	124	124
Total	0	0	0	367	367	367
07:00 AM	0	0	0	83	83	83
07:15 AM	0	0	0	77	77	77
07:30 AM	0	0	0	103	103	103
07:45 AM	0	0	0	125	125	125
Total	0	0	0	388	388	388
Grand Total	0	0	0	849	849	849
Apprch %				100		
Total %	0	0	0	100	100	

	Southbound	Westbound	Northbound	South Vineyard Boulevard Eastbound		
Start Time	App. Total	App. Total	App. Total	Lusitana Exit	App. Total	Int. Total
Peak Hour Analysis From 06:15 AM to 07:45 AM - Peak 1 of 1						
Peak Hour for Entire Intersection Begins at 06:15 AM						
06:15 AM	0	0	0	89	89	89
06:30 AM	0	0	0	95	95	95
06:45 AM	0	0	0	124	124	124
07:00 AM	0	0	0	83	83	83
Total Volume	0	0	0	391	391	391
% App. Total				100		
PHF	.000	.000	.000	.788	.788	.788

Wilson Okamoto Corporation

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

Counted By: TS
Counters: D4-5671
Weather: CLEAR

File Name : LUS VIN PM
Site Code : 00000002
Start Date : 11/2/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Westbound	Northbound	South Vineyard Boulevard Eastbound		
Start Time	App. Total	App. Total	App. Total	Lusitana Exit	App. Total	Int. Total
03:00 PM	0	0	0	103	103	103
03:15 PM	0	0	0	62	62	62
03:30 PM	0	0	0	97	97	97
03:45 PM	0	0	0	83	83	83
Total	0	0	0	345	345	345
04:00 PM	0	0	0	93	93	93
04:15 PM	0	0	0	90	90	90
04:30 PM	0	0	0	75	75	75
04:45 PM	0	0	0	75	75	75
Total	0	0	0	333	333	333
05:00 PM	0	0	0	80	80	80
05:15 PM	0	0	0	82	82	82
05:30 PM	0	0	0	69	69	69
05:45 PM	0	0	0	83	83	83
Total	0	0	0	314	314	314
Grand Total	0	0	0	992	992	992
Apprch %				100		
Total %	0	0	0	100	100	

	Southbound	Westbound	Northbound	South Vineyard Boulevard Eastbound		
Start Time	App. Total	App. Total	App. Total	Lusitana Exit	App. Total	Int. Total
Peak Hour Analysis From 03:30 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	97	97	97
03:45 PM	0	0	0	83	83	83
04:00 PM	0	0	0	93	93	93
04:15 PM	0	0	0	90	90	90
Total Volume	0	0	0	363	363	363
% App. Total				100		
PHF	.000	.000	.000	.936	.936	.936

Wilson Okamoto Corporation

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

Counted By: KG
Counters: D4-5677
Weather: CLEAR

File Name : LUS LAU AM
Site Code : 00000000
Start Date : 11/2/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Lusitana Street Westbound			Lauhala Street Northbound				Lusitana Street Eastbound				
Start Time	App. Total	Left	Thru	App. Total	Left	Right	Peds	App. Total	Thru	Right	Peds	App. Total	Int. Total
05:00 AM	0	4	4	8	0	0	0	0	10	5	3	18	26
05:15 AM	0	9	8	17	0	2	3	5	16	3	2	21	43
05:30 AM	0	10	15	25	1	6	2	9	12	4	5	21	55
05:45 AM	0	16	19	35	2	2	2	6	23	9	10	42	83
Total	0	39	46	85	3	10	7	20	61	21	20	102	207
06:00 AM	0	7	14	21	0	4	4	8	32	17	11	60	89
06:15 AM	0	17	21	38	1	4	18	23	43	21	19	83	144
06:30 AM	0	24	28	52	2	5	15	22	63	28	17	108	182
06:45 AM	0	17	17	34	3	6	11	20	68	30	33	131	185
Total	0	65	80	145	6	19	48	73	206	96	80	382	600
07:00 AM	0	20	18	38	0	8	13	21	62	22	21	105	164
07:15 AM	0	25	28	53	0	4	21	25	64	27	25	116	194
07:30 AM	0	31	31	62	2	4	14	20	83	60	20	163	245
07:45 AM	0	23	37	60	2	7	18	27	96	68	22	186	273
Total	0	99	114	213	4	23	66	93	305	177	88	570	876
Grand Total	0	203	240	443	13	52	121	186	572	294	188	1054	1683
Apprch %		45.8	54.2		7	28	65.1		54.3	27.9	17.8		
Total %	0	12.1	14.3	26.3	0.8	3.1	7.2	11.1	34	17.5	11.2	62.6	

	Southbound	Lusitana Street Westbound			Lauhala Street Northbound			Lusitana Street Eastbound			
Start Time	App. Total	Left	Thru	App. Total	Left	Right	App. Total	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 05:00 AM to 07:45 AM - Peak 1 of 1											
Peak Hour for Entire Intersection Begins at 07:00 AM											
07:00 AM	0	20	18	38	0	8	8	62	22	84	130
07:15 AM	0	25	28	53	0	4	4	64	27	91	148
07:30 AM	0	31	31	62	2	4	6	83	60	143	211
07:45 AM	0	23	37	60	2	7	9	96	68	164	233
Total Volume	0	99	114	213	4	23	27	305	177	482	722
% App. Total		46.5	53.5		14.8	85.2		63.3	36.7		
PHF	.000	.798	.770	.859	.500	.719	.750	.794	.651	.735	.775

Wilson Okamoto Corporation

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

Counted By: KG
Counters: D4-5677
Weather: CLEAR

File Name : LUS LAU PM
Site Code : 00000003
Start Date : 11/2/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Lusitana Street Westbound			Lauhala Street Northbound				Lusitana Street Eastbound				
Start Time	App. Total	Left	Thru	App. Total	Left	Right	Peds	App. Total	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	0	45	5	50	0	14	10	24	79	43	11	133	207
03:15 PM	0	34	13	47	1	12	7	20	59	41	21	121	188
03:30 PM	0	44	11	55	1	24	10	35	101	30	12	143	233
03:45 PM	0	43	9	52	0	14	10	24	82	27	21	130	206
Total	0	166	38	204	2	64	37	103	321	141	65	527	834
04:00 PM	0	39	8	47	0	25	12	37	96	36	28	160	244
04:15 PM	0	37	8	45	0	21	4	25	93	39	11	143	213
04:30 PM	0	55	9	64	3	27	17	47	72	30	24	126	237
04:45 PM	0	49	11	60	0	24	7	31	67	38	16	121	212
Total	0	180	36	216	3	97	40	140	328	143	79	550	906
05:00 PM	0	59	10	69	1	27	14	42	66	29	18	113	224
05:15 PM	0	41	10	51	2	17	2	21	91	31	16	138	210
05:30 PM	0	27	9	36	0	18	2	20	69	13	10	92	148
05:45 PM	0	23	8	31	1	14	1	16	59	21	10	90	137
Total	0	150	37	187	4	76	19	99	285	94	54	433	719
Grand Total	0	496	111	607	9	237	96	342	934	378	198	1510	2459
Apprch %		81.7	18.3		2.6	69.3	28.1		61.9	25	13.1		
Total %	0	20.2	4.5	24.7	0.4	9.6	3.9	13.9	38	15.4	8.1	61.4	

	Southbound	Lusitana Street Westbound			Lauhala Street Northbound			Lusitana Street Eastbound			
Start Time	App. Total	Left	Thru	App. Total	Left	Right	App. Total	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	44	11	55	1	24	25	101	30	131	211
03:45 PM	0	43	9	52	0	14	14	82	27	109	175
04:00 PM	0	39	8	47	0	25	25	96	36	132	204
04:15 PM	0	37	8	45	0	21	21	93	39	132	198
Total Volume	0	163	36	199	1	84	85	372	132	504	788
% App. Total		81.9	18.1		1.2	98.8		73.8	26.2		
PHF	.000	.926	.818	.905	.250	.840	.850	.921	.846	.955	.934

Wilson Okamoto Corporation

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

Counted By: FS
Counters: D4-5672
Weather: CLEAR

File Name : LUS LIS AM
Site Code : 00000004
Start Date : 11/2/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Lusitana Street Westbound				Lisbon Street Northbound				Lusitana Street Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Right	Peds	App. Total	Left	Thru	Right	App. Total	Int. Total
05:00 AM	0	1	9	2	12	0	0	0	0	0	9	2	11	23
05:15 AM	0	2	19	1	22	0	0	4	4	5	13	0	18	44
05:30 AM	0	7	27	7	41	0	0	3	3	2	14	1	17	61
05:45 AM	0	6	33	10	49	1	0	4	5	8	18	0	26	80
Total	0	16	88	20	124	1	0	11	12	15	54	3	72	208
06:00 AM	0	11	21	9	41	0	0	5	5	6	23	6	35	81
06:15 AM	0	12	46	8	66	0	1	16	17	12	28	9	49	132
06:30 AM	0	13	51	19	83	0	2	19	21	14	43	11	68	172
06:45 AM	0	14	40	16	70	1	0	13	14	12	48	20	80	164
Total	0	50	158	52	260	1	3	53	57	44	142	46	232	549
07:00 AM	0	10	36	23	69	3	1	20	24	17	46	5	68	161
07:15 AM	0	10	60	21	91	2	0	25	27	13	56	7	76	194
07:30 AM	0	13	67	28	108	2	1	13	16	12	63	9	84	208
07:45 AM	0	9	60	22	91	2	2	22	26	21	79	6	106	223
Total	0	42	223	94	359	9	4	80	93	63	244	27	334	786
Grand Total	0	108	469	166	743	11	7	144	162	122	440	76	638	1543
Apprch %		14.5	63.1	22.3		6.8	4.3	88.9		19.1	69	11.9		
Total %	0	7	30.4	10.8	48.2	0.7	0.5	9.3	10.5	7.9	28.5	4.9	41.3	

	Southbound	Lusitana Street Westbound				Lisbon Street Northbound			Lusitana Street Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 05:00 AM to 07:45 AM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 07:00 AM													
07:00 AM	0	10	36	23	69	3	1	4	17	46	5	68	141
07:15 AM	0	10	60	21	91	2	0	2	13	56	7	76	169
07:30 AM	0	13	67	28	108	2	1	3	12	63	9	84	195
07:45 AM	0	9	60	22	91	2	2	4	21	79	6	106	201
Total Volume	0	42	223	94	359	9	4	13	63	244	27	334	706
% App. Total		11.7	62.1	26.2		69.2	30.8		18.9	73.1	8.1		
PHF	.000	.808	.832	.839	.831	.750	.500	.813	.750	.772	.750	.788	.878

Wilson Okamoto Corporation

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

Counted By: FS
Counters: D4-5672
Weather: CLEAR

File Name : LUS LIS PM
Site Code : 00000004
Start Date : 11/2/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Lusitana Street Westbound				Lisbon Street Northbound				Lusitana Street Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Right	Peds	App. Total	Left	Thru	Right	App. Total	Int. Total
03:00 PM	0	6	30	5	41	4	5	16	25	29	97	4	130	196
03:15 PM	0	0	21	6	27	7	4	8	19	8	85	5	98	144
03:30 PM	0	4	23	5	32	4	3	9	16	15	120	10	145	193
03:45 PM	0	2	28	7	37	2	5	6	13	6	111	7	124	174
Total	0	12	102	23	137	17	17	39	73	58	413	26	497	707
04:00 PM	0	1	27	4	32	2	2	12	16	5	138	4	147	195
04:15 PM	0	4	21	2	27	2	2	6	10	1	131	3	135	172
04:30 PM	0	2	22	1	25	4	11	14	29	1	136	2	139	193
04:45 PM	0	1	27	1	29	1	1	5	7	2	107	5	114	150
Total	0	8	97	8	113	9	16	37	62	9	512	14	535	710
05:00 PM	0	0	26	1	27	1	0	10	11	1	122	2	125	163
05:15 PM	0	2	28	0	30	1	1	7	9	2	121	0	123	162
05:30 PM	0	0	23	0	23	0	2	4	6	1	83	4	88	117
05:45 PM	0	3	17	0	20	3	1	2	6	1	84	3	88	114
Total	0	5	94	1	100	5	4	23	32	5	410	9	424	556
Grand Total	0	25	293	32	350	31	37	99	167	72	1335	49	1456	1973
Apprch %		7.1	83.7	9.1		18.6	22.2	59.3		4.9	91.7	3.4		
Total %	0	1.3	14.9	1.6	17.7	1.6	1.9	5	8.5	3.6	67.7	2.5	73.8	

	Southbound	Lusitana Street Westbound				Lisbon Street Northbound			Lusitana Street Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	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	4	23	5	32	4	3	7	15	120	10	145	184
03:45 PM	0	2	28	7	37	2	5	7	6	111	7	124	168
04:00 PM	0	1	27	4	32	2	2	4	5	138	4	147	183
04:15 PM	0	4	21	2	27	2	2	4	1	131	3	135	166
Total Volume	0	11	99	18	128	10	12	22	27	500	24	551	701
% App. Total		8.6	77.3	14.1		45.5	54.5		4.9	90.7	4.4		
PHF	.000	.688	.884	.643	.865	.625	.600	.786	.450	.906	.600	.937	.952

Wilson Okamoto Corporation

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

Counted By: GH
Counters: D4-3888
Weather: CLEAR

File Name : LUS ALA AM
Site Code : 00000006
Start Date : 11/2/2017
Page No : 1

Groups Printed- Unshifted

	Alapai Street Southbound					Westbound	Alapai Street Northbound					Lusitana Street Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
05:00 AM	0	0	1	0	1	0	0	0	0	0	0	0	7	1	0	8	9
05:15 AM	1	0	0	1	2	0	0	0	0	0	0	0	12	2	3	17	19
05:30 AM	1	1	1	1	4	0	0	0	0	1	1	0	12	2	2	16	21
05:45 AM	0	1	0	0	1	0	0	0	0	4	4	0	15	2	3	20	25
Total	2	2	2	2	8	0	0	0	0	5	5	0	46	7	8	61	74
06:00 AM	1	0	3	2	6	0	0	0	0	2	2	1	21	1	10	33	41
06:15 AM	0	3	1	7	11	0	0	0	0	5	5	0	23	4	13	40	56
06:30 AM	1	1	0	0	2	0	0	0	0	8	8	0	39	2	19	60	70
06:45 AM	2	0	2	0	4	0	0	0	0	5	5	3	40	3	17	63	72
Total	4	4	6	9	23	0	0	0	0	20	20	4	123	10	59	196	239
07:00 AM	2	1	1	3	7	0	0	0	0	8	8	0	50	5	13	68	83
07:15 AM	4	2	0	2	8	0	0	0	0	7	7	0	48	6	18	72	87
07:30 AM	1	3	2	6	12	0	0	0	0	10	10	0	64	4	18	86	108
07:45 AM	2	0	1	3	6	0	0	0	0	11	11	0	77	4	14	95	112
Total	9	6	4	14	33	0	0	0	0	36	36	0	239	19	63	321	390
Grand Total	15	12	12	25	64	0	0	0	0	61	61	4	408	36	130	578	703
Apprch %	23.4	18.8	18.8	39.1			0	0	0	100		0.7	70.6	6.2	22.5		
Total %	2.1	1.7	1.7	3.6	9.1	0	0	0	0	8.7	8.7	0.6	58	5.1	18.5	82.2	

	Alapai Street Southbound				Westbound	Alapai Street Northbound				Lusitana Street Eastbound				
Start Time	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 05:00 AM to 07:45 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 07:00 AM														
07:00 AM	2	1	1	4	0	0	0	0	0	0	50	5	55	59
07:15 AM	4	2	0	6	0	0	0	0	0	0	48	6	54	60
07:30 AM	1	3	2	6	0	0	0	0	0	0	64	4	68	74
07:45 AM	2	0	1	3	0	0	0	0	0	0	77	4	81	84
Total Volume	9	6	4	19	0	0	0	0	0	0	239	19	258	277
% App. Total	47.4	31.6	21.1			0	0	0		0	92.6	7.4		
PHF	.563	.500	.500	.792	.000	.000	.000	.000	.000	.000	.776	.792	.796	.824

Wilson Okamoto Corporation

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

Counted By: GH
Counters: D4-3888
Weather: CLEAR

File Name : LUS ALA PM
Site Code : 00000006
Start Date : 11/2/2017
Page No : 1

Groups Printed- Unshifted

	Alapai Street Southbound					Westbound	Alapai Street Northbound					Lusitana Street Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	1	0	0	7	8	0	0	0	0	12	12	1	100	1	5	107	127
03:15 PM	2	0	0	4	6	0	0	0	0	9	9	0	85	5	4	94	109
03:30 PM	5	0	1	0	6	0	0	0	0	7	7	2	108	8	8	126	139
03:45 PM	5	2	0	0	7	0	0	0	0	5	5	2	112	1	5	120	132
Total	13	2	1	11	27	0	0	0	0	33	33	5	405	15	22	447	507
04:00 PM	2	3	0	2	7	0	0	0	0	10	10	0	134	3	5	142	159
04:15 PM	1	1	1	1	4	0	0	0	0	7	7	0	121	8	7	136	147
04:30 PM	1	0	1	7	9	0	0	0	0	12	12	1	138	3	21	163	184
04:45 PM	0	0	2	0	2	0	0	0	0	3	3	1	111	0	5	117	122
Total	4	4	4	10	22	0	0	0	0	32	32	2	504	14	38	558	612
05:00 PM	1	1	0	4	6	0	0	0	0	10	10	0	111	0	12	123	139
05:15 PM	2	0	3	3	8	0	0	0	0	1	1	1	126	1	16	144	153
05:30 PM	4	0	1	4	9	0	0	0	0	3	3	1	88	4	9	102	114
05:45 PM	1	0	1	4	6	0	0	0	0	0	0	4	70	0	5	79	85
Total	8	1	5	15	29	0	0	0	0	14	14	6	395	5	42	448	491
Grand Total	25	7	10	36	78	0	0	0	0	79	79	13	1304	34	102	1453	1610
Apprch %	32.1	9	12.8	46.2			0	0	0	100		0.9	89.7	2.3	7		
Total %	1.6	0.4	0.6	2.2	4.8	0	0	0	0	4.9	4.9	0.8	81	2.1	6.3	90.2	

	Alapai Street Southbound				Westbound	Alapai Street Northbound				Lusitana Street Eastbound				
Start Time	Left	Thru	Right	App. Total	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 03:45 PM														
03:45 PM	5	2	0	7	0	0	0	0	0	2	112	1	115	122
04:00 PM	2	3	0	5	0	0	0	0	0	0	134	3	137	142
04:15 PM	1	1	1	3	0	0	0	0	0	0	121	8	129	132
04:30 PM	1	0	1	2	0	0	0	0	0	1	138	3	142	144
Total Volume	9	6	2	17	0	0	0	0	0	3	505	15	523	540
% App. Total	52.9	35.3	11.8			0	0	0		0.6	96.6	2.9		
PHF	.450	.500	.500	.607	.000	.000	.000	.000	.000	.375	.915	.469	.921	.938

Wilson Okamoto Corporation

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

Counted By: JB
Counters: D4-5674
Weather: CLEAR

File Name : LUS LUN AM
Site Code : 00000006
Start Date : 11/2/2017
Page No : 1

Groups Printed- Unshifted

	Lunalilo Street Southbound					Lusitana Street Westbound					Lunalilo Street Northbound					Lusitana Street 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
05:00 AM	0	0	2	1	3	0	11	0	0	11	1	0	0	0	1	0	7	0	0	7	22
05:15 AM	0	0	1	0	1	0	25	1	0	26	2	0	0	0	2	0	13	0	0	13	42
05:30 AM	0	0	1	0	1	0	41	0	1	42	6	0	0	0	6	1	12	0	0	13	62
05:45 AM	0	0	1	0	1	0	48	1	0	49	7	0	0	0	7	0	15	0	0	15	72
Total	0	0	5	1	6	0	125	2	1	128	16	0	0	0	16	1	47	0	0	48	198
06:00 AM	0	0	0	0	0	0	43	5	0	48	10	0	0	0	10	0	20	0	0	20	78
06:15 AM	0	0	0	0	0	0	65	0	0	65	10	0	2	0	12	0	26	0	0	26	103
06:30 AM	0	0	1	0	1	0	75	1	0	76	22	2	0	0	24	0	41	0	0	41	142
06:45 AM	0	0	0	0	0	0	51	1	3	55	34	0	0	0	34	1	40	0	0	41	130
Total	0	0	1	0	1	0	234	7	3	244	76	2	2	0	80	1	127	0	0	128	453
07:00 AM	0	0	3	0	3	0	52	0	1	53	21	3	0	0	24	0	52	0	0	52	132
07:15 AM	1	0	3	0	4	0	48	0	3	51	46	0	1	0	47	0	53	0	0	53	155
07:30 AM	0	0	6	0	6	0	57	1	6	64	58	0	2	0	60	0	67	0	0	67	197
07:45 AM	0	0	4	0	4	0	57	1	2	60	45	1	0	0	46	1	78	0	0	79	189
Total	1	0	16	0	17	0	214	2	12	228	170	4	3	0	177	1	250	0	0	251	673
Grand Total	1	0	22	1	24	0	573	11	16	600	262	6	5	0	273	3	424	0	0	427	1324
Apprch %	4.2	0	91.7	4.2		0	95.5	1.8	2.7		96	2.2	1.8	0		0.7	99.3	0	0		
Total %	0.1	0	1.7	0.1	1.8	0	43.3	0.8	1.2	45.3	19.8	0.5	0.4	0	20.6	0.2	32	0	0	32.3	

	Lunalilo Street Southbound				Lusitana Street Westbound				Lunalilo Street Northbound				Lusitana Street 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 05:00 AM to 07:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:00 AM																	
07:00 AM	0	0	3	3	0	52	0	52	21	3	0	24	0	52	0	52	131
07:15 AM	1	0	3	4	0	48	0	48	46	0	1	47	0	53	0	53	152
07:30 AM	0	0	6	6	0	57	1	58	58	0	2	60	0	67	0	67	191
07:45 AM	0	0	4	4	0	57	1	58	45	1	0	46	1	78	0	79	187
Total Volume	1	0	16	17	0	214	2	216	170	4	3	177	1	250	0	251	661
% App. Total	5.9	0	94.1		0	99.1	0.9		96	2.3	1.7		0.4	99.6	0		
PHF	.250	.000	.667	.708	.000	.939	.500	.931	.733	.333	.375	.738	.250	.801	.000	.794	.865

Wilson Okamoto Corporation
1907 S. Beretania Street, Suite 400
Honolulu, HI 96826

Counted By: JB
Counters: D4-5674
Weather: CLEAR

File Name : LUS LUN PM
Site Code : 00000006
Start Date : 11/2/2017
Page No : 1

Groups Printed- Unshifted

	Lunalilo Street Southbound					Lusitana Street Westbound					Lunalilo Street Northbound					Lusitana Street 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	2	1	3	0	20	0	3	23	20	1	0	0	21	1	100	0	0	101	148
03:15 PM	0	0	3	0	3	0	12	1	0	13	20	1	0	0	21	0	85	0	0	85	122
03:30 PM	0	0	5	0	5	0	10	0	1	11	11	3	3	0	17	1	107	0	0	108	141
03:45 PM	0	0	1	0	1	0	17	0	2	19	25	4	2	0	31	0	112	0	0	112	163
Total	0	0	11	1	12	0	59	1	6	66	76	9	5	0	90	2	404	0	0	406	574
04:00 PM	0	0	1	0	1	0	12	0	3	15	21	2	1	0	24	0	142	0	0	142	182
04:15 PM	0	0	9	0	9	0	12	4	5	21	19	5	1	0	25	0	119	0	0	119	174
04:30 PM	0	0	3	0	3	0	16	1	4	21	17	2	1	0	20	0	137	0	0	137	181
04:45 PM	0	0	2	0	2	0	15	0	1	16	21	6	4	0	31	0	113	0	0	113	162
Total	0	0	15	0	15	0	55	5	13	73	78	15	7	0	100	0	511	0	0	511	699
05:00 PM	0	0	5	0	5	0	10	0	4	14	19	2	2	0	23	1	111	0	0	112	154
05:15 PM	0	0	3	0	3	0	12	1	2	15	16	3	0	0	19	3	123	0	0	126	163
05:30 PM	0	0	3	0	3	0	9	1	1	11	10	0	3	0	13	2	87	0	0	89	116
05:45 PM	0	0	5	0	5	0	11	2	2	15	12	4	0	0	16	1	71	0	0	72	108
Total	0	0	16	0	16	0	42	4	9	55	57	9	5	0	71	7	392	0	0	399	541
Grand Total	0	0	42	1	43	0	156	10	28	194	211	33	17	0	261	9	1307	0	0	1316	1814
Apprch %	0	0	97.7	2.3		0	80.4	5.2	14.4		80.8	12.6	6.5	0		0.7	99.3	0	0		
Total %	0	0	2.3	0.1	2.4	0	8.6	0.6	1.5	10.7	11.6	1.8	0.9	0	14.4	0.5	72.1	0	0	72.5	

	Lunalilo Street Southbound				Lusitana Street Westbound				Lunalilo Street Northbound				Lusitana Street 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 03:45 PM																	
03:45 PM	0	0	1	1	0	17	0	17	25	4	2	31	0	112	0	112	161
04:00 PM	0	0	1	1	0	12	0	12	21	2	1	24	0	142	0	142	179
04:15 PM	0	0	9	9	0	12	4	16	19	5	1	25	0	119	0	119	169
04:30 PM	0	0	3	3	0	16	1	17	17	2	1	20	0	137	0	137	177
Total Volume	0	0	14	14	0	57	5	62	82	13	5	100	0	510	0	510	686
% App. Total	0	0	100		0	91.9	8.1		82	13	5		0	100	0		
PHF	.000	.000	.389	.389	.000	.838	.313	.912	.820	.650	.625	.806	.000	.898	.000	.898	.958

Wilson Okamoto Corporation

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

Counted By: LF, EV
Counters: D4-3890, D4-3888
Weather: CLEAR

File Name : SBER ALA AM
Site Code : 00000002
Start Date : 4/10/2018
Page No : 1

Groups Printed- Unshifted

	Alapai Street Southbound			South Beretania Street Westbound				Alapai Street Northbound				
Start Time	Right	Peds	App. Total	Thru	Right	Peds	App. Total	Left	Thru	Peds	App. Total	Int. Total
05:00 AM	7	3	10	53	3	2	58	39	4	0	43	111
05:15 AM	7	3	10	77	3	6	86	56	2	3	61	157
05:30 AM	9	3	12	129	8	13	150	63	7	3	73	235
05:45 AM	10	4	14	125	5	13	143	98	4	7	109	266
Total	33	13	46	384	19	34	437	256	17	13	286	769
06:00 AM	12	9	21	199	5	12	216	103	10	5	118	355
06:15 AM	27	13	40	255	14	14	283	123	12	7	142	465
06:30 AM	21	21	42	364	22	19	405	182	19	6	207	654
06:45 AM	12	11	23	402	23	14	439	210	31	10	251	713
Total	72	54	126	1220	64	59	1343	618	72	28	718	2187
07:00 AM	9	14	23	508	16	25	549	279	36	10	325	897
07:15 AM	14	18	32	585	38	25	648	274	55	15	344	1024
07:30 AM	16	9	25	665	40	33	738	288	58	24	370	1133
07:45 AM	19	9	28	640	51	14	705	278	40	10	328	1061
Total	58	50	108	2398	145	97	2640	1119	189	59	1367	4115
Grand Total	163	117	280	4002	228	190	4420	1993	278	100	2371	7071
Apprch %	58.2	41.8		90.5	5.2	4.3		84.1	11.7	4.2		
Total %	2.3	1.7	4	56.6	3.2	2.7	62.5	28.2	3.9	1.4	33.5	

	Alapai Street Southbound		South Beretania Street Westbound			Alapai Street Northbound			
Start Time	Right	App. Total	Thru	Right	App. Total	Left	Thru	App. Total	Int. Total
Peak Hour Analysis From 05:00 AM to 07:45 AM - Peak 1 of 1									
Peak Hour for Entire Intersection Begins at 07:00 AM									
07:00 AM	9	9	508	16	524	279	36	315	848
07:15 AM	14	14	585	38	623	274	55	329	966
07:30 AM	16	16	665	40	705	288	58	346	1067
07:45 AM	19	19	640	51	691	278	40	318	1028
Total Volume	58	58	2398	145	2543	1119	189	1308	3909
% App. Total	100		94.3	5.7		85.6	14.4		
PHF	.763	.763	.902	.711	.902	.971	.815	.945	.916

Wilson Okamoto Corporation

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

Counted By: MM, EV
Counters: D4-3890, D4-3888
Weather: CLEAR

File Name : SBER ALA PM
Site Code : 00000002
Start Date : 4/10/2018
Page No : 1

Groups Printed- Unshifted

	Alapai Street Southbound			South Beretania Street Westbound				Alapai Street Northbound				
Start Time	Right	Peds	App. Total	Thru	Right	Peds	App. Total	Left	Thru	Peds	App. Total	Int. Total
03:00 PM	8	13	21	455	39	21	515	305	31	4	340	876
03:15 PM	8	4	12	477	25	14	516	295	26	5	326	854
03:30 PM	13	13	26	463	26	33	522	305	33	7	345	893
03:45 PM	6	11	17	469	29	41	539	300	31	7	338	894
Total	35	41	76	1864	119	109	2092	1205	121	23	1349	3517
04:00 PM	10	15	25	461	23	25	509	322	46	11	379	913
04:15 PM	11	6	17	499	37	24	560	314	61	13	388	965
04:30 PM	7	15	22	493	25	34	552	335	55	19	409	983
04:45 PM	7	9	16	454	17	31	502	351	41	18	410	928
Total	35	45	80	1907	102	114	2123	1322	203	61	1586	3789
05:00 PM	7	4	11	395	20	19	434	318	61	20	399	844
05:15 PM	4	7	11	452	24	13	489	346	69	13	428	928
05:30 PM	4	4	8	400	23	14	437	292	57	10	359	804
05:45 PM	7	10	17	308	17	15	340	258	52	9	319	676
Total	22	25	47	1555	84	61	1700	1214	239	52	1505	3252
Grand Total	92	111	203	5326	305	284	5915	3741	563	136	4440	10558
Apprch %	45.3	54.7		90	5.2	4.8		84.3	12.7	3.1		
Total %	0.9	1.1	1.9	50.4	2.9	2.7	56	35.4	5.3	1.3	42.1	

	Alapai Street Southbound		South Beretania Street Westbound			Alapai Street Northbound			
Start Time	Right	App. Total	Thru	Right	App. Total	Left	Thru	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	10	10	461	23	484	322	46	368	862
04:15 PM	11	11	499	37	536	314	61	375	922
04:30 PM	7	7	493	25	518	335	55	390	915
04:45 PM	7	7	454	17	471	351	41	392	870
Total Volume	35	35	1907	102	2009	1322	203	1525	3569
% App. Total	100		94.9	5.1		86.7	13.3		
PHF	.795	.795	.955	.689	.937	.942	.832	.973	.968

Wilson Okamoto Corporation

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

Counted By: WL
Counters: D4-3889
Weather: CLEAR

File Name : SBER LIS AM
Site Code : 00000003
Start Date : 11/1/2017
Page No : 1

Groups Printed- Unshifted

	Lisbon Street Southbound			South Beretania Street Westbound			Northbound	Eastbound	
Start Time	Right	Peds	App. Total	Thru	Right	App. Total	App. Total	App. Total	Int. Total
05:00 AM	1	4	5	104	0	104	0	0	109
05:15 AM	3	3	6	132	1	133	0	0	139
05:30 AM	1	1	2	178	1	179	0	0	181
05:45 AM	3	5	8	194	4	198	0	0	206
Total	8	13	21	608	6	614	0	0	635
06:00 AM	2	5	7	284	2	286	0	0	293
06:15 AM	1	7	8	355	6	361	0	0	369
06:30 AM	10	7	17	455	12	467	0	0	484
06:45 AM	10	7	17	597	12	609	0	0	626
Total	23	26	49	1691	32	1723	0	0	1772
07:00 AM	7	6	13	718	4	722	0	0	735
07:15 AM	1	9	10	825	6	831	0	0	841
07:30 AM	10	11	21	931	5	936	0	0	957
07:45 AM	12	12	24	886	5	891	0	0	915
Total	30	38	68	3360	20	3380	0	0	3448
Grand Total	61	77	138	5659	58	5717	0	0	5855
Apprch %	44.2	55.8		99	1				
Total %	1	1.3	2.4	96.7	1	97.6	0	0	

	Lisbon Street Southbound		South Beretania Street Westbound			Northbound	Eastbound	
Start Time	Right	App. Total	Thru	Right	App. Total	App. Total	App. Total	Int. Total
Peak Hour Analysis From 05:00 AM to 07:45 AM - Peak 1 of 1								
Peak Hour for Entire Intersection Begins at 07:00 AM								
07:00 AM	7	7	718	4	722	0	0	729
07:15 AM	1	1	825	6	831	0	0	832
07:30 AM	10	10	931	5	936	0	0	946
07:45 AM	12	12	886	5	891	0	0	903
Total Volume	30	30	3360	20	3380	0	0	3410
% App. Total	100		99.4	0.6				
PHF	.625	.625	.902	.833	.903	.000	.000	.901

Wilson Okamoto Corporation

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

Counted By: WL
Counters: D4-3889
Weather: CLEAR

File Name : SBER LIS PM
Site Code : 00000000
Start Date : 11/1/2017
Page No : 1

Groups Printed- Unshifted

	Lisbon Street Southbound			South Beretania Street Westbound			Northbound	Eastbound	
Start Time	Right	Peds	App. Total	Thru	Right	App. Total	App. Total	App. Total	Int. Total
03:00 PM	8	5	13	702	6	708	0	0	721
03:15 PM	8	5	13	746	6	752	0	0	765
03:30 PM	16	1	17	801	4	805	0	0	822
03:45 PM	6	2	8	826	2	828	0	0	836
Total	38	13	51	3075	18	3093	0	0	3144
04:00 PM	6	2	8	779	0	779	0	0	787
04:15 PM	0	4	4	793	3	796	0	0	800
04:30 PM	12	6	18	832	3	835	0	0	853
04:45 PM	5	7	12	875	1	876	0	0	888
Total	23	19	42	3279	7	3286	0	0	3328
05:00 PM	6	6	12	791	2	793	0	0	805
05:15 PM	6	6	12	703	1	704	0	0	716
05:30 PM	2	6	8	674	2	676	0	0	684
05:45 PM	2	0	2	670	1	671	0	0	673
Total	16	18	34	2838	6	2844	0	0	2878
Grand Total	77	50	127	9192	31	9223	0	0	9350
Apprch %	60.6	39.4		99.7	0.3				
Total %	0.8	0.5	1.4	98.3	0.3	98.6	0	0	

	Lisbon Street Southbound		South Beretania Street Westbound			Northbound	Eastbound	
Start Time	Right	App. Total	Thru	Right	App. Total	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 04:15 PM								
04:15 PM	0	0	793	3	796	0	0	796
04:30 PM	12	12	832	3	835	0	0	847
04:45 PM	5	5	875	1	876	0	0	881
05:00 PM	6	6	791	2	793	0	0	799
Total Volume	23	23	3291	9	3300	0	0	3323
% App. Total	100		99.7	0.3				
PHF	.479	.479	.940	.750	.942	.000	.000	.943

Wilson Okamoto Corporation

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

Counted By: FS, GH
Counters: D4-5671, D4-5677
Weather: CLEAR

File Name : SBER LAU AM
Site Code : 00000002
Start Date : 11/1/2017
Page No : 1

Groups Printed- Unshifted

	Lauahala Street Southbound				South Beretania Street Westbound					Lauahala Street Northbound				Eastbound	
Start Time	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Peds	App. Total	App. Total	Int. Total
05:00 AM	0	5	2	7	0	104	2	1	107	1	2	0	3	0	117
05:15 AM	1	7	5	13	1	119	5	1	126	1	0	4	5	0	144
05:30 AM	0	11	2	13	1	173	4	2	180	5	2	2	9	0	202
05:45 AM	0	14	5	19	1	186	8	7	202	5	1	6	12	0	233
Total	1	37	14	52	3	582	19	11	615	12	5	12	29	0	696
06:00 AM	1	14	5	20	5	258	17	5	285	2	0	3	5	0	310
06:15 AM	2	26	10	38	5	333	12	12	362	4	0	7	11	0	411
06:30 AM	0	30	8	38	5	431	12	10	458	6	1	8	15	0	511
06:45 AM	1	41	8	50	20	577	9	27	633	4	4	8	16	0	699
Total	4	111	31	146	35	1599	50	54	1738	16	5	26	47	0	1931
07:00 AM	5	29	12	46	15	655	15	16	701	6	3	4	13	0	760
07:15 AM	2	35	25	62	11	811	25	33	880	6	2	2	10	0	952
07:30 AM	2	60	26	88	13	870	20	34	937	13	0	11	24	0	1049
07:45 AM	1	58	33	92	30	833	9	36	908	10	0	9	19	0	1019
Total	10	182	96	288	69	3169	69	119	3426	35	5	26	66	0	3780
Grand Total	15	330	141	486	107	5350	138	184	5779	63	15	64	142	0	6407
Apprch %	3.1	67.9	29		1.9	92.6	2.4	3.2		44.4	10.6	45.1			
Total %	0.2	5.2	2.2	7.6	1.7	83.5	2.2	2.9	90.2	1	0.2	1	2.2	0	

	Lauahala Street Southbound			South Beretania Street Westbound				Lauahala Street Northbound			Eastbound	
Start Time	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	App. Total	App. Total	Int. Total
Peak Hour Analysis From 05:00 AM to 07:30 AM - Peak 1 of 1												
Peak Hour for Entire Intersection Begins at 06:45 AM												
06:45 AM	1	41	42	20	577	9	606	4	4	8	0	656
07:00 AM	5	29	34	15	655	15	685	6	3	9	0	728
07:15 AM	2	35	37	11	811	25	847	6	2	8	0	892
07:30 AM	2	60	62	13	870	20	903	13	0	13	0	978
Total Volume	10	165	175	59	2913	69	3041	29	9	38	0	3254
% App. Total	5.7	94.3		1.9	95.8	2.3		76.3	23.7			
PHF	.500	.688	.706	.738	.837	.690	.842	.558	.563	.731	.000	.832

Wilson Okamoto Corporation

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

Counted By: FS, GH
Counters: D4-5671, D4-5675
Weather: CLEAR

File Name : SBER LAU PM
Site Code : 00000002
Start Date : 11/1/2017
Page No : 1

Groups Printed- Unshifted

	Lauhala Street Southbound				South Beretania Street Westbound					Lauhala Street Northbound				Eastbound	
Start Time	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Peds	App. Total	App. Total	Int. Total
03:00 PM	1	98	7	106	2	683	4	10	699	12	1	8	21	0	826
03:15 PM	2	91	15	108	5	723	2	17	747	25	4	3	32	0	887
03:30 PM	4	85	8	97	5	798	4	26	833	22	7	3	32	0	962
03:45 PM	0	64	14	78	3	845	2	22	872	39	7	5	51	0	1001
Total	7	338	44	389	15	3049	12	75	3151	98	19	19	136	0	3676
04:00 PM	2	83	17	102	1	775	2	26	804	33	11	3	47	0	953
04:15 PM	2	77	9	88	2	784	8	22	816	42	9	8	59	0	963
04:30 PM	0	97	28	125	4	733	1	43	781	98	116	7	221	0	1127
04:45 PM	0	93	14	107	1	886	2	20	909	51	14	12	77	0	1093
Total	4	350	68	422	8	3178	13	111	3310	224	150	30	404	0	4136
05:00 PM	0	86	17	103	1	812	4	34	851	34	17	13	64	0	1018
05:15 PM	2	60	21	83	2	755	0	19	776	30	9	1	40	0	899
05:30 PM	2	59	8	69	0	703	3	15	721	19	9	3	31	0	821
05:45 PM	0	37	5	42	0	684	4	6	694	17	3	8	28	0	764
Total	4	242	51	297	3	2954	11	74	3042	100	38	25	163	0	3502
Grand Total	15	930	163	1108	26	9181	36	260	9503	422	207	74	703	0	11314
Apprch %	1.4	83.9	14.7		0.3	96.6	0.4	2.7		60	29.4	10.5			
Total %	0.1	8.2	1.4	9.8	0.2	81.1	0.3	2.3	84	3.7	1.8	0.7	6.2	0	

	Lauhala Street Southbound			South Beretania Street Westbound				Lauhala Street Northbound			Eastbound	
Start Time	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	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 04:15 PM												
04:15 PM	2	77	79	2	784	8	794	42	9	51	0	924
04:30 PM	0	97	97	4	733	1	738	98	116	214	0	1049
04:45 PM	0	93	93	1	886	2	889	51	14	65	0	1047
05:00 PM	0	86	86	1	812	4	817	34	17	51	0	954
Total Volume	2	353	355	8	3215	15	3238	225	156	381	0	3974
% App. Total	0.6	99.4		0.2	99.3	0.5		59.1	40.9			
PHF	.250	.910	.915	.500	.907	.469	.911	.574	.336	.445	.000	.947

Wilson Okamoto Corporation

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

Counted By: DY, BE
Counters: D4-3888, D4-5674
Weather: CLEAR

File Name : SBER PUN AM
Site Code : 00000001
Start Date : 11/1/2017
Page No : 1

Groups Printed- Unshifted

	Punchbowl Street Southbound				South Beretania Street Westbound					Punchbowl Street Northbound			South Beretania Street Eastbound		
Start Time	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Thru	Peds	App. Total	Peds	App. Total	Int. Total
05:00 AM	69	13	6	88	5	62	37	5	109	0	0	0	1	1	198
05:15 AM	106	11	6	123	8	70	55	5	138	2	2	4	0	0	265
05:30 AM	127	21	12	160	12	93	78	5	188	13	2	15	1	1	364
05:45 AM	172	40	16	228	14	111	92	7	224	15	8	23	3	3	478
Total	474	85	40	599	39	336	262	22	659	30	12	42	5	5	1305
06:00 AM	212	37	20	269	33	138	111	13	295	18	12	30	3	3	597
06:15 AM	248	45	49	342	53	206	114	15	388	11	21	32	5	5	767
06:30 AM	189	74	32	295	52	262	150	27	491	21	17	38	4	4	828
06:45 AM	237	43	31	311	73	334	201	17	625	29	20	49	19	19	1004
Total	886	199	132	1217	211	940	576	72	1799	79	70	149	31	31	3196
07:00 AM	253	53	24	330	82	479	161	16	738	48	13	61	9	9	1138
07:15 AM	259	63	43	365	115	549	174	40	878	37	23	60	12	12	1315
07:30 AM	258	53	25	336	121	647	177	28	973	52	29	81	16	16	1406
07:45 AM	269	48	43	360	140	656	195	42	1033	48	22	70	7	7	1470
Total	1039	217	135	1391	458	2331	707	126	3622	185	87	272	44	44	5329
Grand Total	2399	501	307	3207	708	3607	1545	220	6080	294	169	463	80	80	9830
Apprch %	74.8	15.6	9.6		11.6	59.3	25.4	3.6		63.5	36.5		100		
Total %	24.4	5.1	3.1	32.6	7.2	36.7	15.7	2.2	61.9	3	1.7	4.7	0.8	0.8	

	Punchbowl Street Southbound			South Beretania Street Westbound				Punchbowl Street Northbound		Eastbound	
Start Time	Thru	Right	App. Total	Left	Thru	Right	App. Total	Thru	App. Total	App. Total	Int. Total
Peak Hour Analysis From 05:00 AM to 07:45 AM - Peak 1 of 1											
Peak Hour for Entire Intersection Begins at 07:00 AM											
07:00 AM	253	53	306	82	479	161	722	48	48	0	1076
07:15 AM	259	63	322	115	549	174	838	37	37	0	1197
07:30 AM	258	53	311	121	647	177	945	52	52	0	1308
07:45 AM	269	48	317	140	656	195	991	48	48	0	1356
Total Volume	1039	217	1256	458	2331	707	3496	185	185	0	4937
% App. Total	82.7	17.3		13.1	66.7	20.2		100			
PHF	.966	.861	.975	.818	.888	.906	.882	.889	.889	.000	.910

Wilson Okamoto Corporation

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

Counted By: DY, BE
Counters: D4-3888, D4-5674
Weather: CLEAR

File Name : SBER PUN PM
Site Code : 00000001
Start Date : 11/1/2017
Page No : 1

Groups Printed- Unshifted

	Punchbowl Street Southbound				South Beretania Street Westbound					Punchbowl Street Northbound			South Beretania Street Eastbound					
Start Time	Right	Thru	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Thru	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
03:00 PM	35	179	32	246	213	557	73	17	860	72	9	81	0	0	0	16	16	1203
03:15 PM	39	217	32	288	212	595	85	24	916	53	26	79	0	0	0	18	18	1301
03:30 PM	33	208	31	272	227	655	87	9	978	70	24	94	0	0	0	11	11	1355
03:45 PM	37	221	29	287	222	690	105	19	1036	88	21	109	0	0	0	12	12	1444
Total	144	825	124	1093	874	2497	350	69	3790	283	80	363	0	0	0	57	57	5303
04:00 PM	41	190	36	267	194	666	94	19	973	115	22	137	0	0	0	17	17	1394
04:15 PM	51	203	23	277	221	702	95	22	1040	108	16	124	0	0	0	19	19	1460
04:30 PM	36	173	56	265	139	668	139	50	996	127	39	166	0	0	0	37	37	1464
04:45 PM	31	209	20	260	167	685	135	20	1007	145	46	191	0	0	0	21	21	1479
Total	159	775	135	1069	721	2721	463	111	4016	495	123	618	0	0	0	94	94	5797
05:00 PM	31	195	34	260	184	618	102	19	923	72	23	95	0	0	0	20	20	1298
05:15 PM	36	182	17	235	194	575	98	28	895	129	22	151	0	0	0	12	12	1293
05:30 PM	24	180	14	218	152	461	62	6	681	86	11	97	0	0	0	10	10	1006
05:45 PM	0	0	0	0	147	399	61	11	618	64	6	70	0	0	0	0	0	688
Total	91	557	65	713	677	2053	323	64	3117	351	62	413	0	0	0	42	42	4285
Grand Total	394	2157	324	2875	2272	7271	1136	244	10923	1129	265	1394	0	0	0	193	193	15385
Apprch %	13.7	75	11.3		20.8	66.6	10.4	2.2		81	19		0	0	0	100		
Total %	2.6	14	2.1	18.7	14.8	47.3	7.4	1.6	71	7.3	1.7	9.1	0	0	0	1.3	1.3	

	Punchbowl Street Southbound			South Beretania Street Westbound				Punchbowl Street Northbound		South Beretania Street Eastbound				
Start Time	Right	Thru	App. Total	Right	Thru	Left	App. Total	Thru	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 04:00 PM														
04:00 PM	41	190	231	194	666	94	954	115	115	0	0	0	0	1300
04:15 PM	**51**	**203**	**254**	**221**	**702**	**95**	**1018**	108	108	0	0	0	0	**1380**
04:30 PM	36	173	209	139	668	**139**	946	127	127	0	0	0	0	1282
04:45 PM	31	**209**	240	167	685	135	987	**145**	**145**	0	0	0	0	1372
Total Volume	159	775	934	721	2721	463	3905	495	495	0	0	0	0	5334
% App. Total	17	83		18.5	69.7	11.9		100		0	0	0		
PHF	.779	.927	.919	.816	.969	.833	.959	.853	.853	.000	.000	.000	.000	.966

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.

LEVEL OF SERVICE DEFINITIONS

LEVEL-OF-SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS

Level of Service (LOS) criteria are given in Table 1. As used here, control delay is defined as the total elapsed time from the time a vehicle stops at the end of the queue to the time required for the vehicle to travel from the last-in-queue position to the first-in-queue position, including deceleration of vehicles from free-flow speed to the speed of vehicles in the queue.

The average total delay for any particular minor movement is a function of the service rate or capacity of the approach and the degree of saturation. If the degree of saturation is greater than about 0.9, average control delay is significantly affected by the length of the analysis period.

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

Level of Service	Average Control Delay (Sec/Veh)
A	≤10.0
B	>10.0 and ≤15.0
C	>15.0 and ≤25.0
D	>25.0 and ≤35.0
E	>35.0 and ≤50.0
F	>50.0

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

APPENDIX C

CAPACITY ANALYSIS CALCULATIONS
EXISTING PEAK HOUR TRAFFIC ANALYSIS

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	5	141	1112	460	152	453	817	12	26	888	33	0
Future Volume (vph)	5	141	1112	460	152	453	817	12	26	888	33	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		5.0	5.0		
Lane Util. Factor		1.00	0.95	1.00		0.97	0.91		1.00	0.95		
Frpb, ped/bikes		1.00	1.00	0.97		1.00	1.00		1.00	1.00		
Flpb, ped/bikes		1.00	1.00	1.00		1.00	1.00		1.00	1.00		
Frt		1.00	1.00	0.85		1.00	1.00		1.00	0.99		
Flt Protected		0.95	1.00	1.00		0.95	1.00		0.95	1.00		
Satd. Flow (prot)		1770	3539	1532		3433	5062		1763	3505		
Flt Permitted		0.95	1.00	1.00		0.95	1.00		0.17	1.00		
Satd. Flow (perm)		1770	3539	1532		3433	5062		318	3505		
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	5	155	1222	505	167	498	898	13	29	976	36	0
RTOR Reduction (vph)	0	0	0	50	0	0	0	0	0	1	0	0
Lane Group Flow (vph)	0	160	1222	455	0	665	911	0	29	1011	0	0
Confl. Peds. (#/hr)				11				87	11		70	70
Turn Type	Prot	Prot	NA	Perm	Prot	Prot	NA		Perm	NA		
Protected Phases	5	5	2		1	1	6			8		
Permitted Phases				2					8			
Actuated Green, G (s)		18.8	63.0	63.0		33.5	77.7		48.5	48.5		
Effective Green, g (s)		18.8	63.0	63.0		33.5	77.7		48.5	48.5		
Actuated g/C Ratio		0.12	0.39	0.39		0.21	0.49		0.30	0.30		
Clearance Time (s)		5.0	5.0	5.0		5.0	5.0		5.0	5.0		
Vehicle Extension (s)		2.5	2.5	2.5		2.5	2.5		2.5	2.5		
Lane Grp Cap (vph)		207	1393	603		718	2458		96	1062		
v/s Ratio Prot		0.09	c0.35			c0.19	0.18			c0.29		
v/s Ratio Perm				0.30					0.09			
v/c Ratio		0.77	0.88	0.76		0.93	0.37		0.30	0.95		
Uniform Delay, d1		68.5	44.9	41.8		62.0	25.8		42.8	54.6		
Progression Factor		1.00	1.00	1.00		1.00	1.00		1.00	1.00		
Incremental Delay, d2		15.7	8.1	8.5		17.8	0.4		1.3	17.2		
Delay (s)		84.2	53.0	50.4		79.9	26.2		44.1	71.8		
Level of Service		F	D	D		E	C		D	E		
Approach Delay (s)			54.9				48.9			71.0		
Approach LOS			D				D			E		

Intersection Summary			
HCM 2000 Control Delay	55.8	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	86.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	647	30
Future Volume (vph)	647	30
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3511	
Flt Permitted	1.00	
Satd. Flow (perm)	3511	
Peak-hour factor, PHF	0.91	0.91
Adj. Flow (vph)	711	33
RTOR Reduction (vph)	2	0
Lane Group Flow (vph)	742	0
Confl. Peds. (#/hr)		11
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	48.5	
Effective Green, g (s)	48.5	
Actuated g/C Ratio	0.30	
Clearance Time (s)	5.0	
Vehicle Extension (s)	2.5	
Lane Grp Cap (vph)	1064	
v/s Ratio Prot	0.21	
v/s Ratio Perm		
v/c Ratio	0.70	
Uniform Delay, d1	49.3	
Progression Factor	1.00	
Incremental Delay, d2	1.9	
Delay (s)	51.1	
Level of Service	D	
Approach Delay (s)	51.1	
Approach LOS	D	

Intersection Summary

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	3	242	1468	231	60	288	437	6	55	1118	90	0
Future Volume (vph)	3	242	1468	231	60	288	437	6	55	1118	90	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	5.0		
Lane Util. Factor		1.00	0.91			0.97	0.91		1.00	0.95		
Frpb, ped/bikes		1.00	0.99			1.00	1.00		1.00	1.00		
Flpb, ped/bikes		1.00	1.00			1.00	1.00		0.99	1.00		
Frt		1.00	0.98			1.00	1.00		1.00	0.99		
Flt Protected		0.95	1.00			0.95	1.00		0.95	1.00		
Satd. Flow (prot)		1770	4933			3433	5074		1745	3487		
Flt Permitted		0.95	1.00			0.95	1.00		0.40	1.00		
Satd. Flow (perm)		1770	4933			3433	5074		743	3487		
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	3	249	1513	238	62	297	451	6	57	1153	93	0
RTOR Reduction (vph)	0	0	13	0	0	0	0	0	0	4	0	0
Lane Group Flow (vph)	0	252	1738	0	0	359	457	0	57	1242	0	0
Confl. Peds. (#/hr)				32				7	19		22	
Turn Type	Prot	Prot	NA		Prot	Prot	NA		Perm	NA		
Protected Phases	5	5	2		1	1	6			8		
Permitted Phases									8			
Actuated Green, G (s)		27.3	64.9			19.8	57.4		60.3	60.3		
Effective Green, g (s)		27.3	64.9			19.8	57.4		60.3	60.3		
Actuated g/C Ratio		0.17	0.41			0.12	0.36		0.38	0.38		
Clearance Time (s)		5.0	5.0			5.0	5.0		5.0	5.0		
Vehicle Extension (s)		2.5	2.5			2.5	2.5		2.5	2.5		
Lane Grp Cap (vph)		302	2000			424	1820		280	1314		
v/s Ratio Prot		c0.14	c0.35			0.10	0.09			c0.36		
v/s Ratio Perm									0.08			
v/c Ratio		0.83	0.87			0.85	0.25		0.20	0.95		
Uniform Delay, d1		64.2	43.6			68.6	36.2		33.6	48.3		
Progression Factor		1.00	1.00			1.00	1.00		1.00	1.00		
Incremental Delay, d2		17.4	5.5			14.2	0.3		0.3	13.7		
Delay (s)		81.6	49.1			82.8	36.5		33.9	62.0		
Level of Service		F	D			F	D		C	E		
Approach Delay (s)			53.2				56.9			60.8		
Approach LOS			D				E			E		

Intersection Summary			
HCM 2000 Control Delay	54.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	90.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	424	19
Future Volume (vph)	424	19
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3509	
Flt Permitted	1.00	
Satd. Flow (perm)	3509	
Peak-hour factor, PHF	0.97	0.97
Adj. Flow (vph)	437	20
RTOR Reduction (vph)	2	0
Lane Group Flow (vph)	455	0
Confl. Peds. (#/hr)		19
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	60.3	
Effective Green, g (s)	60.3	
Actuated g/C Ratio	0.38	
Clearance Time (s)	5.0	
Vehicle Extension (s)	2.5	
Lane Grp Cap (vph)	1322	
v/s Ratio Prot	0.13	
v/s Ratio Perm		
v/c Ratio	0.34	
Uniform Delay, d1	35.7	
Progression Factor	1.00	
Incremental Delay, d2	0.1	
Delay (s)	35.8	
Level of Service	D	
Approach Delay (s)	35.8	
Approach LOS	D	

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	305	177	99	114	4	23
Future Volume (Veh/h)	305	177	99	114	4	23
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	347	201	113	130	5	26
Pedestrians	88				66	
Lane Width (ft)	12.0				12.0	
Walking Speed (ft/s)	3.5				3.5	
Percent Blockage	8				6	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			614		958	514
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			614		958	514
tC, single (s)			4.1		*5.4	*5.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			88		98	96
cM capacity (veh/h)			905		282	608

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	548	243	31
Volume Left	0	113	5
Volume Right	201	0	26
cSH	1700	905	512
Volume to Capacity	0.32	0.12	0.06
Queue Length 95th (ft)	0	11	5
Control Delay (s)	0.0	5.1	12.5
Lane LOS		A	B
Approach Delay (s)	0.0	5.1	12.5
Approach LOS			B

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	53.4%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	298	136	200	38	4	99
Future Volume (Veh/h)	298	136	200	38	4	99
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	317	145	213	40	4	105
Pedestrians	69				42	
Lane Width (ft)	12.0				12.0	
Walking Speed (ft/s)	3.5				3.5	
Percent Blockage	7				4	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			504		966	432
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			504		966	432
tC, single (s)			4.1		*5.4	*5.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			79		98	84
cM capacity (veh/h)			1018		263	677

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	462	253	109
Volume Left	0	213	4
Volume Right	145	0	105
cSH	1700	1018	640
Volume to Capacity	0.27	0.21	0.17
Queue Length 95th (ft)	0	20	15
Control Delay (s)	0.0	8.3	11.8
Lane LOS		A	B
Approach Delay (s)	0.0	8.3	11.8
Approach LOS			B

Intersection Summary			
Average Delay	4.1		
Intersection Capacity Utilization	54.5%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	63	244	27	42	223	94	9	0	4	0	0	0
Future Volume (Veh/h)	63	244	27	42	223	94	9	0	4	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	72	277	31	48	253	107	10	0	5	0	0	0
Pedestrians								80				
Lane Width (ft)								12.0				
Walking Speed (ft/s)								3.5				
Percent Blockage								8				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	360			388			919	972	372	844	934	306
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	360			388			919	972	372	844	934	306
tC, single (s)	4.1			4.1			*6.1	6.5	*5.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	94			96			96	100	99	100	100	100
cM capacity (veh/h)	1199			1081			262	209	691	244	220	733

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	380	408	15
Volume Left	72	48	10
Volume Right	31	107	5
cSH	1199	1081	331
Volume to Capacity	0.06	0.04	0.05
Queue Length 95th (ft)	5	3	4
Control Delay (s)	2.0	1.4	16.4
Lane LOS	A	A	C
Approach Delay (s)	2.0	1.4	16.4
Approach LOS			C

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	38.9%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	5	496	12	7	96	5	8	0	14	0	0	0
Future Volume (Veh/h)	5	496	12	7	96	5	8	0	14	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	5	528	13	7	102	5	9	0	15	0	0	0
Pedestrians								35				
Lane Width (ft)								12.0				
Walking Speed (ft/s)								3.5				
Percent Blockage								3				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	107			576			698	700	570	678	704	104
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	107			576			698	700	570	678	704	104
tC, single (s)	4.1			4.1			*6.1	6.5	*5.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			99			98	100	97	100	100	100
cM capacity (veh/h)	1484			964			404	347	592	345	345	950

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	546	114	24
Volume Left	5	7	9
Volume Right	13	5	15
cSH	1484	964	504
Volume to Capacity	0.00	0.01	0.05
Queue Length 95th (ft)	0	1	4
Control Delay (s)	0.1	0.6	12.5
Lane LOS	A	A	B
Approach Delay (s)	0.1	0.6	12.5
Approach LOS			B

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	38.3%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	239	19	1	350	41	0	0	0	9	6	4
Future Volume (Veh/h)	0	239	19	1	350	41	0	0	0	9	6	4
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	272	22	1	398	47	0	0	0	10	7	5
Pedestrians		42			12			14			15	
Lane Width (ft)		12.0			12.0			0.0			12.0	
Walking Speed (ft/s)		3.5			3.5			3.5			3.5	
Percent Blockage		4			1			0			1	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	460			308			771	759	309	734	746	478
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	460			308			771	759	309	734	746	478
tC, single (s)	4.1			4.1			7.1	6.5	6.2	*6.1	*5.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	97	98	99
cM capacity (veh/h)	1085			1253			295	331	723	398	416	636

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	294	446	22
Volume Left	0	1	10
Volume Right	22	47	5
cSH	1085	1253	442
Volume to Capacity	0.00	0.00	0.05
Queue Length 95th (ft)	0	0	4
Control Delay (s)	0.0	0.0	13.6
Lane LOS		A	B
Approach Delay (s)	0.0	0.0	13.6
Approach LOS			B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	39.4%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		4			4						4	
Traffic Volume (veh/h)	2	481	11	1	98	45	0	0	0	3	2	12
Future Volume (Veh/h)	2	481	11	1	98	45	0	0	0	3	2	12
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	2	512	12	1	104	48	0	0	0	3	2	13
Pedestrians		42			12			14			15	
Lane Width (ft)		12.0			12.0			0.0			12.0	
Walking Speed (ft/s)		3.5			3.5			3.5			3.5	
Percent Blockage		4			1			0			1	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	167			538			722	705	544	679	687	185
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	167			538			722	705	544	679	687	185
tC, single (s)	4.1			4.1			7.1	6.5	6.2	*6.1	*5.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	99	100	98
cM capacity (veh/h)	1391			1030			318	355	533	426	442	855

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	526	153	18
Volume Left	2	1	3
Volume Right	12	48	13
cSH	1391	1030	672
Volume to Capacity	0.00	0.00	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.1	10.5
Lane LOS	A	A	B
Approach Delay (s)	0.0	0.1	10.5
Approach LOS			B

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	44.9%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	250	0	0	214	1	170	4	3	0	0	17
Future Volume (Veh/h)	1	250	0	0	214	1	170	4	3	0	0	17
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	1	284	0	0	243	1	193	5	3	0	0	19
Pedestrians		12										
Lane Width (ft)		12.0										
Walking Speed (ft/s)		3.5										
Percent Blockage		1										
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	244			284			542	530	284	535	530	256
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	244			284			542	530	284	535	530	256
tC, single (s)	4.1			4.1			*6.1	*5.5	*5.2	7.1	6.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			62	99	100	100	100	98
cM capacity (veh/h)	1322			1278			508	528	818	451	454	832

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	285	244	201	19
Volume Left	1	0	193	0
Volume Right	0	1	3	19
cSH	1322	1700	512	832
Volume to Capacity	0.00	0.14	0.39	0.02
Queue Length 95th (ft)	0	0	46	2
Control Delay (s)	0.0	0.0	16.5	9.4
Lane LOS	A		C	A
Approach Delay (s)	0.0	0.0	16.5	9.4
Approach LOS			C	A

Intersection Summary			
Average Delay	4.7		
Intersection Capacity Utilization	37.8%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	480	0	0	53	5	76	15	8	0	0	18
Future Volume (Veh/h)	1	480	0	0	53	5	76	15	8	0	0	18
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	1	511	0	0	56	5	81	16	9	0	0	19
Pedestrians		12										
Lane Width (ft)		12.0										
Walking Speed (ft/s)		3.5										
Percent Blockage		1										
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	61			511			584	574	511	588	572	70
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	61			511			584	574	511	588	572	70
tC, single (s)	4.1			4.1			*6.1	*5.5	*5.2	7.1	6.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			83	97	99	100	100	98
cM capacity (veh/h)	1542			1054			484	505	650	404	430	1001

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	512	61	106	19
Volume Left	1	0	81	0
Volume Right	0	5	9	19
cSH	1542	1700	498	1001
Volume to Capacity	0.00	0.04	0.21	0.02
Queue Length 95th (ft)	0	0	20	1
Control Delay (s)	0.0	0.0	14.2	8.7
Lane LOS	A		B	A
Approach Delay (s)	0.0	0.0	14.2	8.7
Approach LOS			B	A

Intersection Summary			
Average Delay	2.4		
Intersection Capacity Utilization	44.9%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	0	2398	145	1119	189	0	0	0	58
Future Volume (vph)	0	0	0	0	2398	145	1119	189	0	0	0	58
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					0.81		0.94	1.00				1.00
Frpb, ped/bikes					1.00		1.00	1.00				1.00
Flpb, ped/bikes					1.00		1.00	1.00				1.00
Frt					0.99		1.00	1.00				0.86
Flt Protected					1.00		0.95	1.00				1.00
Satd. Flow (prot)					7444		4990	1863				1611
Flt Permitted					1.00		0.95	1.00				1.00
Satd. Flow (perm)					7444		4990	1863				1611
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	2607	158	1216	205	0	0	0	63
RTOR Reduction (vph)	0	0	0	0	12	0	15	0	0	0	0	15
Lane Group Flow (vph)	0	0	0	0	2753	0	1201	205	0	0	0	48
Confl. Peds. (#/hr)						50						
Turn Type					NA		Perm	NA				Perm
Protected Phases					6			8				
Permitted Phases							8					4
Actuated Green, G (s)					46.0		34.0	34.0				34.0
Effective Green, g (s)					46.0		34.0	34.0				34.0
Actuated g/C Ratio					0.51		0.38	0.38				0.38
Clearance Time (s)					5.0		5.0	5.0				5.0
Vehicle Extension (s)					3.0		3.0	3.0				3.0
Lane Grp Cap (vph)					3804		1885	703				608
v/s Ratio Prot					c0.37			0.11				
v/s Ratio Perm							c0.24					0.03
v/c Ratio					0.72		0.64	0.29				0.08
Uniform Delay, d1					17.1		22.9	19.6				18.0
Progression Factor					1.00		1.00	1.00				1.00
Incremental Delay, d2					1.2		1.7	1.1				0.3
Delay (s)					18.3		24.6	20.6				18.2
Level of Service					B		C	C				B
Approach Delay (s)		0.0			18.3			24.0			18.2	
Approach LOS		A			B			C			B	

Intersection Summary			
HCM 2000 Control Delay	20.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	67.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	0	1818	123	1349	234	0	0	0	17
Future Volume (vph)	0	0	0	0	1818	123	1349	234	0	0	0	17
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					0.81		0.94	1.00				1.00
Frt					0.99		1.00	1.00				0.86
Flt Protected					1.00		0.95	1.00				1.00
Satd. Flow (prot)					7473		4990	1863				1611
Flt Permitted					1.00		0.95	1.00				1.00
Satd. Flow (perm)					7473		4990	1863				1611
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	0	1914	129	1420	246	0	0	0	18
RTOR Reduction (vph)	0	0	0	0	13	0	14	0	0	0	0	10
Lane Group Flow (vph)	0	0	0	0	2030	0	1406	246	0	0	0	8
Turn Type					NA		Perm	NA				Perm
Protected Phases					6			8				
Permitted Phases							8					4
Actuated Green, G (s)					42.0		38.0	38.0				38.0
Effective Green, g (s)					42.0		38.0	38.0				38.0
Actuated g/C Ratio					0.47		0.42	0.42				0.42
Clearance Time (s)					5.0		5.0	5.0				5.0
Vehicle Extension (s)					3.0		3.0	3.0				3.0
Lane Grp Cap (vph)					3487		2106	786				680
v/s Ratio Prot					c0.27			0.13				
v/s Ratio Perm							c0.28					0.00
v/c Ratio					0.58		0.67	0.31				0.01
Uniform Delay, d1					17.6		20.9	17.3				15.1
Progression Factor					1.00		1.00	1.00				1.00
Incremental Delay, d2					0.7		1.7	1.0				0.0
Delay (s)					18.3		22.6	18.3				15.1
Level of Service					B		C	B				B
Approach Delay (s)		0.0			18.3			22.0			15.1	
Approach LOS		A			B			C			B	

Intersection Summary			
HCM 2000 Control Delay	19.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	65.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	560	20	0	30
Future Volume (Veh/h)	0	0	560	20	0	30
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	0	0	615	22	0	33
Pedestrians					38	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					4	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	675				664	664
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	675				664	664
tC, single (s)	4.1				6.4	*5.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	94
cM capacity (veh/h)	883				410	536

Direction, Lane #	WB 1	SB 1
Volume Total	637	33
Volume Left	0	0
Volume Right	22	33
cSH	1700	536
Volume to Capacity	0.37	0.06
Queue Length 95th (ft)	0	5
Control Delay (s)	0.0	12.2
Lane LOS		B
Approach Delay (s)	0.0	12.2
Approach LOS		B

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	40.8%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	549	9	0	23
Future Volume (Veh/h)	0	0	549	9	0	23
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	0	0	584	10	0	24
Pedestrians					23	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					2	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	617				612	612
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	617				612	612
tC, single (s)	4.1				6.4	*5.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	96
cM capacity (veh/h)	942				446	574

Direction, Lane #	WB 1	SB 1
Volume Total	594	24
Volume Left	0	0
Volume Right	10	24
cSH	1700	574
Volume to Capacity	0.35	0.04
Queue Length 95th (ft)	0	3
Control Delay (s)	0.0	11.5
Lane LOS		B
Approach Delay (s)	0.0	11.5
Approach LOS		B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	39.5%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	69	3169	69	35	5	0	0	10	182
Future Volume (vph)	0	0	0	69	3169	69	35	5	0	0	10	182
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					0.76		0.97	1.00			0.95	0.95
Frpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Flpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Frt					1.00		1.00	1.00			0.87	0.85
Flt Protected					1.00		0.95	1.00			1.00	1.00
Satd. Flow (prot)					8423		3433	1863			1531	1504
Flt Permitted					1.00		0.68	1.00			1.00	1.00
Satd. Flow (perm)					8423		2459	1863			1531	1504
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	0	0	0	76	3482	76	38	5	0	0	11	200
RTOR Reduction (vph)	0	0	0	0	3	0	0	0	0	0	0	20
Lane Group Flow (vph)	0	0	0	0	3631	0	38	5	0	0	107	84
Confl. Peds. (#/hr)				26		96						
Turn Type				Perm	NA		Perm	NA			NA	Perm
Protected Phases					6			8			4	
Permitted Phases				6			8					4
Actuated Green, G (s)					66.1		13.9	13.9			13.9	13.9
Effective Green, g (s)					66.1		13.9	13.9			13.9	13.9
Actuated g/C Ratio					0.73		0.15	0.15			0.15	0.15
Clearance Time (s)					5.0		5.0	5.0			5.0	5.0
Vehicle Extension (s)					3.0		3.0	3.0			3.0	3.0
Lane Grp Cap (vph)					6186		379	287			236	232
v/s Ratio Prot								0.00			c0.07	
v/s Ratio Perm					0.43		0.02					0.06
v/c Ratio					0.59		0.10	0.02			0.45	0.36
Uniform Delay, d1					5.6		32.7	32.3			34.6	34.1
Progression Factor					0.64		1.00	1.00			1.00	1.00
Incremental Delay, d2					0.3		0.1	0.0			1.4	1.0
Delay (s)					3.9		32.8	32.3			36.0	35.0
Level of Service					A		C	C			D	D
Approach Delay (s)		0.0			3.9			32.7			35.5	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM 2000 Control Delay	5.9	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.56		
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	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	8	3215	15	225	156	0	0	2	353
Future Volume (vph)	0	0	0	8	3215	15	225	156	0	0	2	353
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					0.76		0.97	1.00			0.95	0.95
Frpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Flpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Frt					1.00		1.00	1.00			0.85	0.85
Flt Protected					1.00		0.95	1.00			1.00	1.00
Satd. Flow (prot)					8481		3433	1863			1507	1504
Flt Permitted					1.00		0.49	1.00			1.00	1.00
Satd. Flow (perm)					8481		1781	1863			1507	1504
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	8	3384	16	237	164	0	0	2	372
RTOR Reduction (vph)	0	0	0	0	1	0	0	0	0	0	0	19
Lane Group Flow (vph)	0	0	0	0	3407	0	237	164	0	0	188	167
Confl. Peds. (#/hr)				40		68						
Turn Type				Perm	NA		Perm	NA			NA	Perm
Protected Phases					6			8			4	
Permitted Phases				6			8					4
Actuated Green, G (s)					62.3		17.7	17.7			17.7	17.7
Effective Green, g (s)					62.3		17.7	17.7			17.7	17.7
Actuated g/C Ratio					0.69		0.20	0.20			0.20	0.20
Clearance Time (s)					5.0		5.0	5.0			5.0	5.0
Vehicle Extension (s)					3.0		3.0	3.0			3.0	3.0
Lane Grp Cap (vph)					5870		350	366			296	295
v/s Ratio Prot								0.09			0.12	
v/s Ratio Perm					0.40		c0.13					0.11
v/c Ratio					0.58		0.68	0.45			0.64	0.57
Uniform Delay, d1					7.1		33.5	31.8			33.2	32.7
Progression Factor					0.83		1.00	1.00			1.00	1.00
Incremental Delay, d2					0.3		5.1	0.9			4.4	2.5
Delay (s)					6.3		38.6	32.7			37.6	35.1
Level of Service					A		D	C			D	D
Approach Delay (s)		0.0			6.3			36.2			36.4	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM 2000 Control Delay	11.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	458	2331	707	0	185	0	0	1039	217
Future Volume (vph)	0	0	0	458	2331	707	0	185	0	0	1039	217
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				0.81	0.81	1.00		1.00			0.91	
Frpb, ped/bikes				1.00	1.00	0.81		1.00			0.99	
Flpb, ped/bikes				0.70	0.99	1.00		1.00			1.00	
Frt				1.00	1.00	0.85		1.00			0.97	
Flt Protected				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (prot)				998	5994	1289		1863			4895	
Flt Permitted				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (perm)				998	5994	1289		1863			4895	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	0	0	0	509	2590	786	0	206	0	0	1154	241
RTOR Reduction (vph)	0	0	0	0	0	69	0	0	0	0	1	0
Lane Group Flow (vph)	0	0	0	458	2641	717	0	206	0	0	1394	0
Confl. Peds. (#/hr)				282		158	66		155	155		66
Turn Type				Perm	NA	Perm		NA			NA	
Protected Phases					6			8			4	
Permitted Phases				6		6						
Actuated Green, G (s)				49.1	49.1	49.1		30.9			30.9	
Effective Green, g (s)				49.1	49.1	49.1		30.9			30.9	
Actuated g/C Ratio				0.55	0.55	0.55		0.34			0.34	
Clearance Time (s)				5.0	5.0	5.0		5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				544	3270	703		639			1680	
v/s Ratio Prot								0.11			c0.28	
v/s Ratio Perm				0.46	0.44	c0.56						
v/c Ratio				0.84	0.81	1.02		0.32			0.83	
Uniform Delay, d1				17.2	16.6	20.4		21.8			27.1	
Progression Factor				0.52	0.51	0.46		1.00			1.00	
Incremental Delay, d2				12.7	1.9	36.4		0.3			3.6	
Delay (s)				21.7	10.5	45.7		22.1			30.7	
Level of Service				C	B	D		C			C	
Approach Delay (s)		0.0			18.9			22.1			30.7	
Approach LOS		A			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	22.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	76.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	471	2673	711	0	452	0	0	777	162
Future Volume (vph)	0	0	0	471	2673	711	0	452	0	0	777	162
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				0.81	0.81	1.00		1.00			0.91	
Frpb, ped/bikes				1.00	1.00	0.84		1.00			0.98	
Flpb, ped/bikes				0.86	1.00	1.00		1.00			1.00	
Frt				1.00	1.00	0.85		1.00			0.97	
Flt Protected				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (prot)				1233	6016	1332		1863			4872	
Flt Permitted				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (perm)				1233	6016	1332		1863			4872	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	0	0	491	2784	741	0	471	0	0	809	169
RTOR Reduction (vph)	0	0	0	0	0	75	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	442	2833	666	0	471	0	0	978	0
Confl. Peds. (#/hr)				124		133						97
Turn Type				Perm	NA	Perm		NA			NA	
Protected Phases					6			8			4	
Permitted Phases				6		6						
Actuated Green, G (s)				52.7	52.7	52.7		27.3			27.3	
Effective Green, g (s)				52.7	52.7	52.7		27.3			27.3	
Actuated g/C Ratio				0.59	0.59	0.59		0.30			0.30	
Clearance Time (s)				5.0	5.0	5.0		5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				721	3522	779		565			1477	
v/s Ratio Prot								c0.25			0.20	
v/s Ratio Perm				0.36	0.47	c0.50						
v/c Ratio				0.61	0.80	0.85		0.83			0.66	
Uniform Delay, d1				12.1	14.6	15.5		29.2			27.3	
Progression Factor				0.44	0.48	0.44		1.00			1.00	
Incremental Delay, d2				3.3	1.7	10.0		10.2			1.1	
Delay (s)				8.6	8.7	16.7		39.5			28.5	
Level of Service				A	A	B		D			C	
Approach Delay (s)		0.0			10.2			39.5			28.5	
Approach LOS		A			B			D			C	

Intersection Summary			
HCM 2000 Control Delay	16.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	82.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX D

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2026 PEAK HOUR TRAFFIC
ANALYSIS WITHOUT PROJECT

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	6	154	1213	502	166	494	891	14	29	968	36	0
Future Volume (vph)	6	154	1213	502	166	494	891	14	29	968	36	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		5.0	5.0		
Lane Util. Factor		1.00	0.95	1.00		0.97	0.91		1.00	0.95		
Frpb, ped/bikes		1.00	1.00	0.97		1.00	1.00		1.00	1.00		
Flpb, ped/bikes		1.00	1.00	1.00		1.00	1.00		1.00	1.00		
Frt		1.00	1.00	0.85		1.00	1.00		1.00	0.99		
Flt Protected		0.95	1.00	1.00		0.95	1.00		0.95	1.00		
Satd. Flow (prot)		1770	3539	1532		3433	5060		1770	3504		
Flt Permitted		0.95	1.00	1.00		0.95	1.00		0.14	1.00		
Satd. Flow (perm)		1770	3539	1532		3433	5060		267	3504		
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	7	169	1333	552	182	543	979	15	32	1064	40	0
RTOR Reduction (vph)	0	0	0	51	0	0	0	0	0	1	0	0
Lane Group Flow (vph)	0	176	1333	501	0	725	994	0	32	1103	0	0
Confl. Peds. (#/hr)				11				87	11		70	70
Turn Type	Prot	Prot	NA	Perm	Prot	Prot	NA		Perm	NA		
Protected Phases	5	5	2		1	1	6			8		
Permitted Phases				2					8			
Actuated Green, G (s)		20.3	61.0	61.0		34.0	74.7		50.0	50.0		
Effective Green, g (s)		20.3	61.0	61.0		34.0	74.7		50.0	50.0		
Actuated g/C Ratio		0.13	0.38	0.38		0.21	0.47		0.31	0.31		
Clearance Time (s)		5.0	5.0	5.0		5.0	5.0		5.0	5.0		
Vehicle Extension (s)		2.5	2.5	2.5		2.5	2.5		2.5	2.5		
Lane Grp Cap (vph)		224	1349	584		729	2362		83	1095		
v/s Ratio Prot		0.10	c0.38			c0.21	0.20			c0.31		
v/s Ratio Perm				0.33					0.12			
v/c Ratio		0.79	0.99	0.86		0.99	0.42		0.39	1.01		
Uniform Delay, d1		67.7	49.1	45.5		62.9	28.3		43.0	55.0		
Progression Factor		1.00	1.00	1.00		1.00	1.00		1.00	1.00		
Incremental Delay, d2		15.9	21.8	15.1		31.8	0.6		2.2	28.9		
Delay (s)		83.6	71.0	60.6		94.7	28.9		45.2	83.9		
Level of Service		F	E	E		F	C		D	F		
Approach Delay (s)			69.3				56.6			82.8		
Approach LOS			E				E			F		

Intersection Summary			
HCM 2000 Control Delay	65.7	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	92.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	706	33
Future Volume (vph)	706	33
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3511	
Flt Permitted	1.00	
Satd. Flow (perm)	3511	
Peak-hour factor, PHF	0.91	0.91
Adj. Flow (vph)	776	36
RTOR Reduction (vph)	2	0
Lane Group Flow (vph)	810	0
Confl. Peds. (#/hr)		11
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	50.0	
Effective Green, g (s)	50.0	
Actuated g/C Ratio	0.31	
Clearance Time (s)	5.0	
Vehicle Extension (s)	2.5	
Lane Grp Cap (vph)	1097	
v/s Ratio Prot	0.23	
v/s Ratio Perm		
v/c Ratio	0.74	
Uniform Delay, d1	49.2	
Progression Factor	1.00	
Incremental Delay, d2	2.5	
Delay (s)	51.6	
Level of Service	D	
Approach Delay (s)	51.6	
Approach LOS	D	

Intersection Summary

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	4	264	1601	252	66	314	477	7	60	1219	99	0
Future Volume (vph)	4	264	1601	252	66	314	477	7	60	1219	99	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	5.0		
Lane Util. Factor		1.00	0.91			0.97	0.91		1.00	0.95		
Frpb, ped/bikes		1.00	0.99			1.00	1.00		1.00	1.00		
Flpb, ped/bikes		1.00	1.00			1.00	1.00		0.99	1.00		
Frt		1.00	0.98			1.00	1.00		1.00	0.99		
Flt Protected		0.95	1.00			0.95	1.00		0.95	1.00		
Satd. Flow (prot)		1770	4933			3433	5073		1747	3487		
Flt Permitted		0.95	1.00			0.95	1.00		0.38	1.00		
Satd. Flow (perm)		1770	4933			3433	5073		699	3487		
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	4	272	1651	260	68	324	492	7	62	1257	102	0
RTOR Reduction (vph)	0	0	13	0	0	0	0	0	0	4	0	0
Lane Group Flow (vph)	0	276	1898	0	0	392	499	0	62	1355	0	0
Confl. Peds. (#/hr)				32				7	19		22	
Turn Type	Prot	Prot	NA		Prot	Prot	NA		Perm	NA		
Protected Phases	5	5	2		1	1	6			8		
Permitted Phases									8			
Actuated Green, G (s)		29.4	63.2			19.8	53.6		62.0	62.0		
Effective Green, g (s)		29.4	63.2			19.8	53.6		62.0	62.0		
Actuated g/C Ratio		0.18	0.40			0.12	0.34		0.39	0.39		
Clearance Time (s)		5.0	5.0			5.0	5.0		5.0	5.0		
Vehicle Extension (s)		2.5	2.5			2.5	2.5		2.5	2.5		
Lane Grp Cap (vph)		325	1948			424	1699		270	1351		
v/s Ratio Prot		c0.16	c0.38			0.11	0.10			c0.39		
v/s Ratio Perm									0.09			
v/c Ratio		0.85	0.97			0.92	0.29		0.23	1.00		
Uniform Delay, d1		63.2	47.6			69.4	39.2		32.9	49.0		
Progression Factor		1.00	1.00			1.00	1.00		1.00	1.00		
Incremental Delay, d2		18.0	15.1			25.8	0.4		0.3	25.3		
Delay (s)		81.2	62.7			95.1	39.7		33.3	74.3		
Level of Service		F	E			F	D		C	E		
Approach Delay (s)			65.1				64.1			72.5		
Approach LOS			E				E			E		

Intersection Summary			
HCM 2000 Control Delay	64.0	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	97.3%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	463	21
Future Volume (vph)	463	21
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3509	
Flt Permitted	1.00	
Satd. Flow (perm)	3509	
Peak-hour factor, PHF	0.97	0.97
Adj. Flow (vph)	477	22
RTOR Reduction (vph)	2	0
Lane Group Flow (vph)	497	0
Confl. Peds. (#/hr)		19
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	62.0	
Effective Green, g (s)	62.0	
Actuated g/C Ratio	0.39	
Clearance Time (s)	5.0	
Vehicle Extension (s)	2.5	
Lane Grp Cap (vph)	1359	
v/s Ratio Prot	0.14	
v/s Ratio Perm		
v/c Ratio	0.37	
Uniform Delay, d1	35.0	
Progression Factor	1.00	
Incremental Delay, d2	0.1	
Delay (s)	35.1	
Level of Service	D	
Approach Delay (s)	35.1	
Approach LOS	D	

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	305	177	99	114	4	23
Future Volume (Veh/h)	305	177	99	114	4	23
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	347	201	113	130	5	26
Pedestrians	88				66	
Lane Width (ft)	12.0				12.0	
Walking Speed (ft/s)	3.5				3.5	
Percent Blockage	8				6	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			614		958	514
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			614		958	514
tC, single (s)			4.1		*5.4	*5.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			88		98	96
cM capacity (veh/h)			905		282	608

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	548	243	31
Volume Left	0	113	5
Volume Right	201	0	26
cSH	1700	905	512
Volume to Capacity	0.32	0.12	0.06
Queue Length 95th (ft)	0	11	5
Control Delay (s)	0.0	5.1	12.5
Lane LOS		A	B
Approach Delay (s)	0.0	5.1	12.5
Approach LOS			B

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	53.4%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	298	136	200	38	4	99
Future Volume (Veh/h)	298	136	200	38	4	99
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	317	145	213	40	4	105
Pedestrians	69				42	
Lane Width (ft)	12.0				12.0	
Walking Speed (ft/s)	3.5				3.5	
Percent Blockage	7				4	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			504		966	432
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			504		966	432
tC, single (s)			4.1		*5.4	*5.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			79		98	84
cM capacity (veh/h)			1018		263	677

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	462	253	109
Volume Left	0	213	4
Volume Right	145	0	105
cSH	1700	1018	640
Volume to Capacity	0.27	0.21	0.17
Queue Length 95th (ft)	0	20	15
Control Delay (s)	0.0	8.3	11.8
Lane LOS		A	B
Approach Delay (s)	0.0	8.3	11.8
Approach LOS			B

Intersection Summary			
Average Delay	4.1		
Intersection Capacity Utilization	54.5%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	63	244	27	42	223	94	9	0	4	0	0	0
Future Volume (Veh/h)	63	244	27	42	223	94	9	0	4	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	72	277	31	48	253	107	10	0	5	0	0	0
Pedestrians								80				
Lane Width (ft)								12.0				
Walking Speed (ft/s)								3.5				
Percent Blockage								8				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	360			388			919	972	372	844	934	306
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	360			388			919	972	372	844	934	306
tC, single (s)	4.1			4.1			*6.1	6.5	*5.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	94			96			96	100	99	100	100	100
cM capacity (veh/h)	1199			1081			262	209	691	244	220	733

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	380	408	15
Volume Left	72	48	10
Volume Right	31	107	5
cSH	1199	1081	331
Volume to Capacity	0.06	0.04	0.05
Queue Length 95th (ft)	5	3	4
Control Delay (s)	2.0	1.4	16.4
Lane LOS	A	A	C
Approach Delay (s)	2.0	1.4	16.4
Approach LOS			C

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	38.9%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣				
Traffic Volume (veh/h)	5	496	12	7	96	5	8	0	14	0	0	0
Future Volume (Veh/h)	5	496	12	7	96	5	8	0	14	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	5	528	13	7	102	5	9	0	15	0	0	0
Pedestrians								35				
Lane Width (ft)								12.0				
Walking Speed (ft/s)								3.5				
Percent Blockage								3				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	107			576			698	700	570	678	704	104
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	107			576			698	700	570	678	704	104
tC, single (s)	4.1			4.1			*6.1	6.5	*5.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			99			98	100	97	100	100	100
cM capacity (veh/h)	1484			964			404	347	592	345	345	950

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	546	114	24
Volume Left	5	7	9
Volume Right	13	5	15
cSH	1484	964	504
Volume to Capacity	0.00	0.01	0.05
Queue Length 95th (ft)	0	1	4
Control Delay (s)	0.1	0.6	12.5
Lane LOS	A	A	B
Approach Delay (s)	0.1	0.6	12.5
Approach LOS			B

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	38.3%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	239	19	1	350	41	0	0	0	9	6	4
Future Volume (Veh/h)	0	239	19	1	350	41	0	0	0	9	6	4
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	272	22	1	398	47	0	0	0	10	7	5
Pedestrians		42			12			14			15	
Lane Width (ft)		12.0			12.0			0.0			12.0	
Walking Speed (ft/s)		3.5			3.5			3.5			3.5	
Percent Blockage		4			1			0			1	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	460			308			771	759	309	734	746	478
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	460			308			771	759	309	734	746	478
tC, single (s)	4.1			4.1			7.1	6.5	6.2	*6.1	*5.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	97	98	99
cM capacity (veh/h)	1085			1253			295	331	723	398	416	636

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	294	446	22
Volume Left	0	1	10
Volume Right	22	47	5
cSH	1085	1253	442
Volume to Capacity	0.00	0.00	0.05
Queue Length 95th (ft)	0	0	4
Control Delay (s)	0.0	0.0	13.6
Lane LOS		A	B
Approach Delay (s)	0.0	0.0	13.6
Approach LOS			B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	39.4%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	2	481	11	1	98	45	0	0	0	3	2	12
Future Volume (Veh/h)	2	481	11	1	98	45	0	0	0	3	2	12
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	2	512	12	1	104	48	0	0	0	3	2	13
Pedestrians		42			12			14			15	
Lane Width (ft)		12.0			12.0			0.0			12.0	
Walking Speed (ft/s)		3.5			3.5			3.5			3.5	
Percent Blockage		4			1			0			1	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	167			538			722	705	544	679	687	185
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	167			538			722	705	544	679	687	185
tC, single (s)	4.1			4.1			7.1	6.5	6.2	*6.1	*5.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	99	100	98
cM capacity (veh/h)	1391			1030			318	355	533	426	442	855

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	526	153	18
Volume Left	2	1	3
Volume Right	12	48	13
cSH	1391	1030	672
Volume to Capacity	0.00	0.00	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.1	10.5
Lane LOS	A	A	B
Approach Delay (s)	0.0	0.1	10.5
Approach LOS			B

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	44.9%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	250	0	0	214	1	170	4	3	0	0	17
Future Volume (Veh/h)	1	250	0	0	214	1	170	4	3	0	0	17
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	1	284	0	0	243	1	193	5	3	0	0	19
Pedestrians		12										
Lane Width (ft)		12.0										
Walking Speed (ft/s)		3.5										
Percent Blockage		1										
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	244			284			542	530	284	535	530	256
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	244			284			542	530	284	535	530	256
tC, single (s)	4.1			4.1			*6.1	*5.5	*5.2	7.1	6.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			62	99	100	100	100	98
cM capacity (veh/h)	1322			1278			508	528	818	451	454	832

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	285	244	201	19
Volume Left	1	0	193	0
Volume Right	0	1	3	19
cSH	1322	1700	512	832
Volume to Capacity	0.00	0.14	0.39	0.02
Queue Length 95th (ft)	0	0	46	2
Control Delay (s)	0.0	0.0	16.5	9.4
Lane LOS	A		C	A
Approach Delay (s)	0.0	0.0	16.5	9.4
Approach LOS			C	A

Intersection Summary			
Average Delay	4.7		
Intersection Capacity Utilization	37.8%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	480	0	0	53	5	76	15	8	0	0	18
Future Volume (Veh/h)	1	480	0	0	53	5	76	15	8	0	0	18
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	1	511	0	0	56	5	81	16	9	0	0	19
Pedestrians		12										
Lane Width (ft)		12.0										
Walking Speed (ft/s)		3.5										
Percent Blockage		1										
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	61			511			584	574	511	588	572	70
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	61			511			584	574	511	588	572	70
tC, single (s)	4.1			4.1			*6.1	*5.5	*5.2	7.1	6.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			83	97	99	100	100	98
cM capacity (veh/h)	1542			1054			484	505	650	404	430	1001

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	512	61	106	19
Volume Left	1	0	81	0
Volume Right	0	5	9	19
cSH	1542	1700	498	1001
Volume to Capacity	0.00	0.04	0.21	0.02
Queue Length 95th (ft)	0	0	20	1
Control Delay (s)	0.0	0.0	14.2	8.7
Lane LOS	A		B	A
Approach Delay (s)	0.0	0.0	14.2	8.7
Approach LOS			B	A

Intersection Summary			
Average Delay	2.4		
Intersection Capacity Utilization	44.9%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	0	2614	145	1220	189	0	0	0	58
Future Volume (vph)	0	0	0	0	2614	145	1220	189	0	0	0	58
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					0.81		0.94	1.00				1.00
Frpb, ped/bikes					1.00		1.00	1.00				1.00
Flpb, ped/bikes					1.00		1.00	1.00				1.00
Frt					0.99		1.00	1.00				0.86
Flt Protected					1.00		0.95	1.00				1.00
Satd. Flow (prot)					7452		4990	1863				1611
Flt Permitted					1.00		0.95	1.00				1.00
Satd. Flow (perm)					7452		4990	1863				1611
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	2841	158	1326	205	0	0	0	63
RTOR Reduction (vph)	0	0	0	0	11	0	15	0	0	0	0	15
Lane Group Flow (vph)	0	0	0	0	2988	0	1311	205	0	0	0	48
Confl. Peds. (#/hr)						50						
Turn Type					NA		Perm	NA				Perm
Protected Phases					6			8				
Permitted Phases							8					4
Actuated Green, G (s)					46.0		34.0	34.0				34.0
Effective Green, g (s)					46.0		34.0	34.0				34.0
Actuated g/C Ratio					0.51		0.38	0.38				0.38
Clearance Time (s)					5.0		5.0	5.0				5.0
Vehicle Extension (s)					3.0		3.0	3.0				3.0
Lane Grp Cap (vph)					3808		1885	703				608
v/s Ratio Prot					c0.40			0.11				
v/s Ratio Perm							c0.26					0.03
v/c Ratio					0.78		0.70	0.29				0.08
Uniform Delay, d1					18.0		23.6	19.6				18.0
Progression Factor					1.00		1.00	1.00				1.00
Incremental Delay, d2					1.7		2.1	1.1				0.3
Delay (s)					19.7		25.8	20.6				18.2
Level of Service					B		C	C				B
Approach Delay (s)		0.0			19.7			25.1			18.2	
Approach LOS		A			B			C			B	

Intersection Summary			
HCM 2000 Control Delay	21.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	0	1982	123	1471	234	0	0	0	17
Future Volume (vph)	0	0	0	0	1982	123	1471	234	0	0	0	17
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					0.81		0.94	1.00				1.00
Frt					0.99		1.00	1.00				0.86
Flt Protected					1.00		0.95	1.00				1.00
Satd. Flow (prot)					7478		4990	1863				1611
Flt Permitted					1.00		0.95	1.00				1.00
Satd. Flow (perm)					7478		4990	1863				1611
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	0	2086	129	1548	246	0	0	0	18
RTOR Reduction (vph)	0	0	0	0	13	0	14	0	0	0	0	10
Lane Group Flow (vph)	0	0	0	0	2202	0	1534	246	0	0	0	8
Turn Type					NA		Perm	NA				Perm
Protected Phases					6			8				
Permitted Phases							8					4
Actuated Green, G (s)					41.0		39.0	39.0				39.0
Effective Green, g (s)					41.0		39.0	39.0				39.0
Actuated g/C Ratio					0.46		0.43	0.43				0.43
Clearance Time (s)					5.0		5.0	5.0				5.0
Vehicle Extension (s)					3.0		3.0	3.0				3.0
Lane Grp Cap (vph)					3406		2162	807				698
v/s Ratio Prot					c0.29			0.13				
v/s Ratio Perm							c0.31					0.00
v/c Ratio					0.65		0.71	0.30				0.01
Uniform Delay, d1					18.9		20.9	16.6				14.5
Progression Factor					1.00		1.00	1.00				1.00
Incremental Delay, d2					1.0		2.0	1.0				0.0
Delay (s)					19.9		22.9	17.6				14.5
Level of Service					B		C	B				B
Approach Delay (s)		0.0			19.9			22.2			14.5	
Approach LOS		A			B			C			B	

Intersection Summary			
HCM 2000 Control Delay	20.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	69.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	611	20	0	30
Future Volume (Veh/h)	0	0	611	20	0	30
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	0	0	671	22	0	33
Pedestrians					38	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					4	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	731				720	720
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	731				720	720
tC, single (s)	4.1				6.4	*5.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	93
cM capacity (veh/h)	842				380	506

Direction, Lane #	WB 1	SB 1
Volume Total	693	33
Volume Left	0	0
Volume Right	22	33
cSH	1700	506
Volume to Capacity	0.41	0.07
Queue Length 95th (ft)	0	5
Control Delay (s)	0.0	12.6
Lane LOS		B
Approach Delay (s)	0.0	12.6
Approach LOS		B

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	43.5%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	599	9	0	23
Future Volume (Veh/h)	0	0	599	9	0	23
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	0	0	637	10	0	24
Pedestrians					23	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					2	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	670				665	665
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	670				665	665
tC, single (s)	4.1				6.4	*5.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	96
cM capacity (veh/h)	900				416	543

Direction, Lane #	WB 1	SB 1
Volume Total	647	24
Volume Left	0	0
Volume Right	10	24
cSH	1700	543
Volume to Capacity	0.38	0.04
Queue Length 95th (ft)	0	3
Control Delay (s)	0.0	11.9
Lane LOS		B
Approach Delay (s)	0.0	11.9
Approach LOS		B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	42.1%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	69	3455	69	35	5	0	0	10	182
Future Volume (vph)	0	0	0	69	3455	69	35	5	0	0	10	182
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					0.76		0.97	1.00			0.95	0.95
Frpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Flpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Frt					1.00		1.00	1.00			0.87	0.85
Flt Protected					1.00		0.95	1.00			1.00	1.00
Satd. Flow (prot)					8429		3433	1863			1531	1504
Flt Permitted					1.00		0.68	1.00			1.00	1.00
Satd. Flow (perm)					8429		2459	1863			1531	1504
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	0	0	0	76	3797	76	38	5	0	0	11	200
RTOR Reduction (vph)	0	0	0	0	2	0	0	0	0	0	0	20
Lane Group Flow (vph)	0	0	0	0	3947	0	38	5	0	0	107	84
Confl. Peds. (#/hr)				26		96						
Turn Type				Perm	NA		Perm	NA			NA	Perm
Protected Phases					6			8			4	
Permitted Phases				6			8					4
Actuated Green, G (s)					66.1		13.9	13.9			13.9	13.9
Effective Green, g (s)					66.1		13.9	13.9			13.9	13.9
Actuated g/C Ratio					0.73		0.15	0.15			0.15	0.15
Clearance Time (s)					5.0		5.0	5.0			5.0	5.0
Vehicle Extension (s)					3.0		3.0	3.0			3.0	3.0
Lane Grp Cap (vph)					6190		379	287			236	232
v/s Ratio Prot								0.00			c0.07	
v/s Ratio Perm					0.47		0.02					0.06
v/c Ratio					0.64		0.10	0.02			0.45	0.36
Uniform Delay, d1					6.0		32.7	32.3			34.6	34.1
Progression Factor					0.60		1.00	1.00			1.00	1.00
Incremental Delay, d2					0.3		0.1	0.0			1.4	1.0
Delay (s)					3.9		32.8	32.3			36.0	35.0
Level of Service					A		C	C			D	D
Approach Delay (s)		0.0			3.9			32.7			35.5	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM 2000 Control Delay	5.8	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	59.1%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	8	3505	15	225	156	0	0	2	353
Future Volume (vph)	0	0	0	8	3505	15	225	156	0	0	2	353
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					0.76		0.97	1.00			0.95	0.95
Frpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Flpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Frt					1.00		1.00	1.00			0.85	0.85
Flt Protected					1.00		0.95	1.00			1.00	1.00
Satd. Flow (prot)					8482		3433	1863			1507	1504
Flt Permitted					1.00		0.49	1.00			1.00	1.00
Satd. Flow (perm)					8482		1781	1863			1507	1504
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	8	3689	16	237	164	0	0	2	372
RTOR Reduction (vph)	0	0	0	0	1	0	0	0	0	0	0	19
Lane Group Flow (vph)	0	0	0	0	3712	0	237	164	0	0	188	167
Confl. Peds. (#/hr)				40		68						
Turn Type				Perm	NA		Perm	NA			NA	Perm
Protected Phases					6			8			4	
Permitted Phases				6			8					4
Actuated Green, G (s)					62.3		17.7	17.7			17.7	17.7
Effective Green, g (s)					62.3		17.7	17.7			17.7	17.7
Actuated g/C Ratio					0.69		0.20	0.20			0.20	0.20
Clearance Time (s)					5.0		5.0	5.0			5.0	5.0
Vehicle Extension (s)					3.0		3.0	3.0			3.0	3.0
Lane Grp Cap (vph)					5871		350	366			296	295
v/s Ratio Prot								0.09			0.12	
v/s Ratio Perm					0.44		c0.13					0.11
v/c Ratio					0.63		0.68	0.45			0.64	0.57
Uniform Delay, d1					7.6		33.5	31.8			33.2	32.7
Progression Factor					0.78		1.00	1.00			1.00	1.00
Incremental Delay, d2					0.4		5.1	0.9			4.4	2.5
Delay (s)					6.3		38.6	32.7			37.6	35.1
Level of Service					A		D	C			D	D
Approach Delay (s)		0.0			6.3			36.2			36.4	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM 2000 Control Delay	11.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	67.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	500	2541	771	0	202	0	0	1133	237
Future Volume (vph)	0	0	0	500	2541	771	0	202	0	0	1133	237
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				0.81	0.81	1.00		1.00			0.91	
Frpb, ped/bikes				1.00	1.00	0.81		1.00			0.99	
Flpb, ped/bikes				0.70	0.99	1.00		1.00			1.00	
Frt				1.00	1.00	0.85		1.00			0.97	
Flt Protected				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (prot)				998	5994	1289		1863			4895	
Flt Permitted				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (perm)				998	5994	1289		1863			4895	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	0	0	0	556	2823	857	0	224	0	0	1259	263
RTOR Reduction (vph)	0	0	0	0	0	64	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	500	2879	793	0	224	0	0	1522	0
Confl. Peds. (#/hr)				282		158	66		155	155		66
Turn Type				Perm	NA	Perm		NA			NA	
Protected Phases					6			8			4	
Permitted Phases				6		6						
Actuated Green, G (s)				49.0	49.0	49.0		31.0			31.0	
Effective Green, g (s)				49.0	49.0	49.0		31.0			31.0	
Actuated g/C Ratio				0.54	0.54	0.54		0.34			0.34	
Clearance Time (s)				5.0	5.0	5.0		5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				543	3263	701		641			1686	
v/s Ratio Prot								0.12			c0.31	
v/s Ratio Perm				0.50	0.48	c0.62						
v/c Ratio				0.92	0.88	1.13		0.35			0.90	
Uniform Delay, d1				18.7	18.0	20.5		22.0			28.1	
Progression Factor				0.55	0.54	0.47		1.00			1.00	
Incremental Delay, d2				20.1	3.2	73.5		0.3			7.2	
Delay (s)				30.4	12.9	83.0		22.3			35.2	
Level of Service				C	B	F		C			D	
Approach Delay (s)		0.0			29.2			22.3			35.2	
Approach LOS		A			C			C			D	

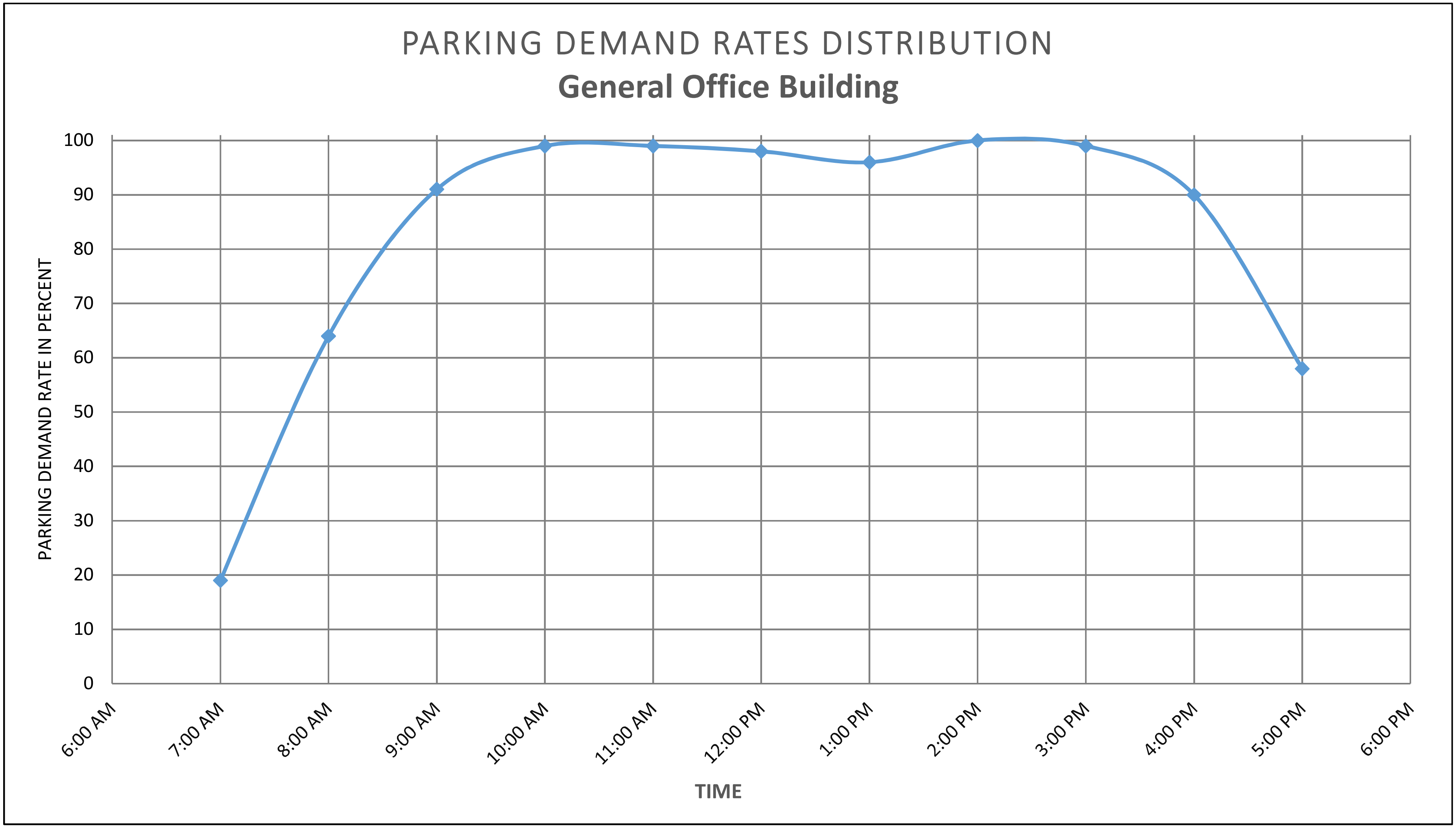
Intersection Summary			
HCM 2000 Control Delay	30.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	80.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	514	2914	775	0	493	0	0	847	177
Future Volume (vph)	0	0	0	514	2914	775	0	493	0	0	847	177
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				0.81	0.81	1.00		1.00			0.91	
Frpb, ped/bikes				1.00	1.00	0.84		1.00			0.98	
Flpb, ped/bikes				0.86	1.00	1.00		1.00			1.00	
Frt				1.00	1.00	0.85		1.00			0.97	
Flt Protected				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (prot)				1233	6015	1332		1863			4873	
Flt Permitted				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (perm)				1233	6015	1332		1863			4873	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	0	0	535	3035	807	0	514	0	0	882	184
RTOR Reduction (vph)	0	0	0	0	0	66	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	481	3089	741	0	514	0	0	1066	0
Confl. Peds. (#/hr)				124		133						97
Turn Type				Perm	NA	Perm		NA			NA	
Protected Phases					6			8			4	
Permitted Phases				6		6						
Actuated Green, G (s)				51.3	51.3	51.3		28.7			28.7	
Effective Green, g (s)				51.3	51.3	51.3		28.7			28.7	
Actuated g/C Ratio				0.57	0.57	0.57		0.32			0.32	
Clearance Time (s)				5.0	5.0	5.0		5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				702	3428	759		594			1553	
v/s Ratio Prot								c0.28			0.22	
v/s Ratio Perm				0.39	0.51	c0.56						
v/c Ratio				0.69	0.90	0.98		0.87			0.69	
Uniform Delay, d1				13.7	17.1	18.8		28.8			26.7	
Progression Factor				0.51	0.54	0.45		1.00			1.00	
Incremental Delay, d2				4.4	3.6	24.3		12.5			1.3	
Delay (s)				11.3	12.9	32.8		41.4			28.0	
Level of Service				B	B	C		D			C	
Approach Delay (s)		0.0			16.4			41.4			28.0	
Approach LOS		A			B			D			C	

Intersection Summary			
HCM 2000 Control Delay	20.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	89.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX E

PARKING DEMAND RATES DISTRIBUTION



Source: Institute of Transportation Engineers *Parking Generation Manual*, 4th Edition.

APPENDIX F

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2026 PEAK HOUR TRAFFIC
ANALYSIS WITH ALTERNATIVE 1

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	6	154	1248	502	166	494	891	14	29	973	37	0
Future Volume (vph)	6	154	1248	502	166	494	891	14	29	973	37	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		5.0	5.0		
Lane Util. Factor		1.00	0.95	1.00		0.97	0.91		1.00	0.95		
Frpb, ped/bikes		1.00	1.00	0.97		1.00	1.00		1.00	1.00		
Flpb, ped/bikes		1.00	1.00	1.00		1.00	1.00		1.00	1.00		
Frt		1.00	1.00	0.85		1.00	1.00		1.00	0.99		
Flt Protected		0.95	1.00	1.00		0.95	1.00		0.95	1.00		
Satd. Flow (prot)		1770	3539	1532		3433	5060		1770	3503		
Flt Permitted		0.95	1.00	1.00		0.95	1.00		0.13	1.00		
Satd. Flow (perm)		1770	3539	1532		3433	5060		243	3503		
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	7	169	1371	552	182	543	979	15	32	1069	41	0
RTOR Reduction (vph)	0	0	0	49	0	0	0	0	0	1	0	0
Lane Group Flow (vph)	0	176	1371	503	0	725	994	0	32	1109	0	0
Confl. Peds. (#/hr)				11				87	11		70	70
Turn Type	Prot	Prot	NA	Perm	Prot	Prot	NA		Perm	NA		
Protected Phases	5	5	2		1	1	6			8		
Permitted Phases				2					8			
Actuated Green, G (s)		20.3	64.0	64.0		33.0	76.7		48.0	48.0		
Effective Green, g (s)		20.3	64.0	64.0		33.0	76.7		48.0	48.0		
Actuated g/C Ratio		0.13	0.40	0.40		0.21	0.48		0.30	0.30		
Clearance Time (s)		5.0	5.0	5.0		5.0	5.0		5.0	5.0		
Vehicle Extension (s)		2.5	2.5	2.5		2.5	2.5		2.5	2.5		
Lane Grp Cap (vph)		224	1415	612		708	2425		72	1050		
v/s Ratio Prot		0.10	c0.39			c0.21	0.20			c0.32		
v/s Ratio Perm				0.33					0.13			
v/c Ratio		0.79	0.97	0.82		1.02	0.41		0.44	1.06		
Uniform Delay, d1		67.7	47.0	42.9		63.5	27.0		45.2	56.0		
Progression Factor		1.00	1.00	1.00		1.00	1.00		1.00	1.00		
Incremental Delay, d2		15.9	17.6	11.8		40.1	0.5		3.2	43.7		
Delay (s)		83.6	64.6	54.7		103.6	27.5		48.4	99.7		
Level of Service		F	E	D		F	C		D	F		
Approach Delay (s)			63.6				59.6			98.3		
Approach LOS			E				E			F		

Intersection Summary			
HCM 2000 Control Delay	67.9	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	94.1%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	706	33
Future Volume (vph)	706	33
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3511	
Flt Permitted	1.00	
Satd. Flow (perm)	3511	
Peak-hour factor, PHF	0.91	0.91
Adj. Flow (vph)	776	36
RTOR Reduction (vph)	2	0
Lane Group Flow (vph)	810	0
Confl. Peds. (#/hr)		11
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	48.0	
Effective Green, g (s)	48.0	
Actuated g/C Ratio	0.30	
Clearance Time (s)	5.0	
Vehicle Extension (s)	2.5	
Lane Grp Cap (vph)	1053	
v/s Ratio Prot	0.23	
v/s Ratio Perm		
v/c Ratio	0.77	
Uniform Delay, d1	51.0	
Progression Factor	1.00	
Incremental Delay, d2	3.3	
Delay (s)	54.2	
Level of Service	D	
Approach Delay (s)	54.2	
Approach LOS	D	

Intersection Summary

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	4	264	1610	252	66	314	477	7	60	1239	105	0
Future Volume (vph)	4	264	1610	252	66	314	477	7	60	1239	105	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	5.0		
Lane Util. Factor		1.00	0.91			0.97	0.91		1.00	0.95		
Frpb, ped/bikes		1.00	0.99			1.00	1.00		1.00	1.00		
Flpb, ped/bikes		1.00	1.00			1.00	1.00		0.99	1.00		
Frt		1.00	0.98			1.00	1.00		1.00	0.99		
Flt Protected		0.95	1.00			0.95	1.00		0.95	1.00		
Satd. Flow (prot)		1770	4933			3433	5073		1747	3485		
Flt Permitted		0.95	1.00			0.95	1.00		0.38	1.00		
Satd. Flow (perm)		1770	4933			3433	5073		704	3485		
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	4	272	1660	260	68	324	492	7	62	1277	108	0
RTOR Reduction (vph)	0	0	13	0	0	0	0	0	0	4	0	0
Lane Group Flow (vph)	0	276	1907	0	0	392	499	0	62	1381	0	0
Confl. Peds. (#/hr)				32				7	19		22	
Turn Type	Prot	Prot	NA		Prot	Prot	NA		Perm	NA		
Protected Phases	5	5	2		1	1	6			8		
Permitted Phases									8			
Actuated Green, G (s)		29.4	62.2			19.8	52.6		63.0	63.0		
Effective Green, g (s)		29.4	62.2			19.8	52.6		63.0	63.0		
Actuated g/C Ratio		0.18	0.39			0.12	0.33		0.39	0.39		
Clearance Time (s)		5.0	5.0			5.0	5.0		5.0	5.0		
Vehicle Extension (s)		2.5	2.5			2.5	2.5		2.5	2.5		
Lane Grp Cap (vph)		325	1917			424	1667		277	1372		
v/s Ratio Prot		c0.16	c0.39			0.11	0.10			c0.40		
v/s Ratio Perm									0.09			
v/c Ratio		0.85	0.99			0.92	0.30		0.22	1.01		
Uniform Delay, d1		63.2	48.7			69.4	40.0		32.2	48.5		
Progression Factor		1.00	1.00			1.00	1.00		1.00	1.00		
Incremental Delay, d2		18.0	19.3			25.8	0.5		0.3	26.0		
Delay (s)		81.2	68.0			95.1	40.4		32.5	74.5		
Level of Service		F	E			F	D		C	E		
Approach Delay (s)			69.7				64.5			72.7		
Approach LOS			E				E			E		

Intersection Summary			
HCM 2000 Control Delay	66.1	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	98.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	463	21
Future Volume (vph)	463	21
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3509	
Flt Permitted	1.00	
Satd. Flow (perm)	3509	
Peak-hour factor, PHF	0.97	0.97
Adj. Flow (vph)	477	22
RTOR Reduction (vph)	2	0
Lane Group Flow (vph)	497	0
Confl. Peds. (#/hr)		19
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	63.0	
Effective Green, g (s)	63.0	
Actuated g/C Ratio	0.39	
Clearance Time (s)	5.0	
Vehicle Extension (s)	2.5	
Lane Grp Cap (vph)	1381	
v/s Ratio Prot	0.14	
v/s Ratio Perm		
v/c Ratio	0.36	
Uniform Delay, d1	34.3	
Progression Factor	1.00	
Incremental Delay, d2	0.1	
Delay (s)	34.4	
Level of Service	C	
Approach Delay (s)	34.4	
Approach LOS	C	

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	340	177	99	114	4	23
Future Volume (Veh/h)	340	177	99	114	4	23
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	386	201	113	130	5	26
Pedestrians	88				66	
Lane Width (ft)	12.0				12.0	
Walking Speed (ft/s)	3.5				3.5	
Percent Blockage	8				6	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			653		996	552
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			653		996	552
tC, single (s)			4.1		*5.4	*5.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			87		98	96
cM capacity (veh/h)			875		269	584

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	587	243	31
Volume Left	0	113	5
Volume Right	201	0	26
cSH	1700	875	491
Volume to Capacity	0.35	0.13	0.06
Queue Length 95th (ft)	0	11	5
Control Delay (s)	0.0	5.2	12.8
Lane LOS		A	B
Approach Delay (s)	0.0	5.2	12.8
Approach LOS			B

Intersection Summary			
Average Delay	1.9		
Intersection Capacity Utilization	55.1%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	307	136	200	38	4	99
Future Volume (Veh/h)	307	136	200	38	4	99
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	327	145	213	40	4	105
Pedestrians	69				42	
Lane Width (ft)	12.0				12.0	
Walking Speed (ft/s)	3.5				3.5	
Percent Blockage	7				4	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			514		976	442
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			514		976	442
tC, single (s)			4.1		*5.4	*5.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			79		98	84
cM capacity (veh/h)			1009		260	670

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	472	253	109
Volume Left	0	213	4
Volume Right	145	0	105
cSH	1700	1009	633
Volume to Capacity	0.28	0.21	0.17
Queue Length 95th (ft)	0	20	15
Control Delay (s)	0.0	8.3	11.9
Lane LOS		A	B
Approach Delay (s)	0.0	8.3	11.9
Approach LOS			B

Intersection Summary			
Average Delay	4.1		
Intersection Capacity Utilization	54.9%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	63	244	62	76	223	94	9	0	9	0	0	0
Future Volume (Veh/h)	63	244	62	76	223	94	9	0	9	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	72	277	70	86	253	107	10	0	10	0	0	0
Pedestrians								80				
Lane Width (ft)								12.0				
Walking Speed (ft/s)								3.5				
Percent Blockage								8				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	360			427			1014	1068	392	944	1050	306
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	360			427			1014	1068	392	944	1050	306
tC, single (s)	4.1			4.1			*6.1	6.5	*5.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	94			92			96	100	99	100	100	100
cM capacity (veh/h)	1199			1046			225	177	678	201	181	733

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	419	446	20
Volume Left	72	86	10
Volume Right	70	107	10
cSH	1199	1046	338
Volume to Capacity	0.06	0.08	0.06
Queue Length 95th (ft)	5	7	5
Control Delay (s)	1.9	2.4	16.3
Lane LOS	A	A	C
Approach Delay (s)	1.9	2.4	16.3
Approach LOS			C

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	40.3%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	5	496	21	19	96	5	8	0	41	0	0	0
Future Volume (Veh/h)	5	496	21	19	96	5	8	0	41	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	5	528	22	20	102	5	9	0	44	0	0	0
Pedestrians								35				
Lane Width (ft)								12.0				
Walking Speed (ft/s)								3.5				
Percent Blockage								3				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	107			585			728	731	574	738	740	104
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	107			585			728	731	574	738	740	104
tC, single (s)	4.1			4.1			*6.1	6.5	*5.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			98			98	100	93	100	100	100
cM capacity (veh/h)	1484			957			385	329	589	296	325	950

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	555	127	53
Volume Left	5	20	9
Volume Right	22	5	44
cSH	1484	957	541
Volume to Capacity	0.00	0.02	0.10
Queue Length 95th (ft)	0	2	8
Control Delay (s)	0.1	1.6	12.4
Lane LOS	A	A	B
Approach Delay (s)	0.1	1.6	12.4
Approach LOS			B

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	38.2%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	239	24	1	384	41	0	0	0	9	6	4
Future Volume (Veh/h)	0	239	24	1	384	41	0	0	0	9	6	4
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	272	27	1	436	47	0	0	0	10	7	5
Pedestrians		42			12			14			15	
Lane Width (ft)		12.0			12.0			0.0			12.0	
Walking Speed (ft/s)		3.5			3.5			3.5			3.5	
Percent Blockage		4			1			0			1	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	498			313			812	800	312	774	790	516
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	498			313			812	800	312	774	790	516
tC, single (s)	4.1			4.1			7.1	6.5	6.2	*6.1	*5.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	97	98	99
cM capacity (veh/h)	1051			1247			276	314	720	379	397	612

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	299	484	22
Volume Left	0	1	10
Volume Right	27	47	5
cSH	1051	1247	421
Volume to Capacity	0.00	0.00	0.05
Queue Length 95th (ft)	0	0	4
Control Delay (s)	0.0	0.0	14.0
Lane LOS		A	B
Approach Delay (s)	0.0	0.0	14.0
Approach LOS			B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	41.2%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	2	481	38	1	110	45	0	0	0	3	2	12
Future Volume (Veh/h)	2	481	38	1	110	45	0	0	0	3	2	12
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	2	512	40	1	117	48	0	0	0	3	2	13
Pedestrians		42			12			14			15	
Lane Width (ft)		12.0			12.0			0.0			12.0	
Walking Speed (ft/s)		3.5			3.5			3.5			3.5	
Percent Blockage		4			1			0			1	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	180			566			749	732	558	706	728	198
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	180			566			749	732	558	706	728	198
tC, single (s)	4.1			4.1			7.1	6.5	6.2	*6.1	*5.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	99	100	98
cM capacity (veh/h)	1376			1006			305	342	523	412	423	844

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	554	166	18
Volume Left	2	1	3
Volume Right	40	48	13
cSH	1376	1006	657
Volume to Capacity	0.00	0.00	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.1	10.6
Lane LOS	A	A	B
Approach Delay (s)	0.0	0.1	10.6
Approach LOS			B

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	46.6%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	250	5	0	248	1	170	4	3	0	0	17
Future Volume (Veh/h)	1	250	5	0	248	1	170	4	3	0	0	17
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	1	284	6	0	282	1	193	5	3	0	0	19
Pedestrians		12										
Lane Width (ft)		12.0										
Walking Speed (ft/s)		3.5										
Percent Blockage		1										
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	283			290			584	572	287	577	574	294
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	283			290			584	572	287	577	574	294
tC, single (s)	4.1			4.1			*6.1	*5.5	*5.2	7.1	6.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			60	99	100	100	100	98
cM capacity (veh/h)	1279			1272			482	505	816	423	428	800

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	291	283	201	19
Volume Left	1	0	193	0
Volume Right	6	1	3	19
cSH	1279	1700	485	800
Volume to Capacity	0.00	0.17	0.41	0.02
Queue Length 95th (ft)	0	0	50	2
Control Delay (s)	0.0	0.0	17.6	9.6
Lane LOS	A		C	A
Approach Delay (s)	0.0	0.0	17.6	9.6
Approach LOS			C	A

Intersection Summary			
Average Delay	4.7		
Intersection Capacity Utilization	39.6%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	480	27	0	65	5	76	15	8	0	0	18
Future Volume (Veh/h)	1	480	27	0	65	5	76	15	8	0	0	18
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	1	511	29	0	69	5	81	16	9	0	0	19
Pedestrians		12										
Lane Width (ft)		12.0										
Walking Speed (ft/s)		3.5										
Percent Blockage		1										
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	74			540			611	602	526	616	614	84
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	74			540			611	602	526	616	614	84
tC, single (s)	4.1			4.1			*6.1	*5.5	*5.2	7.1	6.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			83	97	99	100	100	98
cM capacity (veh/h)	1526			1028			468	490	641	387	407	988

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	541	74	106	19
Volume Left	1	0	81	0
Volume Right	29	5	9	19
cSH	1526	1700	482	988
Volume to Capacity	0.00	0.04	0.22	0.02
Queue Length 95th (ft)	0	0	21	1
Control Delay (s)	0.0	0.0	14.6	8.7
Lane LOS	A		B	A
Approach Delay (s)	0.0	0.0	14.6	8.7
Approach LOS			B	A

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	46.5%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	0	2671	145	1247	189	0	0	0	58
Future Volume (vph)	0	0	0	0	2671	145	1247	189	0	0	0	58
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					0.81		0.94	1.00				1.00
Frpb, ped/bikes					1.00		1.00	1.00				1.00
Flpb, ped/bikes					1.00		1.00	1.00				1.00
Frt					0.99		1.00	1.00				0.86
Flt Protected					1.00		0.95	1.00				1.00
Satd. Flow (prot)					7454		4990	1863				1611
Flt Permitted					1.00		0.95	1.00				1.00
Satd. Flow (perm)					7454		4990	1863				1611
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	2903	158	1355	205	0	0	0	63
RTOR Reduction (vph)	0	0	0	0	11	0	15	0	0	0	0	15
Lane Group Flow (vph)	0	0	0	0	3050	0	1340	205	0	0	0	48
Confl. Peds. (#/hr)						50						
Turn Type					NA		Perm	NA				Perm
Protected Phases					6			8				
Permitted Phases							8					4
Actuated Green, G (s)					47.0		33.0	33.0				33.0
Effective Green, g (s)					47.0		33.0	33.0				33.0
Actuated g/C Ratio					0.52		0.37	0.37				0.37
Clearance Time (s)					5.0		5.0	5.0				5.0
Vehicle Extension (s)					3.0		3.0	3.0				3.0
Lane Grp Cap (vph)					3892		1829	683				590
v/s Ratio Prot					c0.41			0.11				
v/s Ratio Perm							c0.27					0.03
v/c Ratio					0.78		0.73	0.30				0.08
Uniform Delay, d1					17.4		24.7	20.3				18.6
Progression Factor					1.00		1.00	1.00				1.00
Incremental Delay, d2					1.6		2.6	1.1				0.3
Delay (s)					19.0		27.3	21.4				18.9
Level of Service					B		C	C				B
Approach Delay (s)		0.0			19.0			26.5			18.9	
Approach LOS		A			B			C			B	

Intersection Summary			
HCM 2000 Control Delay	21.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.76		
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			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	0	1997	123	1481	234	0	0	0	17
Future Volume (vph)	0	0	0	0	1997	123	1481	234	0	0	0	17
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					0.81		0.94	1.00				1.00
Frt					0.99		1.00	1.00				0.86
Flt Protected					1.00		0.95	1.00				1.00
Satd. Flow (prot)					7479		4990	1863				1611
Flt Permitted					1.00		0.95	1.00				1.00
Satd. Flow (perm)					7479		4990	1863				1611
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	0	2102	129	1559	246	0	0	0	18
RTOR Reduction (vph)	0	0	0	0	12	0	14	0	0	0	0	10
Lane Group Flow (vph)	0	0	0	0	2219	0	1545	246	0	0	0	8
Turn Type					NA		Perm	NA				Perm
Protected Phases					6			8				
Permitted Phases							8					4
Actuated Green, G (s)					41.0		39.0	39.0				39.0
Effective Green, g (s)					41.0		39.0	39.0				39.0
Actuated g/C Ratio					0.46		0.43	0.43				0.43
Clearance Time (s)					5.0		5.0	5.0				5.0
Vehicle Extension (s)					3.0		3.0	3.0				3.0
Lane Grp Cap (vph)					3407		2162	807				698
v/s Ratio Prot					c0.30			0.13				
v/s Ratio Perm							c0.31					0.00
v/c Ratio					0.65		0.71	0.30				0.01
Uniform Delay, d1					19.0		20.9	16.6				14.5
Progression Factor					1.00		1.00	1.00				1.00
Incremental Delay, d2					1.0		2.1	1.0				0.0
Delay (s)					19.9		23.0	17.6				14.5
Level of Service					B		C	B				B
Approach Delay (s)		0.0			19.9			22.3			14.5	
Approach LOS		A			B			C			B	

Intersection Summary			
HCM 2000 Control Delay	21.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	69.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	611	104	0	64
Future Volume (Veh/h)	0	0	611	104	0	64
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	0	0	671	114	0	70
Pedestrians					38	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					4	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	823				766	766
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	823				766	766
tC, single (s)	4.1				6.4	*5.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	85
cM capacity (veh/h)	778				357	482

Direction, Lane #	WB 1	SB 1
Volume Total	785	70
Volume Left	0	0
Volume Right	114	70
cSH	1700	482
Volume to Capacity	0.46	0.15
Queue Length 95th (ft)	0	13
Control Delay (s)	0.0	13.7
Lane LOS		B
Approach Delay (s)	0.0	13.7
Approach LOS		B

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	49.6%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	599	34	0	132
Future Volume (Veh/h)	0	0	599	34	0	132
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	0	0	637	36	0	140
Pedestrians					23	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					2	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	696				678	678
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	696				678	678
tC, single (s)	4.1				6.4	*5.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	74
cM capacity (veh/h)	880				409	536

Direction, Lane #	WB 1	SB 1
Volume Total	673	140
Volume Left	0	0
Volume Right	36	140
cSH	1700	536
Volume to Capacity	0.40	0.26
Queue Length 95th (ft)	0	26
Control Delay (s)	0.0	14.1
Lane LOS		B
Approach Delay (s)	0.0	14.1
Approach LOS		B

Intersection Summary			
Average Delay	2.4		
Intersection Capacity Utilization	48.5%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	69	3489	69	35	5	0	0	10	182
Future Volume (vph)	0	0	0	69	3489	69	35	5	0	0	10	182
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					0.76		0.97	1.00			0.95	0.95
Frpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Flpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Frt					1.00		1.00	1.00			0.87	0.85
Flt Protected					1.00		0.95	1.00			1.00	1.00
Satd. Flow (prot)					8429		3433	1863			1531	1504
Flt Permitted					1.00		0.68	1.00			1.00	1.00
Satd. Flow (perm)					8429		2459	1863			1531	1504
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	0	0	0	76	3834	76	38	5	0	0	11	200
RTOR Reduction (vph)	0	0	0	0	2	0	0	0	0	0	0	20
Lane Group Flow (vph)	0	0	0	0	3984	0	38	5	0	0	107	84
Confl. Peds. (#/hr)				26		96						
Turn Type				Perm	NA		Perm	NA			NA	Perm
Protected Phases					6			8			4	
Permitted Phases				6			8					4
Actuated Green, G (s)					66.1		13.9	13.9			13.9	13.9
Effective Green, g (s)					66.1		13.9	13.9			13.9	13.9
Actuated g/C Ratio					0.73		0.15	0.15			0.15	0.15
Clearance Time (s)					5.0		5.0	5.0			5.0	5.0
Vehicle Extension (s)					3.0		3.0	3.0			3.0	3.0
Lane Grp Cap (vph)					6190		379	287			236	232
v/s Ratio Prot								0.00			c0.07	
v/s Ratio Perm					0.47		0.02					0.06
v/c Ratio					0.64		0.10	0.02			0.45	0.36
Uniform Delay, d1					6.0		32.7	32.3			34.6	34.1
Progression Factor					0.60		1.00	1.00			1.00	1.00
Incremental Delay, d2					0.3		0.1	0.0			1.4	1.0
Delay (s)					4.0		32.8	32.3			36.0	35.0
Level of Service					A		C	C			D	D
Approach Delay (s)		0.0			4.0			32.7			35.5	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM 2000 Control Delay	5.8	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	59.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↰6↱		↰↰	↑			↱	↱
Traffic Volume (vph)	0	0	0	8	3614	15	225	156	0	0	2	353
Future Volume (vph)	0	0	0	8	3614	15	225	156	0	0	2	353
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					0.76		0.97	1.00			0.95	0.95
Frpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Flpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Frt					1.00		1.00	1.00			0.85	0.85
Flt Protected					1.00		0.95	1.00			1.00	1.00
Satd. Flow (prot)					8483		3433	1863			1507	1504
Flt Permitted					1.00		0.49	1.00			1.00	1.00
Satd. Flow (perm)					8483		1781	1863			1507	1504
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	8	3804	16	237	164	0	0	2	372
RTOR Reduction (vph)	0	0	0	0	1	0	0	0	0	0	0	19
Lane Group Flow (vph)	0	0	0	0	3827	0	237	164	0	0	188	167
Confl. Peds. (#/hr)				40		68						
Turn Type				Perm	NA		Perm	NA			NA	Perm
Protected Phases					6			8			4	
Permitted Phases				6			8					4
Actuated Green, G (s)					62.3		17.7	17.7			17.7	17.7
Effective Green, g (s)					62.3		17.7	17.7			17.7	17.7
Actuated g/C Ratio					0.69		0.20	0.20			0.20	0.20
Clearance Time (s)					5.0		5.0	5.0			5.0	5.0
Vehicle Extension (s)					3.0		3.0	3.0			3.0	3.0
Lane Grp Cap (vph)					5872		350	366			296	295
v/s Ratio Prot								0.09			0.12	
v/s Ratio Perm					0.45		c0.13					0.11
v/c Ratio					0.65		0.68	0.45			0.64	0.57
Uniform Delay, d1					7.8		33.5	31.8			33.2	32.7
Progression Factor					0.79		1.00	1.00			1.00	1.00
Incremental Delay, d2					0.4		5.1	0.9			4.4	2.5
Delay (s)					6.6		38.6	32.7			37.6	35.1
Level of Service					A		D	C			D	D
Approach Delay (s)		0.0			6.6			36.2			36.4	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM 2000 Control Delay	11.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	68.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	512	2557	777	0	202	0	0	1133	237
Future Volume (vph)	0	0	0	512	2557	777	0	202	0	0	1133	237
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				0.81	0.81	1.00		1.00			0.91	
Frpb, ped/bikes				1.00	1.00	0.81		1.00			0.99	
Flpb, ped/bikes				0.70	0.99	1.00		1.00			1.00	
Frt				1.00	1.00	0.85		1.00			0.97	
Flt Protected				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (prot)				998	5993	1289		1863			4895	
Flt Permitted				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (perm)				998	5993	1289		1863			4895	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	0	0	0	569	2841	863	0	224	0	0	1259	263
RTOR Reduction (vph)	0	0	0	0	0	64	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	512	2898	799	0	224	0	0	1522	0
Confl. Peds. (#/hr)				282		158	66		155	155		66
Turn Type				Perm	NA	Perm		NA			NA	
Protected Phases					6			8			4	
Permitted Phases				6		6						
Actuated Green, G (s)				49.0	49.0	49.0		31.0			31.0	
Effective Green, g (s)				49.0	49.0	49.0		31.0			31.0	
Actuated g/C Ratio				0.54	0.54	0.54		0.34			0.34	
Clearance Time (s)				5.0	5.0	5.0		5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				543	3262	701		641			1686	
v/s Ratio Prot								0.12			c0.31	
v/s Ratio Perm				0.51	0.48	c0.62						
v/c Ratio				0.94	0.89	1.14		0.35			0.90	
Uniform Delay, d1				19.2	18.1	20.5		22.0			28.1	
Progression Factor				0.55	0.54	0.47		1.00			1.00	
Incremental Delay, d2				23.3	3.3	76.7		0.3			7.2	
Delay (s)				33.8	13.1	86.4		22.3			35.2	
Level of Service				C	B	F		C			D	
Approach Delay (s)		0.0			30.4			22.3			35.2	
Approach LOS		A			C			C			D	

Intersection Summary			
HCM 2000 Control Delay	31.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	81.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	540	2968	804	0	493	0	0	847	177
Future Volume (vph)	0	0	0	540	2968	804	0	493	0	0	847	177
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				0.81	0.81	1.00		1.00			0.91	
Frpb, ped/bikes				1.00	1.00	0.84		1.00			0.98	
Flpb, ped/bikes				0.86	1.00	1.00		1.00			1.00	
Frt				1.00	1.00	0.85		1.00			0.97	
Flt Protected				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (prot)				1233	6015	1332		1863			4873	
Flt Permitted				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (perm)				1233	6015	1332		1863			4873	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	0	0	562	3092	838	0	514	0	0	882	184
RTOR Reduction (vph)	0	0	0	0	0	66	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	507	3148	772	0	514	0	0	1066	0
Confl. Peds. (#/hr)				124		133						97
Turn Type				Perm	NA	Perm		NA			NA	
Protected Phases					6			8			4	
Permitted Phases				6		6						
Actuated Green, G (s)				51.3	51.3	51.3		28.7			28.7	
Effective Green, g (s)				51.3	51.3	51.3		28.7			28.7	
Actuated g/C Ratio				0.57	0.57	0.57		0.32			0.32	
Clearance Time (s)				5.0	5.0	5.0		5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				702	3428	759		594			1553	
v/s Ratio Prot								c0.28			0.22	
v/s Ratio Perm				0.41	0.52	c0.58						
v/c Ratio				0.72	0.92	1.02		0.87			0.69	
Uniform Delay, d1				14.1	17.5	19.4		28.8			26.7	
Progression Factor				0.53	0.56	0.45		1.00			1.00	
Incremental Delay, d2				5.1	4.2	33.6		12.5			1.3	
Delay (s)				12.6	13.9	42.3		41.4			28.0	
Level of Service				B	B	D		D			C	
Approach Delay (s)		0.0			19.1			41.4			28.0	
Approach LOS		A			B			D			C	

Intersection Summary			
HCM 2000 Control Delay	22.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.96		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	90.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX G

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2026 PEAK HOUR TRAFFIC
ANALYSIS WITH ALTERNATIVE 2

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	6	154	1249	502	166	494	891	14	29	976	37	0
Future Volume (vph)	6	154	1249	502	166	494	891	14	29	976	37	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		5.0	5.0		
Lane Util. Factor		1.00	0.95	1.00		0.97	0.91		1.00	0.95		
Frpb, ped/bikes		1.00	1.00	0.97		1.00	1.00		1.00	1.00		
Flpb, ped/bikes		1.00	1.00	1.00		1.00	1.00		1.00	1.00		
Frt		1.00	1.00	0.85		1.00	1.00		1.00	0.99		
Flt Protected		0.95	1.00	1.00		0.95	1.00		0.95	1.00		
Satd. Flow (prot)		1770	3539	1532		3433	5060		1770	3503		
Flt Permitted		0.95	1.00	1.00		0.95	1.00		0.13	1.00		
Satd. Flow (perm)		1770	3539	1532		3433	5060		243	3503		
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	7	169	1373	552	182	543	979	15	32	1073	41	0
RTOR Reduction (vph)	0	0	0	49	0	0	0	0	0	1	0	0
Lane Group Flow (vph)	0	176	1373	503	0	725	994	0	32	1113	0	0
Confl. Peds. (#/hr)				11				87	11		70	70
Turn Type	Prot	Prot	NA	Perm	Prot	Prot	NA		Perm	NA		
Protected Phases	5	5	2		1	1	6			8		
Permitted Phases				2					8			
Actuated Green, G (s)		20.3	64.0	64.0		33.0	76.7		48.0	48.0		
Effective Green, g (s)		20.3	64.0	64.0		33.0	76.7		48.0	48.0		
Actuated g/C Ratio		0.13	0.40	0.40		0.21	0.48		0.30	0.30		
Clearance Time (s)		5.0	5.0	5.0		5.0	5.0		5.0	5.0		
Vehicle Extension (s)		2.5	2.5	2.5		2.5	2.5		2.5	2.5		
Lane Grp Cap (vph)		224	1415	612		708	2425		72	1050		
v/s Ratio Prot		0.10	c0.39			c0.21	0.20			c0.32		
v/s Ratio Perm				0.33					0.13			
v/c Ratio		0.79	0.97	0.82		1.02	0.41		0.44	1.06		
Uniform Delay, d1		67.7	47.1	42.9		63.5	27.0		45.2	56.0		
Progression Factor		1.00	1.00	1.00		1.00	1.00		1.00	1.00		
Incremental Delay, d2		15.9	17.8	11.8		40.1	0.5		3.2	45.0		
Delay (s)		83.6	64.9	54.7		103.6	27.5		48.4	101.0		
Level of Service		F	E	D		F	C		D	F		
Approach Delay (s)			63.8				59.6			99.5		
Approach LOS			E				E			F		

Intersection Summary			
HCM 2000 Control Delay	68.3	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	94.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	706	33
Future Volume (vph)	706	33
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3511	
Flt Permitted	1.00	
Satd. Flow (perm)	3511	
Peak-hour factor, PHF	0.91	0.91
Adj. Flow (vph)	776	36
RTOR Reduction (vph)	2	0
Lane Group Flow (vph)	810	0
Confl. Peds. (#/hr)		11
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	48.0	
Effective Green, g (s)	48.0	
Actuated g/C Ratio	0.30	
Clearance Time (s)	5.0	
Vehicle Extension (s)	2.5	
Lane Grp Cap (vph)	1053	
v/s Ratio Prot	0.23	
v/s Ratio Perm		
v/c Ratio	0.77	
Uniform Delay, d1	51.0	
Progression Factor	1.00	
Incremental Delay, d2	3.3	
Delay (s)	54.2	
Level of Service	D	
Approach Delay (s)	54.2	
Approach LOS	D	

Intersection Summary

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	4	264	1613	252	66	314	477	7	60	1239	105	0
Future Volume (vph)	4	264	1613	252	66	314	477	7	60	1239	105	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	5.0		
Lane Util. Factor		1.00	0.91			0.97	0.91		1.00	0.95		
Frpb, ped/bikes		1.00	0.99			1.00	1.00		1.00	1.00		
Flpb, ped/bikes		1.00	1.00			1.00	1.00		0.99	1.00		
Frt		1.00	0.98			1.00	1.00		1.00	0.99		
Flt Protected		0.95	1.00			0.95	1.00		0.95	1.00		
Satd. Flow (prot)		1770	4934			3433	5073		1747	3485		
Flt Permitted		0.95	1.00			0.95	1.00		0.38	1.00		
Satd. Flow (perm)		1770	4934			3433	5073		704	3485		
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	4	272	1663	260	68	324	492	7	62	1277	108	0
RTOR Reduction (vph)	0	0	13	0	0	0	0	0	0	4	0	0
Lane Group Flow (vph)	0	276	1910	0	0	392	499	0	62	1381	0	0
Confl. Peds. (#/hr)				32				7	19		22	
Turn Type	Prot	Prot	NA		Prot	Prot	NA		Perm	NA		
Protected Phases	5	5	2		1	1	6			8		
Permitted Phases									8			
Actuated Green, G (s)		29.4	62.2			19.8	52.6		63.0	63.0		
Effective Green, g (s)		29.4	62.2			19.8	52.6		63.0	63.0		
Actuated g/C Ratio		0.18	0.39			0.12	0.33		0.39	0.39		
Clearance Time (s)		5.0	5.0			5.0	5.0		5.0	5.0		
Vehicle Extension (s)		2.5	2.5			2.5	2.5		2.5	2.5		
Lane Grp Cap (vph)		325	1918			424	1667		277	1372		
v/s Ratio Prot		c0.16	c0.39			0.11	0.10			c0.40		
v/s Ratio Perm									0.09			
v/c Ratio		0.85	1.00			0.92	0.30		0.22	1.01		
Uniform Delay, d1		63.2	48.8			69.4	40.0		32.2	48.5		
Progression Factor		1.00	1.00			1.00	1.00		1.00	1.00		
Incremental Delay, d2		18.0	19.5			25.8	0.5		0.3	26.0		
Delay (s)		81.2	68.3			95.1	40.4		32.5	74.5		
Level of Service		F	E			F	D		C	E		
Approach Delay (s)			69.9				64.5			72.7		
Approach LOS			E				E			E		

Intersection Summary			
HCM 2000 Control Delay	66.2	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	98.3%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	463	21
Future Volume (vph)	463	21
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3509	
Flt Permitted	1.00	
Satd. Flow (perm)	3509	
Peak-hour factor, PHF	0.97	0.97
Adj. Flow (vph)	477	22
RTOR Reduction (vph)	2	0
Lane Group Flow (vph)	497	0
Confl. Peds. (#/hr)		19
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	63.0	
Effective Green, g (s)	63.0	
Actuated g/C Ratio	0.39	
Clearance Time (s)	5.0	
Vehicle Extension (s)	2.5	
Lane Grp Cap (vph)	1381	
v/s Ratio Prot	0.14	
v/s Ratio Perm		
v/c Ratio	0.36	
Uniform Delay, d1	34.3	
Progression Factor	1.00	
Incremental Delay, d2	0.1	
Delay (s)	34.4	
Level of Service	C	
Approach Delay (s)	34.4	
Approach LOS	C	

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	341	177	99	114	4	23
Future Volume (Veh/h)	341	177	99	114	4	23
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	388	201	113	130	5	26
Pedestrians	88				66	
Lane Width (ft)	12.0				12.0	
Walking Speed (ft/s)	3.5				3.5	
Percent Blockage	8				6	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			655		998	554
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			655		998	554
tC, single (s)			4.1		*5.4	*5.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			87		98	96
cM capacity (veh/h)			874		268	583

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	589	243	31
Volume Left	0	113	5
Volume Right	201	0	26
cSH	1700	874	490
Volume to Capacity	0.35	0.13	0.06
Queue Length 95th (ft)	0	11	5
Control Delay (s)	0.0	5.3	12.8
Lane LOS		A	B
Approach Delay (s)	0.0	5.3	12.8
Approach LOS			B

Intersection Summary			
Average Delay	1.9		
Intersection Capacity Utilization	55.2%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	310	136	200	38	4	99
Future Volume (Veh/h)	310	136	200	38	4	99
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	330	145	213	40	4	105
Pedestrians	69				42	
Lane Width (ft)	12.0				12.0	
Walking Speed (ft/s)	3.5				3.5	
Percent Blockage	7				4	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			517		980	444
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			517		980	444
tC, single (s)			4.1		*5.4	*5.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			79		98	84
cM capacity (veh/h)			1007		259	668

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	475	253	109
Volume Left	0	213	4
Volume Right	145	0	105
cSH	1700	1007	631
Volume to Capacity	0.28	0.21	0.17
Queue Length 95th (ft)	0	20	16
Control Delay (s)	0.0	8.4	11.9
Lane LOS		A	B
Approach Delay (s)	0.0	8.4	11.9
Approach LOS			B

Intersection Summary			
Average Delay	4.1		
Intersection Capacity Utilization	55.1%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	63	244	63	76	223	94	9	0	12	0	0	0
Future Volume (Veh/h)	63	244	63	76	223	94	9	0	12	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	72	277	72	86	253	107	10	0	14	0	0	0
Pedestrians								80				
Lane Width (ft)								12.0				
Walking Speed (ft/s)								3.5				
Percent Blockage								8				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	360			429			1016	1069	393	950	1052	306
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	360			429			1016	1069	393	950	1052	306
tC, single (s)	4.1			4.1			*6.1	6.5	*5.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	94			92			96	100	98	100	100	100
cM capacity (veh/h)	1199			1044			225	176	677	198	181	733

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	421	446	24
Volume Left	72	86	10
Volume Right	72	107	14
cSH	1199	1044	369
Volume to Capacity	0.06	0.08	0.07
Queue Length 95th (ft)	5	7	5
Control Delay (s)	1.9	2.4	15.4
Lane LOS	A	A	C
Approach Delay (s)	1.9	2.4	15.4
Approach LOS			C

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	40.3%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	5	496	24	23	96	5	8	0	42	0	0	0
Future Volume (Veh/h)	5	496	24	23	96	5	8	0	42	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	5	528	26	24	102	5	9	0	45	0	0	0
Pedestrians								35				
Lane Width (ft)								12.0				
Walking Speed (ft/s)								3.5				
Percent Blockage								3				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	107			589			738	741	576	748	752	104
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	107			589			738	741	576	748	752	104
tC, single (s)	4.1			4.1			*6.1	6.5	*5.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			97			98	100	92	100	100	100
cM capacity (veh/h)	1484			953			379	323	588	289	319	950

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	559	131	54
Volume Left	5	24	9
Volume Right	26	5	45
cSH	1484	953	539
Volume to Capacity	0.00	0.03	0.10
Queue Length 95th (ft)	0	2	8
Control Delay (s)	0.1	1.8	12.4
Lane LOS	A	A	B
Approach Delay (s)	0.1	1.8	12.4
Approach LOS			B

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	38.3%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	239	27	1	384	41	0	0	0	9	6	4
Future Volume (Veh/h)	0	239	27	1	384	41	0	0	0	9	6	4
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	272	31	1	436	47	0	0	0	10	7	5
Pedestrians		42			12			14			15	
Lane Width (ft)		12.0			12.0			0.0			12.0	
Walking Speed (ft/s)		3.5			3.5			3.5			3.5	
Percent Blockage		4			1			0			1	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	498			317			814	802	314	776	794	516
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	498			317			814	802	314	776	794	516
tC, single (s)	4.1			4.1			7.1	6.5	6.2	*6.1	*5.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	97	98	99
cM capacity (veh/h)	1051			1243			276	313	719	378	396	612

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	303	484	22
Volume Left	0	1	10
Volume Right	31	47	5
cSH	1051	1243	420
Volume to Capacity	0.00	0.00	0.05
Queue Length 95th (ft)	0	0	4
Control Delay (s)	0.0	0.0	14.0
Lane LOS		A	B
Approach Delay (s)	0.0	0.0	14.0
Approach LOS			B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	41.2%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	2	481	39	1	114	45	0	0	0	3	2	12
Future Volume (Veh/h)	2	481	39	1	114	45	0	0	0	3	2	12
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	2	512	41	1	121	48	0	0	0	3	2	13
Pedestrians		42			12			14			15	
Lane Width (ft)		12.0			12.0			0.0			12.0	
Walking Speed (ft/s)		3.5			3.5			3.5			3.5	
Percent Blockage		4			1			0			1	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	184			567			754	736	558	710	733	202
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	184			567			754	736	558	710	733	202
tC, single (s)	4.1			4.1			7.1	6.5	6.2	*6.1	*5.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	99	100	98
cM capacity (veh/h)	1371			1005			303	340	523	410	421	840

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	555	170	18
Volume Left	2	1	3
Volume Right	41	48	13
cSH	1371	1005	654
Volume to Capacity	0.00	0.00	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.1	10.7
Lane LOS	A	A	B
Approach Delay (s)	0.0	0.1	10.7
Approach LOS			B

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	46.7%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	250	8	0	248	1	170	4	3	0	0	17
Future Volume (Veh/h)	1	250	8	0	248	1	170	4	3	0	0	17
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	1	284	9	0	282	1	193	5	3	0	0	19
Pedestrians		12										
Lane Width (ft)		12.0										
Walking Speed (ft/s)		3.5										
Percent Blockage		1										
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	283			293			585	574	288	578	578	294
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	283			293			585	574	288	578	578	294
tC, single (s)	4.1			4.1			*6.1	*5.5	*5.2	7.1	6.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			60	99	100	100	100	98
cM capacity (veh/h)	1279			1269			481	505	815	422	427	800

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	294	283	201	19
Volume Left	1	0	193	0
Volume Right	9	1	3	19
cSH	1279	1700	484	800
Volume to Capacity	0.00	0.17	0.41	0.02
Queue Length 95th (ft)	0	0	50	2
Control Delay (s)	0.0	0.0	17.6	9.6
Lane LOS	A		C	A
Approach Delay (s)	0.0	0.0	17.6	9.6
Approach LOS			C	A

Intersection Summary			
Average Delay	4.7		
Intersection Capacity Utilization	39.6%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	480	28	0	69	5	76	15	8	0	0	18
Future Volume (Veh/h)	1	480	28	0	69	5	76	15	8	0	0	18
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	1	511	30	0	73	5	81	16	9	0	0	19
Pedestrians		12										
Lane Width (ft)		12.0										
Walking Speed (ft/s)		3.5										
Percent Blockage		1										
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	78			541			616	606	526	620	618	88
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	78			541			616	606	526	620	618	88
tC, single (s)	4.1			4.1			*6.1	*5.5	*5.2	7.1	6.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			83	97	99	100	100	98
cM capacity (veh/h)	1520			1028			465	488	640	384	404	984

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	542	78	106	19
Volume Left	1	0	81	0
Volume Right	30	5	9	19
cSH	1520	1700	480	984
Volume to Capacity	0.00	0.05	0.22	0.02
Queue Length 95th (ft)	0	0	21	1
Control Delay (s)	0.0	0.0	14.6	8.7
Lane LOS	A		B	A
Approach Delay (s)	0.0	0.0	14.6	8.7
Approach LOS			B	A

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	46.6%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	0	2672	145	1247	189	0	0	0	58
Future Volume (vph)	0	0	0	0	2672	145	1247	189	0	0	0	58
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					0.81		0.94	1.00				1.00
Frpb, ped/bikes					1.00		1.00	1.00				1.00
Flpb, ped/bikes					1.00		1.00	1.00				1.00
Frt					0.99		1.00	1.00				0.86
Flt Protected					1.00		0.95	1.00				1.00
Satd. Flow (prot)					7454		4990	1863				1611
Flt Permitted					1.00		0.95	1.00				1.00
Satd. Flow (perm)					7454		4990	1863				1611
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	2904	158	1355	205	0	0	0	63
RTOR Reduction (vph)	0	0	0	0	11	0	15	0	0	0	0	15
Lane Group Flow (vph)	0	0	0	0	3051	0	1340	205	0	0	0	48
Confl. Peds. (#/hr)						50						
Turn Type					NA		Perm	NA				Perm
Protected Phases					6			8				
Permitted Phases							8					4
Actuated Green, G (s)					47.0		33.0	33.0				33.0
Effective Green, g (s)					47.0		33.0	33.0				33.0
Actuated g/C Ratio					0.52		0.37	0.37				0.37
Clearance Time (s)					5.0		5.0	5.0				5.0
Vehicle Extension (s)					3.0		3.0	3.0				3.0
Lane Grp Cap (vph)					3892		1829	683				590
v/s Ratio Prot					c0.41			0.11				
v/s Ratio Perm							c0.27					0.03
v/c Ratio					0.78		0.73	0.30				0.08
Uniform Delay, d1					17.4		24.7	20.3				18.6
Progression Factor					1.00		1.00	1.00				1.00
Incremental Delay, d2					1.7		2.6	1.1				0.3
Delay (s)					19.0		27.3	21.4				18.9
Level of Service					B		C	C				B
Approach Delay (s)		0.0			19.0			26.5			18.9	
Approach LOS		A			B			C			B	

Intersection Summary				
HCM 2000 Control Delay	21.5	HCM 2000 Level of Service	C	
HCM 2000 Volume to Capacity ratio	0.76			
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				

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	0	2001	123	1485	234	0	0	0	17
Future Volume (vph)	0	0	0	0	2001	123	1485	234	0	0	0	17
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					0.81		0.94	1.00				1.00
Frt					0.99		1.00	1.00				0.86
Flt Protected					1.00		0.95	1.00				1.00
Satd. Flow (prot)					7479		4990	1863				1611
Flt Permitted					1.00		0.95	1.00				1.00
Satd. Flow (perm)					7479		4990	1863				1611
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	0	2106	129	1563	246	0	0	0	18
RTOR Reduction (vph)	0	0	0	0	12	0	14	0	0	0	0	10
Lane Group Flow (vph)	0	0	0	0	2223	0	1549	246	0	0	0	8
Turn Type					NA		Perm	NA				Perm
Protected Phases					6			8				
Permitted Phases							8					4
Actuated Green, G (s)					42.0		38.0	38.0				38.0
Effective Green, g (s)					42.0		38.0	38.0				38.0
Actuated g/C Ratio					0.47		0.42	0.42				0.42
Clearance Time (s)					5.0		5.0	5.0				5.0
Vehicle Extension (s)					3.0		3.0	3.0				3.0
Lane Grp Cap (vph)					3490		2106	786				680
v/s Ratio Prot					c0.30			0.13				
v/s Ratio Perm							c0.31					0.00
v/c Ratio					0.64		0.74	0.31				0.01
Uniform Delay, d1					18.2		21.8	17.3				15.1
Progression Factor					1.00		1.00	1.00				1.00
Incremental Delay, d2					0.9		2.3	1.0				0.0
Delay (s)					19.1		24.1	18.3				15.1
Level of Service					B		C	B				B
Approach Delay (s)		0.0			19.1			23.3			15.1	
Approach LOS		A			B			C			B	

Intersection Summary			
HCM 2000 Control Delay	21.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	69.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	611	105	0	84
Future Volume (Veh/h)	0	0	611	105	0	84
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	0	0	671	115	0	92
Pedestrians					38	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					4	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	824				766	766
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	824				766	766
tC, single (s)	4.1				6.4	*5.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	81
cM capacity (veh/h)	777				357	482

Direction, Lane #	WB 1	SB 1
Volume Total	786	92
Volume Left	0	0
Volume Right	115	92
cSH	1700	482
Volume to Capacity	0.46	0.19
Queue Length 95th (ft)	0	17
Control Delay (s)	0.0	14.2
Lane LOS		B
Approach Delay (s)	0.0	14.2
Approach LOS		B

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	50.9%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	599	42	0	133
Future Volume (Veh/h)	0	0	599	42	0	133
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	0	0	637	45	0	141
Pedestrians					23	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					2	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	705				682	682
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	705				682	682
tC, single (s)	4.1				6.4	*5.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	74
cM capacity (veh/h)	873				406	533

Direction, Lane #	WB 1	SB 1
Volume Total	682	141
Volume Left	0	0
Volume Right	45	141
cSH	1700	533
Volume to Capacity	0.40	0.26
Queue Length 95th (ft)	0	26
Control Delay (s)	0.0	14.2
Lane LOS		B
Approach Delay (s)	0.0	14.2
Approach LOS		B

Intersection Summary			
Average Delay	2.4		
Intersection Capacity Utilization	49.1%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	69	3509	69	35	5	0	0	10	182
Future Volume (vph)	0	0	0	69	3509	69	35	5	0	0	10	182
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					0.76		0.97	1.00			0.95	0.95
Frpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Flpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Frt					1.00		1.00	1.00			0.87	0.85
Flt Protected					1.00		0.95	1.00			1.00	1.00
Satd. Flow (prot)					8430		3433	1863			1531	1504
Flt Permitted					1.00		0.68	1.00			1.00	1.00
Satd. Flow (perm)					8430		2459	1863			1531	1504
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	0	0	0	76	3856	76	38	5	0	0	11	200
RTOR Reduction (vph)	0	0	0	0	2	0	0	0	0	0	0	20
Lane Group Flow (vph)	0	0	0	0	4006	0	38	5	0	0	107	84
Confl. Peds. (#/hr)				26		96						
Turn Type				Perm	NA		Perm	NA			NA	Perm
Protected Phases					6			8			4	
Permitted Phases				6			8					4
Actuated Green, G (s)					66.1		13.9	13.9			13.9	13.9
Effective Green, g (s)					66.1		13.9	13.9			13.9	13.9
Actuated g/C Ratio					0.73		0.15	0.15			0.15	0.15
Clearance Time (s)					5.0		5.0	5.0			5.0	5.0
Vehicle Extension (s)					3.0		3.0	3.0			3.0	3.0
Lane Grp Cap (vph)					6191		379	287			236	232
v/s Ratio Prot								0.00			c0.07	
v/s Ratio Perm					0.48		0.02					0.06
v/c Ratio					0.65		0.10	0.02			0.45	0.36
Uniform Delay, d1					6.0		32.7	32.3			34.6	34.1
Progression Factor					0.61		1.00	1.00			1.00	1.00
Incremental Delay, d2					0.3		0.1	0.0			1.4	1.0
Delay (s)					4.0		32.8	32.3			36.0	35.0
Level of Service					A		C	C			D	D
Approach Delay (s)		0.0			4.0			32.7			35.5	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM 2000 Control Delay	5.9	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	59.7%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	8	3615	15	225	156	0	0	2	353
Future Volume (vph)	0	0	0	8	3615	15	225	156	0	0	2	353
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					0.76		0.97	1.00			0.95	0.95
Frpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Flpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Frt					1.00		1.00	1.00			0.85	0.85
Flt Protected					1.00		0.95	1.00			1.00	1.00
Satd. Flow (prot)					8483		3433	1863			1507	1504
Flt Permitted					1.00		0.49	1.00			1.00	1.00
Satd. Flow (perm)					8483		1781	1863			1507	1504
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	8	3805	16	237	164	0	0	2	372
RTOR Reduction (vph)	0	0	0	0	1	0	0	0	0	0	0	19
Lane Group Flow (vph)	0	0	0	0	3828	0	237	164	0	0	188	167
Confl. Peds. (#/hr)				40		68						
Turn Type				Perm	NA		Perm	NA			NA	Perm
Protected Phases					6			8			4	
Permitted Phases				6			8					4
Actuated Green, G (s)					62.3		17.7	17.7			17.7	17.7
Effective Green, g (s)					62.3		17.7	17.7			17.7	17.7
Actuated g/C Ratio					0.69		0.20	0.20			0.20	0.20
Clearance Time (s)					5.0		5.0	5.0			5.0	5.0
Vehicle Extension (s)					3.0		3.0	3.0			3.0	3.0
Lane Grp Cap (vph)					5872		350	366			296	295
v/s Ratio Prot								0.09			0.12	
v/s Ratio Perm					0.45		c0.13					0.11
v/c Ratio					0.65		0.68	0.45			0.64	0.57
Uniform Delay, d1					7.8		33.5	31.8			33.2	32.7
Progression Factor					0.80		1.00	1.00			1.00	1.00
Incremental Delay, d2					0.4		5.1	0.9			4.4	2.5
Delay (s)					6.7		38.6	32.7			37.6	35.1
Level of Service					A		D	C			D	D
Approach Delay (s)		0.0			6.7			36.2			36.4	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM 2000 Control Delay	11.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	68.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	509	2566	800	0	202	0	0	1133	237
Future Volume (vph)	0	0	0	509	2566	800	0	202	0	0	1133	237
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				0.81	0.81	1.00		1.00			0.91	
Frpb, ped/bikes				1.00	1.00	0.81		1.00			0.99	
Flpb, ped/bikes				0.70	0.99	1.00		1.00			1.00	
Frt				1.00	1.00	0.85		1.00			0.97	
Flt Protected				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (prot)				998	5994	1289		1863			4895	
Flt Permitted				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (perm)				998	5994	1289		1863			4895	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	0	0	0	566	2851	889	0	224	0	0	1259	263
RTOR Reduction (vph)	0	0	0	0	0	64	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	509	2908	825	0	224	0	0	1522	0
Confl. Peds. (#/hr)				282		158	66		155	155		66
Turn Type				Perm	NA	Perm		NA			NA	
Protected Phases					6			8			4	
Permitted Phases				6		6						
Actuated Green, G (s)				49.0	49.0	49.0		31.0			31.0	
Effective Green, g (s)				49.0	49.0	49.0		31.0			31.0	
Actuated g/C Ratio				0.54	0.54	0.54		0.34			0.34	
Clearance Time (s)				5.0	5.0	5.0		5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				543	3263	701		641			1686	
v/s Ratio Prot								0.12			c0.31	
v/s Ratio Perm				0.51	0.49	c0.64						
v/c Ratio				0.94	0.89	1.18		0.35			0.90	
Uniform Delay, d1				19.1	18.1	20.5		22.0			28.1	
Progression Factor				0.55	0.54	0.47		1.00			1.00	
Incremental Delay, d2				22.4	3.4	91.5		0.3			7.2	
Delay (s)				32.8	13.2	101.2		22.3			35.2	
Level of Service				C	B	F		C			D	
Approach Delay (s)		0.0			33.7			22.3			35.2	
Approach LOS		A			C			C			D	

Intersection Summary			
HCM 2000 Control Delay	33.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	1.07		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	82.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	540	2969	804	0	493	0	0	847	177
Future Volume (vph)	0	0	0	540	2969	804	0	493	0	0	847	177
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				0.81	0.81	1.00		1.00			0.91	
Frpb, ped/bikes				1.00	1.00	0.84		1.00			0.98	
Flpb, ped/bikes				0.86	1.00	1.00		1.00			1.00	
Frt				1.00	1.00	0.85		1.00			0.97	
Flt Protected				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (prot)				1233	6015	1332		1863			4873	
Flt Permitted				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (perm)				1233	6015	1332		1863			4873	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	0	0	562	3093	838	0	514	0	0	882	184
RTOR Reduction (vph)	0	0	0	0	0	66	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	507	3149	772	0	514	0	0	1066	0
Confl. Peds. (#/hr)				124		133						97
Turn Type				Perm	NA	Perm		NA			NA	
Protected Phases					6			8			4	
Permitted Phases				6		6						
Actuated Green, G (s)				51.3	51.3	51.3		28.7			28.7	
Effective Green, g (s)				51.3	51.3	51.3		28.7			28.7	
Actuated g/C Ratio				0.57	0.57	0.57		0.32			0.32	
Clearance Time (s)				5.0	5.0	5.0		5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				702	3428	759		594			1553	
v/s Ratio Prot								c0.28			0.22	
v/s Ratio Perm				0.41	0.52	c0.58						
v/c Ratio				0.72	0.92	1.02		0.87			0.69	
Uniform Delay, d1				14.1	17.5	19.4		28.8			26.7	
Progression Factor				0.52	0.55	0.44		1.00			1.00	
Incremental Delay, d2				5.1	4.2	33.6		12.5			1.3	
Delay (s)				12.4	13.8	42.1		41.4			28.0	
Level of Service				B	B	D		D			C	
Approach Delay (s)		0.0			18.9			41.4			28.0	
Approach LOS		A			B			D			C	

Intersection Summary			
HCM 2000 Control Delay	22.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.96		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	90.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX G

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2026 PEAK HOUR TRAFFIC
ANALYSIS WITH ALTERNATIVE 3

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	6	154	1309	502	166	494	891	14	29	977	37	0
Future Volume (vph)	6	154	1309	502	166	494	891	14	29	977	37	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		5.0	5.0		
Lane Util. Factor		1.00	0.95	1.00		0.97	0.91		1.00	0.95		
Frpb, ped/bikes		1.00	1.00	0.97		1.00	1.00		1.00	1.00		
Flpb, ped/bikes		1.00	1.00	1.00		1.00	1.00		1.00	1.00		
Frt		1.00	1.00	0.85		1.00	1.00		1.00	0.99		
Flt Protected		0.95	1.00	1.00		0.95	1.00		0.95	1.00		
Satd. Flow (prot)		1770	3539	1532		3433	5060		1770	3503		
Flt Permitted		0.95	1.00	1.00		0.95	1.00		0.13	1.00		
Satd. Flow (perm)		1770	3539	1532		3433	5060		243	3503		
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	7	169	1438	552	182	543	979	15	32	1074	41	0
RTOR Reduction (vph)	0	0	0	49	0	0	0	0	0	1	0	0
Lane Group Flow (vph)	0	176	1438	503	0	725	994	0	32	1114	0	0
Confl. Peds. (#/hr)				11				87	11		70	70
Turn Type	Prot	Prot	NA	Perm	Prot	Prot	NA		Perm	NA		
Protected Phases	5	5	2		1	1	6			8		
Permitted Phases				2					8			
Actuated Green, G (s)		20.3	64.0	64.0		33.0	76.7		48.0	48.0		
Effective Green, g (s)		20.3	64.0	64.0		33.0	76.7		48.0	48.0		
Actuated g/C Ratio		0.13	0.40	0.40		0.21	0.48		0.30	0.30		
Clearance Time (s)		5.0	5.0	5.0		5.0	5.0		5.0	5.0		
Vehicle Extension (s)		2.5	2.5	2.5		2.5	2.5		2.5	2.5		
Lane Grp Cap (vph)		224	1415	612		708	2425		72	1050		
v/s Ratio Prot		0.10	c0.41			c0.21	0.20			c0.32		
v/s Ratio Perm				0.33					0.13			
v/c Ratio		0.79	1.02	0.82		1.02	0.41		0.44	1.06		
Uniform Delay, d1		67.7	48.0	42.9		63.5	27.0		45.2	56.0		
Progression Factor		1.00	1.00	1.00		1.00	1.00		1.00	1.00		
Incremental Delay, d2		15.9	28.1	11.8		40.1	0.5		3.2	45.3		
Delay (s)		83.6	76.1	54.7		103.6	27.5		48.4	101.3		
Level of Service		F	E	D		F	C		D	F		
Approach Delay (s)			71.2				59.6			99.8		
Approach LOS			E				E			F		

Intersection Summary			
HCM 2000 Control Delay	71.1	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	95.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations		
Traffic Volume (vph)	706	33
Future Volume (vph)	706	33
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3511	
Flt Permitted	1.00	
Satd. Flow (perm)	3511	
Peak-hour factor, PHF	0.91	0.91
Adj. Flow (vph)	776	36
RTOR Reduction (vph)	2	0
Lane Group Flow (vph)	810	0
Confl. Peds. (#/hr)		11
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	48.0	
Effective Green, g (s)	48.0	
Actuated g/C Ratio	0.30	
Clearance Time (s)	5.0	
Vehicle Extension (s)	2.5	
Lane Grp Cap (vph)	1053	
v/s Ratio Prot	0.23	
v/s Ratio Perm		
v/c Ratio	0.77	
Uniform Delay, d1	51.0	
Progression Factor	1.00	
Incremental Delay, d2	3.3	
Delay (s)	54.2	
Level of Service	D	
Approach Delay (s)	54.2	
Approach LOS	D	

Intersection Summary

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Traffic Volume (vph)	4	264	1613	252	66	314	477	7	60	1264	110	0
Future Volume (vph)	4	264	1613	252	66	314	477	7	60	1264	110	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	5.0		
Lane Util. Factor		1.00	0.91			0.97	0.91		1.00	0.95		
Frpb, ped/bikes		1.00	0.99			1.00	1.00		1.00	1.00		
Flpb, ped/bikes		1.00	1.00			1.00	1.00		0.99	1.00		
Frt		1.00	0.98			1.00	1.00		1.00	0.99		
Flt Protected		0.95	1.00			0.95	1.00		0.95	1.00		
Satd. Flow (prot)		1770	4934			3433	5073		1747	3484		
Flt Permitted		0.95	1.00			0.95	1.00		0.38	1.00		
Satd. Flow (perm)		1770	4934			3433	5073		704	3484		
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	4	272	1663	260	68	324	492	7	62	1303	113	0
RTOR Reduction (vph)	0	0	13	0	0	0	0	0	0	4	0	0
Lane Group Flow (vph)	0	276	1910	0	0	392	499	0	62	1412	0	0
Confl. Peds. (#/hr)				32				7	19		22	
Turn Type	Prot	Prot	NA		Prot	Prot	NA		Perm	NA		
Protected Phases	5	5	2		1	1	6			8		
Permitted Phases									8			
Actuated Green, G (s)		29.4	63.0			19.0	52.6		63.0	63.0		
Effective Green, g (s)		29.4	63.0			19.0	52.6		63.0	63.0		
Actuated g/C Ratio		0.18	0.39			0.12	0.33		0.39	0.39		
Clearance Time (s)		5.0	5.0			5.0	5.0		5.0	5.0		
Vehicle Extension (s)		2.5	2.5			2.5	2.5		2.5	2.5		
Lane Grp Cap (vph)		325	1942			407	1667		277	1371		
v/s Ratio Prot		0.16	c0.39			c0.11	0.10			c0.41		
v/s Ratio Perm									0.09			
v/c Ratio		0.85	0.98			0.96	0.30		0.22	1.03		
Uniform Delay, d1		63.2	48.0			70.2	40.0		32.2	48.5		
Progression Factor		1.00	1.00			1.00	1.00		1.00	1.00		
Incremental Delay, d2		18.0	16.8			34.9	0.5		0.3	32.2		
Delay (s)		81.2	64.8			105.0	40.4		32.5	80.7		
Level of Service		F	E			F	D		C	F		
Approach Delay (s)			66.9				68.9			78.7		
Approach LOS			E				E			E		

Intersection Summary			
HCM 2000 Control Delay	67.5	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	99.1%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations	↑↱	
Traffic Volume (vph)	463	21
Future Volume (vph)	463	21
Ideal Flow (vphpl)	1900	1900
Total Lost time (s)	5.0	
Lane Util. Factor	0.95	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.99	
Flt Protected	1.00	
Satd. Flow (prot)	3509	
Flt Permitted	1.00	
Satd. Flow (perm)	3509	
Peak-hour factor, PHF	0.97	0.97
Adj. Flow (vph)	477	22
RTOR Reduction (vph)	2	0
Lane Group Flow (vph)	497	0
Confl. Peds. (#/hr)		19
Turn Type	NA	
Protected Phases	4	
Permitted Phases		
Actuated Green, G (s)	63.0	
Effective Green, g (s)	63.0	
Actuated g/C Ratio	0.39	
Clearance Time (s)	5.0	
Vehicle Extension (s)	2.5	
Lane Grp Cap (vph)	1381	
v/s Ratio Prot	0.14	
v/s Ratio Perm		
v/c Ratio	0.36	
Uniform Delay, d1	34.3	
Progression Factor	1.00	
Incremental Delay, d2	0.1	
Delay (s)	34.4	
Level of Service	C	
Approach Delay (s)	34.4	
Approach LOS	C	

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	401	177	99	114	4	23
Future Volume (Veh/h)	401	177	99	114	4	23
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	456	201	113	130	5	26
Pedestrians	88				66	
Lane Width (ft)	12.0				12.0	
Walking Speed (ft/s)	3.5				3.5	
Percent Blockage	8				6	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			723		1066	622
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			723		1066	622
tC, single (s)			4.1		*5.4	*5.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			86		98	95
cM capacity (veh/h)			824		246	544

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	657	243	31
Volume Left	0	113	5
Volume Right	201	0	26
cSH	1700	824	455
Volume to Capacity	0.39	0.14	0.07
Queue Length 95th (ft)	0	12	5
Control Delay (s)	0.0	5.5	13.5
Lane LOS		A	B
Approach Delay (s)	0.0	5.5	13.5
Approach LOS			B

Intersection Summary			
Average Delay	1.9		
Intersection Capacity Utilization	58.2%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	310	136	200	38	4	99
Future Volume (Veh/h)	310	136	200	38	4	99
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	330	145	213	40	4	105
Pedestrians	69				42	
Lane Width (ft)	12.0				12.0	
Walking Speed (ft/s)	3.5				3.5	
Percent Blockage	7				4	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			517		980	444
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			517		980	444
tC, single (s)			4.1		*5.4	*5.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			79		98	84
cM capacity (veh/h)			1007		259	668

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	475	253	109
Volume Left	0	213	4
Volume Right	145	0	105
cSH	1700	1007	631
Volume to Capacity	0.28	0.21	0.17
Queue Length 95th (ft)	0	20	16
Control Delay (s)	0.0	8.4	11.9
Lane LOS		A	B
Approach Delay (s)	0.0	8.4	11.9
Approach LOS			B

Intersection Summary			
Average Delay	4.1		
Intersection Capacity Utilization	55.1%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

HCM Unsignalized Intersection Capacity Analysis
4: Lisbon St. /Parking Garage & Lusitania St.

05/16/2019

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	63	244	123	133	223	94	9	0	13	0	0	0
Future Volume (Veh/h)	63	244	123	133	223	94	9	0	13	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	72	277	140	151	253	107	10	0	15	0	0	0
Pedestrians								80				
Lane Width (ft)								12.0				
Walking Speed (ft/s)								3.5				
Percent Blockage								8				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	360			497			1180	1233	427	1114	1250	306
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	360			497			1180	1233	427	1114	1250	306
tC, single (s)	4.1			4.1			*6.1	6.5	*5.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	94			85			94	100	98	100	100	100
cM capacity (veh/h)	1199			986			172	130	654	144	127	733

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	489	511	25
Volume Left	72	151	10
Volume Right	140	107	15
cSH	1199	986	308
Volume to Capacity	0.06	0.15	0.08
Queue Length 95th (ft)	5	13	7
Control Delay (s)	1.8	4.0	17.7
Lane LOS	A	A	C
Approach Delay (s)	1.8	4.0	17.7
Approach LOS			C

Intersection Summary			
Average Delay	3.3		
Intersection Capacity Utilization	54.9%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	5	496	24	21	96	5	8	0	73	0	0	0
Future Volume (Veh/h)	5	496	24	21	96	5	8	0	73	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	5	528	26	22	102	5	9	0	78	0	0	0
Pedestrians								35				
Lane Width (ft)								12.0				
Walking Speed (ft/s)								3.5				
Percent Blockage								3				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	107			589			734	737	576	778	748	104
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	107			589			734	737	576	778	748	104
tC, single (s)	4.1			4.1			*6.1	6.5	*5.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			98			98	100	87	100	100	100
cM capacity (veh/h)	1484			953			381	326	588	260	321	950

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	559	129	87
Volume Left	5	22	9
Volume Right	26	5	78
cSH	1484	953	557
Volume to Capacity	0.00	0.02	0.16
Queue Length 95th (ft)	0	2	14
Control Delay (s)	0.1	1.7	12.7
Lane LOS	A	A	B
Approach Delay (s)	0.1	1.7	12.7
Approach LOS			B

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	40.0%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	239	28	1	441	41	0	0	0	9	6	4
Future Volume (Veh/h)	0	239	28	1	441	41	0	0	0	9	6	4
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	0	272	32	1	501	47	0	0	0	10	7	5
Pedestrians		42			12			14			15	
Lane Width (ft)		12.0			12.0			0.0			12.0	
Walking Speed (ft/s)		3.5			3.5			3.5			3.5	
Percent Blockage		4			1			0			1	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	563			318			879	867	314	842	860	582
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	563			318			879	867	314	842	860	582
tC, single (s)	4.1			4.1			7.1	6.5	6.2	*6.1	*5.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	97	98	99
cM capacity (veh/h)	994			1242			249	286	718	347	369	573

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	304	549	22
Volume Left	0	1	10
Volume Right	32	47	5
cSH	994	1242	390
Volume to Capacity	0.00	0.00	0.06
Queue Length 95th (ft)	0	0	4
Control Delay (s)	0.0	0.0	14.8
Lane LOS		A	B
Approach Delay (s)	0.0	0.0	14.8
Approach LOS			B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	44.2%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	2	481	70	1	112	45	0	0	0	3	2	12
Future Volume (Veh/h)	2	481	70	1	112	45	0	0	0	3	2	12
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	2	512	74	1	119	48	0	0	0	3	2	13
Pedestrians		42			12			14			15	
Lane Width (ft)		12.0			12.0			0.0			12.0	
Walking Speed (ft/s)		3.5			3.5			3.5			3.5	
Percent Blockage		4			1			0			1	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	182			600			768	751	575	725	764	200
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	182			600			768	751	575	725	764	200
tC, single (s)	4.1			4.1			7.1	6.5	6.2	*6.1	*5.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	99	100	98
cM capacity (veh/h)	1373			977			296	334	512	402	408	842

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	588	168	18
Volume Left	2	1	3
Volume Right	74	48	13
cSH	1373	977	647
Volume to Capacity	0.00	0.00	0.03
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.1	10.7
Lane LOS	A	A	B
Approach Delay (s)	0.0	0.1	10.7
Approach LOS			B

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	48.7%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	250	9	0	305	1	170	4	3	0	0	17
Future Volume (Veh/h)	1	250	9	0	305	1	170	4	3	0	0	17
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	1	284	10	0	347	1	193	5	3	0	0	19
Pedestrians		12										
Lane Width (ft)		12.0										
Walking Speed (ft/s)		3.5										
Percent Blockage		1										
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	348			294			650	639	289	644	644	360
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	348			294			650	639	289	644	644	360
tC, single (s)	4.1			4.1			*6.1	*5.5	*5.2	7.1	6.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			56	99	100	100	100	97
cM capacity (veh/h)	1211			1268			442	472	814	381	391	750

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	295	348	201	19
Volume Left	1	0	193	0
Volume Right	10	1	3	19
cSH	1211	1700	446	750
Volume to Capacity	0.00	0.20	0.45	0.03
Queue Length 95th (ft)	0	0	57	2
Control Delay (s)	0.0	0.0	19.5	9.9
Lane LOS	A		C	A
Approach Delay (s)	0.0	0.0	19.5	9.9
Approach LOS			C	A

Intersection Summary			
Average Delay	4.8		
Intersection Capacity Utilization	42.6%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	480	59	0	57	5	76	15	8	0	0	18
Future Volume (Veh/h)	1	480	59	0	57	5	76	15	8	0	0	18
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	1	511	63	0	61	5	81	16	9	0	0	19
Pedestrians		12										
Lane Width (ft)		12.0										
Walking Speed (ft/s)		3.5										
Percent Blockage		1										
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	66			574			620	610	542	625	640	76
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	66			574			620	610	542	625	640	76
tC, single (s)	4.1			4.1			*6.1	*5.5	*5.2	7.1	6.5	*5.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			82	97	99	100	100	98
cM capacity (veh/h)	1536			999			463	486	630	382	393	996

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	575	66	106	19
Volume Left	1	0	81	0
Volume Right	63	5	9	19
cSH	1536	1700	477	996
Volume to Capacity	0.00	0.04	0.22	0.02
Queue Length 95th (ft)	0	0	21	1
Control Delay (s)	0.0	0.0	14.7	8.7
Lane LOS	A		B	A
Approach Delay (s)	0.0	0.0	14.7	8.7
Approach LOS			B	A

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	48.5%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	0	2769	145	1297	189	0	0	0	58
Future Volume (vph)	0	0	0	0	2769	145	1297	189	0	0	0	58
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					0.81		0.94	1.00				1.00
Frpb, ped/bikes					1.00		1.00	1.00				1.00
Flpb, ped/bikes					1.00		1.00	1.00				1.00
Frt					0.99		1.00	1.00				0.86
Flt Protected					1.00		0.95	1.00				1.00
Satd. Flow (prot)					7457		4990	1863				1611
Flt Permitted					1.00		0.95	1.00				1.00
Satd. Flow (perm)					7457		4990	1863				1611
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	3010	158	1410	205	0	0	0	63
RTOR Reduction (vph)	0	0	0	0	10	0	15	0	0	0	0	15
Lane Group Flow (vph)	0	0	0	0	3158	0	1395	205	0	0	0	48
Confl. Peds. (#/hr)						50						
Turn Type					NA		Perm	NA				Perm
Protected Phases					6			8				
Permitted Phases							8					4
Actuated Green, G (s)					47.0		33.0	33.0				33.0
Effective Green, g (s)					47.0		33.0	33.0				33.0
Actuated g/C Ratio					0.52		0.37	0.37				0.37
Clearance Time (s)					5.0		5.0	5.0				5.0
Vehicle Extension (s)					3.0		3.0	3.0				3.0
Lane Grp Cap (vph)					3894		1829	683				590
v/s Ratio Prot					c0.42			0.11				
v/s Ratio Perm							c0.28					0.03
v/c Ratio					0.81		0.76	0.30				0.08
Uniform Delay, d1					17.8		25.1	20.3				18.6
Progression Factor					1.00		1.00	1.00				1.00
Incremental Delay, d2					1.9		3.1	1.1				0.3
Delay (s)					19.8		28.1	21.4				18.9
Level of Service					B		C	C				B
Approach Delay (s)		0.0			19.8			27.3			18.9	
Approach LOS		A			B			C			B	

Intersection Summary			
HCM 2000 Control Delay	22.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	75.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	0	2001	123	1484	234	0	0	0	17
Future Volume (vph)	0	0	0	0	2001	123	1484	234	0	0	0	17
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					0.81		0.94	1.00				1.00
Frt					0.99		1.00	1.00				0.86
Flt Protected					1.00		0.95	1.00				1.00
Satd. Flow (prot)					7479		4990	1863				1611
Flt Permitted					1.00		0.95	1.00				1.00
Satd. Flow (perm)					7479		4990	1863				1611
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	0	2106	129	1562	246	0	0	0	18
RTOR Reduction (vph)	0	0	0	0	12	0	14	0	0	0	0	10
Lane Group Flow (vph)	0	0	0	0	2223	0	1548	246	0	0	0	8
Turn Type					NA		Perm	NA				Perm
Protected Phases					6			8				
Permitted Phases							8					4
Actuated Green, G (s)					41.0		39.0	39.0				39.0
Effective Green, g (s)					41.0		39.0	39.0				39.0
Actuated g/C Ratio					0.46		0.43	0.43				0.43
Clearance Time (s)					5.0		5.0	5.0				5.0
Vehicle Extension (s)					3.0		3.0	3.0				3.0
Lane Grp Cap (vph)					3407		2162	807				698
v/s Ratio Prot					c0.30			0.13				
v/s Ratio Perm							c0.31					0.00
v/c Ratio					0.65		0.72	0.30				0.01
Uniform Delay, d1					19.0		21.0	16.6				14.5
Progression Factor					1.00		1.00	1.00				1.00
Incremental Delay, d2					1.0		2.1	1.0				0.0
Delay (s)					20.0		23.0	17.6				14.5
Level of Service					B		C	B				B
Approach Delay (s)		0.0			20.0			22.3			14.5	
Approach LOS		A			B			C			B	

Intersection Summary			
HCM 2000 Control Delay	21.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	69.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	611	247	0	89
Future Volume (Veh/h)	0	0	611	247	0	89
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	0	0	671	271	0	98
Pedestrians					38	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					4	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	980				844	844
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	980				844	844
tC, single (s)	4.1				6.4	*5.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	78
cM capacity (veh/h)	679				321	444

Direction, Lane #	WB 1	SB 1
Volume Total	942	98
Volume Left	0	0
Volume Right	271	98
cSH	1700	444
Volume to Capacity	0.55	0.22
Queue Length 95th (ft)	0	21
Control Delay (s)	0.0	15.4
Lane LOS		C
Approach Delay (s)	0.0	15.4
Approach LOS		C

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	60.3%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	599	41	0	261
Future Volume (Veh/h)	0	0	599	41	0	261
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	0	0	637	44	0	278
Pedestrians					23	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					2	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	704				682	682
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	704				682	682
tC, single (s)	4.1				6.4	*5.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	48
cM capacity (veh/h)	874				406	534

Direction, Lane #	WB 1	SB 1
Volume Total	681	278
Volume Left	0	0
Volume Right	44	278
cSH	1700	534
Volume to Capacity	0.40	0.52
Queue Length 95th (ft)	0	75
Control Delay (s)	0.0	18.8
Lane LOS		C
Approach Delay (s)	0.0	18.8
Approach LOS		C

Intersection Summary			
Average Delay	5.5		
Intersection Capacity Utilization	57.0%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	69	3514	69	35	5	0	0	10	182
Future Volume (vph)	0	0	0	69	3514	69	35	5	0	0	10	182
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					0.76		0.97	1.00			0.95	0.95
Frpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Flpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Frt					1.00		1.00	1.00			0.87	0.85
Flt Protected					1.00		0.95	1.00			1.00	1.00
Satd. Flow (prot)					8430		3433	1863			1531	1504
Flt Permitted					1.00		0.68	1.00			1.00	1.00
Satd. Flow (perm)					8430		2459	1863			1531	1504
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	0	0	0	76	3862	76	38	5	0	0	11	200
RTOR Reduction (vph)	0	0	0	0	2	0	0	0	0	0	0	20
Lane Group Flow (vph)	0	0	0	0	4012	0	38	5	0	0	107	84
Confl. Peds. (#/hr)				26		96						
Turn Type				Perm	NA		Perm	NA			NA	Perm
Protected Phases					6			8			4	
Permitted Phases				6			8					4
Actuated Green, G (s)					66.1		13.9	13.9			13.9	13.9
Effective Green, g (s)					66.1		13.9	13.9			13.9	13.9
Actuated g/C Ratio					0.73		0.15	0.15			0.15	0.15
Clearance Time (s)					5.0		5.0	5.0			5.0	5.0
Vehicle Extension (s)					3.0		3.0	3.0			3.0	3.0
Lane Grp Cap (vph)					6191		379	287			236	232
v/s Ratio Prot								0.00			c0.07	
v/s Ratio Perm					0.48		0.02					0.06
v/c Ratio					0.65		0.10	0.02			0.45	0.36
Uniform Delay, d1					6.1		32.7	32.3			34.6	34.1
Progression Factor					0.62		1.00	1.00			1.00	1.00
Incremental Delay, d2					0.3		0.1	0.0			1.4	1.0
Delay (s)					4.1		32.8	32.3			36.0	35.0
Level of Service					A		C	C			D	D
Approach Delay (s)		0.0			4.1			32.7			35.5	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM 2000 Control Delay	5.9	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	59.7%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↰↑↑↱		↰↰	↑			↑↱	↱
Traffic Volume (vph)	0	0	0	8	3743	15	225	156	0	0	2	353
Future Volume (vph)	0	0	0	8	3743	15	225	156	0	0	2	353
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					0.76		0.97	1.00			0.95	0.95
Frpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Flpb, ped/bikes					1.00		1.00	1.00			1.00	1.00
Frt					1.00		1.00	1.00			0.85	0.85
Flt Protected					1.00		0.95	1.00			1.00	1.00
Satd. Flow (prot)					8483		3433	1863			1507	1504
Flt Permitted					1.00		0.49	1.00			1.00	1.00
Satd. Flow (perm)					8483		1781	1863			1507	1504
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	8	3940	16	237	164	0	0	2	372
RTOR Reduction (vph)	0	0	0	0	1	0	0	0	0	0	0	19
Lane Group Flow (vph)	0	0	0	0	3963	0	237	164	0	0	188	167
Confl. Peds. (#/hr)				40		68						
Turn Type				Perm	NA		Perm	NA			NA	Perm
Protected Phases					6			8			4	
Permitted Phases				6			8					4
Actuated Green, G (s)					62.3		17.7	17.7			17.7	17.7
Effective Green, g (s)					62.3		17.7	17.7			17.7	17.7
Actuated g/C Ratio					0.69		0.20	0.20			0.20	0.20
Clearance Time (s)					5.0		5.0	5.0			5.0	5.0
Vehicle Extension (s)					3.0		3.0	3.0			3.0	3.0
Lane Grp Cap (vph)					5872		350	366			296	295
v/s Ratio Prot								0.09			0.12	
v/s Ratio Perm					0.47		c0.13					0.11
v/c Ratio					0.67		0.68	0.45			0.64	0.57
Uniform Delay, d1					8.0		33.5	31.8			33.2	32.7
Progression Factor					0.80		1.00	1.00			1.00	1.00
Incremental Delay, d2					0.5		5.1	0.9			4.4	2.5
Delay (s)					6.9		38.6	32.7			37.6	35.1
Level of Service					A		D	C			D	D
Approach Delay (s)		0.0			6.9			36.2			36.4	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM 2000 Control Delay	11.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	69.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	510	2569	792	0	202	0	0	1133	237
Future Volume (vph)	0	0	0	510	2569	792	0	202	0	0	1133	237
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				0.81	0.81	1.00		1.00			0.91	
Frpb, ped/bikes				1.00	1.00	0.81		1.00			0.99	
Flpb, ped/bikes				0.70	0.99	1.00		1.00			1.00	
Frt				1.00	1.00	0.85		1.00			0.97	
Flt Protected				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (prot)				998	5994	1289		1863			4895	
Flt Permitted				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (perm)				998	5994	1289		1863			4895	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	0	0	0	567	2854	880	0	224	0	0	1259	263
RTOR Reduction (vph)	0	0	0	0	0	64	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	510	2911	816	0	224	0	0	1522	0
Confl. Peds. (#/hr)				282		158	66		155	155		66
Turn Type				Perm	NA	Perm		NA			NA	
Protected Phases					6			8			4	
Permitted Phases				6		6						
Actuated Green, G (s)				49.0	49.0	49.0		31.0			31.0	
Effective Green, g (s)				49.0	49.0	49.0		31.0			31.0	
Actuated g/C Ratio				0.54	0.54	0.54		0.34			0.34	
Clearance Time (s)				5.0	5.0	5.0		5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				543	3263	701		641			1686	
v/s Ratio Prot								0.12			c0.31	
v/s Ratio Perm				0.51	0.49	c0.63						
v/c Ratio				0.94	0.89	1.16		0.35			0.90	
Uniform Delay, d1				19.1	18.2	20.5		22.0			28.1	
Progression Factor				0.56	0.55	0.48		1.00			1.00	
Incremental Delay, d2				22.7	3.4	86.3		0.3			7.2	
Delay (s)				33.3	13.4	96.1		22.3			35.2	
Level of Service				C	B	F		C			D	
Approach Delay (s)		0.0			32.7			22.3			35.2	
Approach LOS		A			C			C			D	

Intersection Summary			
HCM 2000 Control Delay	32.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	82.1%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	570	3033	838	0	493	0	0	847	177
Future Volume (vph)	0	0	0	570	3033	838	0	493	0	0	847	177
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				0.81	0.81	1.00		1.00			0.91	
Frpb, ped/bikes				1.00	1.00	0.84		1.00			0.98	
Flpb, ped/bikes				0.86	1.00	1.00		1.00			1.00	
Frt				1.00	1.00	0.85		1.00			0.97	
Flt Protected				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (prot)				1233	6014	1332		1863			4873	
Flt Permitted				0.95	1.00	1.00		1.00			1.00	
Satd. Flow (perm)				1233	6014	1332		1863			4873	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	0	0	594	3159	873	0	514	0	0	882	184
RTOR Reduction (vph)	0	0	0	0	0	66	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	535	3218	807	0	514	0	0	1066	0
Confl. Peds. (#/hr)				124		133						97
Turn Type				Perm	NA	Perm		NA			NA	
Protected Phases					6			8			4	
Permitted Phases				6		6						
Actuated Green, G (s)				51.3	51.3	51.3		28.7			28.7	
Effective Green, g (s)				51.3	51.3	51.3		28.7			28.7	
Actuated g/C Ratio				0.57	0.57	0.57		0.32			0.32	
Clearance Time (s)				5.0	5.0	5.0		5.0			5.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				702	3427	759		594			1553	
v/s Ratio Prot								c0.28			0.22	
v/s Ratio Perm				0.43	0.54	c0.61						
v/c Ratio				0.76	0.94	1.06		0.87			0.69	
Uniform Delay, d1				14.7	17.9	19.4		28.8			26.7	
Progression Factor				0.55	0.57	0.47		1.00			1.00	
Incremental Delay, d2				6.1	5.3	47.3		12.5			1.3	
Delay (s)				14.1	15.5	56.3		41.4			28.0	
Level of Service				B	B	E		D			C	
Approach Delay (s)		0.0			23.0			41.4			28.0	
Approach LOS		A			C			D			C	

Intersection Summary			
HCM 2000 Control Delay	25.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	92.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Appendix J

Geotechnical Data Report
Masa Fujioka & Associates, 2012

EXHIBIT 5

MASA FUJIOKA & ASSOCIATES
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October 30, 2012

Architects Hawaii Ltd.
ASB Tower
1001 Bishop St., Suite 200
Honolulu, HI 96813

Attn: Lloyd Arakaki

Subject: **Geotechnical Data Report**
Board of Water Supply
630 S. Beretania Street
Honolulu, O'ahu, Hawai'i

Masa Fujioka & Associates (MFA) is pleased to submit this data report for the subject property.

On June 27, 2012, Masa Fujioka and Associates (MFA) submitted a revised proposal to conduct a geotechnical investigation for geotechnical services for the subject project. This was a reduction in scope from our original proposal, based on our providing information on general site conditions rather than a more thorough investigation.

The general location of the project is depicted on Figure 1, Project Location Map.

PROJECT CONSIDERATIONS

We understand that the project consists of the preparation of RFP documents for the potential redevelopment of various Board of Water Supply buildings and site features at Beretania and Alapai Streets. The redevelopment may include the construction of new buildings and/or the reuse/renovation of existing buildings onsite. Buildings and site features which may be impacted by future redevelopment include a historic pump station building, an administration building, an operations building, and parking lots and appurtenances.

We understand that for geotechnical services, you require a report of general site conditions; and the design-build contractor's geotechnical consultant will conduct a project-specific investigation.

We proposed to conduct a subsurface geotechnical investigation in the existing parking lot areas. Our proposal included conducting a shear wave velocity test at the site to meet IBC 2006 requirements for site seismic class.

At this time the following have been completed: geological reconnaissance; subsurface investigation; shear wave velocity test; laboratory testing; and report preparation.

1.0 SCOPE OF WORK

Based upon our understanding of the foregoing, and geological and geotechnical considerations, the following Scope of Work was proposed and performed:

1. **Data Review and Site Reconnaissance**

   Our Principal Engineer and an MFA Engineering Geologist reviewed readily available geologic and soils information for the project corridor using GIS layers, associated geologic data, and associated Soil Survey Geographic (SSURGO) data from Natural Resources Conservation Service (NRCS). Our Principal Engineer and an MFA Engineering Geologist visited the site and reviewed site conditions.

2. **Geotechnical Investigation and Laboratory Testing**

   We conducted a subsurface investigation consisting of seven borings in parking lot areas across the site. Borings were to be to a depth of approximately 30 feet or refusal on hard coral or tuff. Sampling of the borings consisted of bulk near-surface samples and SPT samples supplemented by coring where hard rock was encountered.

   Borings were drilled by subcontracted drillers, GeoTek Hawaii, Inc., under the technical supervision of an MFA engineer, who logged the borings and recovered soil samples and rock cores for laboratory review and testing.

   Recovered samples were returned to our laboratory for examination and appropriate laboratory testing. Testing included compaction, CBR, and identification tests.

   Prior to drilling, we marked the proposed boring locations and arrange for utility clearance of proposed boring locations utilizing the Hawaii One-Call Procedure.

   All seven borings were located in areas of existing AC pavement. We repaired the holes with asphalt patches, as requested by the Board of Water Supply.

3. **Shear Wave Velocity Survey**

   A shear wave velocity survey was conducted at the site by a subcontracted geophysicist to meet International Building Code (IBC) 2006 requirements for site seismic classification.

4. **Report**

   MFA prepared this data report.

2.0 SITE CONDITIONS

2.1 Regional Geology

The Island of Oahu was formed by two shield volcanoes, the older Waianae and younger Koolau. Each volcano has been truncated by a massive submarine slides – the Waianae Slump to the southeast and the Nuuanu Slide to the northeast. The lavas of the Koolau Volcano banked against the Waianae Volcano, creating the Schofield Plateau.

The Waianae Volcanics date from about 4.0 million years ago (Ma) to about 2.9 Ma. The oldest Koolau Basalts are dated to about 3 Ma, and the youngest to somewhere between about 1.8 to about 2.1 Ma. After a long period of quiet during which deep canyons were cut into the Koolau shield, volcanic activity resumed on the southeastern end of the Koolau Range, consisting of the sporadically scattered lava flows and vent deposits of the Honolulu Volcanics. The Honolulu Volcanics range in age from 0.8 to “somewhat younger than” 0.1 Ma. These rejuvenated-stage volcanics include Punchbowl Crater, a vent approximately one-half mile northeast of the project site. One of the youngest deposits is from the Tantalus Peak – Sugar Loaf vent system.[1]

Tantalus Peak is about 3 miles northeast of the project site, and Sugar Loaf – consisting of two craters – is about a mile south of Tantalus on the divide between Manoa and Makiki valleys.

The island’s geologic history includes a deep (>1200 feet), gradual, submergence of Oahu in possibly Early Pleistocene Time – resulting from deformation of the Earth’s crust caused by the island’s load on it – and oscillations of sea level – attributable to advances and recessions of the polar ice caps – in Middle and Late Pleistocene Time. The variations during the

[1] Macdonald, G. A., Abbott, A.T., & Peterson, F.L. (1983). *Volcanoes in the Sea: The Geology of Hawaii* (2nd Ed.). Honolulu: University of Hawaii Press.

activity that produced the Honolulu Volcanics include, in sequence, a rise to 95 feet above present level, known as the "Kaena Stand"; recession to +70 feet (Laie Stand); halt at +40 (?) feet (Waialae Stand); recession to -60 (Waipio Stand); and rise to +25 (Waimanalo Stand). In the Late Pleistocene or Recent Time, the sea receded to present level[2].

Punchbowl probably erupted during the Waipio (-60 feet) Stand, depositing tuff in the area of the project site. The Waimanalo Stand (+25 feet) followed, creating coral ledges. Erosion occurred during the subsequent Waipio Stand (-60 feet) during which channels were cut in the coral ledges. The cinders of Tantalus and Sugar Loaf eruptions rest atop the emerged reef created during the Waimanalo Stand and in some places have sifted down into crevices and caves in the limestone. Because of its high permeability, it is "a valuable [water] intake formation. As it fell on a dissected and in places soil-covered Koolau surface, it gave rise to several springs. Punchbowl would have been covered by the firefountain deposits of the Tantalus and Sugar Loaf volcanics, but the material was later washed off the steep slopes, re-exposing the tuff at Punchbowl Crater[3].

2.2 Site Geology

The project site and adjacent properties are mapped on the *Geologic Map of the State of Hawai'i*[4] as falling completely within a single map unit (designated *Qtf*), comprised of vent deposits from the Tantalus Vent of the Honolulu Volcanic Series, age approximately 0.1 Ma. The site is downslope from the older Punchbowl vent, aged approximately 0.4 Ma, whose rock type is listed as tuff. Geologic units are presented on Figure 2, Project Geologic Map. The accuracy of the geologic units is about 100 m (±50 m); the nearest mapped boundary to a different geological unit is approximately 135 m east of the northern portion of the site.

Stearns and Vaksvik describe geologic unit *Qtf* as: "Very permeable, friable, bedded black firefountain deposits from Tantalus and Sugar Loaf craters, and forming parts of Tantalus and Sugar Loaf volcanics; in places cemented by secondary calcite, coarse near the vents, but elsewhere mostly small fragments of glassy ribbon bombs and pumice mantling preexisting surfaces[5]."

Figure 2 also presents geologic symbols, which are a newer nomenclature than the map units. In the area of the project site, the map unit and geologic symbol boundaries coincide. The

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[2] Stearns, H.T and Vaksik, K.N. 1935. *Geology and Ground-water Resources of the Island of Oahu, Hawaii*. [Bulletin 1.] Hawaii Division of Hydrography. Published in Cooperation with the Geological Survey, United States Department of the Interior. pp. 178-179.
[3] Ibid. pp. 141-142 and 154-156.
[4] Sherrod, D.R., Sinton, J.M., Watkins, S.E., and Brunt, K.M. 2007. *Geologic Map of the State of Hawai'i.* Open-File Report 2007-1089. United States Geological Survey.
[5] Stearns and Vaksik. Op. cit.

project site falls within the symbol *Qott*, tuff from Tantalus Peak and Sugar Loaf vents described as: "Bedded black cindery ash and lapilli. Ejected during strombolian eruptions. Blankets large area southwest of vents, likely owing to position of vents on high ridge and subsequent deflection of eruptive plume by trade winds[6]."

Stearns and Vaksvik's discussion of Punchbowl Volcanics indicated that the first blasts were steam explosions that created the brown tuff, followed by the rise of liquid lava in the crater, forming a lava lake. The lake subsided… " This subsidence was probably caused by a cone fissuring on the southwest side, for a dike is exposed at the city reservoir on Alapai near Crescent Street, from which lava has flowed southward under the present site on the Beretania pumping plant [the project site]. Logs of wells 88A to 88F at this station show a lava flow about 15 feet thick resting on about 50 feet of Punchbowl tuff and overlain by 5 to 15 feet of reef and 10 feet of black sand."[7]

Stearns and Vaksvik note that the alignment of the Tantalus and Sugar Loaf craters suggests that both eruptions occurred concurrently along a nearly north-south fissure producing lava flows and firefountain deposits. The firefountain deposits are locally known as "black sand" even though they are mostly coarser than sand. The eruptions took place on high ridges exposed to strong trade winds; the firefountain deposits were drifted several miles southwestward and are more widespread than usual. In addition, coarse material rolled down the cliffs and accumulated at depth of 50 feet or more at their base; some of this material was transported by streams. In many places, the firefountain deposits "are even-bedded and partly cemented by calcium carbonate. In other places they show cross-bedding as a result of being reworked by water." [8]

Board of Water Supply personnel provided MFA with the drilling log of an on-site deep monitoring well (T-85) that was drilled in 1960. The well's location is depicted on Figures 3-5. The log indicates 8 feet of black sand overlying 3 feet of "blue" rock[9], overlying 2 feet of clay[10], overlying one foot of hard rock[11], overlying 77 feet of soft "puka rock"[12]. Beneath the basalt, which ended at 91 feet below ground surface (bgs), the boring encountered various layers of coral and clay to 432 feet bgs. Hard rock was logged from 432 to 436 feet bgs, and possible clay for a short thickness below that. Material was not continually logged, at deeper depths, presumably due to lack of recovery, but, with the exception of "Cement"[13] from about 445 to 461 feet bgs, most of what was logged appears to be basalt to about 955 feet bgs, below which

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[6] Sherrod, et. al, Op cit. p.71.
[7] Stearns and Vaksik. Op. cit., pp. 145-148.
[8] Stearns and Vaksik. Op. cit., pp. 154-155.
[9] MFA note: Local driller's term generally indicating ā'a core rock.
[10] MFA note: This could be interpreted as lagoonal deposits.
[11] MFA note: This could indicate a boulder.
[12] MFA note: Local driller's term generally indicating vesicular basalt, possibly pāhoehoe.
[13] MFA note: This may represent a lithified coralline sandstone or cemented coral.

was varying soft and hard material, with some voids, to the termination of the boring at 1516 feet bgs.

2.3 Site Soils

Soils in the project area were mapped by the United States Department of Agriculture (USDA) Soil Conservation Service[14]. Soils in the northern roughly half of the site are mapped as *Tantalus silty clay loam, 8 to 15 percent slopes* (*TCC*). Soils in the southern roughly half of the site are mapped as *Makiki clay loam, 0 to 2 percent slopes* (*MkA*). A soils map is presented as Figure 3, Project Soils Map. The Soil Survey for this area was mapped at a 1:24,000 scale. The contact between map units is approximate at the scale of the project site.

The Tantalus Series consists of well-drained soils on uplands of the islands of Oahu. These soils developed in volcanic ash and material weathered from cinders. They are moderately sloping to very steep.

In a representative profile of *Tantalus silty clay loam, 8 to 15 percent slopes*, the surface layer, about 18 inches thick, consists of very dark brown silt loam that has subangular blocky structure. The subsoil, about 11 inches thick, is dark reddish-brown, massive very fine sandy loam. The substratum is black, unweathered, gravel-sized cinders. Permeability is moderately rapid, runoff is slow, and the erosional hazard is slight (p.121). Included in mapping were small areas of stony soils in drainageways. The soil has moderate compressibility, and slopes as much as 70%; it is susceptible to sliding (pp. 196-197)

The Makiki Series consists of well-drained soils on alluvial fans and terraces in the city of Honolulu. These soils, which are nearly level, formed in alluvium mixed with volcanic ash and cinders. Makiki clay loam, 0 to 2 percent slopes is on smooth fans and terraces. In a representative profile, the surface layer is dark-brown clay loam about 20 inches thick, underlain by an approximately 10-inch layer of dark-brown clay loam that has subangular blocky structure and contains cinders and rock fragments. This subsoil in underlain by similar material, about 24 inches thick, that is massive. Below this are volcanic cinders. Permeability is moderately rapid, runoff is slow, and the erosion hazard is slight (pp. 91-92). The soil has moderate shrink-swell potential and moderate shear strength (pp. 188-189).

[14] United States Department of Agriculture Soil Conservation Service [in cooperation with The University of Hawaii Agricultural Experiment Station]. 1972. *Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii*. Washington, DC: U.S. Government Printing Office.

2.4 Site Geomorphology

Topography of the project site generally reflects the underlying geology, but with man-made terraces. The elevation change across the site is approximately 40 feet, with the highest area toward Punchbowl, sloping generally down toward the ocean. Boring locations superimposed on a site plan are depicted in Figure 4.

Ground surface elevation ranges from a high of 51 feet at the east corner of Parking Area D (near the corner of Lisbon and Lusitana Streets), to a low of approximately 11.1 feet on the southeast corner of the Site. A topographic site map is presented as Figure 5.

In the parking areas between Lauhala and Lisbon Street, borings B1 and B2 (ground surface elevations of approximately 21.0 and 25.2 feet, respectively) are located in the BWS equipment lot.

Borings B3 and B4 (ground surface elevations of approximately 33.6 and 48.9 feet, respectively) are in Parking Area D, which is at a higher elevation than the equipment lot; there is a retaining wall between the lots.

Likewise, to the east of Lisbon Street, Parking Area C, in which borings B5 and B6 are located (ground surface elevations of approximately 48.0 and 42.0 feet, respectively) is at a higher elevation than Parking Area B (no borings), separated by a retaining wall.

Boring B7 (ground surface elevation of approximately 21.1 feet) is in the courtyard seaward of the Engineering Building.

2.5 Relevant Site History

The following is information that MFA encountered or was provided during the course of our investigation and is not meant to be a comprehensive site history.

The 'Beretania pumping station' "was established with two wells in 1895 as a result of the several droughts and a recent increase in population. Two more wells increased its capacity in 1909; one well each in 1923 and 1924, and three wells in 1926.[15]

According to BWS personnel, there is a World War II era underground bomb shelter that is believed to run north from the area of the engineering building. Exact location, size, and depth of this tunnel are unknown. MFA did not encounter the tunnel in any of our borings.

[15] Stearns and Vaksvik, Op cit, p. 249

2.6 Review of Previous Investigations

A 2004 Geotechnical Engineering Consultation for the parking structure on the property adjacent to the west (Corner of Beretania and Lauhala Streets) indicates that subsurface soil conditions consist of a layer of volcanic cinder sand overlying a coral reef formation that dips down in the southerly direction and is known to have cavities. The coral reef formation typically consists of cemented coral fragments and coral sand overlying hard coral[16].

A Master's thesis of subsurface geology includes a paleogeologic map of Waikiki, Moilili and Kakaako that depicts a large, filled alluvial channel, denoted in the thesis as the "HIC Channel," which *may* have cut through the Project Site or a portion of the site. The thesis study area's northern boundary is King Street but extrapolation suggests this possibility. Further, the thesis states, "Boring data available north of King Street (outside the project area) indicate that the HIC alluvial channel continues toward the northwest..."

The master's thesis study area is dominated by three coral ledges from the Waimanalo High Sea Stand, denoted +5, -15, and -30, all roughly paralleling the modern shoreline. The +5 ledge is the inland-most of the three, and extends at least as far north as King Street. The top of this ledge generally occurs between +5 and -5 feet elevation. The thesis indicates that "All of the coral ledges are dissected by various alluvial channels, some of which extend to elevation -180 feet and deeper. In addition, various basalt flows are found, both above and below the coral ledges, and in some cases within the alluvial channels."

The channel that *may* cut through a portion of the Project Site is denoted in the thesis as the "HIC Channel." It passes across the Honolulu International Center (now Neil Blaisdell Center), from roughly northwest to southeast, and then likely continues south to Kewalo Basin. It is described as 100 – 300 feet wide, and has eroded out the +5 coral ledge. In the channel, within the Master's thesis study area, alluvium with cinders / cinder sand and coralline debris was deposited, overlain by swamp deposits up to about -10 feet elevation. Atop this, deposits are similar to the deposits found overlying the coral outside the channel – surface fill (~3 feet thick) overlying swamp deposits (~4 feet thick), overlying cemented cinder sand (at least 2 feet, and possibly up to 9 feet thick) atop the coral. In some areas, the coral ledge is overlain by 4-5 feet of partly cemented coralline debris. One deep boring indicated channel deposits to a depth of -82 feet, where coral was encountered.[17]

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[16] URS Corporation. 2004. Geotechnical Engineering Consultation, Additional Floors Above the Existing Parking Structure, Honolulu Medical Group, 550 South Beretania Street, Honolulu, Hawaii 96813.
[17] Ferrall, Jr. Charles C. 1976. Subsurface Geology of Waikiki, Moilili and Kakaako with Engineering Application. Unpublished Master of Science thesis, University of Hawaii.

3.0 FIELD INVESTIGATION AND LABORATORY TESTING

MFA's geotechnical investigation was conducted from September 17-20, 2012. Seven borings were drilled / cored by GeoTek Hawaii, Inc., under the technical supervision of an MFA engineer, utilizing a Mobile B-59 drill rig. The locations of the borings are indicated on Figures 3-5. Ground surface elevations of the borings were estimated from topographic maps provided by the Board of Water Supply.

SPT sampling was conducted in soil, and coring with an HQ (2.5-in. ID) core barrel was performed when rock was encountered. Bulk soil samples were collected from all seven borings. Borings were backfilled with cuttings, supplemented by bentonite as necessary. The AC pavement was patched with an asphalt cold patch.

Logs of subsurface conditions encountered within the boreholes are presented in Figure 6, Logs of Borings. Soils encountered within the test pits were classified in accordance with the Unified Soil Classification System, Exhibit 1. A boring log legend is presented as Exhibit 2. Coralline-derived materials encountered were classified in accordance with the Calcareous Rock Classification System for Hawaii, Exhibit 3.

Selected recovered soil samples were tested for gradation, compaction, and CBR (California Bearing Ratio). The results of the laboratory testing are presented in Appendix A, Laboratory Test Data, and select test results are included on the Logs of Borings.

Cores were recovered during the course of the investigation. Photographs of cores are presented in Appendix B.

Because water was introduced into the boreholes as part of the coring process, it was not possible to tell if the groundwater table was encountered during the drilling.

Borings were drilled to 30 feet below ground surface (bgs), or terminated earlier when coring was in hard rock for a minimum of 10 consecutive feet.

MFA found the site to be geologically complex. The samples contain unusual rock types such as travertine[18], polymitic conglomerates (i.e. containing clasts of many different rock types), partially to completely welded basaltic volcanic ash (tuff) and others.

All the borings encountered 2 inches of asphaltic concrete underlain by 4 - 6 inches of basecourse.

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[18] Travertine is calcium carbonate deposited by hot or cold calcareous spring water around the mouths of caves (Klein, Conrnelis, and Hurlbut, C.S., Jr. 1993. Manual of Mineralogy (after James D. Dana), 21st Edition. New York: John Wiley & Sons, Inc. p. 407.

Borings B1 and B3 encountered black sand (ash cinders) to 9 feet bgs overlying a one-foot thick layer of tuff, overlying pāhoehoe basalt to the termination of the boring at 20 feet bgs. These borings are generally in line with one another perpendicular to the contours, i.e. following the likely direction of flow from Punchbowl Crater.

Boring B2 encountered <2 feet of black to light brown sand (volcanic ash) overlying approximately 2 feet of pāhoehoe, overlying ~ 3 feet of a basalt / coralline polymict conglomerate, overlying a sequence of layers of a pāhoehoe boulder, tuff, coralline sandstone, and pāhoehoe to the termination of the boring at 17 feet bgs.

Boring B4 encountered black sand (ash cinders) to approximately 7.5 feet bgs, overlying 5 feet of tuff, overlying layers of pāhoehoe interbedded with a layer of dark red-brown sand (weathered volcanic ash) from about 14.5 to about 15.5 feet bgs. The pāhoehoe persisted to the termination of the boring at 31 feet bgs.

Boring B5 encountered weathered ash sand to 8 feet bgs, overlying partially welded black volcanic ash to 14 feet bgs, overlying 2.5 feet of black sand (ash cinders), overlying pāhoehoe from about 16.5 feet to the termination of the boring at 25.5 feet bgs.

Boring B6 encountered sand with silt (volcanic ash) to 4 feet bgs overlying pāhoehoe layers interbedded with a layer of clayey silty basalt gravel from about 5 to 6.5 feet bgs. The pāhoehoe persisted to the termination of the boring at 16 feet bgs.

Boring B7 encountered red-brown sand (volcanic ash) to about 2.5 feet bgs, overlying a basalt / coralline polymict conglomerate to 9 feet bgs, overlying layers of pāhoehoe to 20 feet bgs, overlying tuff to the termination of the boring at 26 feet bgs. Traverine was observed in the tuff layer and the 4-foot thick pāhoehoe layer immediately overlying the tuff.

The +5 coral ledge discussed by Ferrell was not encountered in MFA borings or in the borehole of monitoring well T-85. It is possible that the conglomerate and secondary rock in borings B2 and B7 were deposited in a channel's estuary. They are probably surf zone deposits, as they lack the silt and clay that are characteristic of stream deposits.

Coral was encountered on the property adjacent to the west, and is also mentioned by Stearns and Vaksvik as being about 5 to 15 feet thick on the subject property (refer to *Section 2.2, Site Geology*). Therefore, if the channel theory is correct, it may only have cut through a portion of the subject property, and can therefore be expected to have varying depths, because at least one of the channel sidewalls would have been on the subject property. Additionally, it was likely a shallow channel, because the pāhoehoe, which likely predated the reef-building and subsequent erosion, is relatively shallow. Further, it was likely in the surf zone, based on the conglomerate and secondary rock encountered in borings B2 and B7.

4.0 SEISMIC SITE CLASSIFICATION

A shear wave velocity test was conducted on the site by a subcontractor, AECOM Technical Services, Incorporated (AECOM). The results are presented in Appendix C.

Based on the results of the shear wave velocity test, Seismic Site Class C is indicated as defined by the IBC.

5.0 LIMITATIONS

The geotechnical recommendations and conclusions presented in this report are based on the following assumptions:

1. The scope of the construction project, as described, does not change appreciably.

2. Significant variations in soil properties from those encountered during our investigation do not occur.

3. A geotechnical engineer-of-record will be retained to observe actual field conditions encountered during construction to check the applicability of the recommendations presented in this report and to recommend appropriate changes in design or construction procedures, if differing conditions occur.

This report was prepared for the use of Architects Hawaii Ltd., in accordance with generally accepted geotechnical engineering principles and practices, and may not be suitable for the use of other parties.

Our services were provided consistent with normal standard of practice. No other representation is intended or implied.

- o 0 o -

It has been our pleasure to prepare this geotechnical data report for you. Please contact the undersigned if there are any questions regarding this data report.

Respectfully submitted,

MASA FUJIOKA & ASSOCIATES
A Professional Partnership

Masanobu R. Fujioka, P.E.
Managing Partner

MASANOBU R. FUJIOKA
LICENSED PROFESSIONAL ENGINEER
No. 4357-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION

LICENSE EXPIRES : 4-30-14

MRF/ecl

Attachments:

FIGURES

Figure 1.	Project Location Map
Figure 2.	Project Geologic Map
Figure 3.	Project Soils Map
Figure 4.	Project Contour Map
Figure 5.	Site Plan
Figure 6	Logs of Borings

EXHIBITS

Exhibit 1.	Unified Soil Classification System
Exhibit 2.	Boring Log Legend
Exhibit 3.	Calcareous Rock Classification System for Hawaii

APPENDICES

Appendix A.	Laboratory Test Data
Appendix B.	Photographs of Cores
Appendix C.	Shear Wave Velocity Test Report

APPENDICES

APPENDIX A

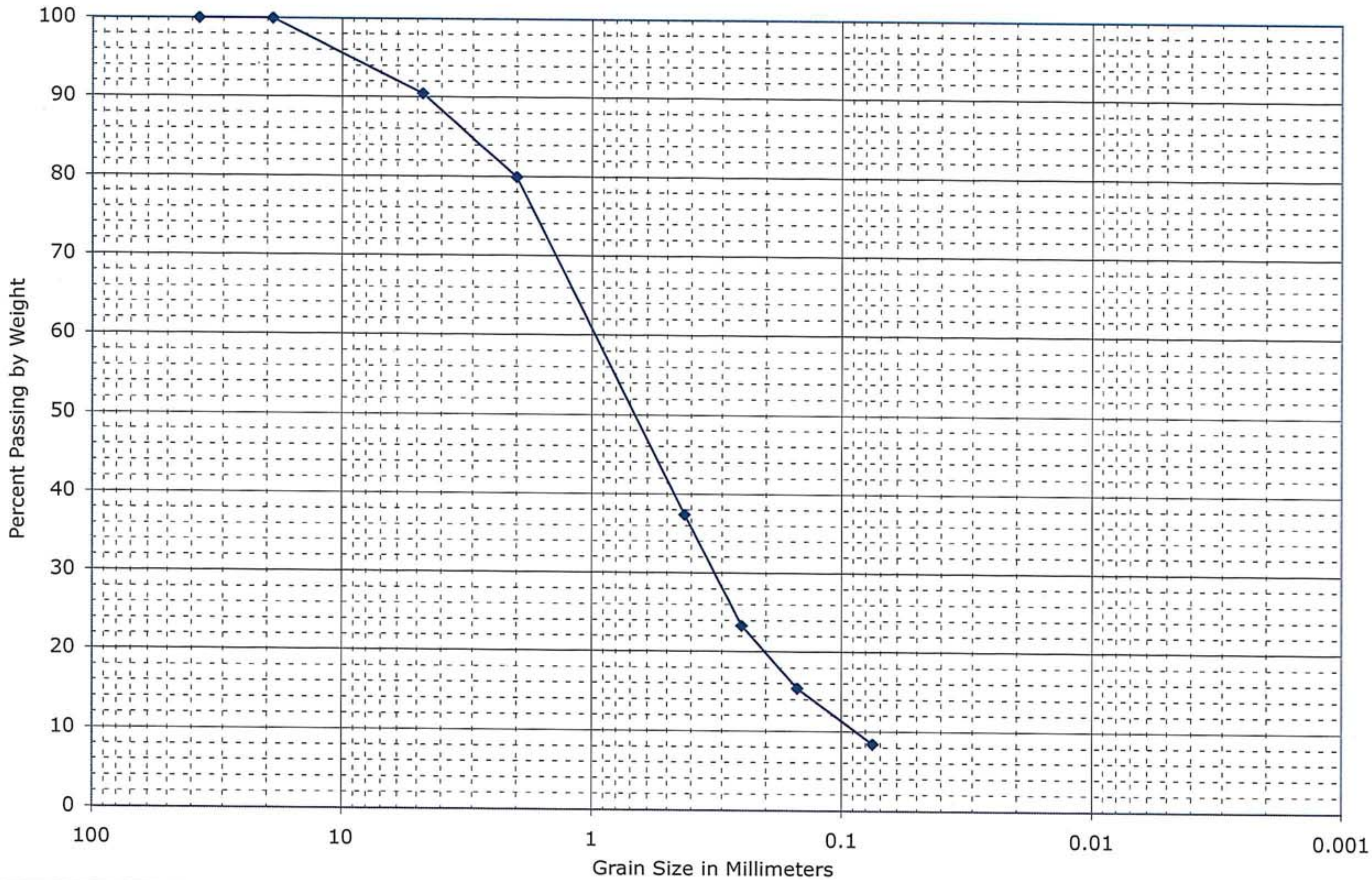
LABORATORY TEST DATA

Grain Size Analysis

Project: Board of Water Supply
Sample: B1- Bulk
Depth: 1'
Location: Honolulu

Date Received: 9/18/12
Date Performed: 9/24/12
Date Reported: 10/3/12
Client: Architects Hawaii

Figure: A1.1
MFA Job No.: 062-050
Soil Classification Well graded sand w/ silt
UCSC: SW-SM



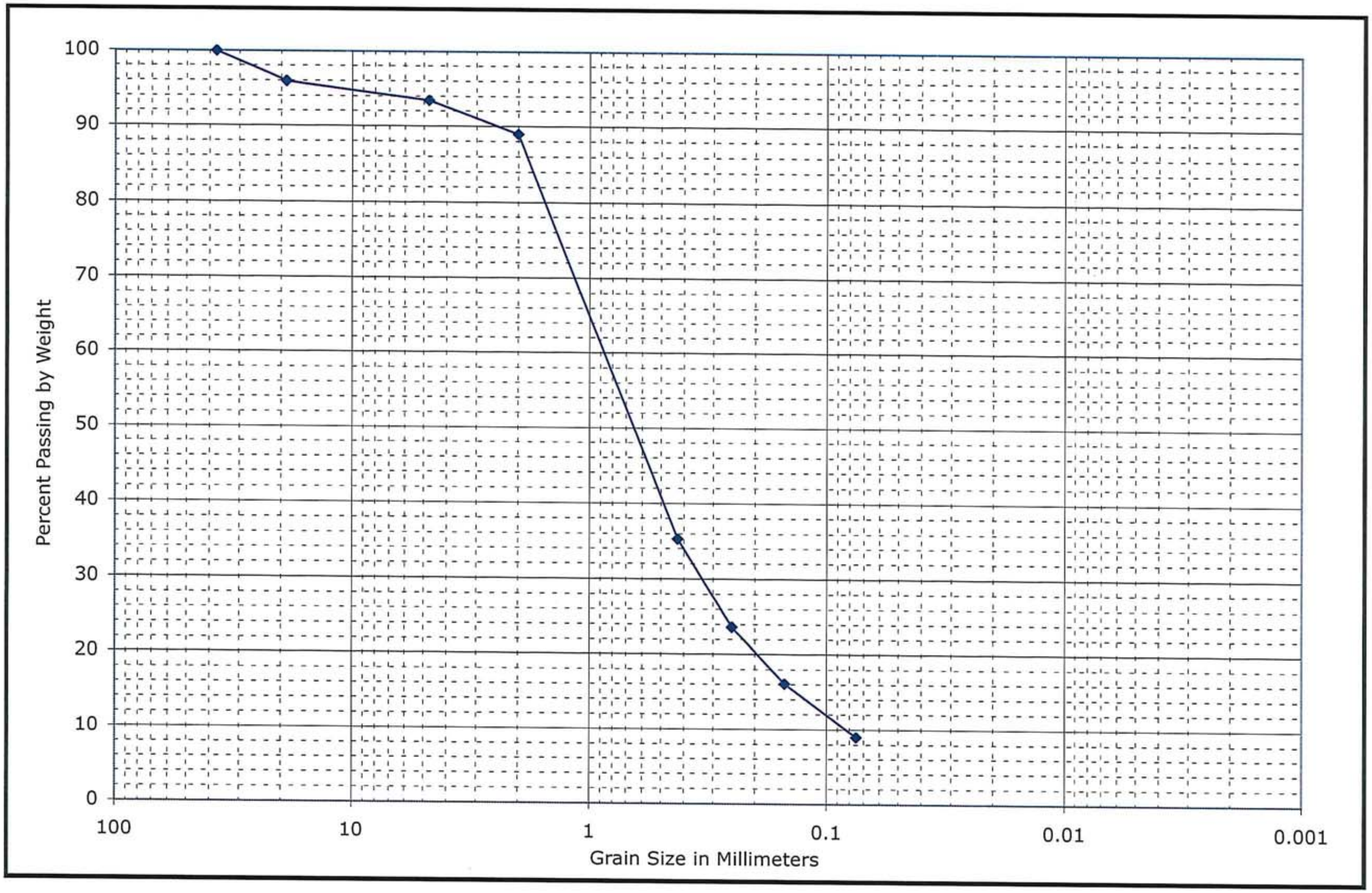
MASA FUJIOKA & ASSOCIATES

Grain Size Analysis

Project: Board of Water Supply
Sample: B1- 2
Depth: 3'
Location: Honolulu

Date Received: 9/18/12
Date Performed: 9/24/12
Date Reported: 10/3/12
Client: Architects Hawaii

Figure: A1.2
MFA Job No.: 062-050
Soil Classification Well graded sand w/ silt
UCSC: SW-SM



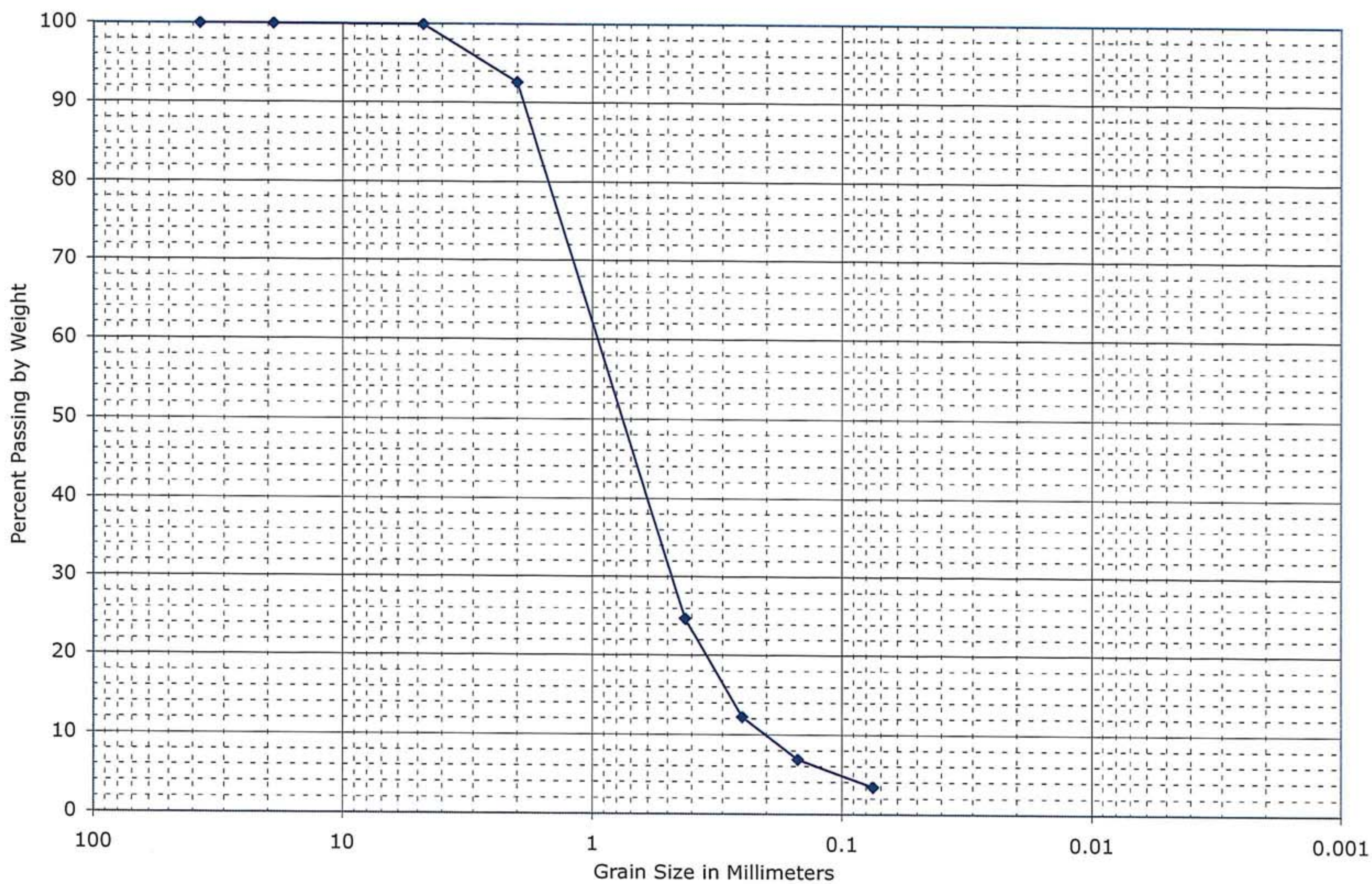
MASA FUJIOKA & ASSOCIATES

Grain Size Analysis

Project: Board of Water Supply
Sample: B1- 3
Depth: 5'
Location: Honolulu

Date Received: 9/18/12
Date Performed: 9/24/12
Date Reported: 10/3/12
Client: Architects Hawaii

Figure: A1.3
MFA Job No.: 062-050
Soil Classification Poorly graded sand
UCSC: SP



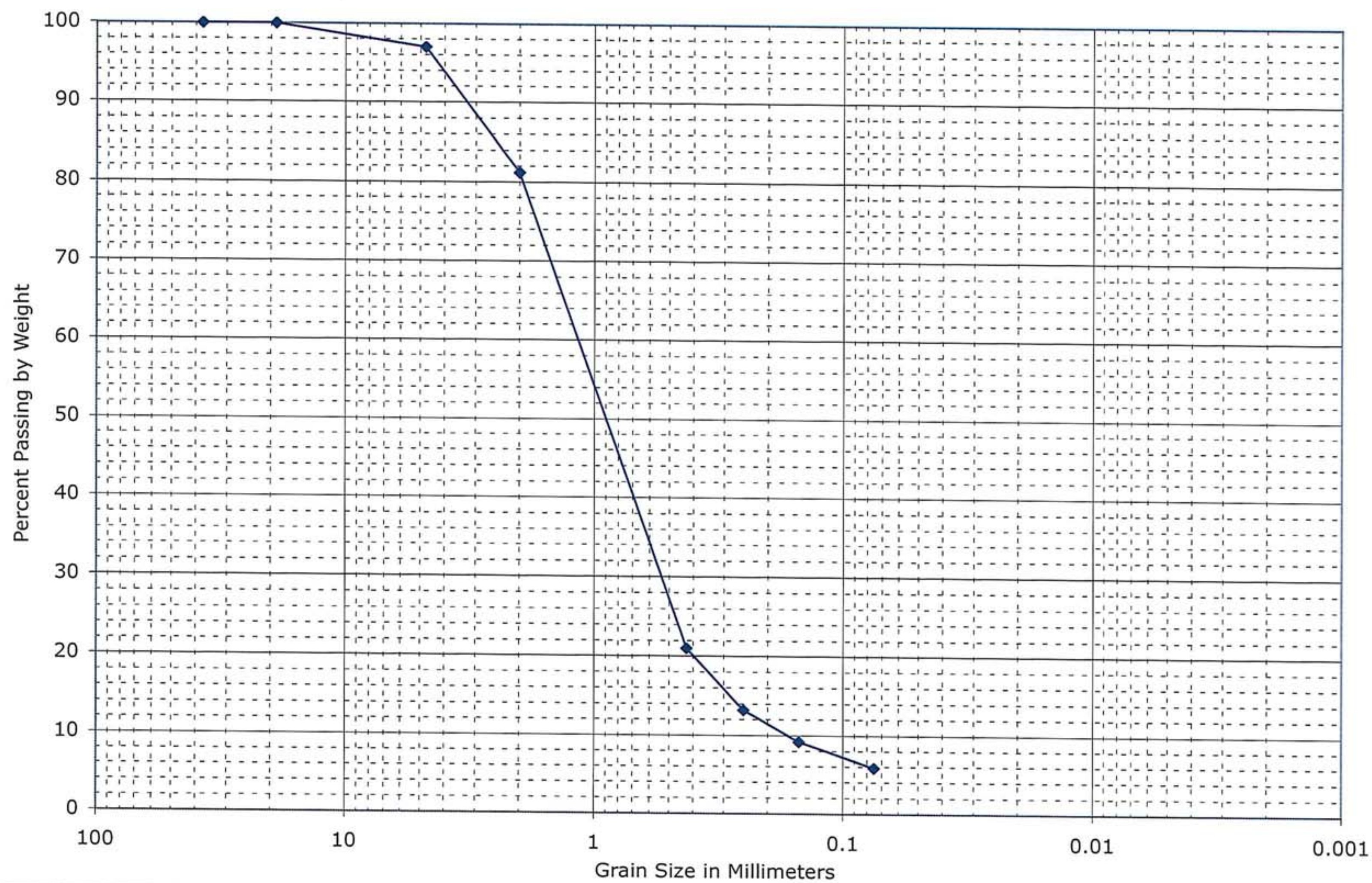
MASA FUJIOKA & ASSOCIATES

Grain Size Analysis

Project: Board of Water Supply
Sample: B2- bulk
Depth: 1'
Location: Honolulu

Date Received: 9/18/12
Date Performed: 9/24/12
Date Reported: 10/3/12
Client: Architects Hawaii

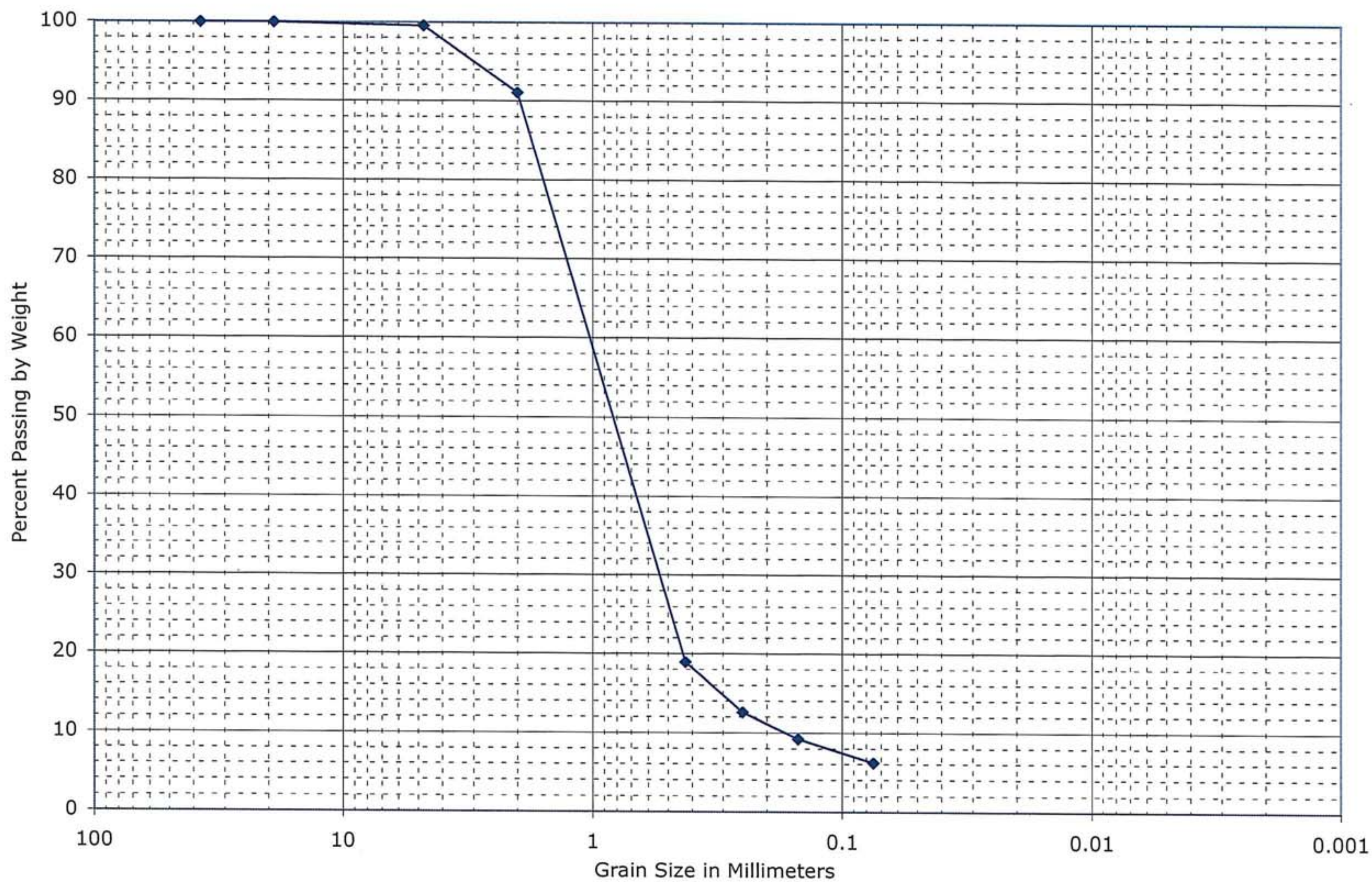
Figure: A.4
MFA Job No.: 062-050
Soil Classification Well graded sand w/ silt
UCSC: SW-SM



MASA FUJIOKA & ASSOCIATES

Grain Size Analysis

Project:	Board of Water Supply	Date Received:	9/18/12	Figure:	A1.5
Sample:	B3- bulk	Date Performed:	9/24/12	MFA Job No.:	062-050
Depth:	1'	Date Reported:	10/3/12	Soil Classification	Well graded sand w/ silt
Location:	Honolulu	Client:	Architects Hawaii	UCSC:	SW-SM



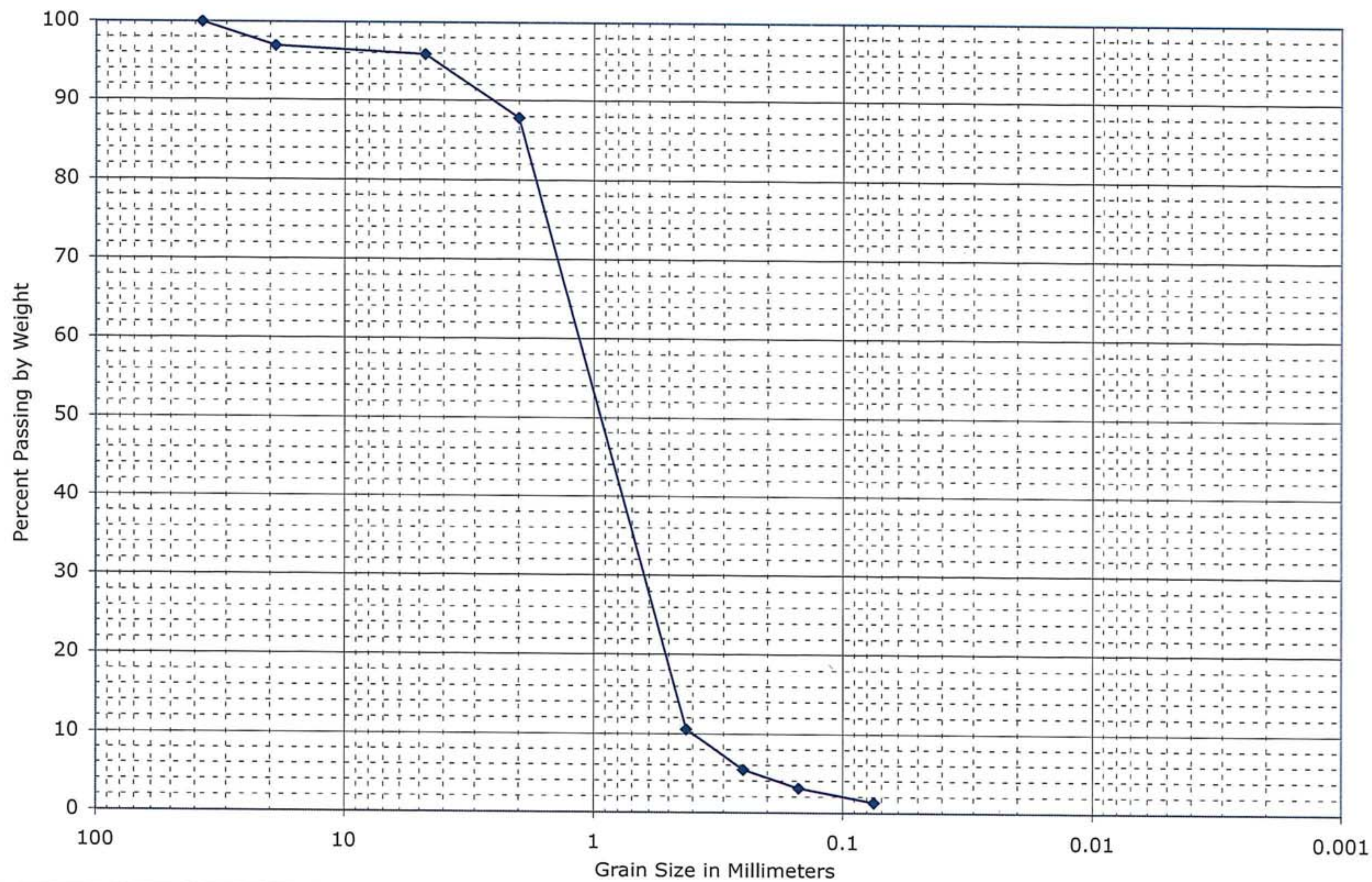
MASA FUJIOKA & ASSOCIATES

Grain Size Analysis

Project: Board of Water Supply
Sample: B3-2
Depth: 3'
Location: Honolulu

Date Received: 9/18/12
Date Performed: 9/24/12
Date Reported: 10/3/12
Client: Architects Hawaii

Figure: A1.6
MFA Job No.: 062-050
Soil Classification Poorly graded sand
UCSC: SP



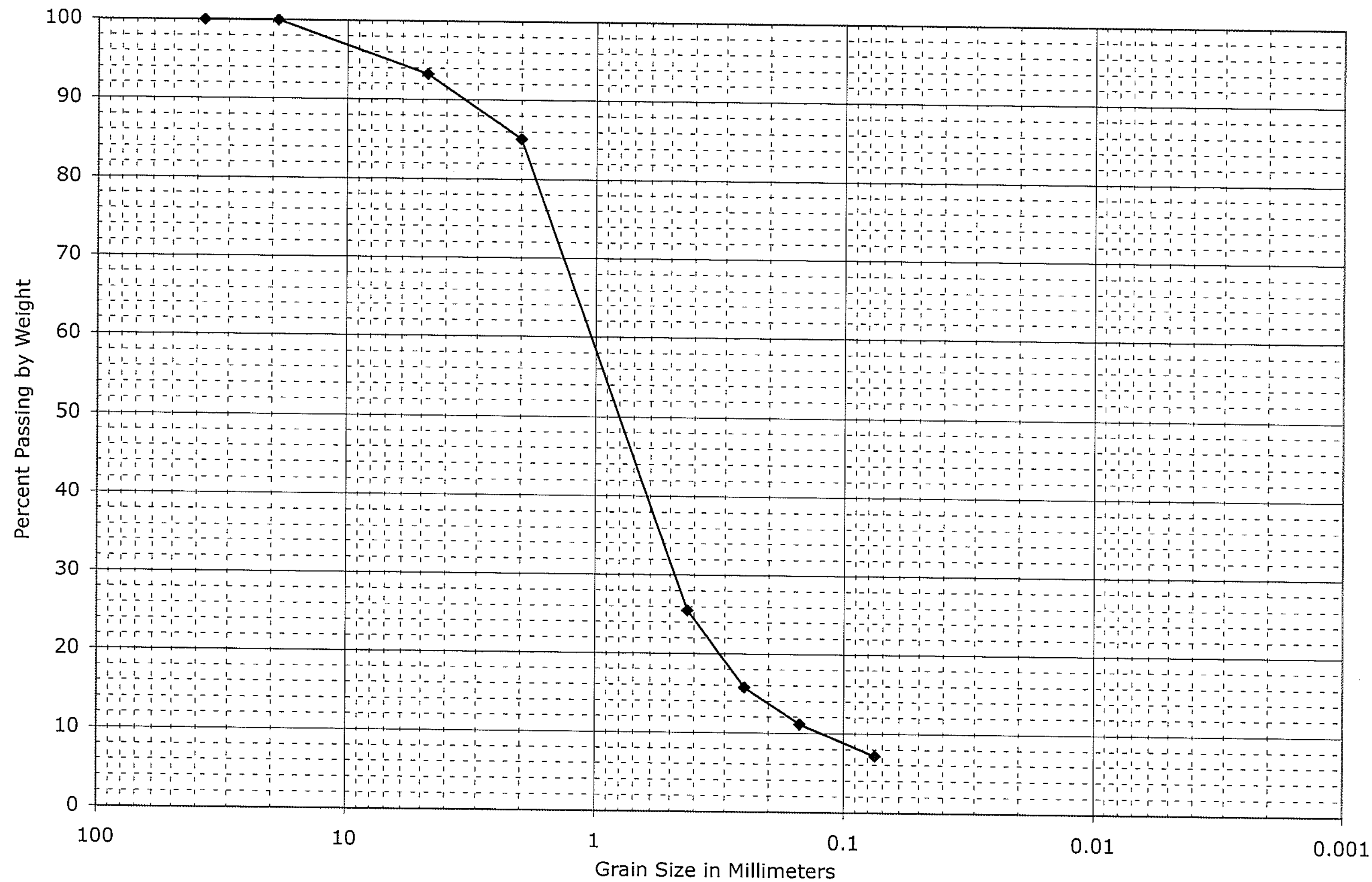
MASA FUJIOKA & ASSOCIATES

Grain Size Analysis

Project: Board of Water Supply
Sample: B4-bulk
Depth: 1'
Location: Honolulu

Date Received: 9/18/12
Date Performed: 9/24/12
Date Reported: 10/3/12
Client: Architects Hawaii

Figure: A1.7
MFA Job No.: 062-050
Soil Classification Well graded sand w/ silt
UCSC: SW-SM



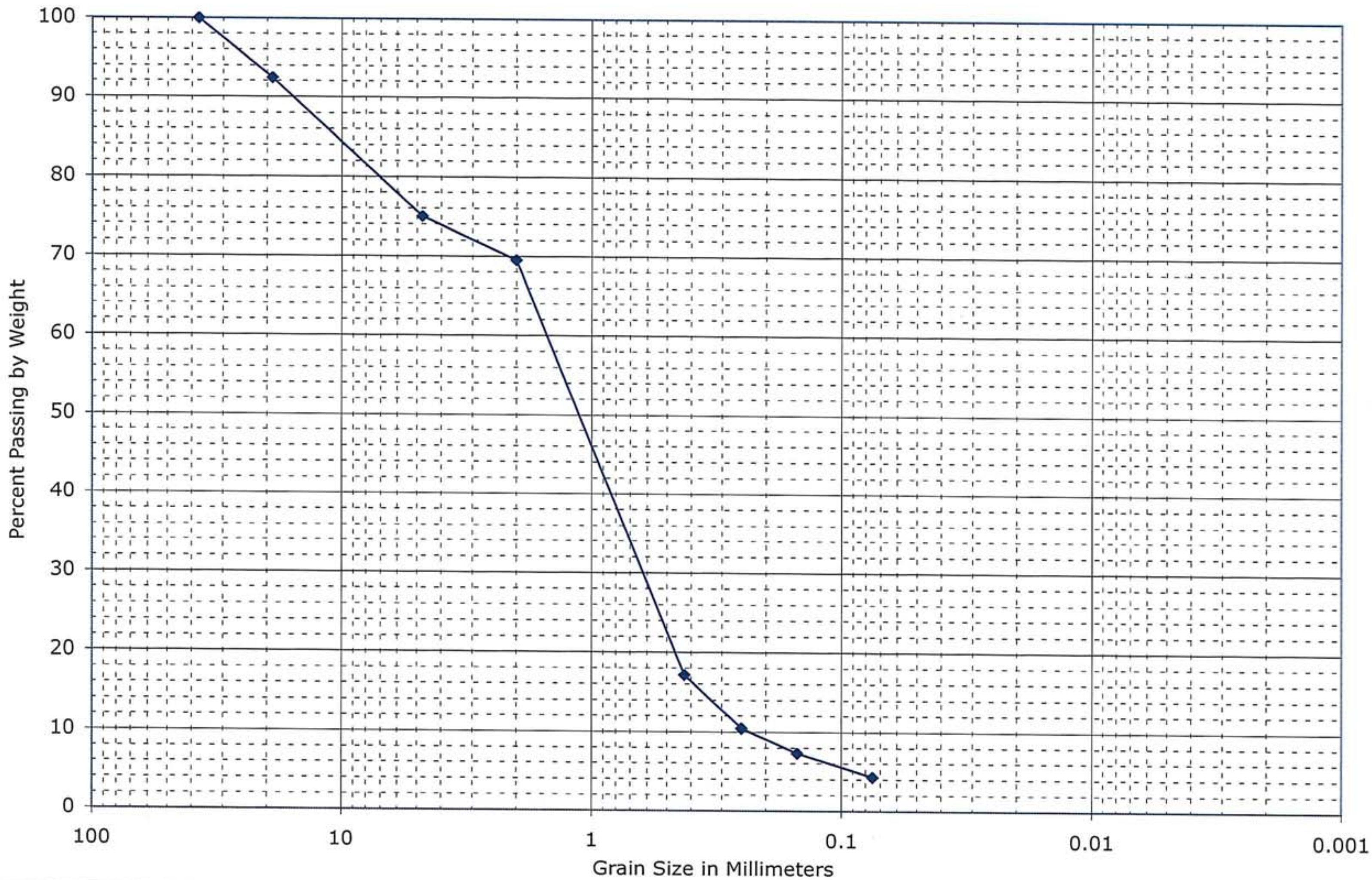
MASA FUJIOKA & ASSOCIATES

Grain Size Analysis

Project: Board of Water Supply
Sample: B4-2
Depth: 3'
Location: Honolulu

Date Received: 9/18/12
Date Performed: 9/24/12
Date Reported: 10/3/12
Client: Architects Hawaii

Figure: A1.8
MFA Job No.: 062-050
Soil Classification Poorly graded sand w/ gravel
UCSC: SP



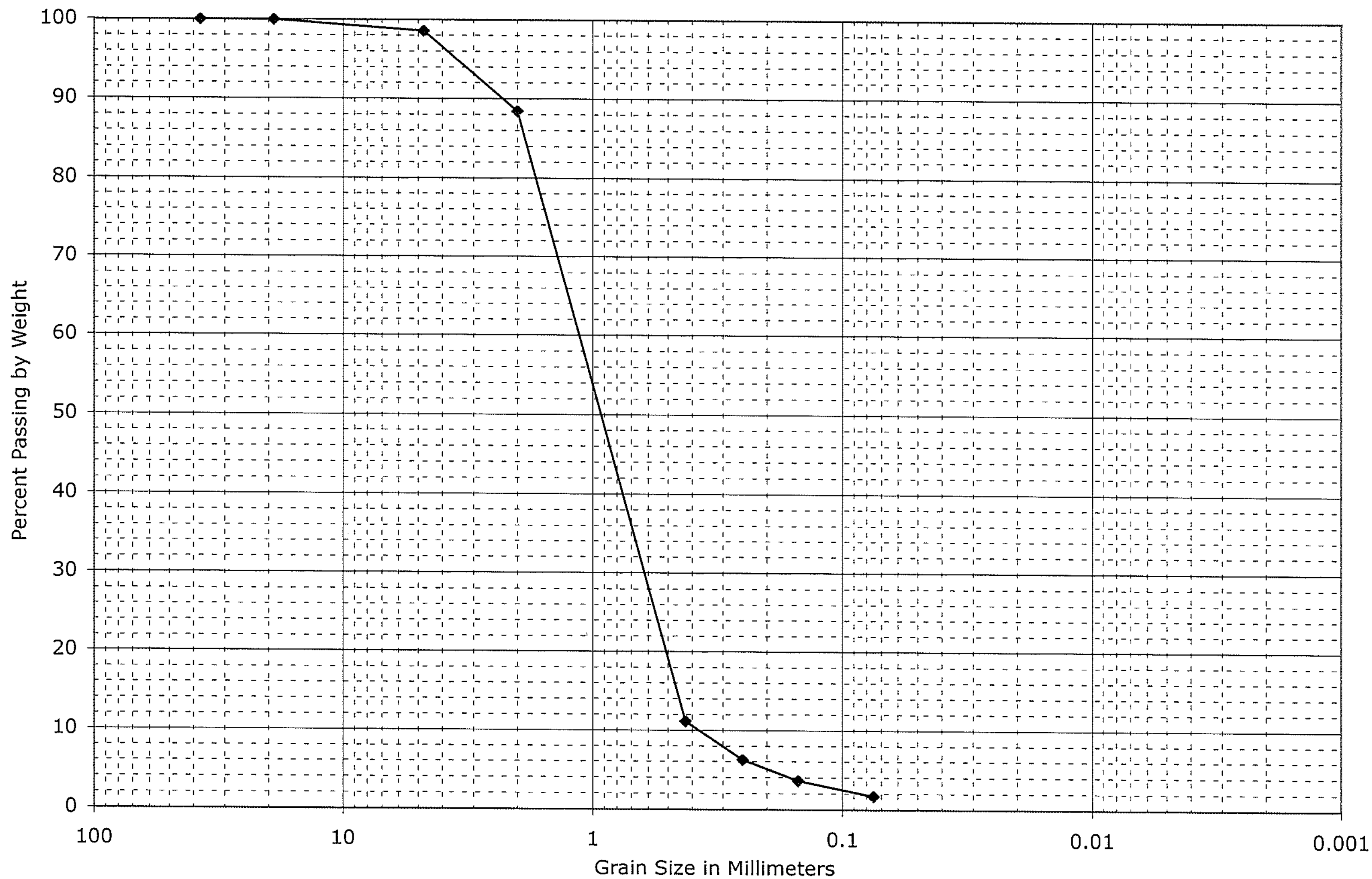
MASA FUJIOKA & ASSOCIATES

Grain Size Analysis

Project: Board of Water Supply
Sample: B4-3
Depth: 5'
Location: Honolulu

Date Received: 9/18/12
Date Performed: 9/24/12
Date Reported: 10/3/12
Client: Architects Hawaii

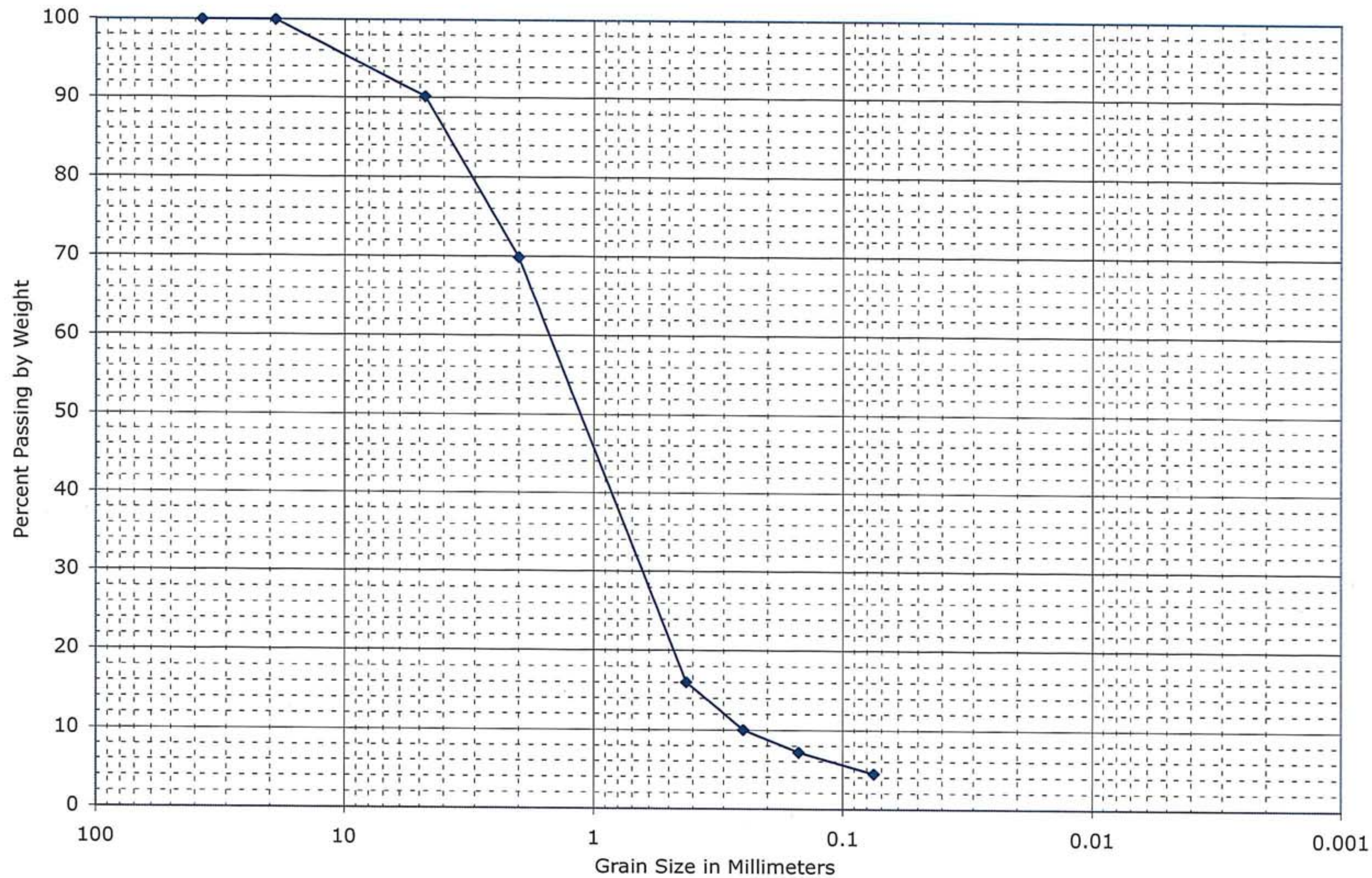
Figure: A1.9
MFA Job No.: 062-050
Soil Classification Poorly graded sand
UCSC: SP



MASA FUJIOKA & ASSOCIATES

Grain Size Analysis

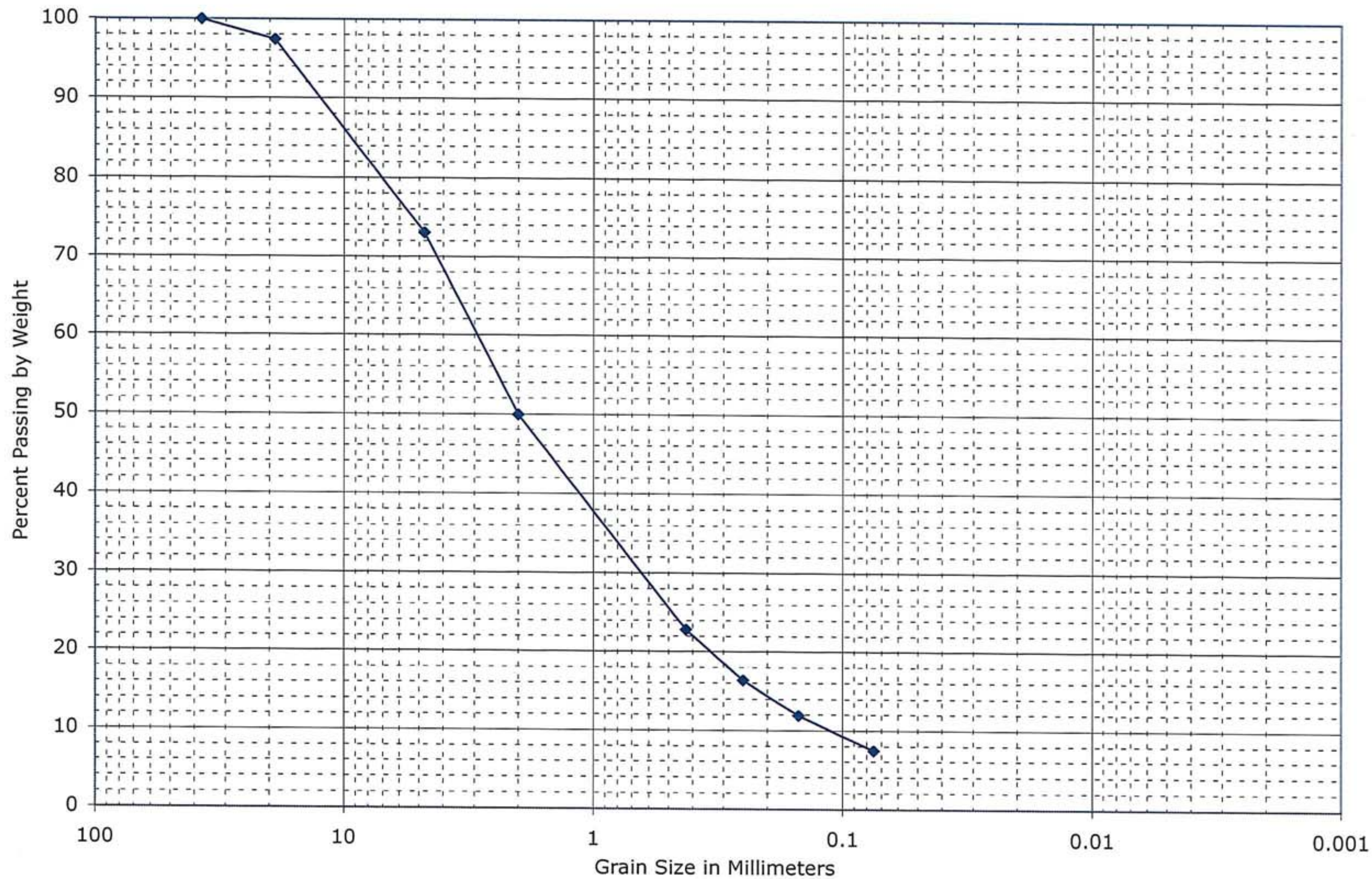
Project:	Board of Water Supply	Date Received:	9/18/12	Figure:	A1.10
Sample:	B4-4	Date Performed:	9/24/12	MFA Job No.:	062-050
Depth:	10'	Date Reported:	10/3/12	Soil Classification	Poorly graded sand
Location:	Honolulu	Client:	Architects Hawaii	UCSC:	SP



MASA FUJIOKA & ASSOCIATES

Grain Size Analysis

Project:	Board of Water Supply	Date Received:	9/18/12	Figure:	A1.11
Sample:	B5-bulk	Date Performed:	9/24/12	MFA Job No.:	062-050
Depth:	1'	Date Reported:	10/3/12	Soil Classification	Well graded sand w/ silt & gravel
Location:	Honolulu	Client:	Architects Hawaii	UCSC:	SW-SM



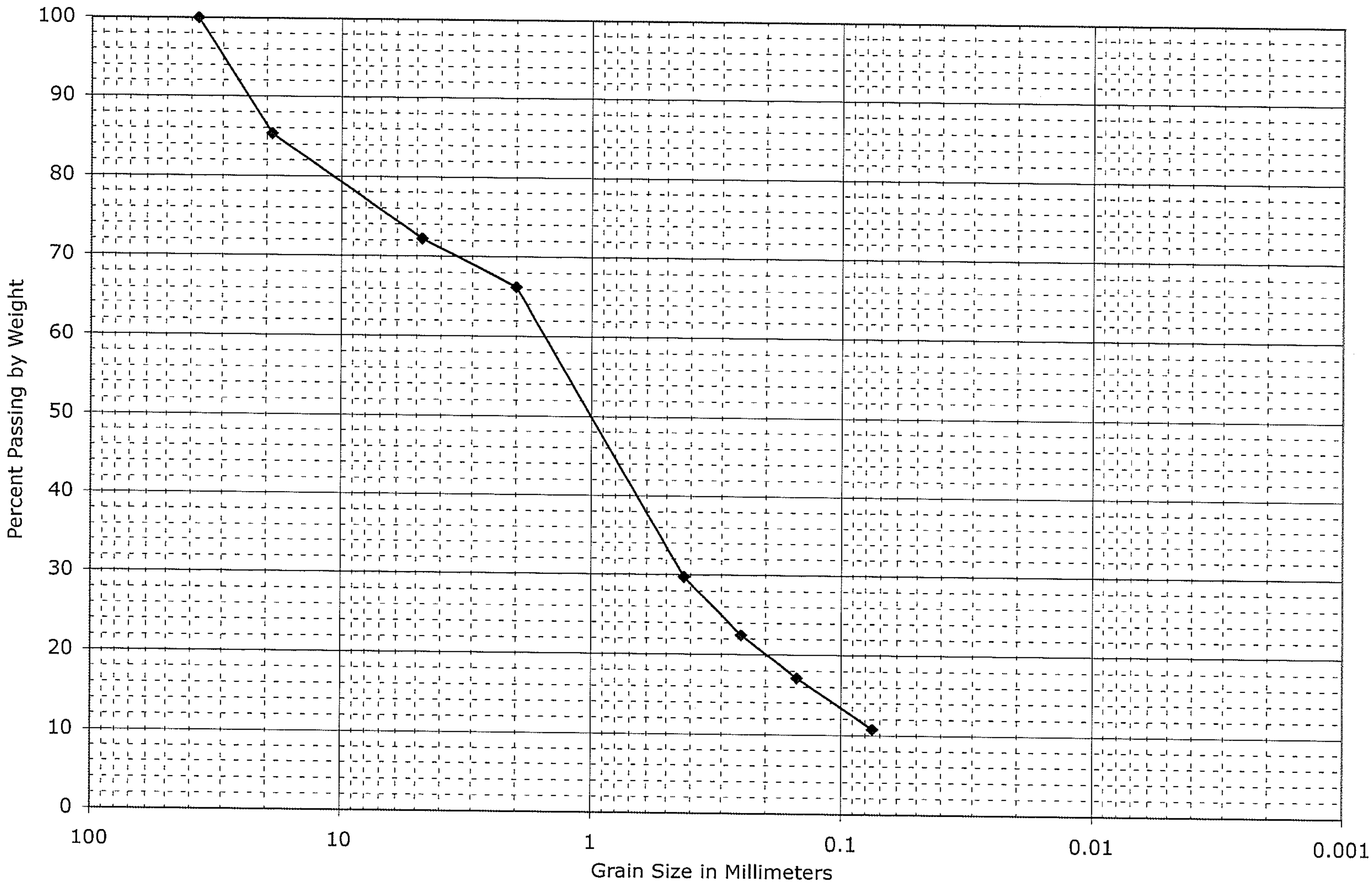
MASA FUJIOKA & ASSOCIATES

Grain Size Analysis

Project: Board of Water Supply
Sample: B5-2
Depth: 3'
Location: Honolulu

Date Received: 9/18/12
Date Performed: 9/24/12
Date Reported: 10/3/12
Client: Architects Hawaii

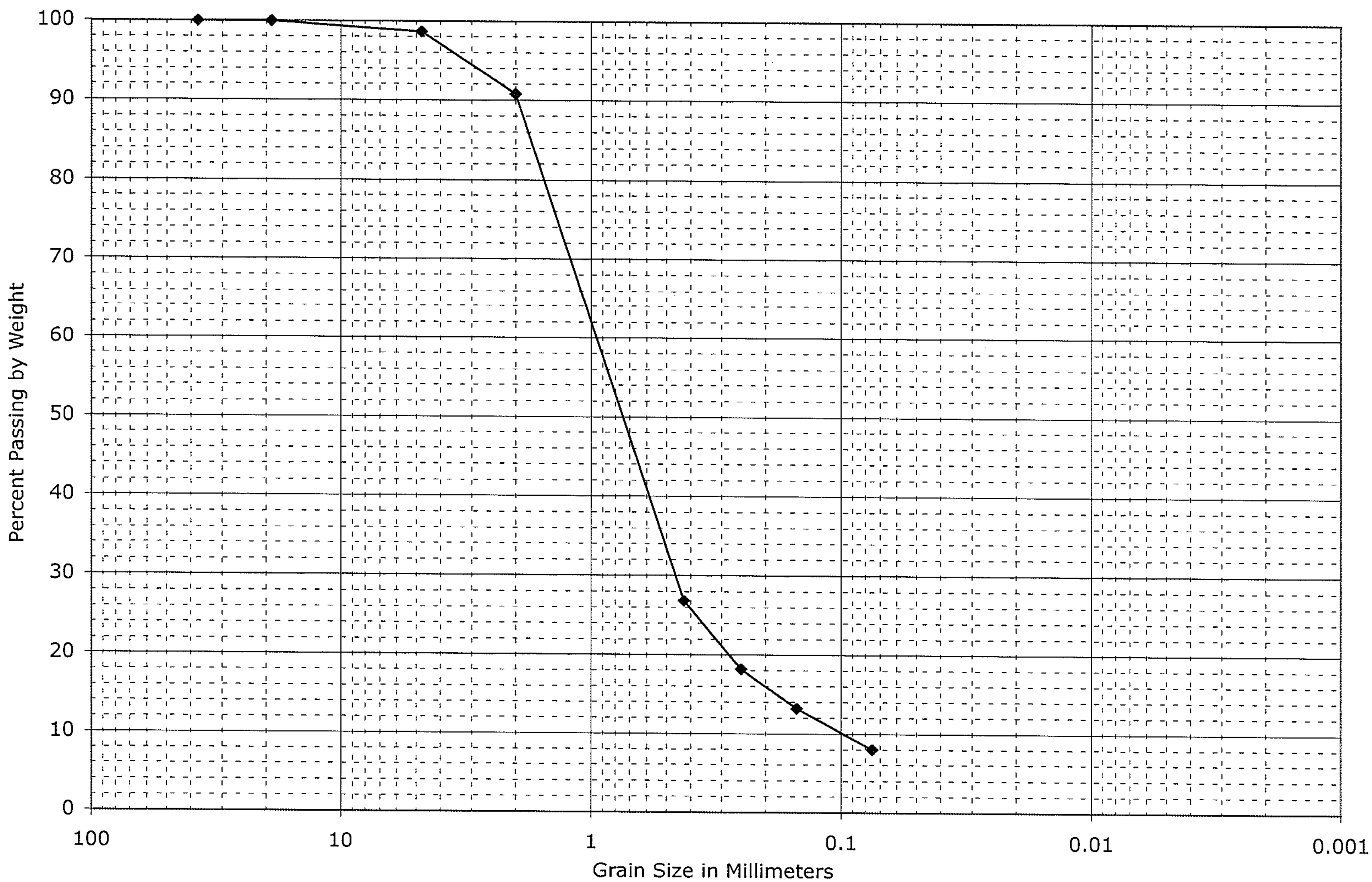
Figure: A1.12
MFA Job No.: 062-050
Soil Classification Well graded sand w/ silt & gravel
UCSC: SW-SM



MASA FUJIOKA & ASSOCIATES

Grain Size Analysis

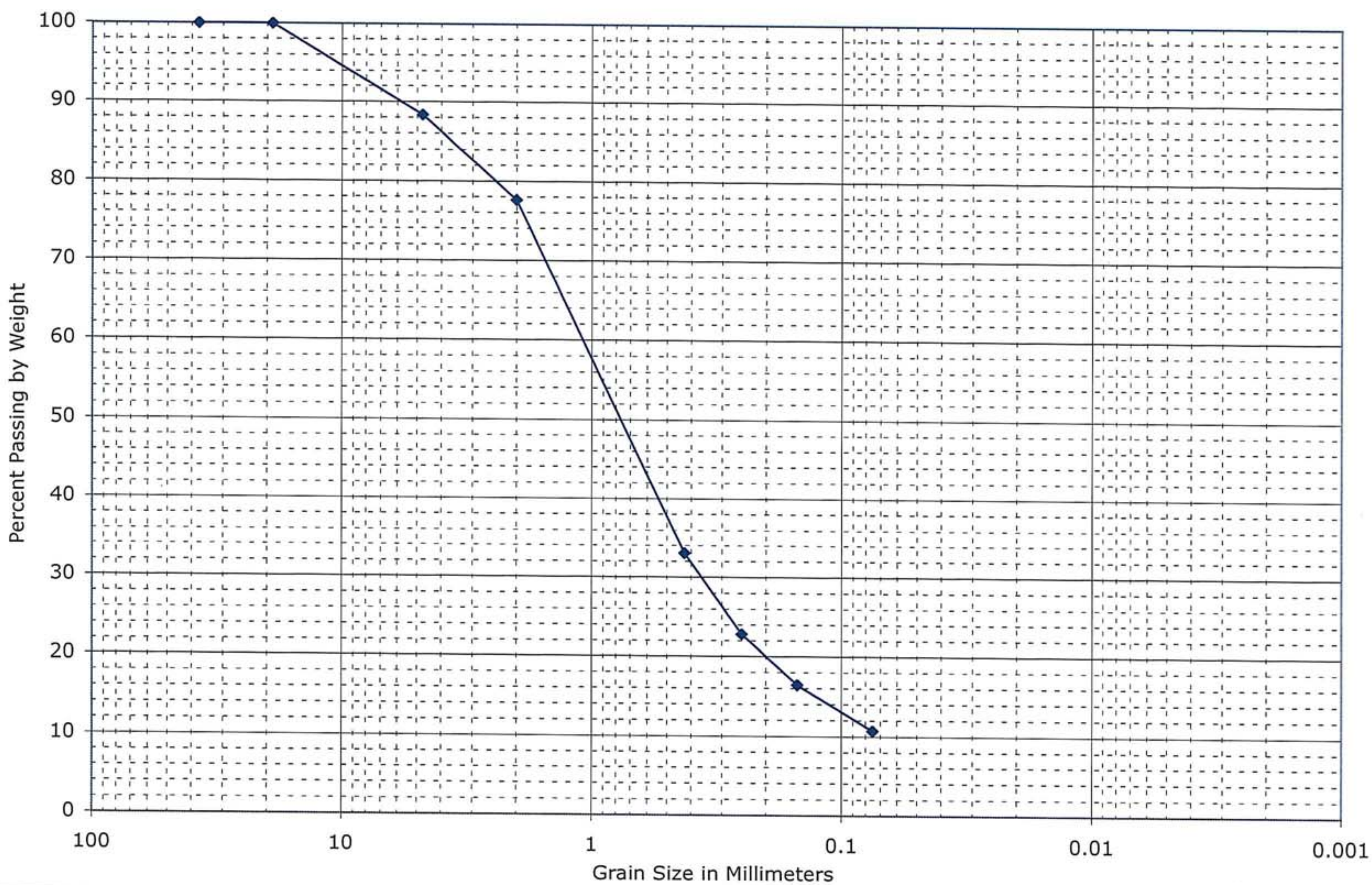
Project:	Board of Water Supply	Date Received:	9/18/12	Figure:	A1.13
Sample:	B5-3	Date Performed:	9/24/12	MFA Job No.:	062-050
Depth:	5'	Date Reported:	10/3/12	Soil Classification	Well graded sand w/ silt
Location:	Honolulu	Client:	Architects Hawaii	UCSC:	SW-SM



MASA FUJIOKA & ASSOCIATES

Grain Size Analysis

Project:	Board of Water Supply	Date Received:	9/18/12	Figure:	A1.14
Sample:	B6-bulk	Date Performed:	9/24/12	MFA Job No.:	062-050
Depth:	1'	Date Reported:	10/3/12	Soil Classification	Well graded sand w/ silt
Location:	Honolulu	Client:	Architects Hawaii	UCSC:	SW-SM



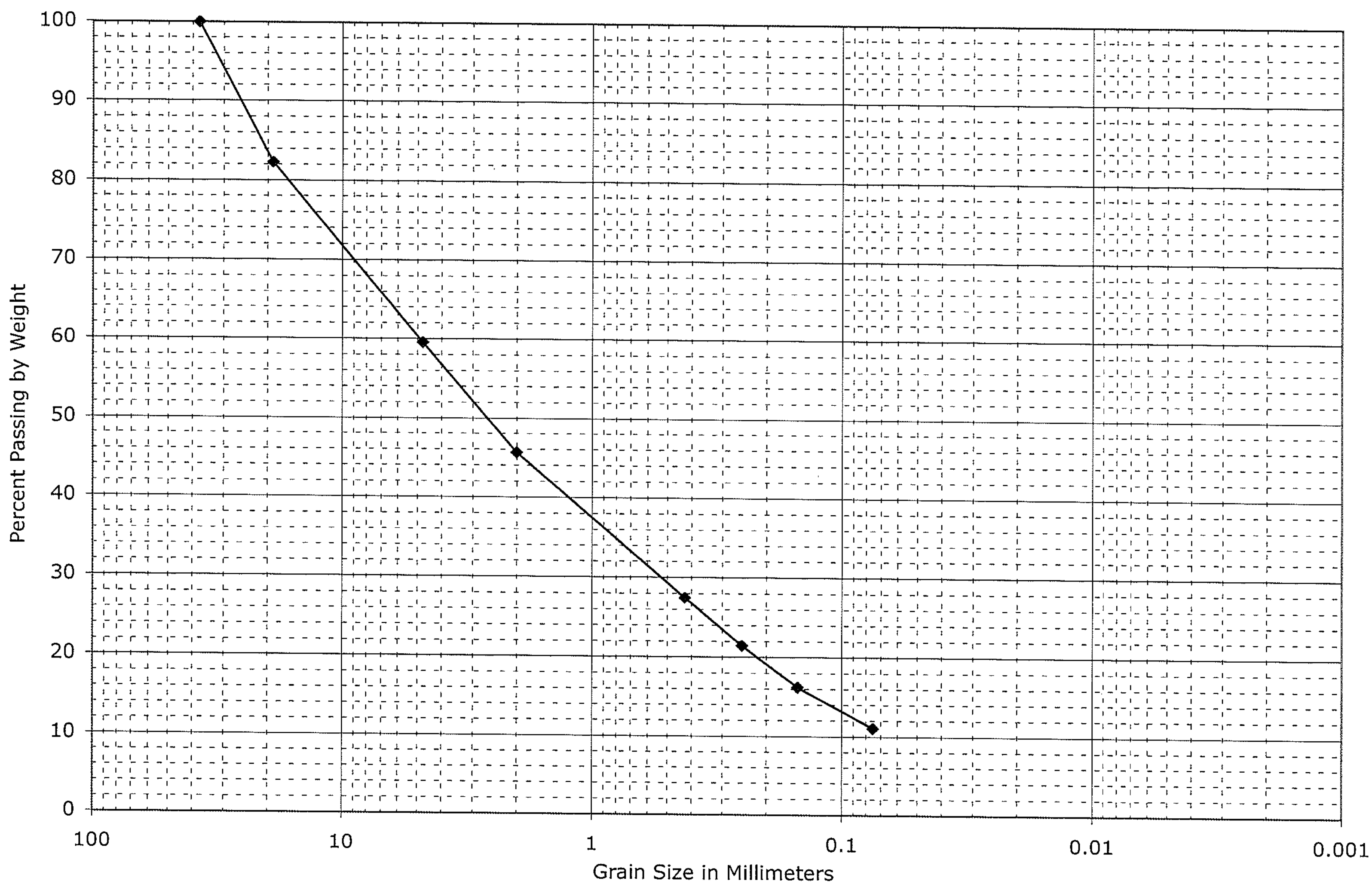
MASA FUJIOKA & ASSOCIATES

Grain Size Analysis

Project: Board of Water Supply
Sample: B6-2
Depth: 2.5'
Location: Honolulu

Date Received: 9/18/12
Date Performed: 9/24/12
Date Reported: 10/3/12
Client: Architects Hawaii

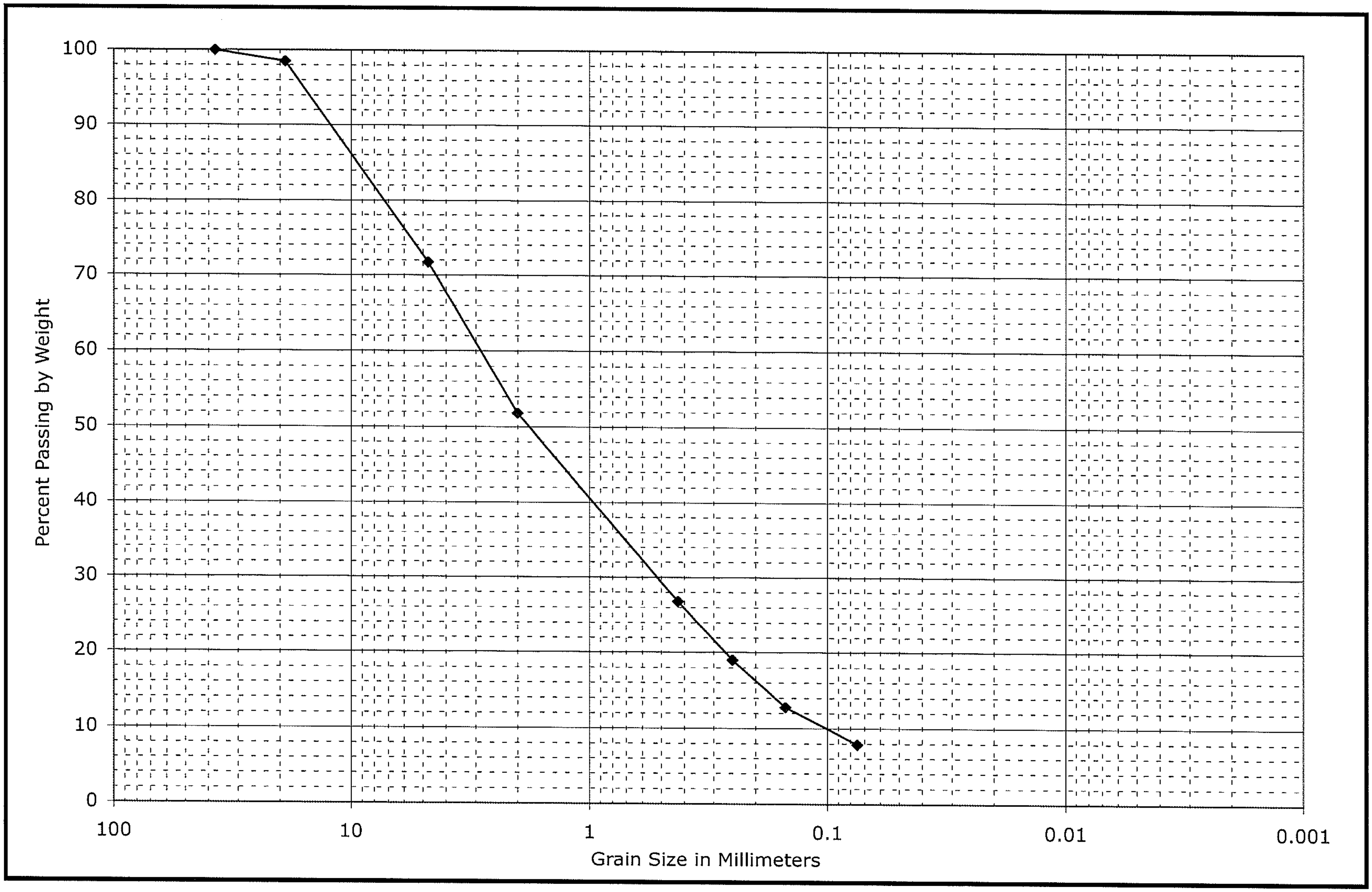
Figure: A1.15
MFA Job No.: 062-050
Soil Classification Poorly graded sand w/ silt & gravel
UCSC: SP-SM



MASA FUJIOKA & ASSOCIATES

Grain Size Analysis

Project:	Board of Water Supply	Date Received:	9/18/12	Figure:	A1.16
Sample:	B7-bulk	Date Performed:	9/24/12	MFA Job No.:	062-050
Depth:	1'	Date Reported:	10/3/12	Soil Classification	Poorly graded sand w/ silt & gravel
Location:	Honolulu	Client:	Architects Hawaii	UCSC:	SP-SM



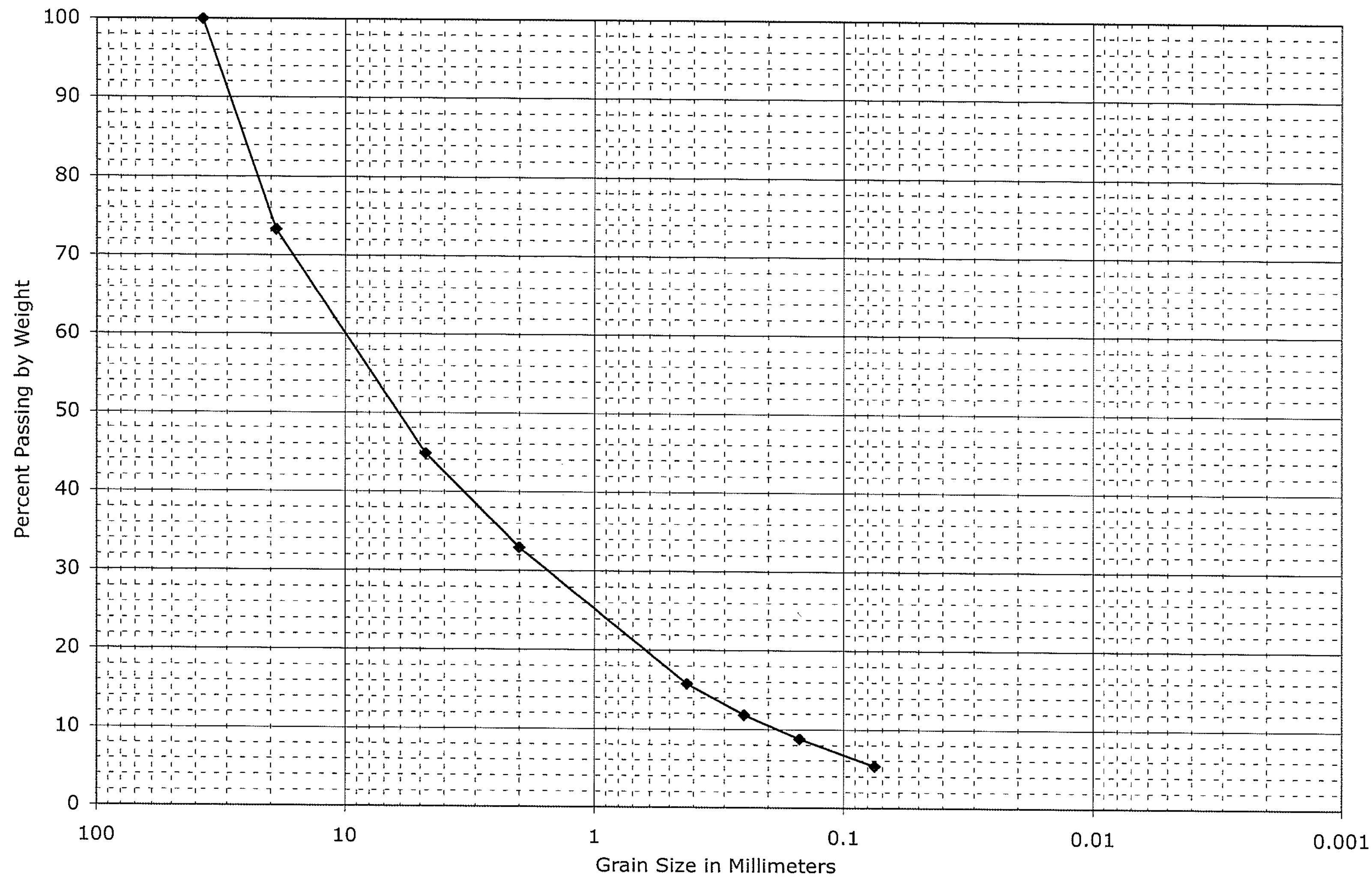
MASA FUJIOKA & ASSOCIATES

Grain Size Analysis

Project: Board of Water Supply
Sample: B7-1
Depth: 1'
Location: Honolulu

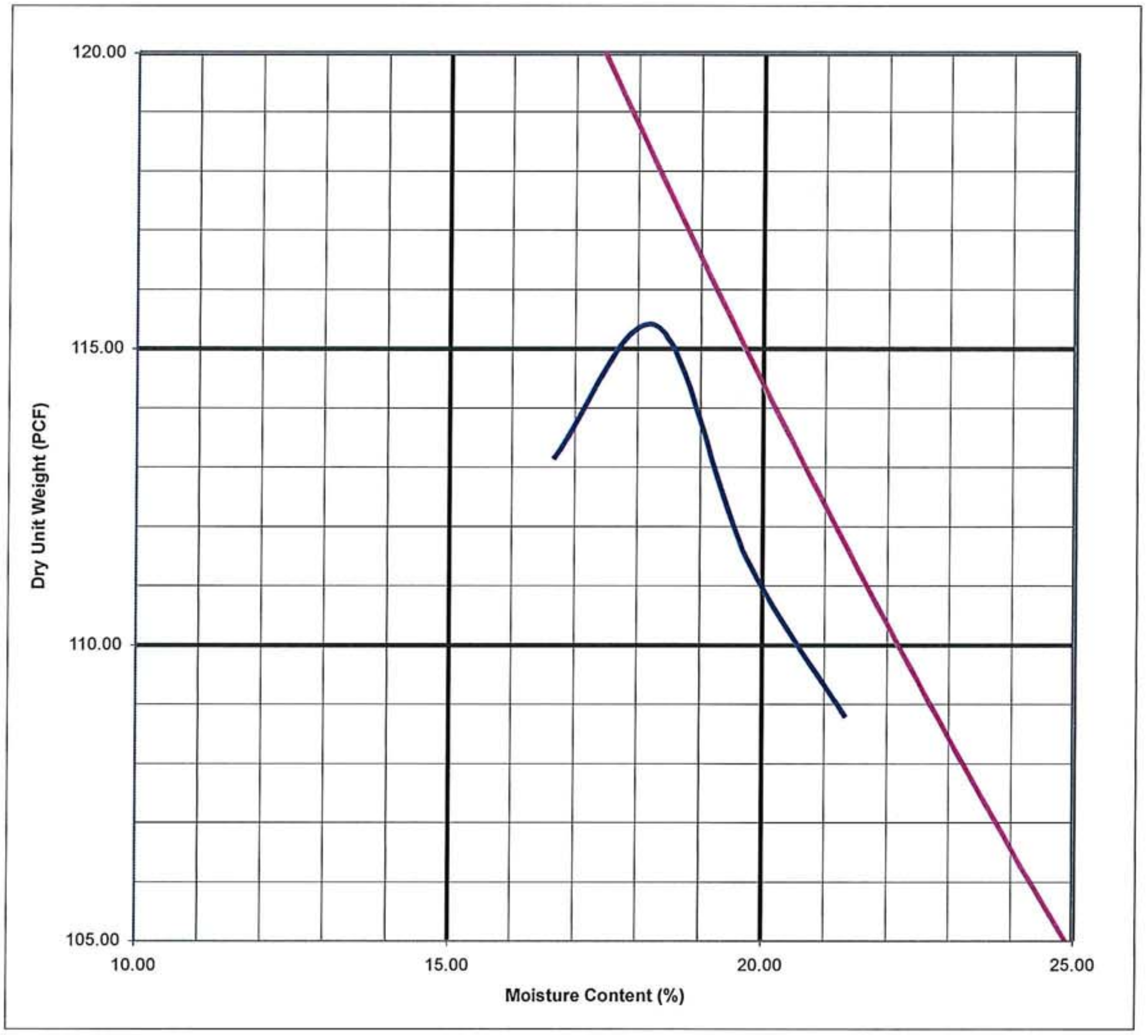
Date Received: 9/18/12
Date Performed: 9/24/12
Date Reported: 10/3/12
Client: Architects Hawaii

Figure: A1.17
MFA Job No.: 062-050
Soil Classification Well graded gravel w/ silt & sand
UCSC: GW-GM



MASA FUJIOKA & ASSOCIATES

Project:	Board of Water Supply	Figure:	A2.1
Location:	Honolulu	Method Used:	A
Soil:	Olive silty sand	Preparation Method:	Dry
Sample:	B1	Rammer:	Mechanical
Depth:	1'	Date Received:	9/20/12
Job No.:	12062-050	Date Tested:	9/25/12
Client:	Architects Hawaii	Date Reported:	10/3/12



Specific Gravity:

Method of Compaction: Modified (ASTM D1557)

Test Results:

Optimum Moisture Content = 18.2 %

Maximum Dry Density = 115.3 PCF

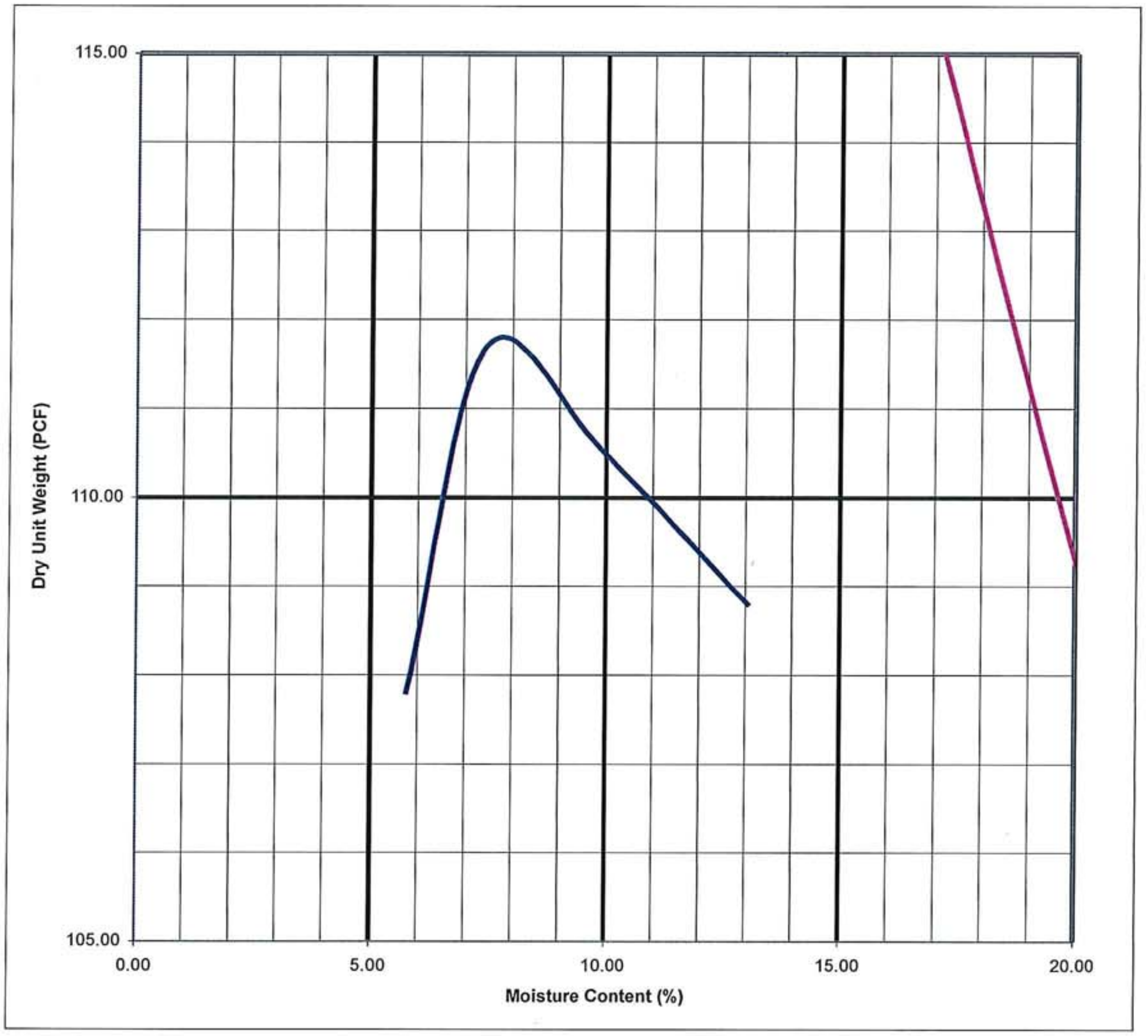
Total wt.	40.8
retained 3/4	0.0%
retained 3/8	1.1%
retained #4	15.1%
passing #4	83.8%

Masa Fujioka & Associates

98-021 Kamehameha Hwy. #337

Aiea, HI 96701

Project:	Board of Water Supply	Figure:	A2.2
Location:	Honolulu	Method Used:	A
Soil:	Blk silty sand	Preparation Method:	Dry
Sample:	B2	Rammer:	Mechanical
Depth:	1'	Date Received:	9/20/12
Job No.:	12062-050	Date Tested:	9/25/12
Client:	Architects Hawaii	Date Reported:	10/3/12



Specific Gravity:

Method of Compaction: Modified (ASTM D1557)

Test Results:

Optimum Moisture Content = 7.5 %

Maximum Dry Density = 111.7 PCF

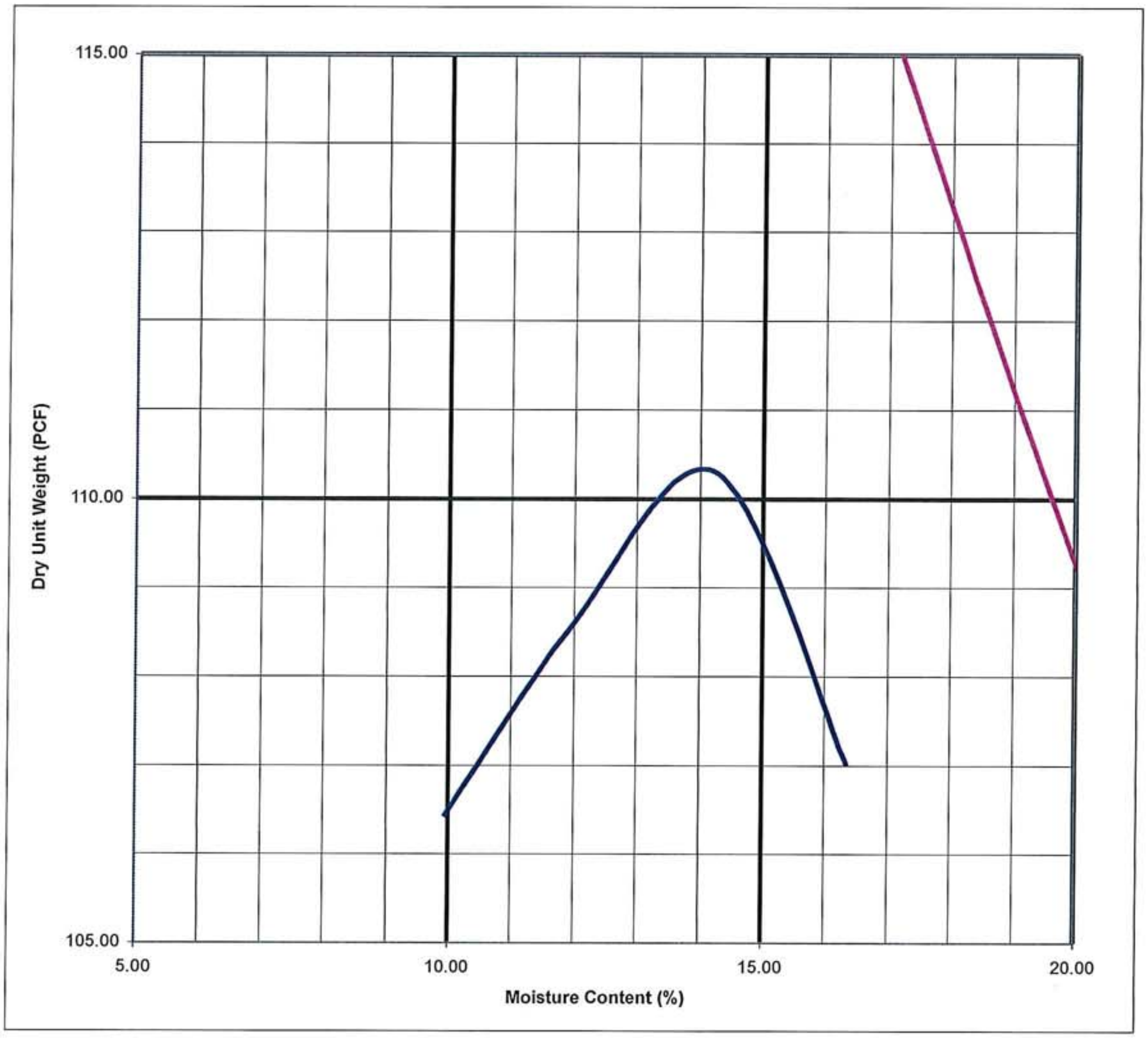
Total wt.	43.3
retained 3/4	0.0%
retained 3/8	2.2%
retained #4	4.3%
passing #4	93.5%

Masa Fujioka & Associates

98-021 Kamehameha Hwy. #337

Aiea, HI 96701

Project:	Board of Water Supply	Figure:	A2.3
Location:	Honolulu	Method Used:	A
Soil:	Blk silty sand	Preparation Method:	Dry
Sample:	B3	Rammer:	Mechanical
Depth:	1'	Date Received:	9/20/12
Job No.:	12062-050	Date Tested:	9/25/12
Client:	Architects Hawaii	Date Reported:	10/3/12



Specific Gravity:

Method of Compaction: Modified (ASTM D1557)

Test Results:

Optimum Moisture Content = 14 %

Maximum Dry Density = 110.3 PCF

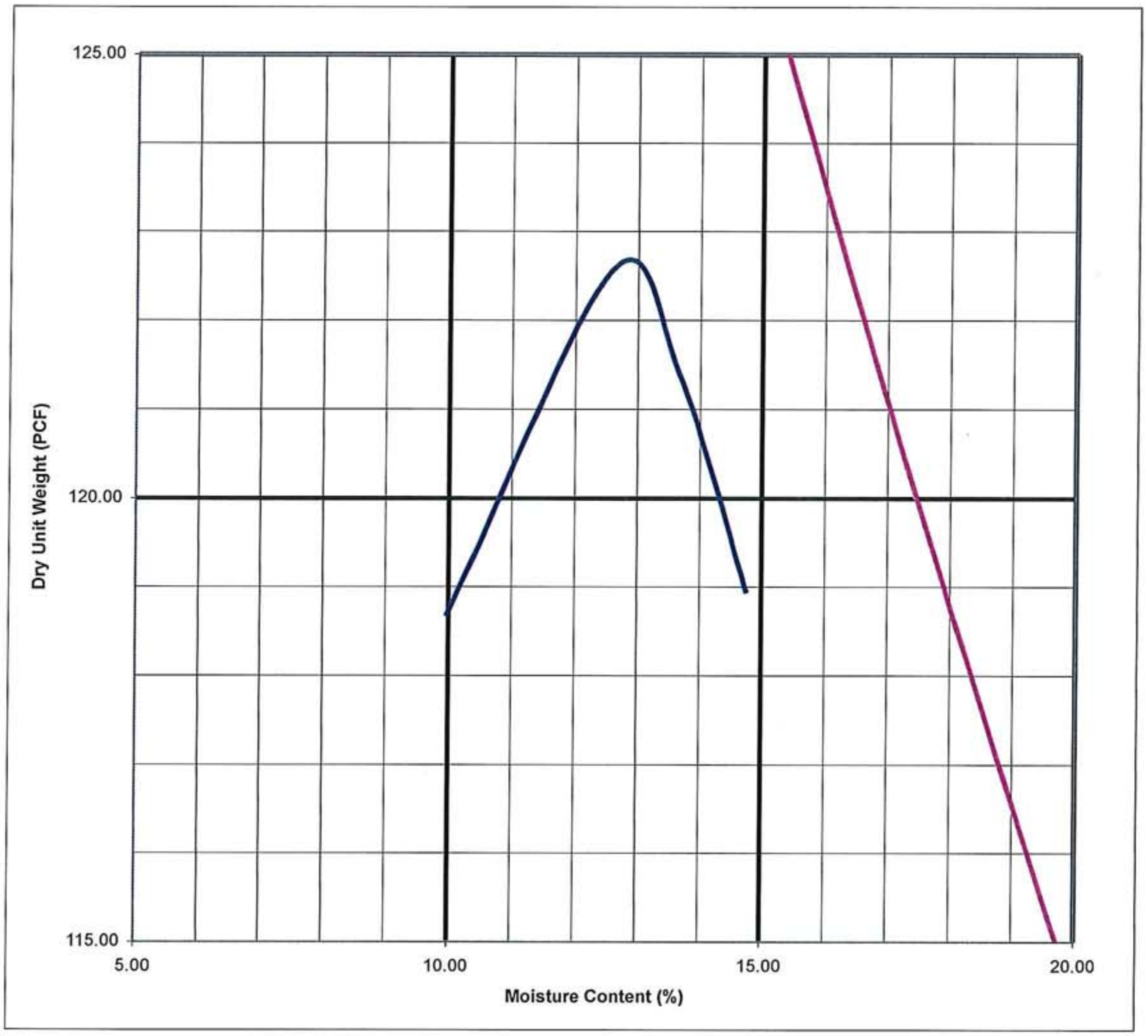
Total wt.	51.1
retained 3/4	0.0%
retained 3/8	1.1%
retained #4	1.9%
passing #4	97.1%

Masa Fujioka & Associates

98-021 Kamehameha Hwy. #337

Aiea, HI 96701

Project:	Board of Water Supply	Figure:	A2.4
Location:	Honolulu	Method Used:	A
Soil:	Blk-olive silty sand	Preparation Method:	Dry
Sample:	B4	Rammer:	Mechanical
Depth:	1'	Date Received:	9/20/12
Job No.:	12062-050	Date Tested:	9/25/12
Client:	Architects Hawaii	Date Reported:	10/3/12



Specific Gravity:

Method of Compaction: Modified (ASTM D1557)

Test Results:

Optimum Moisture Content = 13 %

Maximum Dry Density = 122.7 PCF

Total wt.	36.45
retained 3/4	4.5%
retained 3/8	4.5%
retained #4	7.0%
passing #4	84.0%

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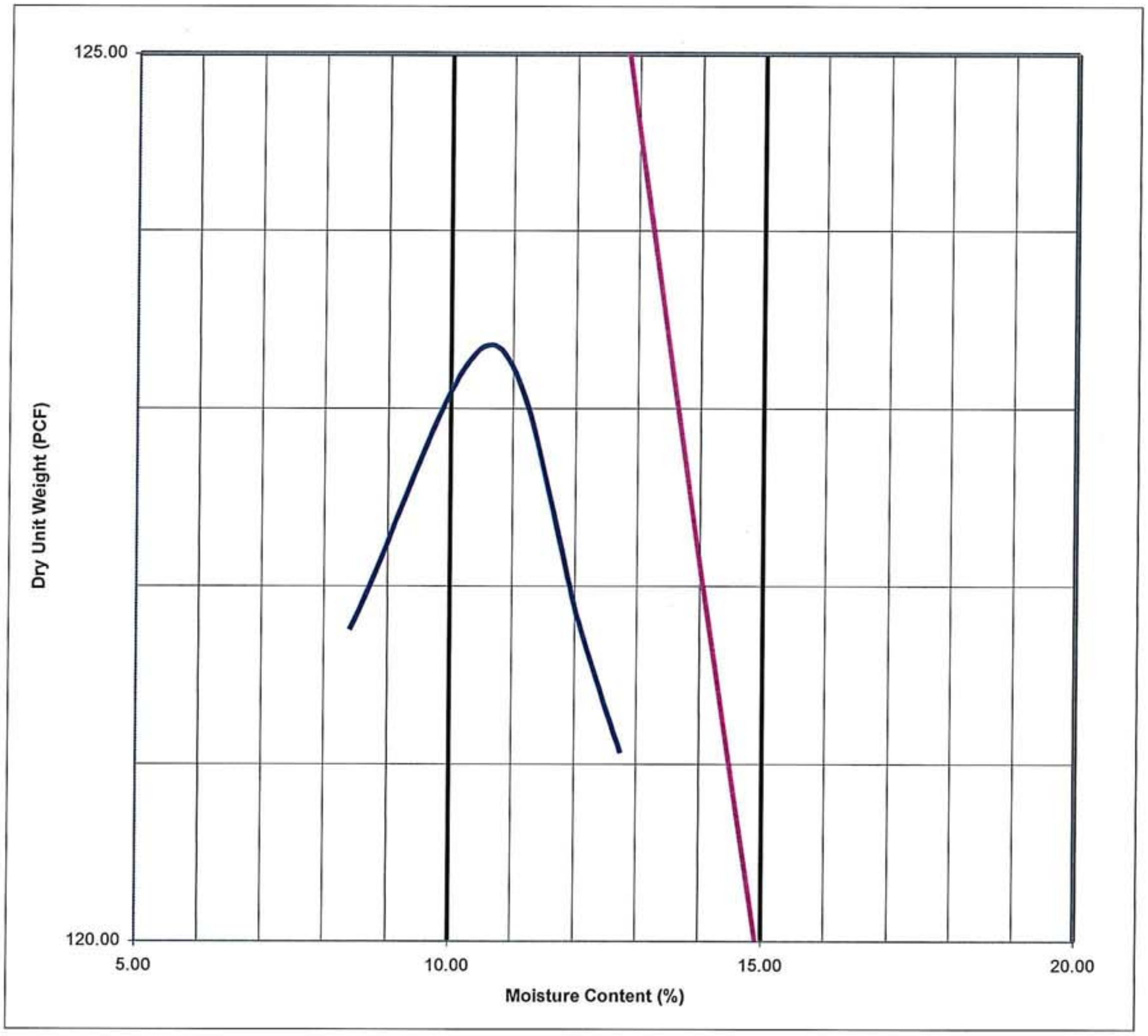
98-021 Kamehameha Hwy. #337

Aiea, HI 96701

Project:	Board of Water Supply	Figure:	A2.5
Location:	Honolulu	Method Used:	B
Soil:	Olive silty sand w/ gravel	Preparation Method:	Dry
Sample:	B5	Rammer:	Mechanical
Depth:	1'	Date Received:	9/20/12
Job No.:	12062-050	Date Tested:	9/25/12
Client:	Architects Hawaii	Date Reported:	10/3/12



Specific Gravity:

Method of Compaction: Modified (ASTM D1557)

Test Results:

Optimum Moisture Content = 10.5 %

Maximum Dry Density = 123.3 PCF

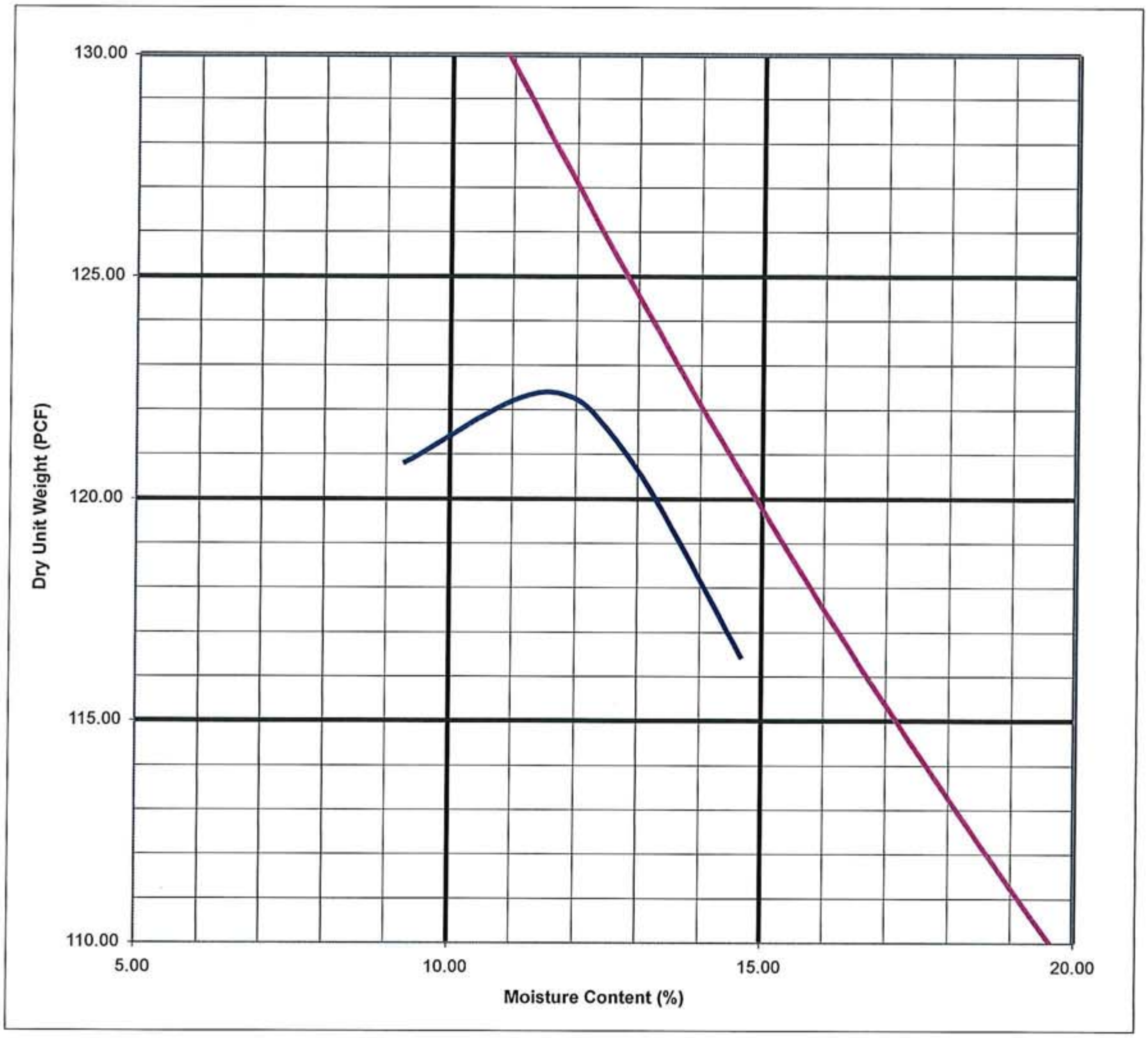
Total wt.	23.6
retained 3/4	3.4%
retained 3/8	6.8%
retained #4	23.1%
passing #4	66.7%

Masa Fujioka & Associates

98-021 Kamehameha Hwy. #337

Aiea, HI 96701

Project:	Board of Water Supply	Figure:	A2.6
Location:	Honolulu	Method Used:	A
Soil:	Olive silty sand	Preparation Method:	Dry
Sample:	B6	Rammer:	Mechanical
Depth:	1'	Date Received:	9/20/12
Job No.:	12062-050	Date Tested:	9/25/12
Client:	Architects Hawaii	Date Reported:	10/3/12



Specific Gravity:

Method of Compaction: Modified (ASTM D1557)

Test Results:

Optimum Moisture Content = 11.5 %

Maximum Dry Density = 122.5 PCF

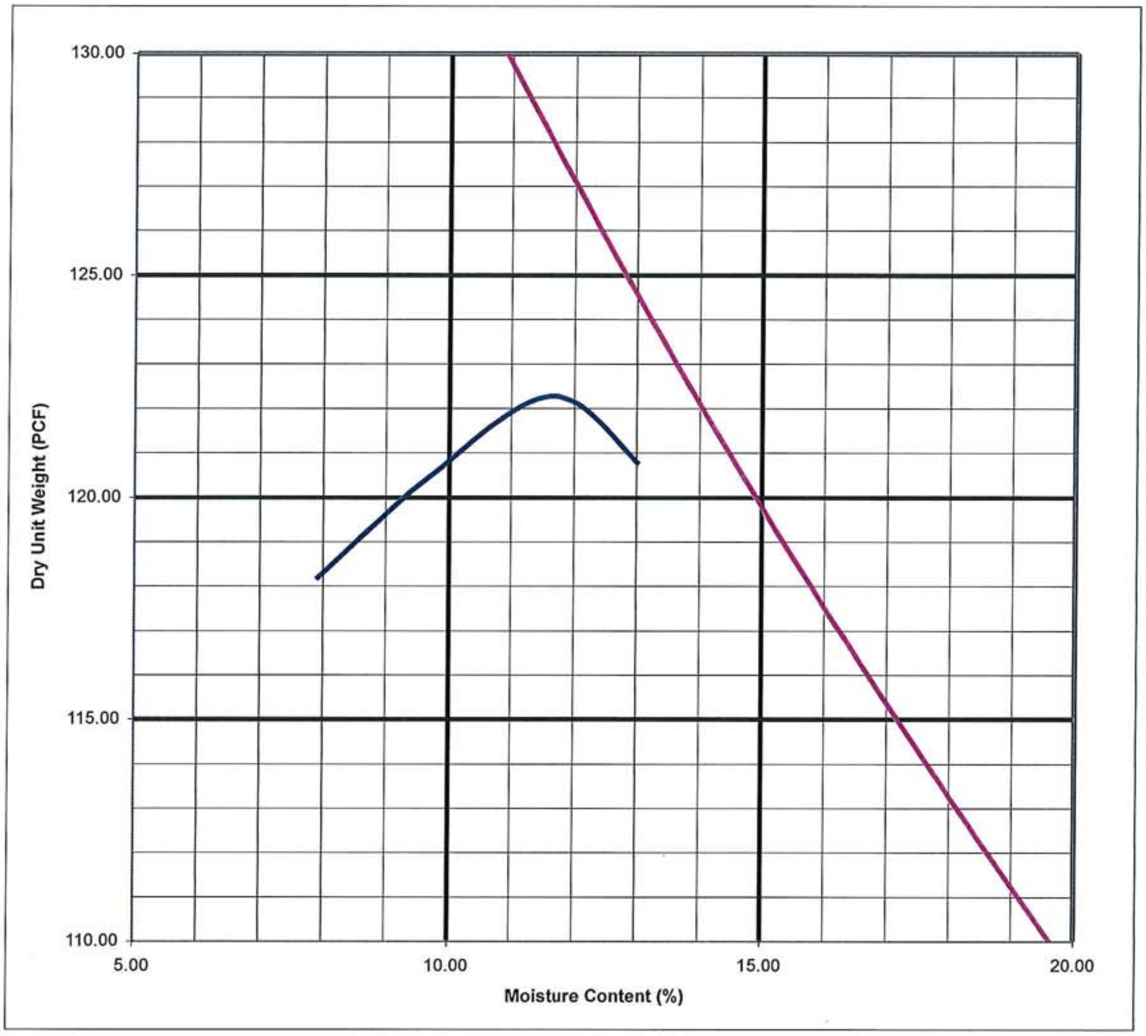
Total wt.	23.6
retained 3/4	3.4%
retained 3/8	6.8%
retained #4	23.1%
passing #4	66.7%

Masa Fujioka & Associates

98-021 Kamehameha Hwy. #337

Aiea, HI 96701

Project:	Board of Water Supply	Figure:	A2.7
Location:	Honolulu	Method Used:	A
Soil:	Olive silty sand w/ gravel	Preparation Method:	Dry
Sample:	B7	Rammer:	Mechanical
Depth:	1'	Date Received:	9/20/12
Job No.:	12062-050	Date Tested:	9/25/12
Client:	Architects Hawaii	Date Reported:	10/3/12



Specific Gravity:

Method of Compaction: Modified (ASTM D1557)

Test Results:

Optimum Moisture Content = 11.5 %

Maximum Dry Density = 122.5 PCF

Total wt.	36.55
retained 3/4	4.5%
retained 3/8	12.0%
retained #4	19.7%
passing #4	63.7%

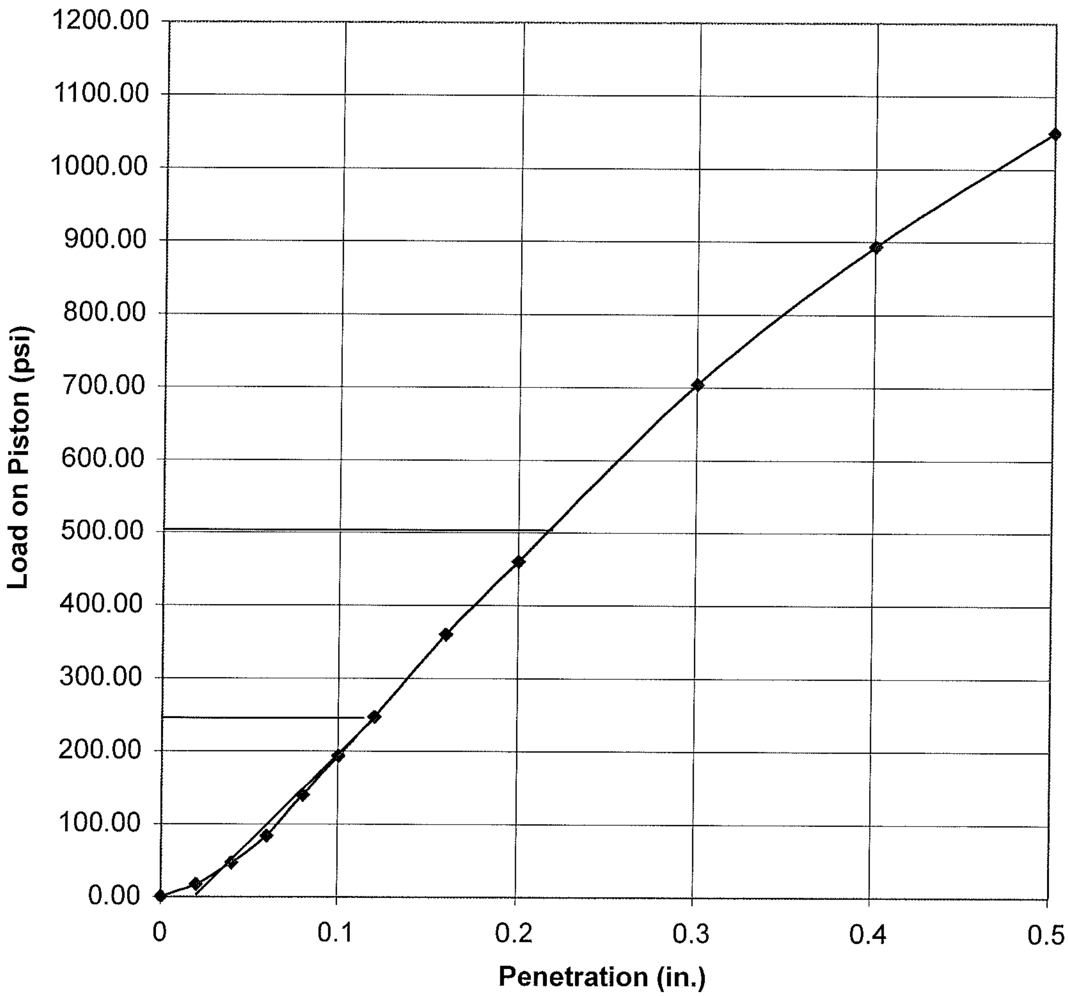
Masa Fujioka & Associates

98-021 Kamehameha Hwy. #337

Aiea, HI 96701

Project: Board of Water Supply
Job No.: 062-050
Location: Honolulu
Soil: Olive silty sand
Sample: B1-bulk Depth: 1'

Method: ASTM 1557
Surcharge: 12.5 lbs
Condition of Sample: Soaked
Client: Architects Hawaii
Figure: A3.1



CBR at 0.1 =	25 %
at 0.2 =	33 %
LINEAR EXPANSION:	0.26 %
Dry Unit wt. before soaking:	113.4 PCF
Dry Unit wt. after soaking:	112.6 PCF
H2O before soaking:	20.0 %
H2O after soaking:	22.0 %
H2O top 1":	23.3 %

CBR 1883 Test Result

Date Reveived:	9/18/12
Date Tested:	9/27/12
Date Reported:	10/3/12

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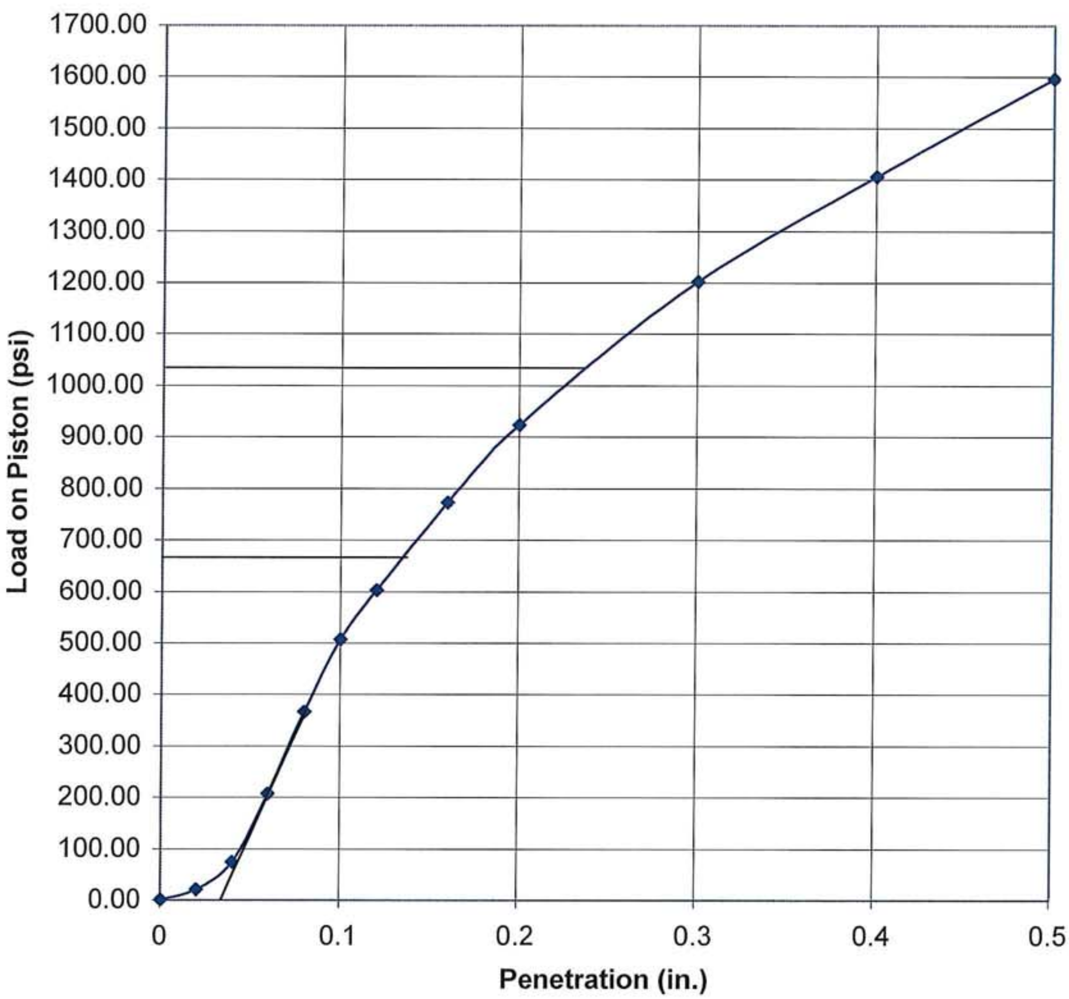
98-021 Kamehameha Hwy. #337

Aiea, HI 96701

Project:	Board of Water Supply		Method: ASTM 1557
Job No.:	062-050		Surcharge: 12.5 lbs
Location:	Honolulu		Condition of Sample: Soaked
Soil:	Blk silty sand		Client: Architects Hawaii
Sample:	B2-bulk	Depth: 1'	Figure: A3.2



CBR at 0.1 =	66 %	CBR 1883 Test Result	
at 0.2 =	96 %	Date Reveived:	9/18/12
LINEAR EXPANSION:	0.00 %	Date Tested:	9/27/12
Dry Unit wt. before soaking:	111.4 PCF	Date Reported:	10/3/12
Dry Unit wt. after soaking:	107.0 PCF		
H2O before soaking:	7.7 %		
H2O after soaking:	17.2 %		
H2O top 1":	17.2 %		

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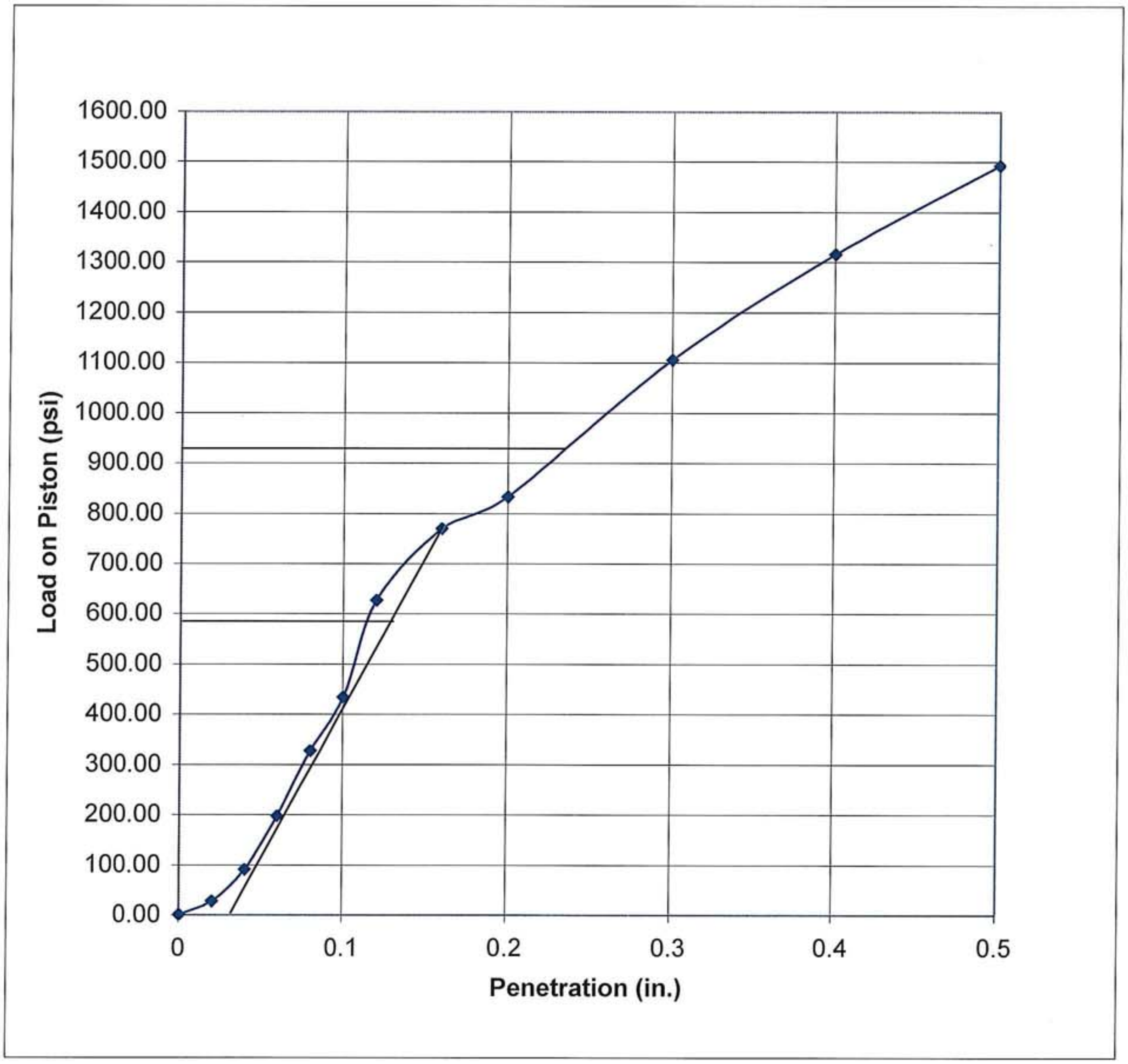
98-021 Kamehameha Hwy. #337

Aiea, HI 96701

Project: Board of Water Supply
Job No.: 062-050
Location: Honolulu
Soil: Blk silty sand
Sample: B3-bulk Depth: 1'

Method: ASTM 1557
Surcharge: 12.5 lbs
Condition of Sample: Soaked
Client: Architects Hawaii
Figure: A3.3



CBR at 0.1 =	59 %
at 0.2 =	61 %
LINEAR EXPANSION:	0.00 %
Dry Unit wt. before soaking:	108.9 PCF
Dry Unit wt. after soaking:	108.3 PCF
H2O before soaking:	14.5 %
H2O after soaking:	21.2 %
H2O top 1":	20.4 %

CBR 1883 Test Result

Date Reveived:	9/18/12
Date Tested:	9/27/12
Date Reported:	10/3/12

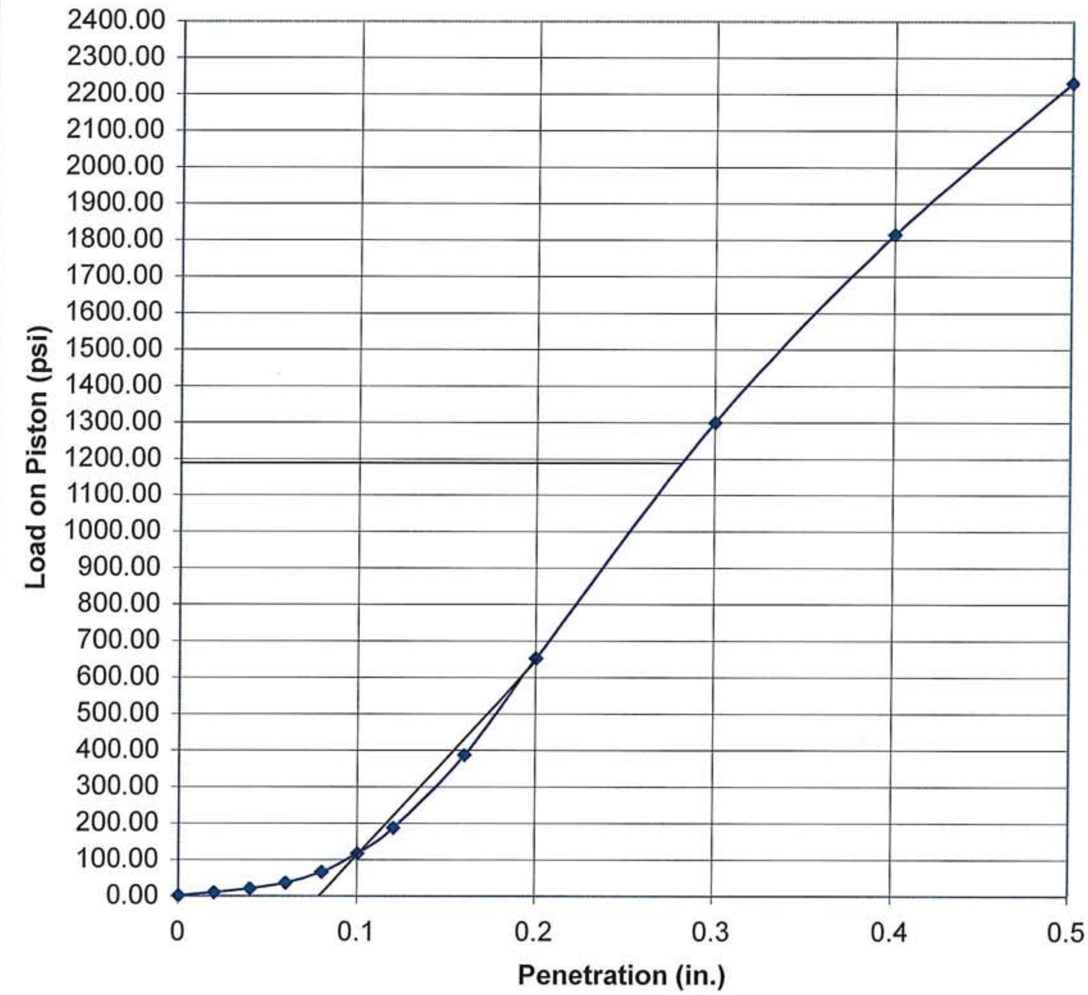
MASA FUJIOKA & ASSOCIATES

98-021 Kamehameha Hwy. #337

Aiea, HI 96701

Project: Board of Water Supply
Job No.: 062-050
Location: Honolulu
Soil: Blk-olive silty sand
Sample: B4-bulk   Depth: 1'

Method: ASTM 1557
Surcharge: 12.5 lbs
Condition of Sample: Soaked
Client: Architects Hawaii
Figure: A3.4



CBR at 0.1 = 119 %
at 0.2 = 113 %
LINEAR EXPANSION: 0.00 %
Dry Unit wt. before soaking: 122.3 PCF
Dry Unit wt. after soaking: 122.4 PCF
H2O before soaking: 13.4 %
H2O after soaking: 15.5 %
H2O top 1": 15.6 %

CBR 1883 Test Result

Date Reveived: 9/18/12
Date Tested: 9/27/12
Date Reported: 10/3/12

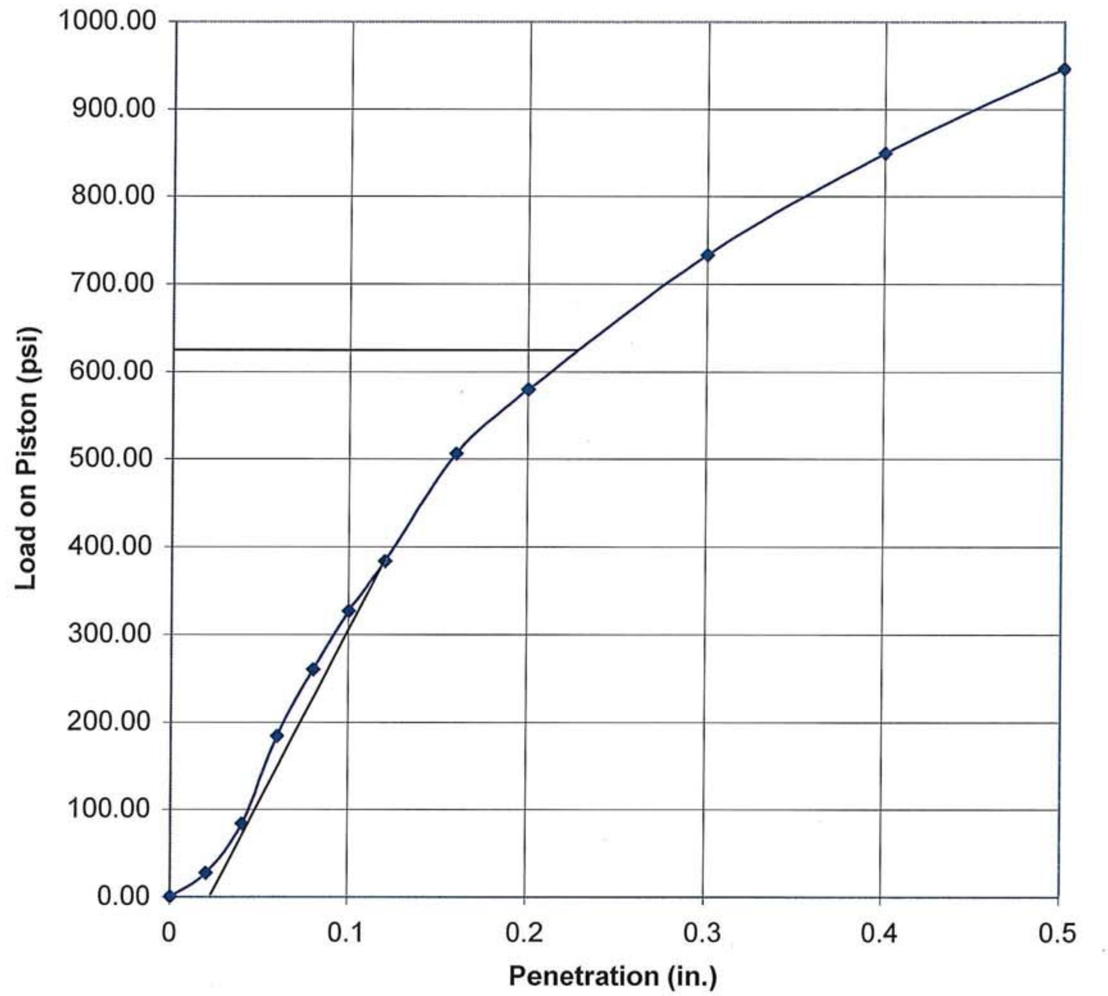
MASA FUJIOKA & ASSOCIATES

98-021 Kamehameha Hwy. #337

Aiea, HI 96701

Project: Board of Water Supply
Job No.: 062-050
Location: Honolulu
Soil: Olive silty sand w/ gravel
Sample: B5-bulk   Depth: 1'

Method: ASTM 1557
Surcharge: 12.5 lbs
Condition of Sample: Soaked
Client: Architects Hawaii
Figure: A3.5



CBR at 0.1 =	40 %
at 0.2 =	42 %
LINEAR EXPANSION:	0.66 %
Dry Unit wt. before soaking:	120.4 PCF
Dry Unit wt. after soaking:	115.8 PCF
H2O before soaking:	10.8 %
H2O after soaking:	17.5 %
H2O top 1":	18.6 %

CBR 1883 Test Result

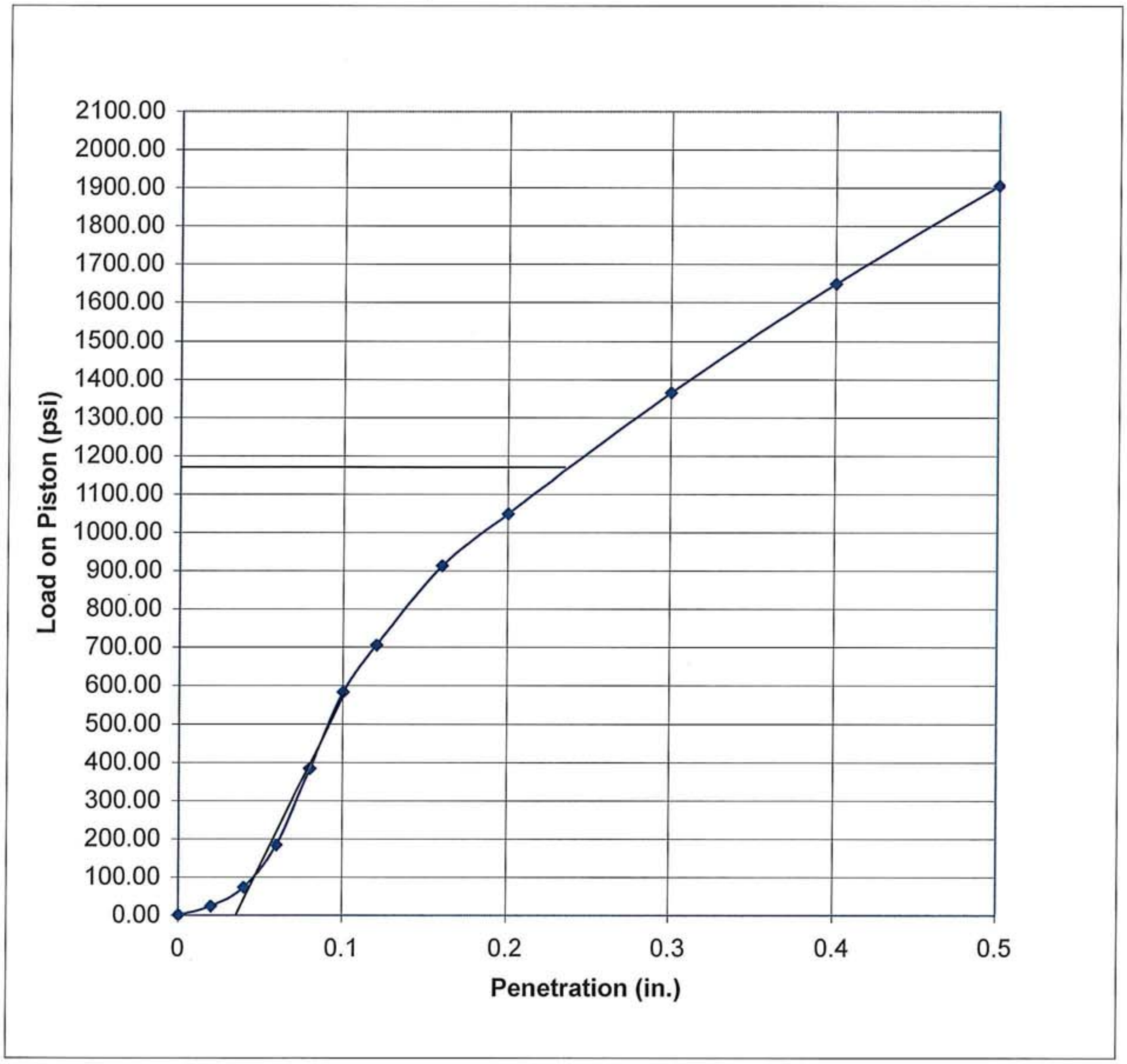
Date Reveived:	9/18/12
Date Tested:	9/27/12
Date Reported:	10/3/12

MASA FUJIOKA & ASSOCIATES

98-021 Kamehameha Hwy. #337

Aiea, HI 96701

Project:	Board of Water Supply		Method: ASTM 1557
Job No.:	062-050		Surcharge: 12.5 lbs
Location:	Honolulu		Condition of Sample: Soaked
Soil:	Olive silty sand		Client: Architects Hawaii
Sample:	B6-bulk	Depth: 1'	Figure: A3.6



CBR at 0.1 =	80 %
at 0.2 =	78 %
LINEAR EXPANSION:	0.15 %
Dry Unit wt. before soaking:	120.5 PCF
Dry Unit wt. after soaking:	116.6 PCF
H2O before soaking:	11.8 %
H2O after soaking:	17.8 %
H2O top 1":	18.2 %

CBR 1883 Test Result

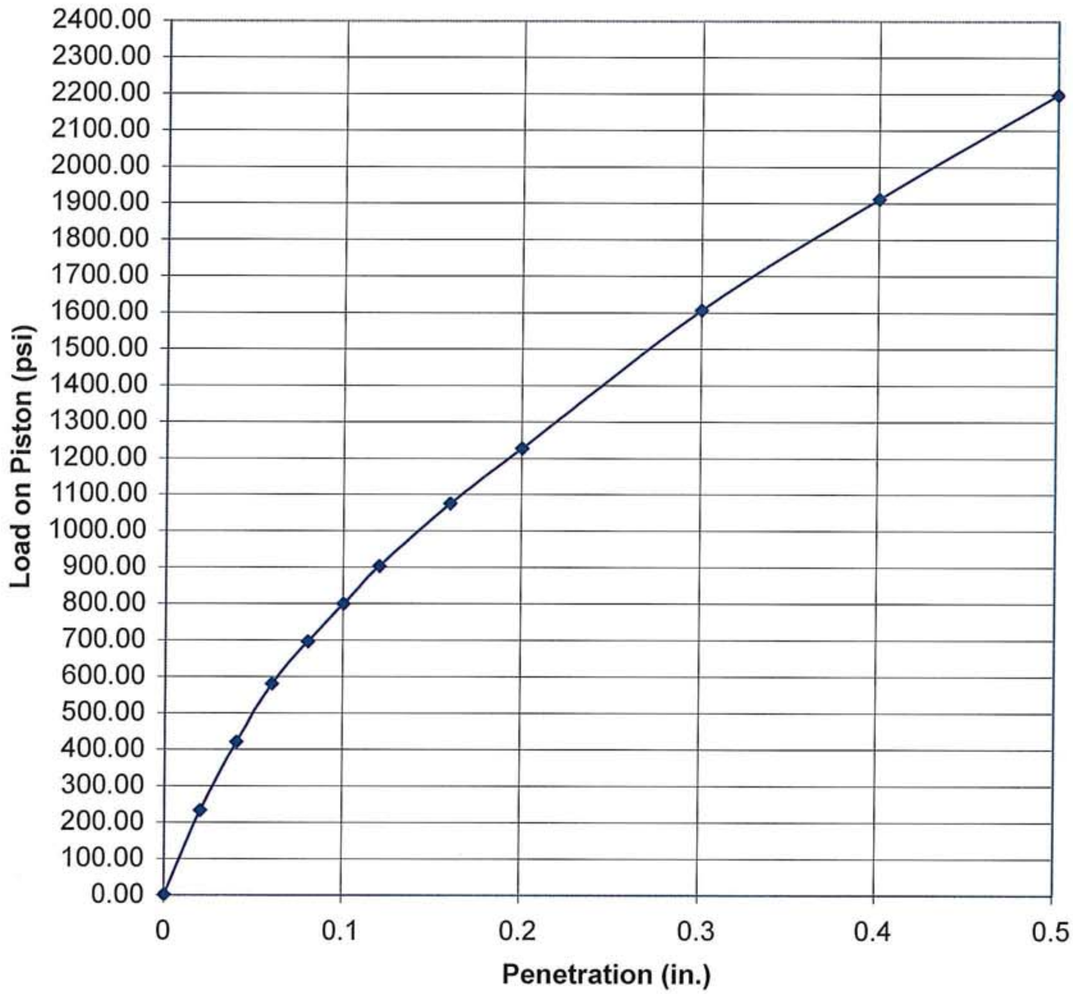
Date Reveived:	9/18/12
Date Tested:	9/27/12
Date Reported:	10/3/12

MASA FUJIOKA & ASSOCIATES

98-021 Kamehameha Hwy. #337

Aiea, HI 96701

Project:	Board of Water Supply	Method: ASTM 1557	
Job No.:	062-050	Surcharge: 12.5 lbs	
Location:	Honolulu	Condition of Sample: Soaked	
Soil:	Olive silty sand w/ gravel	Client: Architects Hawaii	
Sample:	B7-bulk	Depth: 1'	Figure: A3.7



CBR at 0.1 =	80 %
at 0.2 =	82 %
LINEAR EXPANSION:	0.68 %
Dry Unit wt. before soaking:	121.4 PCF
Dry Unit wt. after soaking:	122.2 PCF
H2O before soaking:	11.0 %
H2O after soaking:	14.6 %
H2O top 1":	15.4 %

CBR 1883 Test Result

Date Reveived:	9/18/12
Date Tested:	9/27/12
Date Reported:	10/3/12

MASA FUJIOKA & ASSOCIATES

98-021 Kamehameha Hwy. #337

Aiea, HI 96701

APPENDIX B

PHOTOGRAPHS OF CORES

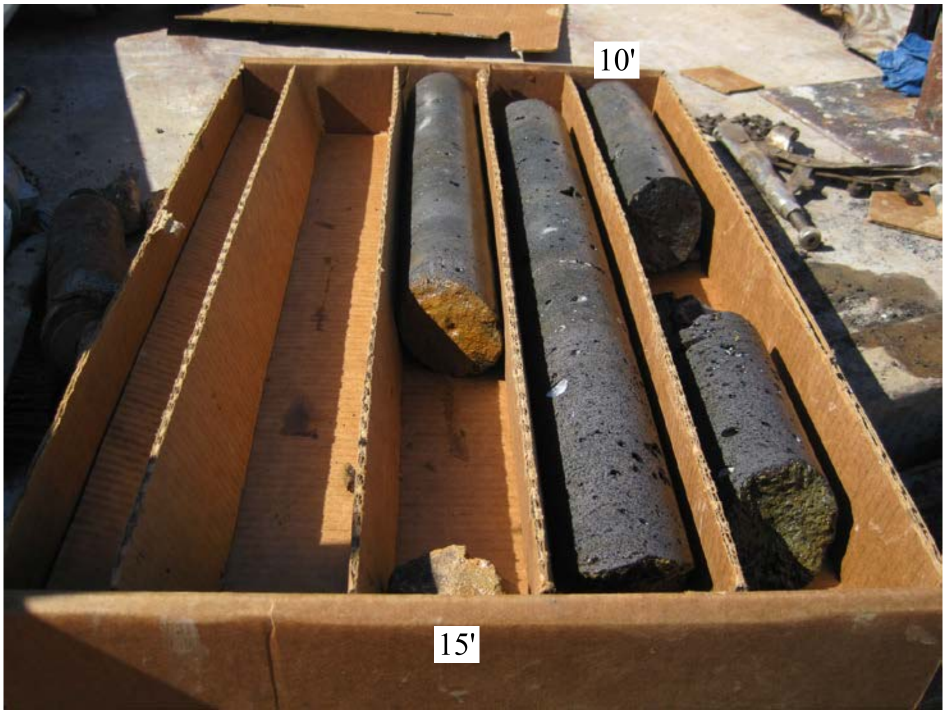


Photo 1
B1
10' - 15'

Photo 2
B1
15' - 20', top view

Photo 3
B1
15' - 20', end view

Photo 4
B2
2.5' - 5' (bottom two rows and right portion of middle row);
5'-10' (beginning at cardboard divider in middle row)

Photo 5
B2
10' - 13' (bottom two rows, beginning at bottom right);
13'- 15' (middle row, beginning at right)

Photo 6
B3
11' - 15' (bottom two rows, beginning at bottom right);
15'- 20' (beginning at right of middle row)

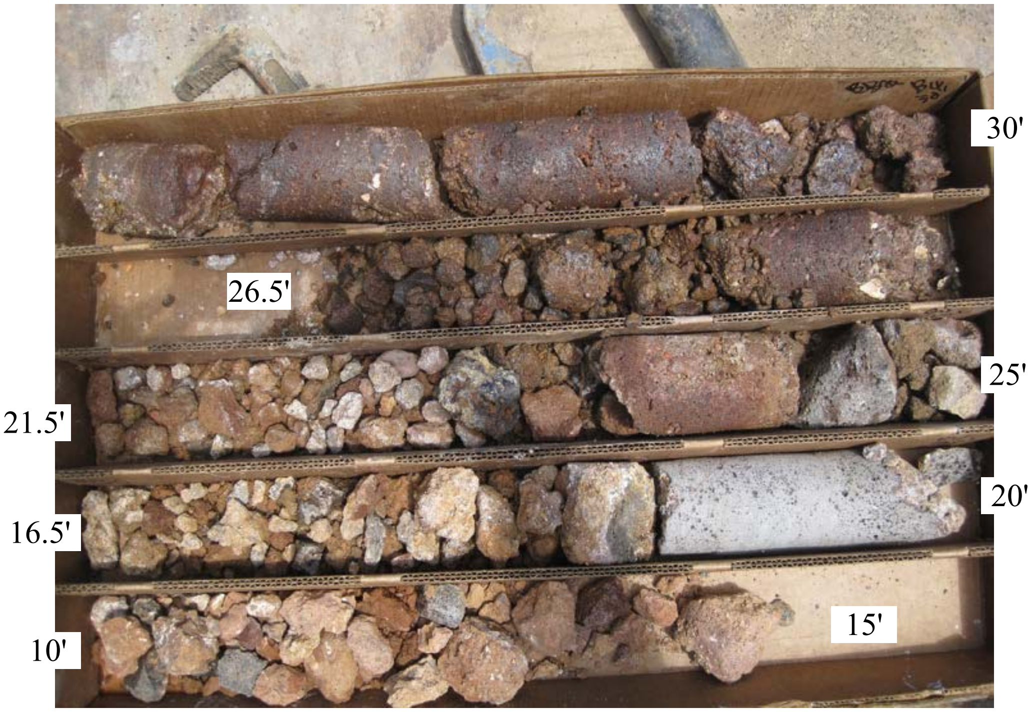


Photo 7
B4
10' - 15' (bottom row, beginning at left);
16.5'- 20' (2nd row from bottom, beginning at left)
21.5'- 25' (middle row, beginning at left);
26.5'- 30' (top two rows, beginning at left)

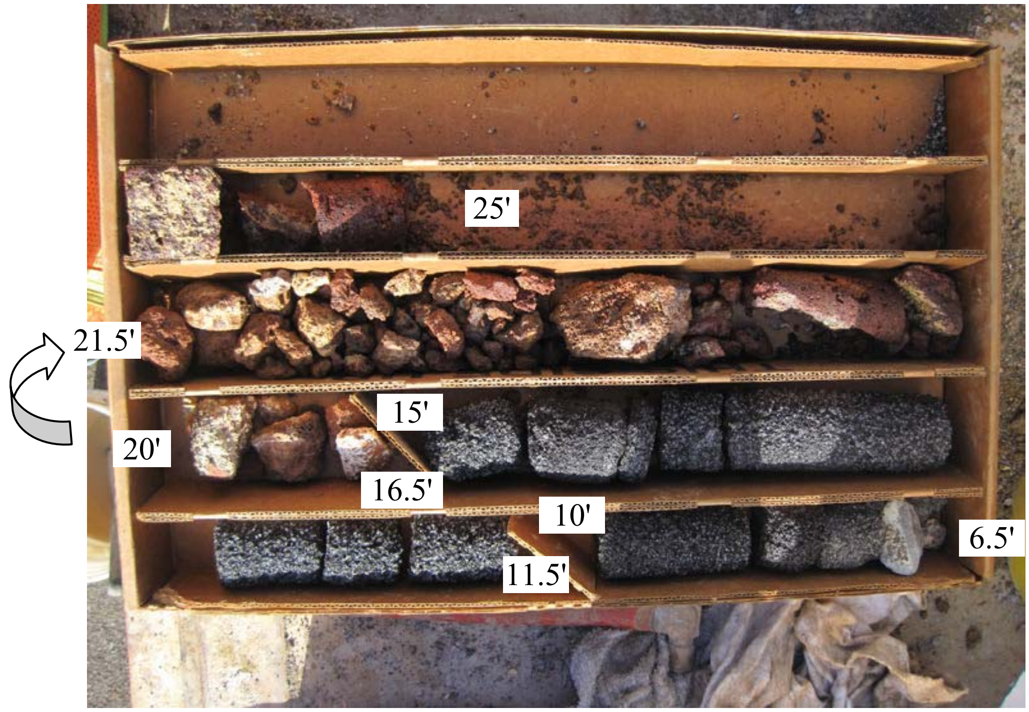


Photo 8
B5
6.5' - 10' (bottom row, beginning at right);
11.5' - 15' (bottom two rows, beginning at middle);
16.5'- 20' (2nd row from bottom, beginning at middle)
21.5'- 25' (middle row, beginning at left and continuing to 2nd row, beginning at left)

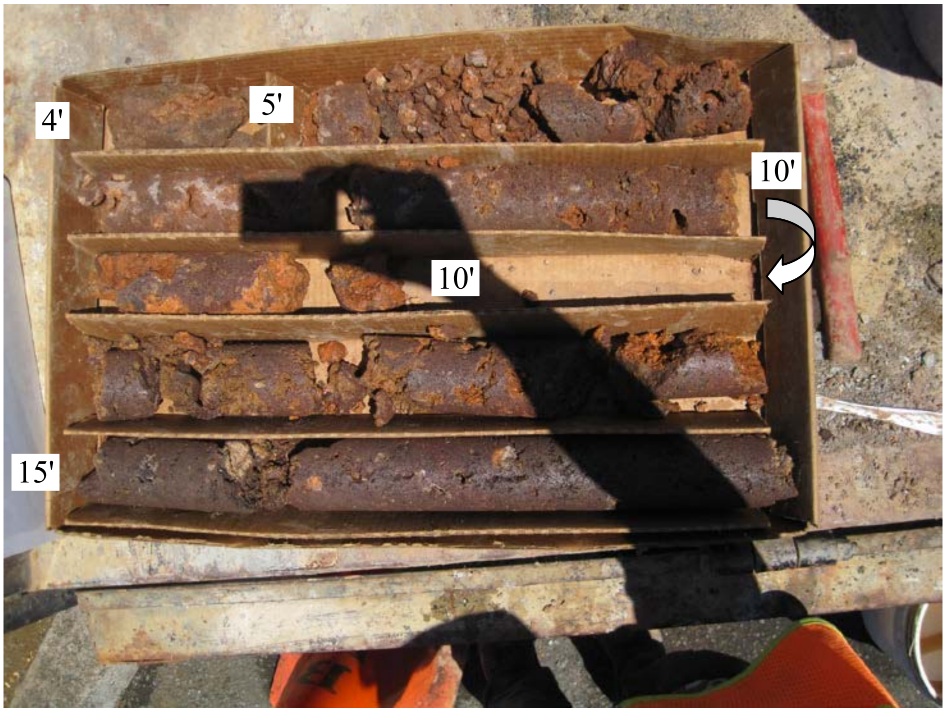


Photo 9
B6
4' - 5' (top row, beginning at left);
5' - 10' (top two rows, beginning at top middle);
10'- 15' (bottom three rows, beginning at middle right)

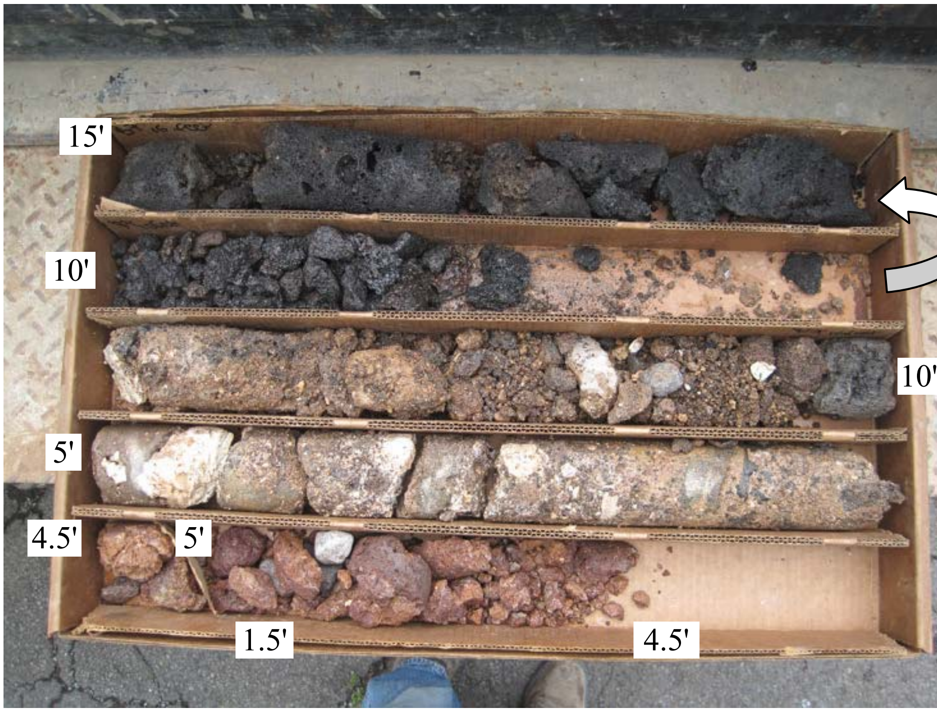


Photo 10
B7
1.5' - 4.5' (bottom row, right);
4.5' - 5' (bottom row, beginning at left);
5' - 10' (two rows, beginning at left);
10'- 15' (top two rows, beginning at 2nd row left)

Photo 11
B7
16.5' - 20' (bottom row, beginning at left);
21.5'- 25' (2nd and middle rows, beginning at 2nd row right)

APPENDIX C

SHEAR WAVE VELOCITY TEST REPORT

AECOM

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October 12, 2012

Masa Fujioka
Managing Partner, Masa Fujioka and Associates
98-021 Kamehameha Highway, Suite 337
Aiea, HI 96701

Report of Shear Wave Velocity Testing and Seismic Site Classification
Honolulu Water Board Property
Honolulu, Hawaii
AECOM Project Number 60276616

Dear Mr. Fujioka,

As authorized, AECOM Technical Services, Incorporated (AECOM) has conducted shear wave velocity testing to evaluate the Seismic Site Class for the Board of Water Supply property in Honolulu, Hawaii. This report presents a brief summary of our understanding of the project, a discussion of our testing program and our evaluation of the results.

PROJECT INFORMATION

The site of the project consists of several parcels of land located on the north side of South Beretania Street between Alapai and Lauhala Streets near downtown Honolulu. At the present time, these parcels are occupied by low rise buildings and by paved parking lots and access drives.

Soil test borings were being drilled at the time of this study. The results of these borings revealed a thin zone of overburden soils, underlain by interbedded basaltic bedrock and coraline limestone/sandstone/conglomerate.

TESTING PROCEDURE

For the purposes of evaluating the shear wave velocity profile within the project site, AECOM conducted four Refraction Microtremor (ReMi) surveys. In the ReMi technique, which is a form of Multi Channel Analysis of Surface Waves, each line consists of a series of 21 to 24 geophones inserted into surface materials on a 3-meter horizontal spacing. The lines were located in existing parking lots within the parcels as portrayed on Figure 1, attached.

Background vibrations from nearby roadway traffic and other sources were measured and employed in a wavefield transformation data processing technique to allow for the interpretation of the shear wave velocity profile. The profiles developed for Lines 1 through 4 are attached on Figures 2 through 5. The average shear wave velocity to a depth of 100 feet determined from these tests ranged from 1632 to 1836 feet/second. These values are consistent with the characteristics of Seismic Site Class C as defined by the International Building Code.

The IBC probabilistic ground motion values for latitude 21.306185° and longitude -157.852857° obtained from the USGS geohazards web page are as follows:

Period (seconds)	2% Probability of Event in 50 years (%g)	Site Coefficient F_a	Site Coefficient F_v
0.2 (S_s)	0.615	1.154	
1.0 (S_1)	0.178		1.622

The Site Coefficients, Fa and Fv presented in the above table were interpolated from IBC Tables 1615.1.2(1) and 1615.1.2(2) as a function of the site classification and mapped spectral response acceleration at the short (S_s) and 1 second (S_1) periods.

We have appreciated the opportunity to serve as your geotechnical consultant for this project. If you should have any questions, please contact the undersigned at (303) 704-8390.

Sincerely,

AECOM Technical Services, Inc.

This report was prepared by me or under my direct supervision

JAMES W. NIEHOFF
LICENSED PROFESSIONAL ENGINEER
No. PE10338C
HAWAII, U.S.A.

Elliott Drumright

James W. Niehoff, PE
Principal Geotechnical Engineer

Elliott E. Drumright
Geotechnical Consultant

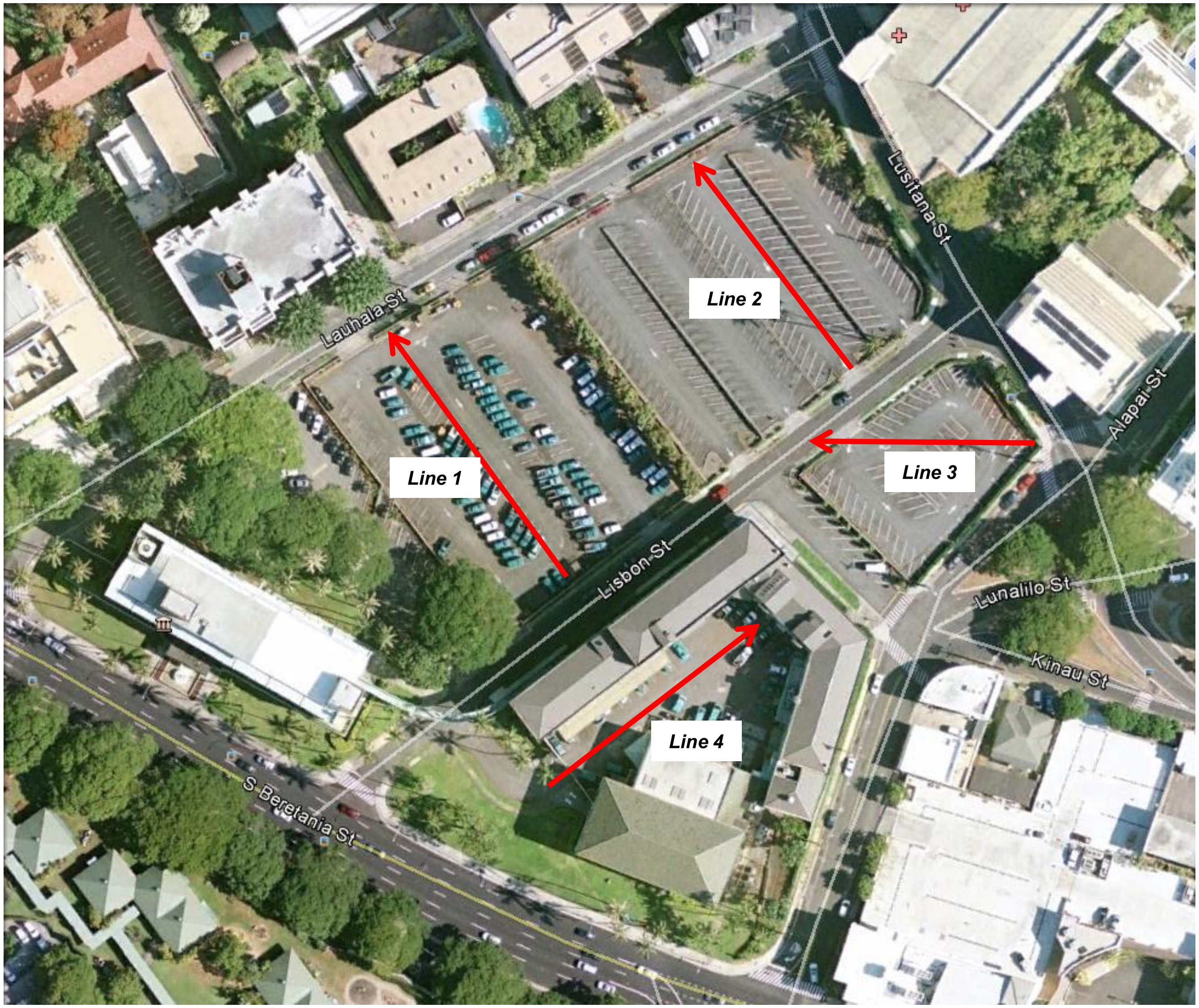

Figure 1	Refraction MicrotremorTest Location Plan Board of Water Supply Site Honolulu, Hawaii	AECOM
AECOM Project Number 60276616		

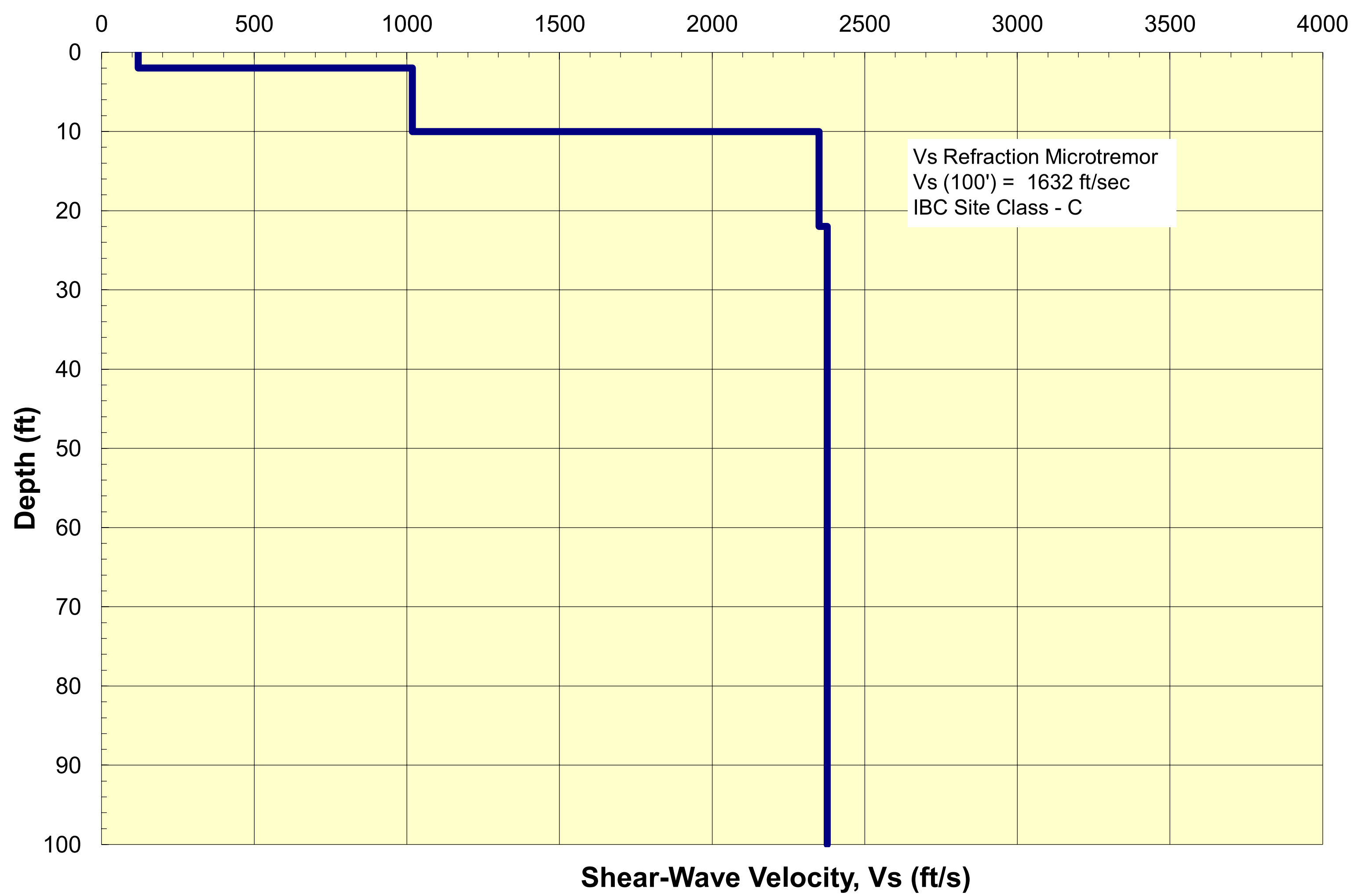

Figure 2	Shear Wave Velocity vs. Depth – Line 1 Board of Water Supply Site Honolulu, Hawaii	AECOM
AECOM Project Number 60276616		

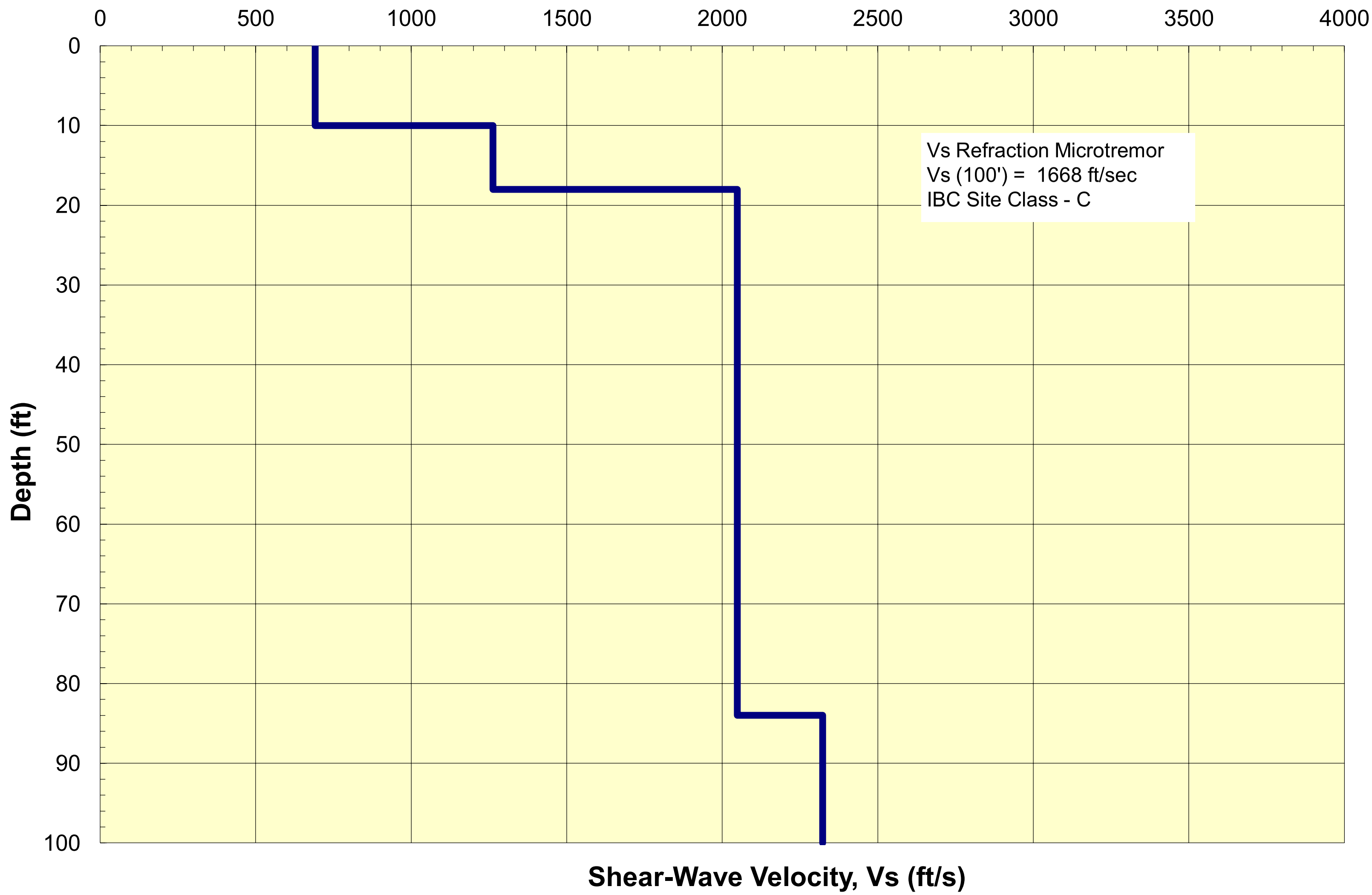

Figure 3

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Shear Wave Velocity vs. Depth – Line 2
Board of Water Supply Site
Honolulu, Hawaii

AECOM

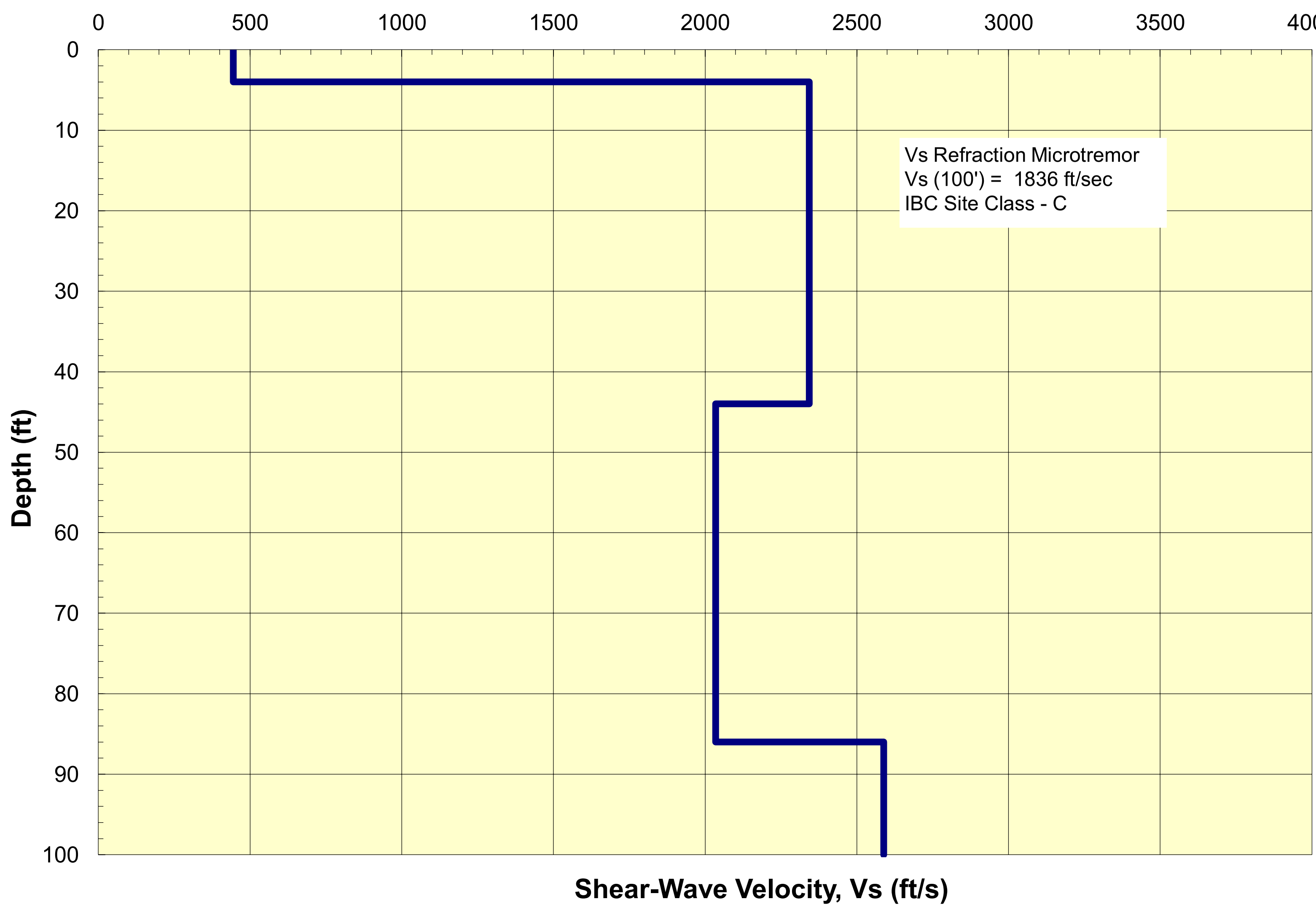

Figure 4	Shear Wave Velocity vs, Depth – Line 3 Board of Water Supply Site Honolulu, Hawaii
AECOM Project Number 60276616	

AECOM

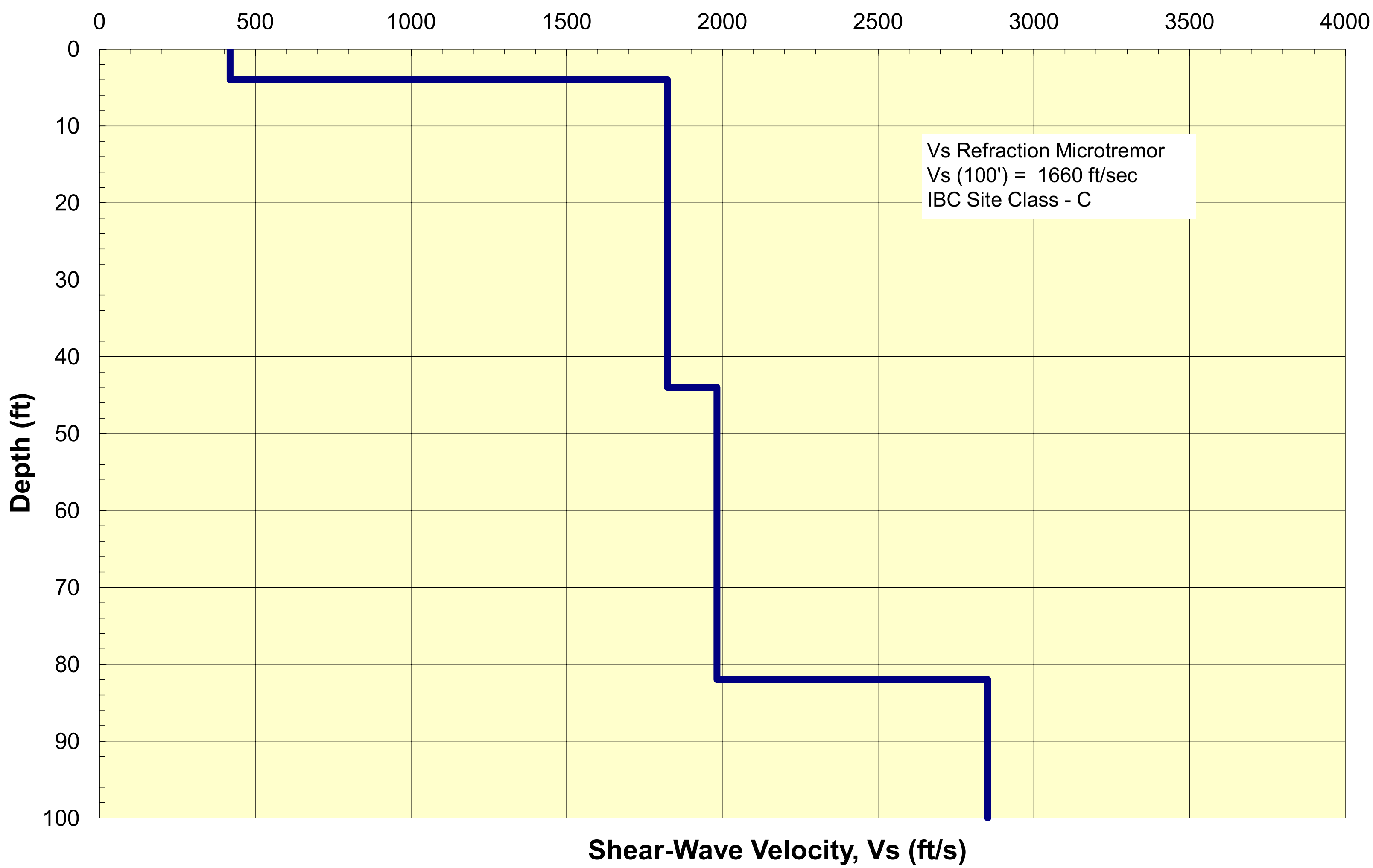

Figure 5	Shear Wave Velocity vs, Depth – Line 4 Board of Water Supply Site Honolulu, Hawaii	AECOM
AECOM Project Number 60276616		