Final Environmental Assessment
Prepared in Accordance with Chapter 343, Hawai'i Revised Statutes and
Title 11, Chapter 200, Hawai'i Administrative Rules

Intersection Improvements Dillingham Ranch Agricultural Subdivision

Waialua, Island of O'ahu, Hawai'i
Tax Map Key: (1) 6-8-003: 015

October 2008

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1-21195-00

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Appendix D – Archaeological Inventory Survey of an Approximately 75-Acre Portion of the Proposed 861-Acre Dillingham Ranch Development Project, Waialua District, Island of O'ahu, Cultural Surveys Hawai'i,
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Appendix F – Agriculture Feasibility Report, (Expanded Supplement on the Working Ranch) Dillingham Ranch, Development Strategies, LLC, November 2007

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Appendix H – Application for Individual Wastewater System (IWS), Dillingham Ranch 'Āina, LLC Mokūle'ia, O'ahu, Hawai'i, Best Industries USA, March 9, 2007.

Appendix I – Preliminary Water System Report, Dillingham Ranch Agricultural Subdivision, Mokūle'ia, O'ahu, Hawai'i, R. M. Towill Corporation, January 17, 2008.

Project Summary

Project:	Intersection Improvements Dillingham Ranch Agricultural Subdivision
Proposing Agency/Applicant:	Dillingham Ranch ʻĀina, LLC 9601 Wilshire Boulevard, Suite 200 Los Angeles, California 90210 Contact: Clifford Smith, Vice President
Accepting Authority:	State of Hawaii Department of Transportation 869 Punchbowl Street, Room 301 Honolulu, Hawaiʻi 96813 Contact: Ken Tatsuguchi, P.E. Engineering Program Manager Highways Division
TMK:	(1) 6-8-003: Parcel 015 and along Farrington Highway, F.A.P. No. 35-A(1)
Location:	Waialua, Island of Oʻahu, Hawaiʻi
Project Area:	Less than 1-acre required for pavement installation, striping and installation of signage
Document Preparers:	R. M. Towill Corporation 2024 North King Street, Suite 200 Honolulu, Hawaii 96819 Contact: Brian Takeda, Planning Project Coordinator
County Zoning:	AG-2, General Agricultural District
State Land Use:	Agricultural
Existing Land Uses:	The proposed area of use serves as an intersection along Farrington Highway and will provide entry to the planned Dillingham Ranch Subdivision
Proposed Action:	Intersection improvements consisting of installation of pavement, striping, and signage
Permits that May be Required:	Building and grading permits

Section 1
Project Description

1.1 Project Purpose

Dillingham Ranch ʻĀina, LLC (DRA), proposes a T-intersection along Farrington Highway, a State Department of Transportation (DOT), Highways Division, facility in the Waialua District of Oʻahu. The T-Intersection will be located at the current westerly access road to Dillingham Ranch. This improvement to the current access to Dillingham Ranch will provide a connection to a proposed subdivision of approximately 77 agricultural lots. The roadway will carry traffic in the south and northbound approaches from the subdivision to the Highway.

1.2 Purpose for Preparation of an Environmental Assessment

The purpose of this Final Environmental Assessment (FEA) is to inform interested parties of the proposed project and to disclose information relating to the potential for adverse environmental impacts. The proposed T-intersection, with its connection to a 77 lot, 385 acre subdivision within the approximately 2,700 acre Dillingham Ranch, has the potential for beneficial and/or adverse environmental impacts that are secondary to the proposed project. This EA describes existing conditions at the location of the intersection improvements and addresses the potential for adverse primary environmental impacts, and the secondary environmental impacts associated with the Dillingham Ranch Agricultural Subdivision.

The expanded discussion offered in this EA provides interested parties with additional documentation for the Dillingham Ranch property including comprehensive reports and reviews that directly and indirectly have the potential to affect the following categories: (1) archaeological preservation areas; (2) agricultural sustainability; (3) rockfall hazards; (4) waste water; and (5) proposed water systems. This information complements and expands upon the assessment of the primary environmental factors associated with construction and operation of the T-intersection. Each of the five categories are supported with corresponding copies of the State or County coordination letters as provided in **Appendix A, Documentation Regarding Application for Subdivision**.

This EA complies with Chapter 343, Section 343-5-1, Hawaii Revised Statutes (HRS), which states an environmental assessment shall be required for actions which, "propose the use of state or county lands or the use of state or county funds, other than funds to be used for feasibility or planning studies for possible future programs or projects which the agency has not approved, adopted, or funded, or funds to be used for the acquisition of unimproved real property; provided that the agency shall consider environmental factors and available alternatives in its feasibility or planning studies".

The proposed project's use of the DOT right-of-way also serves as a trigger for the preparation of an EA in accordance with Section 343-5, HRS. According to Section 343-5:

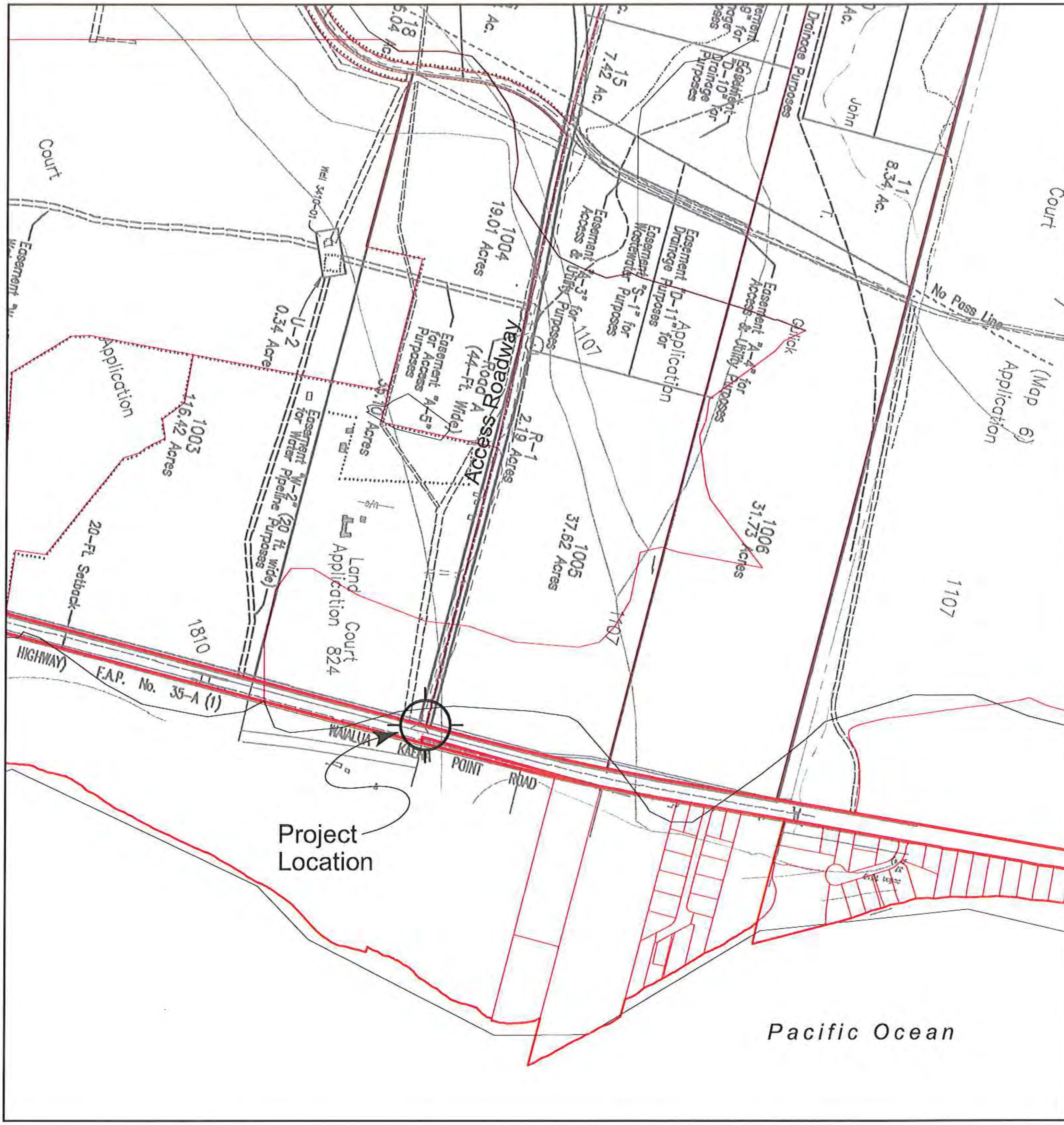
> "(c) Whenever an applicant proposes an action specified by subsection (a) that requires approval of an agency and that is not a specific type of action declared exempt under section 343-6, the agency initially receiving and agreeing to process the request for approval shall prepare an environmental assessment of the proposed action at the earliest practicable time to determine whether an environmental impact statement shall be required ...."

1.3 Project Description

1.3.1 Project Location and Site Characteristics

The proposed project is located in Mokūleʻia, Waialua, along the northern coastline of Oʻahu (See **Figure 1,** Project Location). The location of the subject intersection along the Farrington Highway (F.A.P. 35A(1)) is approximately 750 to 800 feet from shore. The access roadway serving the planned Dillingham Ranch Agricultural Subdivision is located at street address, 68-540 Farrington Highway, Waialua, Oʻahu, Hawaiʻi 96791. The proposed T-intersection improvements will involve use of less than approximately 1 acre. A portion of the intersection improvements will be within the DOT, Highways Division, right-of-way, while the entirety of the access roadway and subdivision is owned by Dillingham Ranch ʻĀina, LLC.

The lands mauka of the proposed project site are in agricultural uses that include ranching, limited diversified agricultural crops, and related pasturage and corral uses. The land on the makai side of the subject intersection is privately owned vacant land that is currently used as a polo field. There are no agricultural activities at the planned intersection improvements.



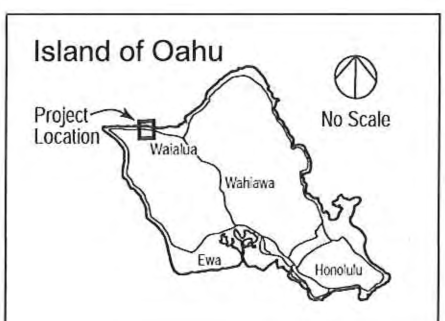


Figure 1 Project Location
Intersection Improvements
Dillingham Ranch ʻĀina, LLC

0 500 Feet 1000

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1.3.2 Proposed Construction Activities

Intersection Improvements

The proposed improvements will consist of limited grading, paving, striping and installation of traffic signage designating the location as a T-intersection connecting the planned subdivision access roadway with the Farrington Highway (**Figure 2,** Proposed T-Intersection). The access roadway will be designed with 12 foot wide travel lanes, paved shoulders, striping and signage to enhance safety and maintenance of the intersection.

The access roadway is planned as a two-lane roadway carrying traffic in both the northbound and southbound directions. A single lane will be provided on the northbound approach that will be shared by traffic making left and right turns onto the highway and a single lane will be provided in the southbound direction into the subdivision.

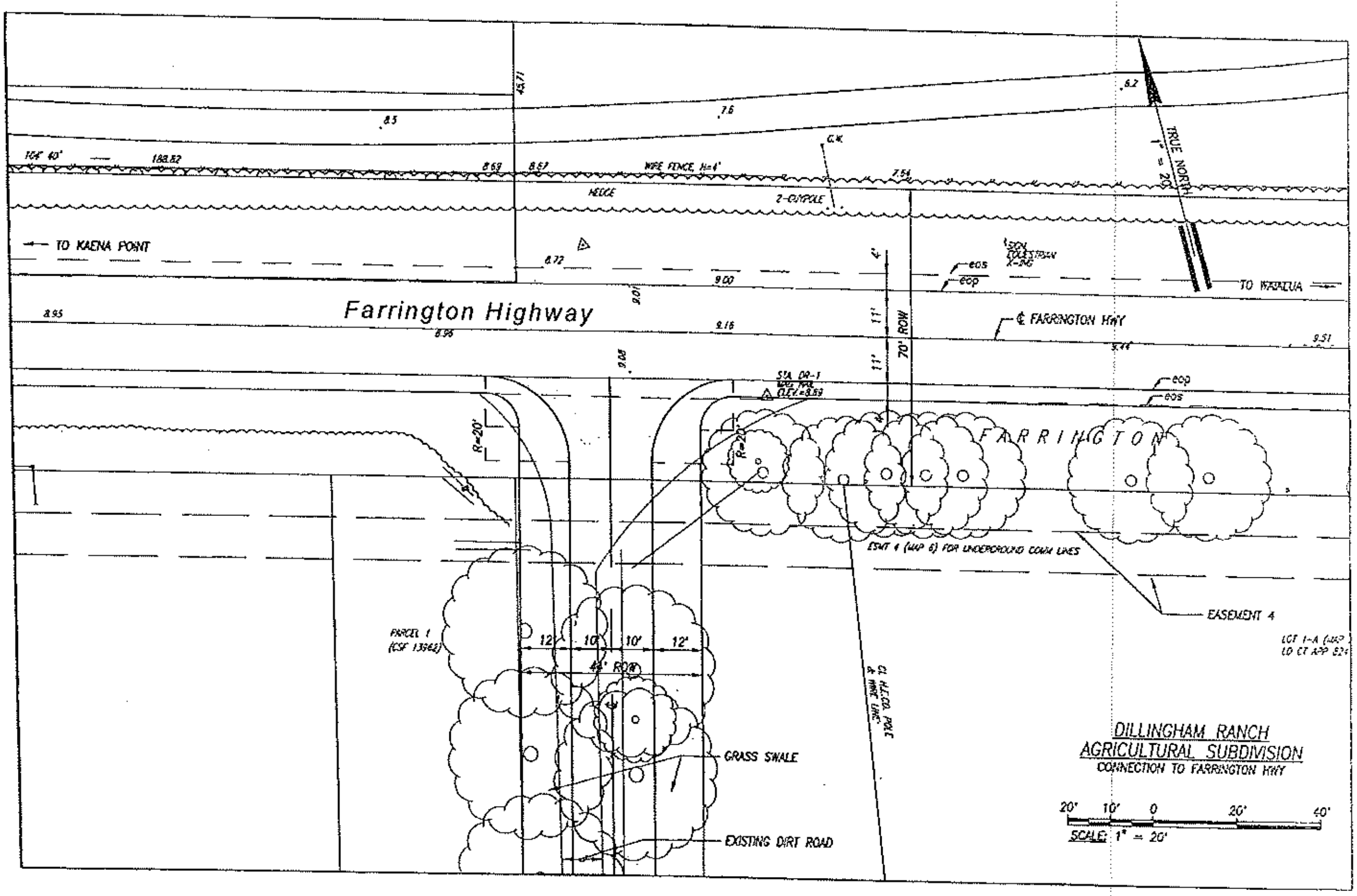
A stop sign will be used to control the northbound approach to the intersection. The intersection will be designed with adequate sight distance for drivers at the stop sign and clearly visible to drivers on the highway. As required, warning signs will be posted on Farrington Highway to improve driver awareness of the new intersection and to alert oncoming traffic to drivers making southbound turns into the Dillingham Ranch Agricultural Subdivision.

Agricultural Subdivision

The proposed T-intersection is designed to provide service to the planned subdivision (see **Figure 3,** Dillingham Ranch Agricultural Subdivision). All lots as identified within the subdivision will be developed in accordance with applicable regulations of the State and City & County of Honolulu. This will include provision of the required infrastructure and utilities including access roads and connection with major public roadways, water, wastewater, power, drainage and solid waste collection.

Status of Agricultural Subdivision

On January 25, 2008 the Department of Agriculture consented to the proposed subdivision and on April 18, 2008 the Department of Planning and Permitting, City & County of Honolulu, issued its Tentative Approval (**Appendix A**).



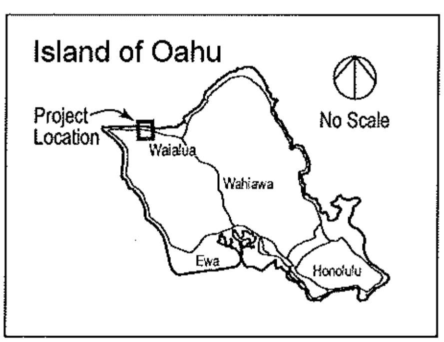


Figure 2 Proposed T-Intersection
Intersection Improvements
Dillingham Ranch ʻĀina, LLC

Graphic Scale as Shown

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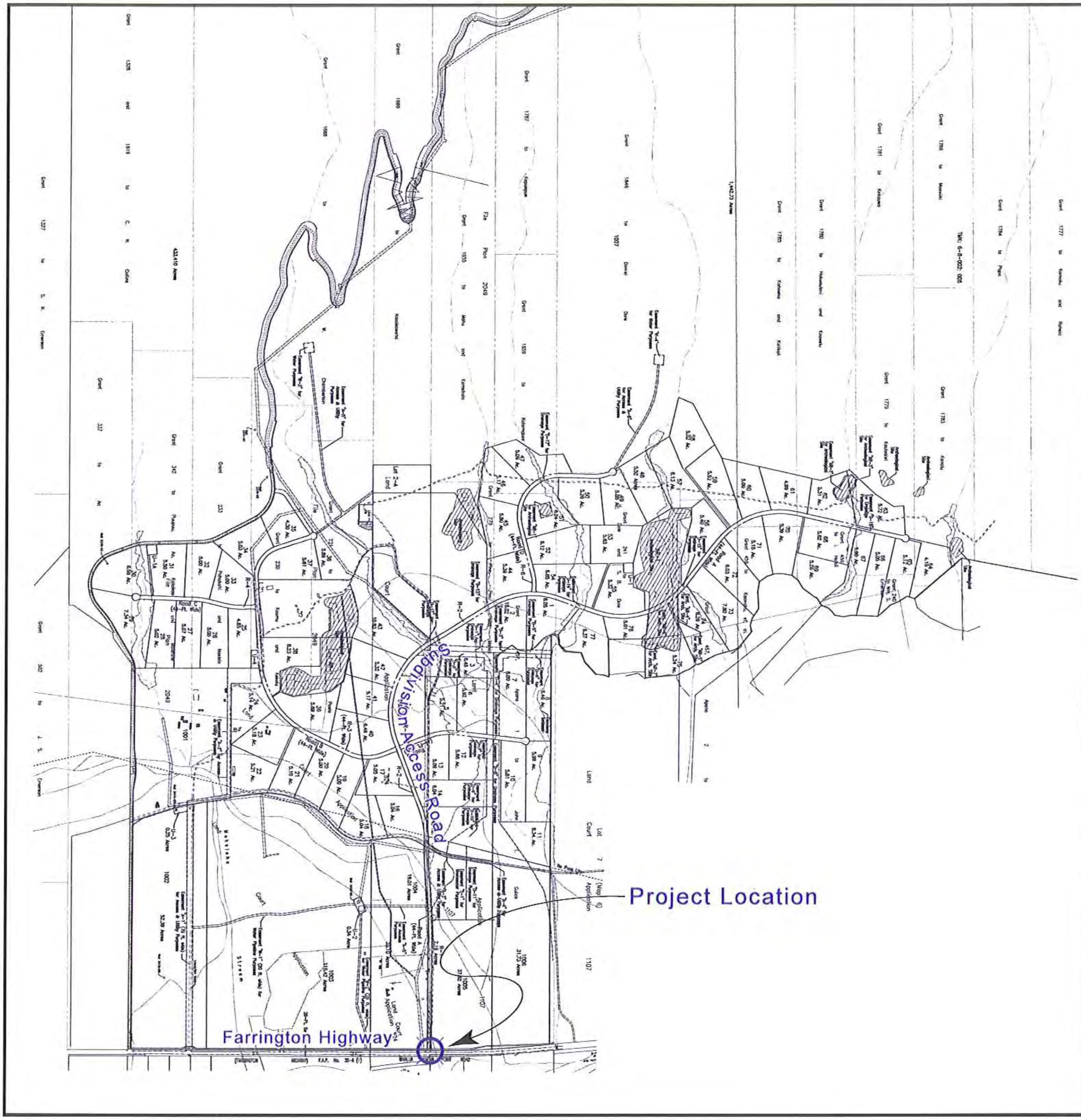

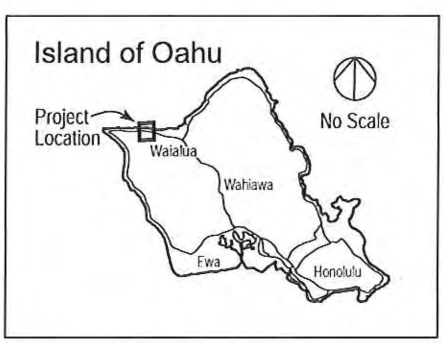

Figure 3
Dillingham Ranch Agricultural Subdivision
Intersection Improvements
Dillingham Ranch 'Āina, LLC

No Scale

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1.3.3 Project Schedule and Cost

Construction of the proposed project is tentatively scheduled for late 2008. The project duration is anticipated at less than approximately 6 months. The preliminary construction cost estimate for the project is approximately $250,000.

All costs associated with the design and construction of the proposed project will be financed by DRA.

Section 2
Environmental Setting, Potential Impacts and Mitigation Measures

2.1 Physical Environment

2.1.1 Climate

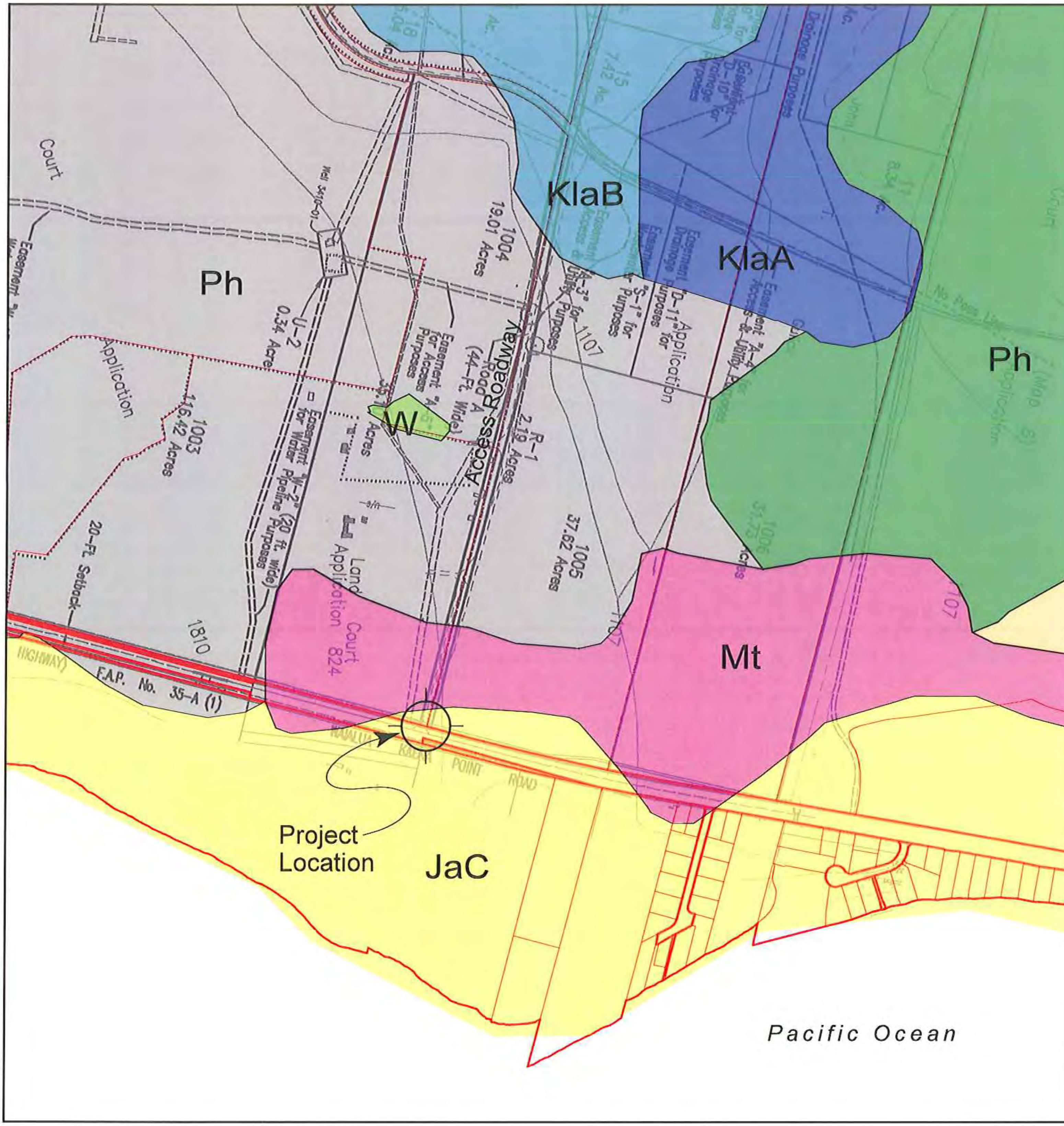
The project site is located along the north shore of O'ahu. Temperatures along the north shore and statewide are moderate and equable throughout most of the year. This reflects the small seasonal variation in the energy received from the sun and the tempering effect of the surrounding Pacific Ocean. The mean annual temperature recorded at Waialua, O'ahu, ranges from between the mid-60s and high 80s, with occasional reaches into the +90 degree Fahrenheit (F) range.

Rainfall for the area ranges in excess of 30 inches per year during the winter months from November through January, to an average of approximately 15 to 20 inches throughout the remainder of the year. Winds are generally from the northeast, except during the winter months when storms are usually accompanied by south winds.

2.1.2 Topography and Soils

According to the Soil Conservation Service (SCS), the project site consists of the Ka'ena-Waialua Soil Association which is normally found on coastal plains and talus slopes and in drainageways. Characteristics include deep, nearly level and gently sloping surfaces, with poorly drained to excessively drained soils that have a fine textured to coarse textured subsoil or underlying material.

Information on the soil type is obtained from the Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii, as prepared by the U.S. Department of Agriculture, 1972. According to the Soil Survey, the soil association at the project location is classified as Jaucas sand, 0 to 15 percent slopes (JaC). See **Figure 4,** Soils. The slope range of this soil is 0 to 15 percent, but in most places the slope does not exceed 7 percent. In a representative profile the soil is single grain, pale brown to very pale brown, sandy, and more than 60 inches deep. In many places the surface layer is dark brown as a result of the accumulation of organic matter and alluvium. The soil is neutral to moderately alkaline throughout the profile. Permeability is rapid, and runoff is very slow to slow.



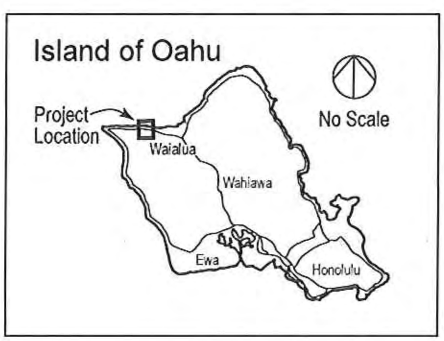


Figure 4 Soils
Intersection Improvements
Dillingham Ranch 'Āina, LLC

0 500 Feet 1000

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The hazard or water erosion is slight, but wind erosion is a severe hazard where vegetation has been removed. Workability is slightly difficult because the soil is loose and lacks stability for use of equipment. (Department of Agriculture, 1972).

Potential Impacts and Mitigation Measures

The proposed project will involve minor grading, backfill, and paving to accomplish the planned improvements. Excavated materials will be reused on-site for backfill as required. Imported fill is not anticipated to be required. However, if imported fill is used it will be limited to the use of clean and uncontaminated material. Any graded or excavated material that cannot be reused will be disposed of at an approved waste facility in accordance with State and City & County of Honolulu regulations.

Areas that are paved are not expected to constitute an erosion hazard. Areas that are exposed as a result of earthwork will be properly handled using management, structural, and vegetative practices as required to ensure against loss of sediment during periods of rainfall or inclement weather. Management practices will include only excavating the area required to accomplish the installation of the intersection improvements; maintaining open areas with appropriate storm water controls to prevent the commingling of runoff with exposed soils and excavated material; and securing the job site following the end of each work day. Structural controls will include the use of berms, silt screens, and PVC or similar covers for exposed soils, excavated materials, or any construction related stockpile sites susceptible to contact with rainfall or runoff. Vegetative practices will include the use of grassing or other vegetative materials to stabilize areas of exposed soils upon completion of work.

Other measures and practices will be followed as required in accordance with applicable State and City & County of Honolulu standards for grading and related construction activities.

2.1.3 Surface Water

According to the Hawaiʻi Stream Assessment the only perennial stream within the project vicinity is Makaleha Stream (CWRM, 1990). Although the Hawaii Stream Assessment lists Makaleha as a perennial stream, conditions of no flow have been observed at various times during both the summer and winter months. Other intermittent no name streams are located in the area.

A small man-made pond is located immediately west of the project site on Dillingham Ranch ʻĀina property. The pond or water feature was created several years ago by previous ownership to handle runoff upland of the property. It has since become a decorative feature of the nearby equestrian facility.

Potential Impacts and Mitigation Measures

No adverse impact to perennial or intermittent streams or the pond in the vicinity of the project is anticipated. Construction activities associated with the intersection improvements are not located near any streams which would require mitigative measures to otherwise minimize, reduce, or eliminate the potential for adverse effects.

The closest edge of the man-made pond is located approximately 230 feet from the planned intersection improvements. Although runoff from the project site is not expected to affect the upgradient location of the pond relative to the intersection improvements, the contractor will manage all work activities to prevent and reduce erosion from the job site. Construction related fugitive dust, which could be carried by wind blowing toward the pond, will be controlled by regular wetting of the work area as required. Only enough water will be used for dust control to suppress the dust from becoming airborne.

2.1.4 Flora/Fauna

Flora Assessment

A botanical survey of the site was conducted on January 4, 8 and 17, 2008 by AECOS Consultants, Inc. The purpose of the survey was to examine the area of the proposed intersection improvements and to provide information on the surrounding agricultural subdivision. A summary of the survey and findings are provided in the following (AECOS Consultants, Inc., 2008) (**Appendix B**):

Much of the lower half of the site Dillingham Ranch property is developed as a stables and horse ranch, with other areas utilized for pasturing cattle or as residences on agricultural lots. As this lower or makai area is not part of the proposed intersection improvements project, only limited survey time was spent here and around the wetlands. Further, plantings of ornamentals around developed facilities (houses, stables, corrals) were ignored, although special attention was paid to the area of a proposed intersection improvements and connection to Farrington Highway. The highway marks the northern or makai boundary of the ranch property, and improvements at the point where the ranch access road connects to the state highway are responsible for the preparation of an EA for the agricultural subdivision project as required by the state DOT.

Given the diversity of environments present on Dillingham Ranch property, the varied disturbances to the vegetation, and the large area (over 900 ac), it is not surprising that the listing of species is a long one. The listing included most of the species reported by Whistler (1991) along with findings in 2008.

A total of 211 species of flowering plants (plus 4 ferns and 1 gymnosperm) were recorded from the survey area in the vegetation surveys of December 1991 and January 2008. Many more species are present as ornamentals within the managed land area, although ornamentals persisting in abandoned former house lots and prominent trees and shrubs in the managed lands are included. For comparison, 48 species (22%) were seen in 1991 but not recorded in 2008; 47 species (22%) were seen in 2008 but not recorded in 1991. At least some of the species recorded by us as "new" were clearly present in 1991 and for whatever reason left off the 1991 list: several species of Eucalyptus trees in the upland pastures and managed lands, and the several different palm trees (including royal and coconut) found in the lowland palm grove.

The majority of the plant species growing on the property and in the project area are considered exotics naturalized in this area. Only 12 species (5.6%) are native plants (indigenous or endemic species) in the listing. Several of these—Cretan brake *(Pteris cretica)*, kākalaioa *(Caesalpinia bonduc)*, and nehe *(Lipochaeta lobata)*—were not observed in 2008, although previously reported by Whistler from both the koa haole scrub and riparian forest areas. The percentage of native species is substantially less than the 12.3% reported by Whistler. This difference can be attributed to (1) the inclusion in the 1991 survey of a separate upland parcel that added a number of natives not observed by Whistler or by us in the agricultural subdivision project area, and (2) the larger species list combining results of both surveys, adding mostly naturalized species.

Some of the species found are on the property as plantings, either ornamental or agricultural, generally limited to the low elevation, managed land. Many more species are present in this area than included in the list, but landscaping plants were mostly ignored in our survey. The several species of Eucalyptus noted growing higher up near the south boundary of the project area are old ranch plantings.

The subject property has a long history of ranching and the present-day vegetation upslope of the managed lands remains partly in grassland/savanna and partly in secondary forest growth overwhelmingly dominated by introduced species, particularly koa haole. The latter species tends to dominate lowland, somewhat dry environments on O'ahu and many other islands in the Pacific on lands that have been disturbed and then abandoned. Some elements of the native flora are present and these plants (especially wiliwili and alahe'e) are deserving of preservation in place, although not especially rare on O'ahu and not protected species. A more diverse native flora is anticipated to be present on the steep slopes starting above the proposed subdivision lots based on Whistler's 1991 survey that included an area with this steeper topography above 400 ft.

The part of the ranch property and state property that will be disturbed by planned improvements to Farrington Highway to establish a vehicular connection to the planned subdivision is a maintained roadway verge of trees (ironwood), shrubs (Chinese hibiscus or Hibiscus sinensis), several grasses and annual herbs. No botanical resources of significance exist in this area.

No plant species listed by the state or federal governments as threatened or endangered (DLNR, 1998; Federal Register, 2005; USFWS, 2005, 2007) were encountered during the present or during past (Char and Linney, 1986; Whistler, 1991) surveys on the property.

Potential Impacts and Mitigation Measures

The botanical survey found no assemblages or instances of rare, threatened, or endangered species that would be potentially impacted by the proposed project. The planned subdivision will also not displace existing ranching activities and are not anticipated to adversely affect botanical resources. Mitigation measures are not anticipated to be required.

Fauna and Avifauna Assessment

An avifaunal and feral mammal survey of the site was conducted on January 4 and 10, 2008, by Phil Bruner, Ph.D. The purpose of the survey was to (1) document what species of birds and mammals currently occur on and near the Dillingham Ranch property, with special attention to any native or migratory species and (2) note any natural resources important to native and migratory species.

A summary of the findings of the survey indicated (Bruner, 2008) (**Appendix C**):

Site Description
The following habitats can be found on this site: pasture/ranch land, residential, second growth alien forest, ephemeral stream drainage/irrigation ditches, and man-made ponds. The topography is mostly flat except for the mauka portions.

Native land Birds
No native land birds were recorded on the survey. The only possible species that might on occasion forage in this area is the Short-eared Owl or Hawaiian Owl known as Pueo in Hawaiian *(Asioflammeus sandwichensis)*. This species is listed as endangered by the State of Hawaii on the island of Oahu. They range over a wide array of habitats including forest (both native and second growth) as well as agricultural/ranch lands. They nest on the ground in areas of tall grass (Pratt et al. 1987, Hawaii Audubon Society 2005).

Native Waterbirds
Three Black-crowned Night Heron or 'Auku'u *(Nycticorax nycticorax hoactli)* were observed on 10 January at the large pond near the entry road to the property. 'Auku'u are the only native waterbird that is not listed as endangered or threatened. Three endangered waterbirds, the Hawaiian Coot or 'Alae Ke'oke'o *(Fulica alai)*, Hawaiian Moorhen or 'Alae 'ula *(Galllinula chloropus sanvicensis)* and Hawaiian Duck or Koloa *(Anas wyvilliana)* were also observed on this same large pond. An average of 8.5 coot and 2.5 moorhen and 10.5 Koloa were tallied over the 2 days of the survey. The endangered Black-necked Stilt or Ae'o *(Himantopus mexicanus knudseni)* was not recorded on the survey but will

forage in flooded areas following heavy rains. Bruner (1992) recorded 10 Hawaiian Coots, 2 Hawaiian Moorhens, 8 Black-crowned Night-Herons and 2 Black-necked Stilt on this property in 1992.

Seabirds

Two seabird species were observed flying over the property, the Great Frigatebird or 'Iwa *(Fregata minorpalmerstoni)* and White-tailed Tropicbird or Koa'ekea *(Phaethon lepturus dorotheae)*. A juvenile Koa'ekea was recently found on the property and was photographed and turned over to Sea Life Park, Oahu for care until it could be released (Chrissy Morris an employee at Dillingham Ranch pers. comm.) This species nests on the cliffs above Mokule'ia (pers. observ.) None of the Seabirds observed are listed as endangered or threatened. At nearby Kaena Point Wedge-tailed Shearwater *(Puffinus pacificus)* and Laysan Albatross *(Phoebastria immutabilis)* are now nesting with increasing success.

Migratory Birds

Three species of migratory shorebirds were recorded, the Pacific Golden-Plover or Kolea *(Pluvialis fulva)*, Ruddy Turnstone or Akekeke *(Arenaria interpres)* and Wandering Tattler or Ulili *(Heteroscelus incanus)*. These birds arrive from their arctic breeding grounds in August and depart back to the arctic in late April. The most extensively studied of the three species is Kolea (Johnson et al. 191, 1989, 1993, 2001 a, 2001b). All of these migratory shorebirds are protected by the Migratory Bird Treaty Act. They are not listed as threatened or endangered. An average of 39.5 plover and 15.5 turnstone were tallied over the course of the survey. Only 1 Wandering Tattler was observed. Sixty-eight plover were previously tallied on the property (Bruner 1992). One migratory Northern Pintail Duck *(Anus acuta)* was also seen on the Bruner (1992) survey. This species was not recorded on this 2008 survey but is one of the two most common migratory ducks wintering in Hawaii (Hawaii Audubon Society 2005).

Alien (Introduced) Birds

A total of 26 alien species were recorded on the survey compared with 17 species tallied by Bruner (1992). Table One (see Appendix C) gives the names of these species and information on their relative abundance. None of these alien birds are listed as threatened or endangered. The array of alien birds was typical of this type of habitat in this region of Oahu (Bruner 1982, 1986, 1991, 1992, 1993, 2003, Pratt et al. 1987, Hawaii Audubon Society 2005).

Feral Mammal

The only feral mammals observed on the survey were 4 pigs *(Sus scrofa)* and 2 cats *(Felis catus)*. Roof Rat *(Rattus rattus)* and House Mouse *(Mus musculus)* likely occur in this area. The endangered Hawaiian Hoary Bat or Ope'ape'a *(Lasiurus cinereus semotus)* was not seen despite an evening search using an ultrasound detector. Ope'ape'a are infrequently reported on Oahu. They are not restricted to native forest but can be seen foraging for flying insects in urban and agricultural areas as well as over bays and ponds. They roost solitarily in trees (Tomich 1986, Kepler and Scott 1990).

Summary of Findings

This property has been significantly altered from its natural state by years of agricultural and ranching activity. Three endangered waterbirds (Hawaiian Coot, Hawaiian Moorhen, Hawaiian Duck) and one non-endangered waterbird (Black-crowned Night Heron) were found on the survey. Two indigenous seabirds and 3 migratory shorebirds species were also observed. The endangered Hawaiian Owl was not seen but could occur in this area. An abundance of alien (26 species) birds were tallied. Feral mammals seen included cats and pigs. The endangered Hawaiian Hoary Bat was not detected. This species is infrequently seen on Oahu. The most valuable habitat for native waterbird are the ponds. The actively grazed pastures are important foraging habitat for migratory shorebirds (Pacific Golden-Plovers and Ruddy Turnstones).

Potential Impacts and Mitigation Measures

A number of common, exotic introduced, and rare native, threatened and endangered species were identified in the course of the survey. Most if not all of the species identified as rare, threatened or endangered do not readily utilize the immediate area of the proposed intersection improvements site for habitat or for foraging based on the regular presence of humans and the transit of vehicles along the Farrington Highway and existing Dillingham Ranch property access road.

The closest point of concern would be the area of the pond, which is located approximately 240 feet from the proposed intersection improvements. Existing mitigation is provided to some extent by a row of mature ironwood trees and brush vegetation that serve to isolate the area of the pond from the intersection. As required, the contractor will control dust and debris migrating from the project site and affecting the pond. Noise will be temporarily generated during construction activities. However, during this period all internal combustion powered equipment will be muffled and work will be limited to daytime hours. No night work will be required. Upon completion of work, the area will return to preconstruction noise levels.

Seabirds that have been observed transiting the area are not expected to be adversely affected. No night work is required that would constitute a source of additional lighting that could affect foraging activities.

2.1.5 Scenic and Visual Resources

Existing views from the project site primarily consist of the Farrington Highway. Makai of the intersection across the highway there are views of an existing grassed polo field, ironwood trees and brush vegetation beyond the field. Limited views of the shoreline and ocean can be seen in the distance. Mauka views along the highway include paddocks and corrals at the nearby Dillingham Ranch (Crowbar Ranch), an equestrian facility that provides stable and exercise facilities. Other mauka views are of the Dillingham Ranch ʻĀina property and the Waiʻanae Mountains beyond.

Potential Impacts and Mitigation Measures

No adverse impacts to visual resources of the project site are expected. The visual qualities of the site will be retained and preserved mostly intact. The only changes expected will be of the intersection improvements consisting of an improved roadway, striping, a stop sign and other signage to alert motorists to the presence of the intersection.

As required, vegetative controls will be used to stabilize open areas of soil to reduce erosion hazards. However, no views are expected to be impeded or otherwise negatively altered.

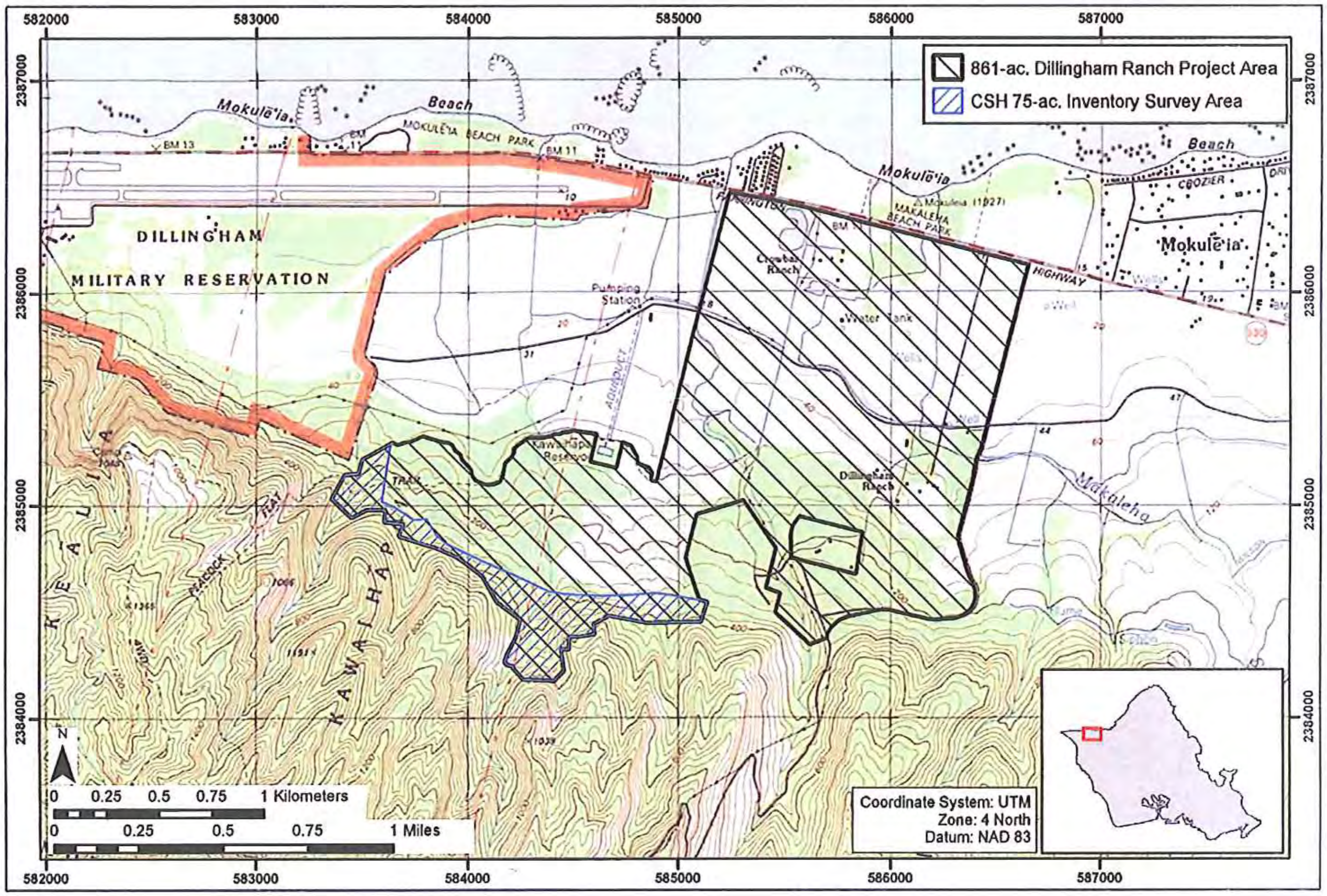
2.1.6 Historic and Archaeological Resources

Background

The proposed project site was included as part of a prior archaeological inventory survey of 787 acres of the Dillingham Ranch property proposed for development. The report was conducted by ERC Environmental and Energy Services Company (ERCE) and detailed in Archaeological Inventory Survey and Evaluation, Mokūleʻia, Waialua District, Oʻahu (TMK 6-8-03 and 6-8-02) (Drolet and Shilz, 1991). This initial report investigated the area of land extending from the Farrington Highway to the uplands as identified in **Figure 5**, Archaeological Study Area. The report was reviewed and accepted by the State Historic Preservation Division (SHPD) in 1992 (Log No. 5155, Doc No. 0682t).

A second archaeological inventory survey was subsequently undertaken in 2007 by Cultural Surveys Hawaiʻi to add approximately 78 acres to ensure sufficient archaeological review of the Dillingham Ranch property planned for an agricultural subdivision. This second report, Archaeological Inventory Survey of an Approximately 75-Acre Portion of the Proposed 861-Acre Dillingham Ranch Development Project, Waialua District, Island of Oʻahu (Tulchin and Hammatt, 2007) (**Appendix D**), was also reviewed and accepted for review by the SHPD in 2007 (Log No. 2007.2421, Doc No. 0712LM03) (The area of investigation is identified in **Figure 5**, Archaeological Study Area).

On January 23, 2008, the SHPD completed its review of the archaeological inventory survey and issued its determination that "no historic properties will be affected" (See **Appendix A**, letter from SHPD, January 23, 2008). The SHPD specifically noted in its determination that because the proposed action for the Dillingham Ranch Agricultural Subdivision involves a "paper transaction" for a proposed zone change, that no ground disturbing activities would occur. However, in order to ensure that construction of the subdivision is consistent with the goal of maintaining preservation of the archaeological and cultural resources of the property, protocols similar to those in place for construction of the T-intersection will be applied to the project when it is constructed (see Potential Impacts and Mitigation Measures, this section).



Source: Base drawing, Figure 1, Portion of USGS 7.5 Minute Series Topographic Map, Ka'ena Quad (1998), showing the location of the CSH 75-acre inventory survey area and the 861-acre Dillingham Ranch project area. Cultural Surveys Hawaii, 2007.

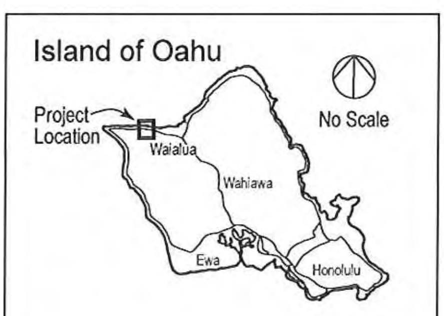


Figure 5 Archaeological Study Area
Intersection Improvements
Dillingham Ranch 'Āina, LLC

0 0.25 0.50 0.75 1 Miles

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History of Project Vicinity

Cultural Surveys Hawai'i, Inc., provides a summary of the history of the project area in the Tulchin and Hammatt, 2007, report identified above. A summary is provided in the following:

Traditional Accounts
The district of Waialua is rich in legends, stories, proverbs, and myths. Waialua is literally translated as "two waters" (Clark 2002) and may refer to the two large stream drainages (Anahulu and Helemano-Poamoho-Kaukonahua) that were once used to irrigate extensive taro fields in the ahupua'a of Kamananui, Pa'ala'a, and Kawailoa, the more populous ahupua'a on the eastern side of the district. The ahupua'a of Kealia, Kawaihāpai, and Mokulē'ia, on the western side of the district, were more arid, and were not as well-watered. However, these western lands were famed for their warm climate, cooling breezes, plant resources, and especially, marine resources.

Early Historic Period
A picture of pre-contact Hawai'i is painted by the recorded accounts of early foreign explorers. After the death of Captain James Cook on the Island of Hawai'i, the crew of the Resolution continued to sail toward O'ahu under the leadership of Captain Charles Clerke.

Clerke describes the highly populated and lush northwest coast of 0'ahu after anchoring in Waimea Bay:

I stood into a Bay just to the Wtward [Westward] of this point the Eastern Shore of which was by far the most beautiful Country we have yet seen among these Isles, here was a fine expanse of Low Land bounteously cloath'd with Verdure, on which were situate many large Villages and extensive plantations; at the Water side it terminated in a fine sloping, sand Beach.. .This Bay, its Geographical situation consider'd is by no means a bad Roadsted, being sheltered from the NEbN [Northeast by North] SEterly [Southeasterly] to SWbW [Southwest by West] with a good depth of Water and a fine firm sandy Bottom; it lays on the NW [Northwest] side of this Island of Wouahoo [O'ahu]. . .surrounded by a fine pleasant fertile Country. (Beaglehole 1967:569).

Economic Changes
About A.D. 1720-1740, the island of O'ahu was united under the high chief Kūali'i after a series of battles with the chiefs of Kona and 'Ewa. Kūali'i continued his wars of conquest by carrying out raids on the islands of Moloka'i and Hawai'i. This began a time period of intraisland and inter-island wars, referred to as the Conquest Period, that culminated in the conquest of O'ahu by the Hawai'i Island chief, Kamehameha, in A.D. 1795 (Sahlins 1992:36). In 1804, the Hawaii chiefs who supported Kamehameha occupied O'ahu, taking control of the lands of the former ruling chiefs. In 1806, Kamehameha traveled around the island of O'ahu to encourage people to rebuild their war-ravaged agricultural fields and fishponds by his own example.

Kamehameha died in 1819, and his son Liholiho and wife Ka'ahumanu shared the duties of ruling the new kingdom. He selected his younger brother Kauikeaouli to be his chief during his absence during a trip to England and heir in the event that he did not return. Both Liholiho and his wife died in 1824 while in England, and Kauikeaouli, later known as Kamehameha III, became the king at the age of nine, with a guardian Kahalai'a as his kahu (personal attendant). This took place during the Sandalwood Period (A.D. 1812- 1830), when the ali'i (high chiefs) made enormous demands upon the common people to gather sandalwood in the upland forests.

Kauikeaouli's assumption of control was marked by the selection of a group of young chiefs and children of important persons, of resident foreigners, and of commoners, to become his favorites, friends, members of his household, and soldiers and sailors to form his bodyguard. This general period ended in the exhaustion of sandalwood on the islands.

Trade continued with visiting whaling ships during the Whaling Period (A.D. 1830-1848) for provisions, but this did not generate the same profits for the ali'i as did the early sandalwood trade. (Sahlins 1992: 108).

Between 1830 and 1850, the demands of the ali'i on the maka'āinana (common people) were severe. The missionary, John Emerson, commenting on the burdensome taxes on the people, wrote that the ruling chiefs "get hungry often and send a vessel to Waialua for food quite as often as it is welcomed by the people" (MsL: 10 Feb 1834, cited in Sahlins 1992:145).

Population Decline

In the pre-contact period, villages in the Waialua District were concentrated along the coast and the well-watered valleys of the ahupua'a on the eastern side of the district. The population of these ahupua'a had been estimated at 6,000 to 8,000 people before Western Contact (Sahlins 1992:20).

The first missionary census of the district, in 1831-32, recorded 2,640 people in Waialua, probably down 20-30 percent from the first decade of the century. The population continued to decline in the first part of the nineteenth century, and by 1848, the population was down to 1,616 persons. Much of this decline was due to a high death rate from newly introduced diseases, such as smallpox, typhus, and venereal diseases.

Mid- to late-1800s

In 1850, a law was passed that allowed foreigners to buy land fee-simple. Two descendants of missionaries, William Emerson and John T. Gulick, were the first foreigners to buy land in Mokule'ia and Kawaihāpai. Over the next few years, Emerson continued to buy land from the original grantees or later owners until he owned a total of 2,605 acres in Waialua (Alameida 1993:xii).

In 1852, the first Chinese were brought to the islands to work in the sugar cane fields. Some of these Chinese later moved to Waialua to begin rice cultivation. A market for rice in California had developed as increasing numbers of Chinese laborers immigrated there since the mid-19th century. Similarly, as Chinese immigration to the islands also accelerated, a domestic market for rice developed.

By 1876 there was still a considerable amount of former taro land available for rice farming. The great demand for rice land brought disused taro patches into requisition - especially because water rights attached to them...(Coulter and Chun 1937: 11).

1900s

By the early 1900s, sugarcane plantations and large ranches came to dominate the lands of western Waialua. Cattle were known to have grazed on the lowlands of Waialua as early as the 1840s (Sahlins 1992:148). In 1897, B.F. Dillingham purchased the Kawailoa Ranch in Mokule'ia. The ranch included over 2,000 head of cattle and over a hundred horses and mules on 10,000-acres of land (Yardley 1981:193). Dillingham also leased additional property in Mokule'ia, including the Gaspar Silva Ranch, the James Gay Estate, and other lands in the area that he could secure. Dillingham's plan was to later sublease or sell the land at a profit, as the lands had potential for being developed into large-scale sugar plantations. He anticipated the land would become valuable once extensive irrigation systems were in place, and when the O'ahu Railway and Land Co. (O.R. & L.) railroad was constructed around Ka'ena Point and along the north shore to Kahuku.

By 1898, the O.R. & L railroad was constructed through the Waialua District. Soon thereafter, Dillingham began selling off or subleasing much of his lands in western Waialua. However, Dillingham retained as his personal ranch "a great strip of mountainside and beaches with flat land in between and a homestead in the middle" (Yardley 1981:206). This land would remain ranch land, with sugar plantations located to the east and west. The Dillingham Ranch was developed into a horse ranch, including stables, pastures, equestrian areas, and a polo field, along with a large, wood-framed house for the Dillingham family (Yardley 1981:193- 194).

By 1946, Robert P. Patterson, Secretary of War of the United States, executed a "Declaration of Taking," which stated that the land of Mokule'ia, Auku'u, Kawaihāpai, Keālia, and Ka'ena, Waialua, O'ahu, Territory of Hawaii; Mokule'ia Ranch and Land Company, Limited, et al. "is taken.. .to provide for a military airfield, an ordnance storage area, and related military purposes incident thereto. The said land has been selected by me for acquisition by the United States for use in connection with such purposes, and for such other uses as may be authorized by Congress or by Executive Order, and is [r]equired for immediate use." Several of the native Hawaiian families, who had retained their small plots of land through the 19th and early 20th centuries, now lost lands through this confiscation (Alameida 1993: 113).

Modern Land Use
With the announcement of the Oahu Railway and Land Company's decision to discontinue service in 1947, the Waialua Agricultural Company began to switch to truck transportation. The change was slowly made, until the last railroad line was closed in 1952. Subsequent historic maps and aerial photographs indicate a general lack of development in the area through the 1970s. Lands in the makai (northern) portion of the project area consisted of improved pasture and ranch activity areas, including the Dillingham family residence and other smaller residences. Lands in the mauka (southern) foothills portion of the 861-acre Dillingham Ranch project area generally appeared to be unimproved pasture areas.

The lands occupied by the Crowbar Ranch, Campbell Ranch, and Dillingham Ranch were later consolidated under the control of the Mokule'ia Land Company. At present, the project area, again known as the Dillingham Ranch, is an active horse and cattle ranch. Much of the level coastal plain portion of the project area is used for equestrian stables and activity areas. The sloping foothills of the project area are used as pasture for grazing cattle. The Dillingham residence remains on the property, as well as a coconut and palm tree farm.

Archaeological Inventory Survey

According to Drolet and Shilz, 1991, an archaeological inventory survey undertaken for the Dillingham Ranch property including the area of the proposed project, found 19 archaeological sites and 41 cultural features. According to the report:

> In March, April, and December of 1991, ERC Environmental and Energy Service Co., Inc. conducted an inventory survey of the coastal plains and foothills at Mokuleia (Drolet and Schilz, 1991). The study covered 897 acres and represents one of the first extensive surveys completed in the north shore area. Nineteen sites with forty-one cultural features were identified, the most numerous consisting of enclosures (13), terraces (9), stone walls (11) and platforms (3). These were found in association with stone alignments, cleared areas, and connected habitation/garden features. The sites were situated exclusively in the upland zone, clustered along flat, adjacent terraces, each bordered by a seasonal stream channel. Three principal terrace top settlement clusters were identified, all showing similar ecological placement and field constructions. The configuration of sites contained prehistoric features dong with some historic constructions consisting of stone paddocks used as ranch corrals. Two of these stone enclosures (4435 and 4437) appear to be those reported by Barrera in his 1987 survey. (Drollet and Shilz, 1991).

None of the features identified in the report were located in the vicinity of the intersection improvements as indicated in **Figure 6**, Drolet and Shilz Archaeological Site Locations (1991).

Potential Impacts and Mitigation Measures

The proposed project is located along the Farrington Highway and serves as an existing developed vehicular entry to the Dillingham Ranch. Although no archaeological sites were identified in the immediate project area, it is always possible that iwi or other cultural remains may be uncovered by earthwork or grading to construct the planned intersection improvements. Should this occur, work will be temporarily halted and the SHPD immediately notified at (808) 692-815 for further instructions. Work will only be resumed upon appropriate notification to do so by the SHPD.

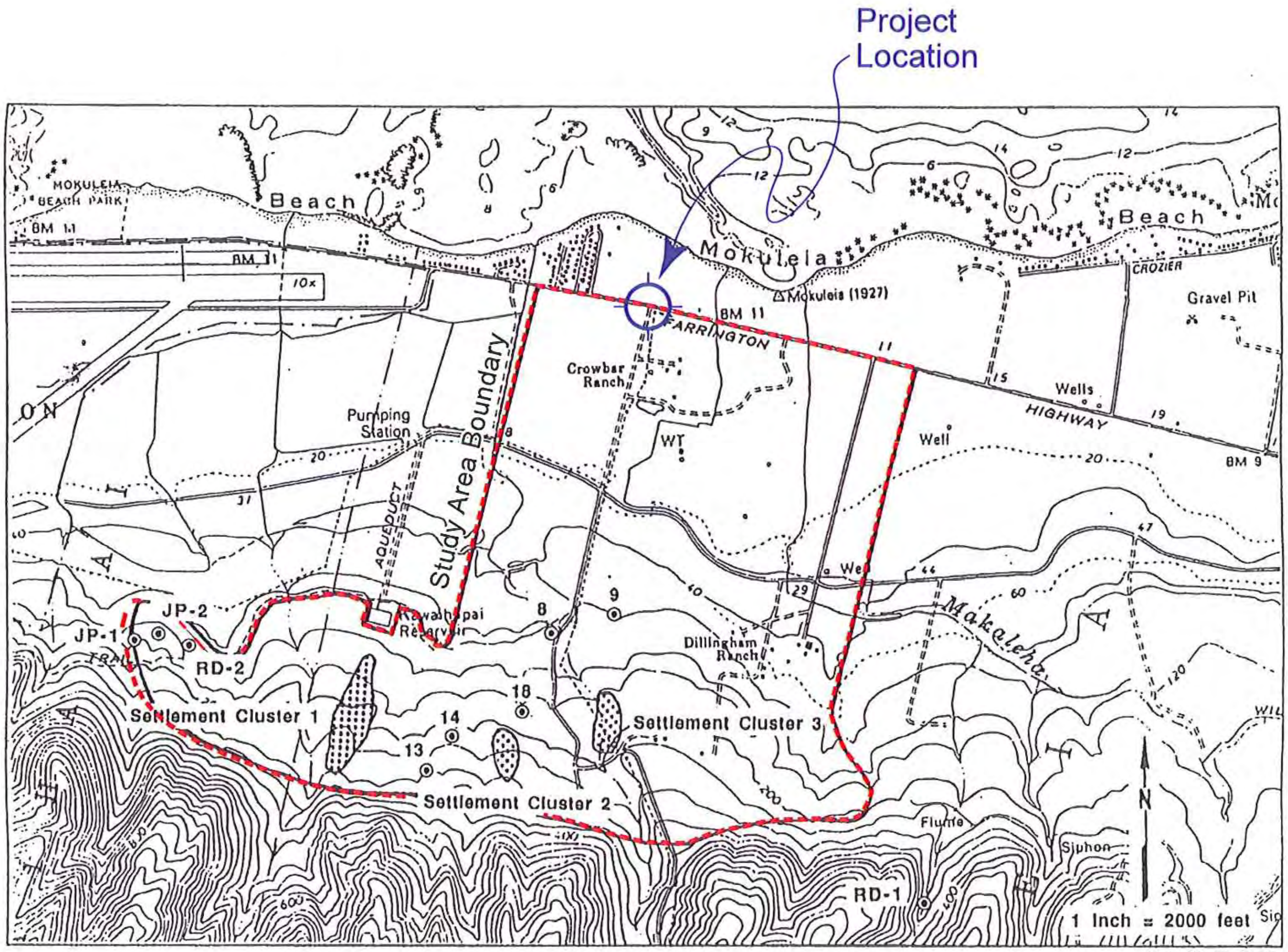
A similar precautionary approach will be applied to work activities for the planned subdivision. All work will be coordinated with the SHPD, including the temporary cessation of earthworking activities in the event that any undocumented inadvertent cultural or archaeological deposits are discovered by the construction contractor. The SHPD will be immediately notified and work may only be resumed upon proper notification to do so by the SHPD.

2.1.7 Beach Erosion and Sand Transport

The project site is located within a small portion of the Dillingham Ranch property and State DOT, Farrington Highway, right-of-way. This location is not normally subject to natural shoreline processes involving the seasonal and tidal movement of sand. Beach erosion as a result of the project is not anticipated or expected based on the project location, the limited nature of work, and preventative measures that will be taken by the contractor to ensure against erosion of soils from the project site.

2.1.8 Noise

Existing sources of noise in the project area are limited to surf, motor vehicles traveling along Farrington Highway, aircraft from the nearby Dillingham Air Field, wind from trees, and avifauna and human associated activities in the area (primarily equestrian activities and groundskeeping associated with the equestrian facilities). Most, if not all of these sources of noise are limited and do not ordinarily constitute an acoustic nuisance.



ERCE

ARCHAEOLOGICAL SITE LOCATIONS

FIGURE 2

Source: Base drawing from ERCE, 1991

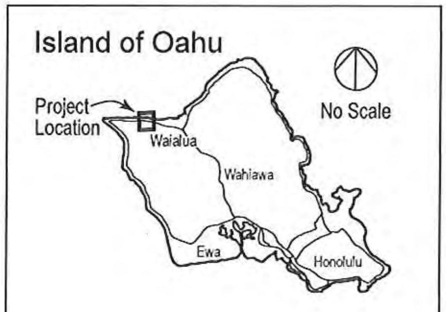


Figure 6 Drolet & Shilz Archaeological Site Locations (1991)
Intersection Improvements
Dillingham Ranch 'Āina, LLC

0 500 Feet 1000

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Potential Impacts and Mitigation Measures

Construction of the proposed project will introduce increased noise in the area immediately surrounding the project site from work crews and the operation of construction equipment. The construction equipment is expected to include, but not be limited to, a compactor, grader, bulldozer, concrete mixer and delivery trucks, and powered hand tools.

The project area is located within a rural, country setting. The closest residences and structures to the project site are identified in **Figure 7,** Proximity of Residences/Structures. According to Figure 7, the closest residences include private homes and the Mokūleʻia Beach Colony at a distance of approximately 800+ linear feet. A maintenance building for upkeep of a polo field is located across the Farrington Highway at a distance of approximately 320 linear feet as shown.

The small scope and scale of the work suggests that there is limited potential for construction related noise to adversely affect residences. Mitigative measures to minimize or reduce potential noise impacts will include construction activities to daylight working hours from about 8:00 am to 4:00 pm and inspecting all combustion powered machinery to ensure the equipment is properly muffled.

2.1.9 Air Quality

No information on air quality was collected. Construction activities are expected to have little or no impact since the project will be of limited duration and where engine exhausts may be a source of potential air pollution, all internal combustion equipment will be governed in accordance with applicable state and county regulations.

Potential Impacts and Mitigation Measures

During construction, fugitive dust may be generated which can constitute a nuisance to traffic along the Farrington Highway. Residences in the area of the project are not anticipated to be affected. The prevailing northeast trade winds should direct any fugitive dust towards the undeveloped hillsides and ravines of the Dillingham Ranch property. Should infrequent Kona winds occur, any construction related fugitive dust would be directed across the polo field or the City's undeveloped Makaleha Beach Park property.

To reduce the incidence of fugitive dust the construction contractor will regularly wet disturbed soil areas or areas that are susceptible to the generation of dust.

Source: Base photo, Google Earth, 2007. Dillingham Ranch Agricultural Subdivision overlay, R. M. Towill Corp., 2007.

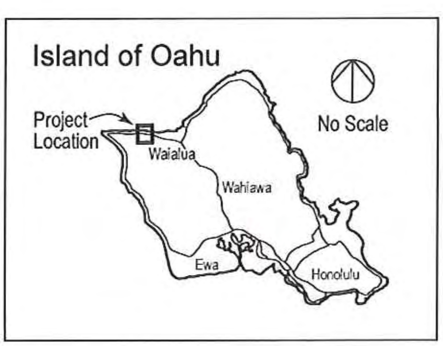

Figure 7
Proximity of Residences/Structures
Intersection Improvements
Dillingham Ranch 'Āina, LLC

No Scale

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2.1.10 Flood Hazard

Federal Emergency Management Agency (FEMA), Flood Insurance Rate Map (FIRM), Map No. 15003C0085F, dated September 30, 2004, the project site is in an area designated as Zone AE (**see Figure 8,** FEMA FIRM Map). The Zone AE designation is the flood insurance rate zone that corresponds to the 1-percent annual chance floodplains that are determined in the Flood Insurance Study by detailed methods of analysis. The Base Flood Elevation determined for this zone is undetermined.

Potential Impacts and Mitigation Measures

Although the proposed facility will be located within the zone AE, it is noted that no habitable structures are proposed that would constitute an unreasonable risk to life or property. Given the traffic control nature of the project, the proposed use is considered reasonable and is not anticipated to have a significant impact on flood conditions. No further mitigation measures are planned or proposed.

2.2 Public Facilities

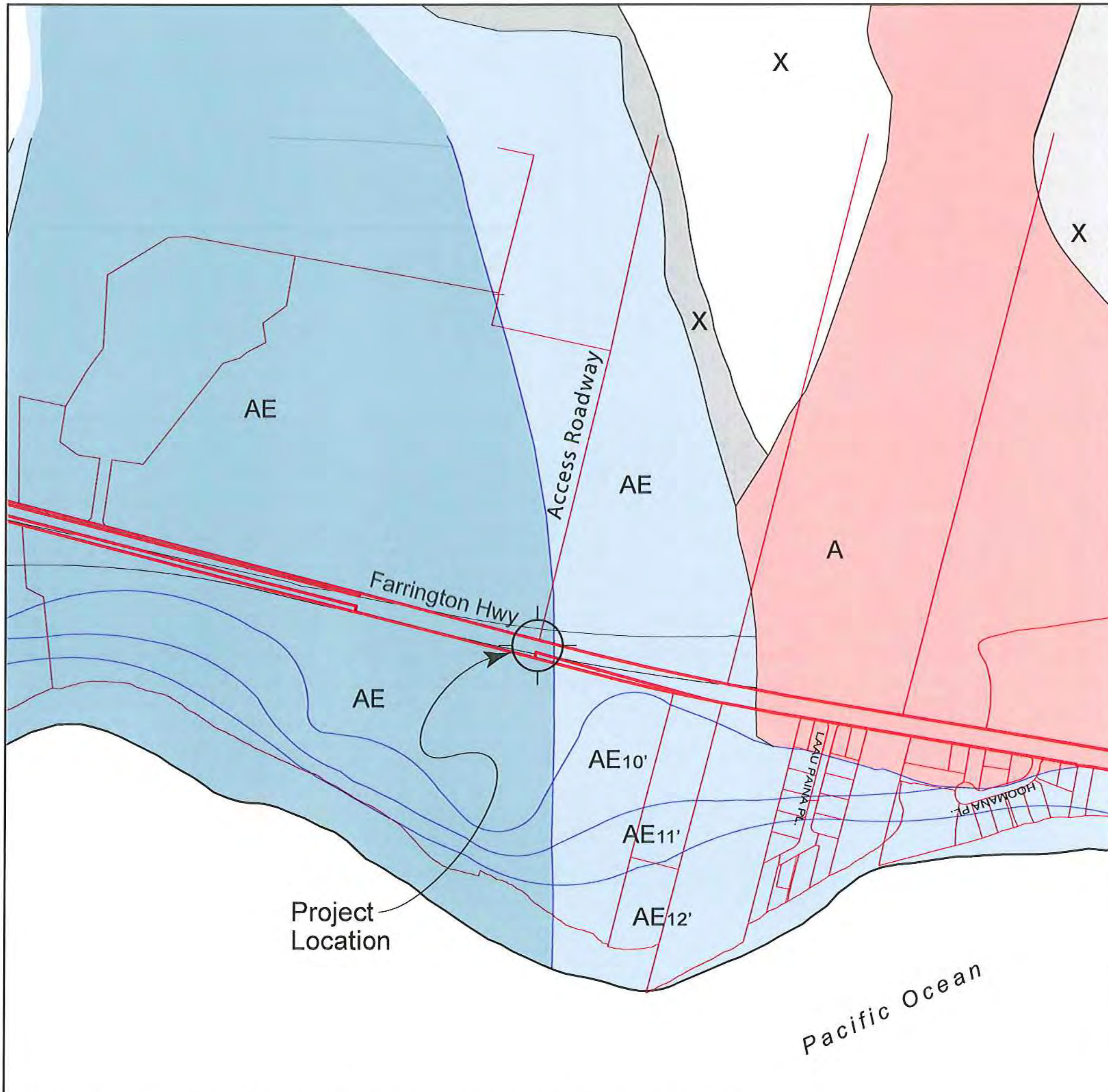
2.2.1 Access

The proposed project will not affect public shoreline access. It is located along the existing Farrington Highway and will provide for improvements to an existing point of entry to the Dillingham Ranch property.

2.2.2 Traffic and Roadways

A Traffic Assessment for the proposed Dillingham Ranch Agricultural Subdivision was completed on January 4, 2008 (Julian Ng, Inc., 2008, See **Appendix E**). The planned subdivision of about 900 acres will create approximately 77 agricultural lots requiring access to the Farrington Highway. The finding of the traffic report was that the existing roadway system would be sufficient to accommodate the anticipated increase in traffic. According to the report:

> Vehicular access to the subdivision will be provided by a dedicated project roadway that intersects Farrington Highway as the stem of a "T"-intersection. Traffic on the project roadway's northbound approach to the intersection will be controlled by a "STOP" sign. The project roadway, a two-lane roadway carrying traffic in both the northbound and southbound directions, will have a single lane on the northbound approach that will be shared by traffic making left turns and right turns onto the highway.



Source: Flood Insurance Rate Map, Panel 0085F, Panel 85 of 395, City & County of Honolulu, Hawaii, Map No. 15003C0085F, Map Revised September 30, 2004, FEMA.

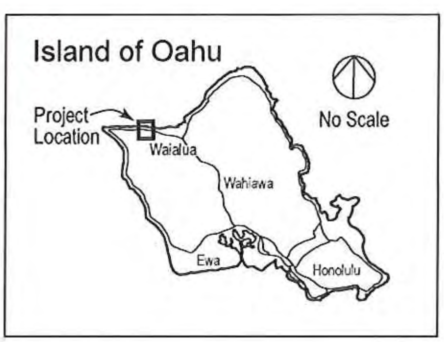


Figure 8 FEMA FIRM Map
Intersection Improvements
Dillingham Ranch 'Āina, LLC

0 500 Feet 1000

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Existing Traffic Conditions

Traffic volumes on Farrington Highway are based on the latest published count data from a 48-hour traffic count taken by the State Highways Division on Farrington Highway at Kapalaau Bridge near the project site in March 2005; the daily totals and peak hour volumes from this count are shown in Table T-1.

Table T-1
Existing Traffic on Farrington Highway

	24-hour total		AM Peak Hour		PM Peak Hour	
	April 19-20, 2004	April 20-21, 2004	April 19-20, 2004	April 20-21, 2004	April 19-20, 2004	April 20-21, 2004
Westbound	1164	1099	120	73	89	76
Eastbound	1154	1177	53	67	93	91
Total	2318	2276	173	140	182	167
Peak Hour			7:15-8:15	7:30-8:30	3:45-4:45	3:00-4:00

Source: State of Hawai'i, Department of Transportation, Highways Division, *Traffic Count Summary-Island of O'ahu 2004.* Station C-23-D, Farrington Highway at Kapalaau Bridge.

Project Impact

The traffic impact of the proposed subdivision was evaluated for approximately 77 new agricultural lots. These lots will typically generate only small volumes of traffic during peak hours; however, in order to determine the potential traffic impact, peak hour traffic volumes generated by these lots were estimated using trip rates for suburban detached (single-family) dwellings from the Institute of Transportation Engineers[1], which assume that residents commute regularly. Table T-2 shows the estimates of peak hour traffic generation (shown to nearest 5 vehicles).

Table T-2
Traffic Generation

	Trip Rates* detached dwellings		Traffic Generated 80 dwelling units	
	Trips per dwelling	% entering	Entering site	Exiting site
Average weekday	9.57	50%	380	380
AM Peak Hour	0.75	25%	15	45
PM Peak Hour	1.01	63%	50	30
*Source: Institute of Transportation Engineers, *Trip Generation, 7th Edition.*				

[1] Institute of Transportation Engineers, *Traffic Access and Impact Studies for Site Development, A Recommended Practice, 1991*

The traffic generated by the project is well below the 100 vehicles per hour in the peak direction that has been suggested by the Institute of Transportation Engineers as the threshold for conducting a traffic impact or site access study.

With Farrington Highway terminating approximately three miles to the west near Kaena Point and no significant destinations for peak hour residential traffic located in that direction, all of the project traffic is expected to use Farrington Highway to the east.

Future Conditions at Proposed Access Intersection

Peak hour conditions at the proposed intersection of the project access road and Farrington Highway would determine if additional improvements will be needed. Future conditions at the intersection, therefore, were analyzed.

The most recent available estimates of the Average Daily Traffic (ADT) volumes on the segment of Farrington Highway between Dillingham Airfield and Puuiki Street, located in Waialua approximately 3 miles to the east of the project, are shown in Table T-3.

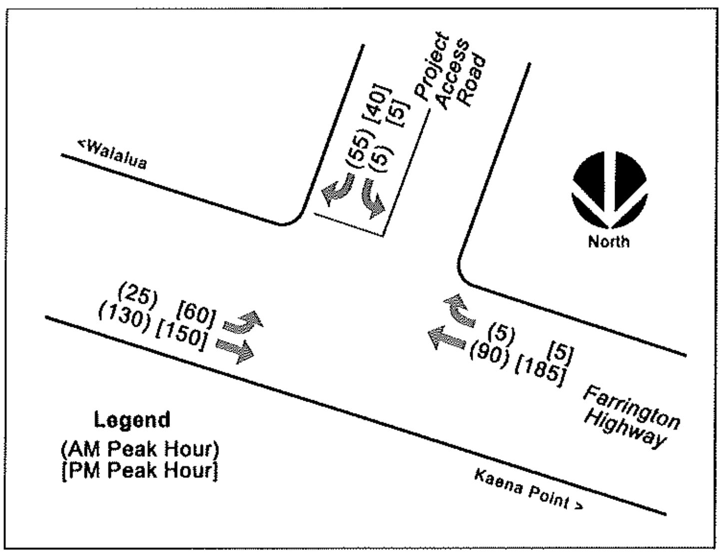
Table T-3
Historic Trend in Highway Traffic Volumes

Year	Average Daily Traffic
1999	3,794
2000	3,953
2001	3,743
2002	4,053
2003	4,074
Source:	State of Hawai'i Department of Transportation Highways Division, *Traffic Summary - Island of O'ahu, 2003.*

The average rate of increase in traffic volumes from 1999 to 2003 was 1.8% per year. At this average rate of increase, traffic volumes in the future year 2030 would be 56% higher than in 2005. Average Daily Traffic at this rate of growth would be 4,450 vehicles per day in 2008 and 6,600 vehicles per day in 2030. As a comparison, the traffic generated by the project (760 vehicles on an average weekday, from Table T-2) would be approximately 17% of the existing traffic on the highway.

Figure T-2 shows estimates of future (year 2030) peak hour traffic volumes at the intersection of the project access road with Farrington Highway. The through volumes on the highway are based on the average peak hour volumes counted at the nearby station in 2005 and the annual rate of increase discussed above. The turning volumes assumed that all of the project traffic would turn to or from the east (Waialua direction). The traffic assignments include additional turning movements to and from the east (an additional 10 vehicles per hour in each direction) to account for other traffic that may use the project access road. Additional traffic movements of 5 vehicles per hour were also added for turning movements to and from the west (Kaena Point direction).

Figure T-2
Traffic Assignments (2030)



The procedure described in the Highway Capacity Manual[2] (HCM) was used to analyze the intersection and acceptable conditions at the intersection were found, as summarized in Table T-4. The analysis estimates average delays based on traffic volumes, these delays are described by "Levels of Service" for the controlled movements at the intersection; the HCM defines the Level of Service (LOS) for unsignalized intersections as follows (Level of Service C or better is considered acceptable):

[2] Transportation Research Board, National Research Council, *Highway Capacity Manual*, Washington, D.C., 2000.

Transportation Related Levels of Service (LOS)

LOS	General Description of Delay	Average Delay (second per vehicle)
A	Little or no delay	≤ 10
B	Short traffic delays	> 10 and ≤ 15
C	Average traffic delays	> 15 and ≤ 25
D	Long traffic delays	> 25 and ≤ 35
E	Very long traffic delays	> 35 and ≤ 50
F	Very long traffic delays	> 50

Table T-4
Intersection Levels of Service (2030)

	Westbound left turns from highway		Northbound approach (shared lane, stop sign)	
	Delay	LOS	Delay	LOS
AM Peak Hour	7.5 seconds	A	9.3 seconds	A
PM Peak Hour	7.8 seconds	A	10.0 seconds	B

While left turns from the highway can be made with minimal delays, the need for a separate left turn lane on the highway was also evaluated. The "green book" design manual published by the American Association of State Highway and Transportation Officials (AASHTO) provides a table showing conditions under which a separate left turn lane should be considered on two-lane highways. The AASHTO table is used to determine the advancing volume at which a separate turning lane should be considered. As shown in Table T-5, the estimates of the advancing volume (from Figure T-2) are less than the volumes at which a separate left turn lane should be considered.

Table T-5
Traffic Characteristics for Consideration of a Separate Left Turn Lane

	AM Peak Hour	PM Peak Hour
Proportion left turns (from Figure 2)	16%	29%
Opposing volume (from Figure 2)	95	190
Advancing volume (from Figure 2)	155	210
Advancing volume at which separate turn lane should be considered, for an operating speed of 50 miles per hour (interpolated)*	380	275
Consider separate left turn lane?	not necessary	not necessary
* Based on Exhibit 9-75 of *A Policy on Geometric Design of Highways and Streets,* from American Association of State Highway and Transportation Officials, Washington, D.C.		

A simple connection to the highway with a stop sign controlling the side street will adequately serve future traffic volumes at the intersection. A separate left turn lane on the highway will not be needed.

Conclusions and Recommendations

The proposed subdivision is not expected to have a significant impact to traffic conditions on Farrington Highway. The estimated peak hour volumes at the intersection of the project access road and the highway do not meet the guidelines for consideration of adding a separate left turn lane.

The intersection should be designed with adequate sight distance for drivers at the stop sign on the side street. The intersection should be clearly visible for drivers on the highway; if necessary, warning signs should be considered to improve driver awareness of the new intersection.

Potential Impacts and Mitigation Measures

The proposed project is not expected to significantly alter the existing volume of traffic along Farrington Highway. However, construction-related work, including delivery of building supplies, and construction vehicles may temporarily affect traffic flow. These effects are expected to be short-term and will be experienced only during construction of the project. Construction activity is planned during the daytime hours with no night work anticipated to be required.

As required, adequate sight distance for drivers will be provided at the stop sign and along Farrington Highway. Warning signs will also be evaluated for use to improve driver awareness of the new intersection.

2.2.3 Police, Fire and Ambulance Service

The project site is readily accessible for police and fire service based on its location along Farrington Highway. Police services are provided for the area from the Wahiawa Police Station. Fire protection is provided by the Waialua Fire Station No. 14, located in Hale'iwa. If additional fire fighting service is required, the Sunset Beach Fire Station No. 11, would be called on to respond. Ambulance service is provided by the City & County of Honolulu facilities at the Waialua and Wahiawa Fire Stations.

Potential Impacts and Mitigation Measures

The proposed project in itself is not expected to generate any new demand for police, fire or ambulance service. During construction, however, these services may be temporarily required but are not expected to result in the requirement for new personnel or construction of new police, fire or ambulance facilities.

No impacts and no mitigation measures are proposed.

2.3 Additional Information Concerning the Potential for Secondary Impacts Associated with the Dillingham Ranch Agricultural Subdivision

This section provides additional information and references to studies, reports and correspondence prepared for the subdivision. Further discussion is provided regarding the potential for secondary impacts as a result of the proposed project involving the T-intersection improvement and its relationship to the planned agricultural subdivision.

2.3.1 Agricultural Feasibility Report

Background

In November 2007, an Agricultural Feasibility Report was prepared to support the processing of an application for the consolidation and resubdivision of the Dillingham Ranch property (Development Strategies, LLC, November 2007). The following is a brief summary of the major items of the Report (**Appendix F**).

The report focused on the creation of an approximately 77 lot subdivision within an agricultural community and provides information on the agricultural activities of the Dillingham Ranch and the plan for its sustainable future.

DRA acquired the 2,722 acre property in 2006, and intends to restore the existing infrastructure and make other improvements to maintain the Ranch in active cattle production and other agricultural activities consistent with the character of the Mokūleʻia -Waialua area. A major part of the effort will involve restoration of the Dillingham House, a historically significant structure located on the premises.

The North Shore Water Company, wholly owned by DRA, operates two active wells on the property and delivers potable and non-potable water to sustain the day-to-day operation of the Ranch. In addition, as a quasi-public utility, the North Shore Water Company provides domestic water to 120 customers in the adjacent community of Mokūleʻia located to the west of the Ranch. The provision of domestic water is an essential public service based on the termination of the Board of Water Supply system approximately a half mile in the Waialua direction (east) of the bulk water meter that provides domestic water to other customers of the region. The North Shore Water Company anticipates that it will continue to provide domestic water service to the Mokūleʻia community for the foreseeable future.

Agricultural Subdivision Concept

The Dillingham Ranch Agricultural Subdivision concept is based on the consolidation and resubdivision of 12 of the 13 existing parcels of the property to create 77, five acre lots, 6 bulk lots ranging in size from 32 acres to 116 acres in The Flats, and an additional large bulk parcel comprising 1,484 acres of The Mauka Lands (collectively known as the "Ranch Lots") (see page 9, Figure 4, of the report).

Agricultural Plan

The Agriculture Plan for the working ranch is intended to restore the Ranch to an efficient, self-sustaining operation. The Plan supports this by focusing on improvements to the existing core activities of the Ranch, making more productive use of the property and enhancing the quality of the products and services provided to the various market segments, rather than attempting to launch new and unfamiliar ventures. This strategy capitalizes on the existing expertise of the Ranch personnel, but redirects the focus to maximizing efficiency and accessing new, untapped markets for existing goods and services:

Cattle

Revenue from the propagation of cattle is marginal and needs to be improved. A modest increase in the size of the herd, along with an upgrade of the stock for the natural food market, is contemplated over the next 3 to 4 years, given the strong demand for range fed beef.

Part of the strategy calls for calves to be kept until they are 8 months old and weigh about 400 pounds. Heifers and steers of this size appeal to both local ranches and mainland operations that service natural food retailers like Whole Foods.

The quality of an open pasture is highly dependent on soil conditions, amount and seasonality of rainfall, micro-climate of the area, type of pasture grass and the topography. Future grazing activities would utilize a gross area of about 1,900 acres. The projected size of the expanded herd would be approximately 220 cows and 15 bulls. In addition to making productive use of the land, the grazing of cattle would also reduce the unchecked growth of vegetation, mitigating the potential for wild fires like those the plagued the Waialua-Mokūleʻia area in 2007.

Coordination of cattle ranching operations in tandem with development of the infrastructure to service the Subdivided Lots will be essential, as the source of drinking water for the cattle will be provided from common water lines. Extension of water lines beyond the perimeter of the agricultural community will be handled by the ranch crew, with backflow prevention devices installed to ensure that the domestic water system is not contaminated.

In addition to the water lines, approximately 30,000 linear feet of cattle fencing will be installed to replace dilapidated fencing. The fencing would be installed incrementally, as the size of the herd is increased.

While it is anticipated that the dollar return is nominal, the grazing of cattle will retain The Mauka Lands in open space, preserve scenic vistas of the Waiʻanae Mountains, reduce the potential for wild fires and maintain the area in valuable watershed.

Tree Farm

The propagation of new coconut trees to replace sold field stock and to meet contracts is anticipated to expand the tree farm by roughly 25%. Expansion of the tree farm by 15 to 20 acres would be into the adjacent underutilized portion of The Flats which are presently subject to occasional flooding by storm water from Makaleha Stream. However, the expansion area is located in the flood fringe, where the back-up of storm water comes from the parcel across the highway that was conveyed to the City & County of Honolulu ("City") for a future park site in 2000.

To mitigate these occasional impacts, DRA has taken the lead and is presently clearing overgrown vegetation in the site of the future park. In addition to vegetation, accumulated silt and debris from an area that is supposed to function as a retention basin is also being removed. This work is being done in conjunction with the City's Department of Parks & Recreation and Department of Facilities Maintenance which have issued the necessary permits to DRA. With this clean-up completed, storm water will be able to flow freely under the bridges on Farrington Highway, into the retention basin and eventually out to the ocean. This will minimize the times that the expansion area for the tree farm is subject to inundation.

With the initial expansion of the tree farm, seedlings will be planted. The future inventory from the expansion area will enable the stock in the existing tree farm to be depleted so that seedlings can eventually be planted with the required on center spacing.

In addition to adequate spacing, drip irrigation will be utilized to improve the growth rate of seedlings. The objective is to quickly grow the trees to the 15' to 25' height that is highly marketable. Properly spaced, trees can be efficiently watered by drip irrigation for an average of 400 to 500 gallons per acre/day.

Drip irrigation significantly lowers water loss during application, minimizes labor costs and has the advantage of limiting the growth of weeds as water is delivered directly to the root ball. The installation of a drip irrigation system in the expansion area would involve nominal expense, as a water distribution line presently runs across area. Flexible drip irrigation lines are easy to handle and relatively inexpensive. The cost for additional extension of distribution lines and drip irrigation tubing is estimated to be $35,000.

Additional access to the landscape community would be provided through membership in the Landscape Industry Council of Hawaii ("LICH"). Another good resource is the Hawaii Chapter of the American Society of Landscape Architects. Both of these organizations provide access to an effective network to landscape contractors and landscape design professionals on Oahu.

Boarding and Equestrian Activities

DRA will shortly initiate a program to completely replace the fencing for the existing paddocks and pasture area. The reconfiguration will create more paddocks with a uniform 70' by 120' size, which is an industry standard.

Up to date pasture management practices will be employed to increase the growth of pasture grass and Giant Bermuda will be introduced incrementally to achieve a better yield per acre of forage. The combination of the foregoing activities is anticipated to enable the Ranch to maintain the equivalent number of horses stabled within the reconfigured and upgraded paddocks and fenced pasture areas with increased efficiency.

A new fenced, multi-horse pasture will be created on the Ka'ena (west) side of the main entry road into Dillingham Ranch. The new pasture area will be implemented once the combined leach field for the agricultural community has been installed (underground piping). The pasture will not be irrigated and is intended to only be used as part of a systematic rotation designed to provide a chance for the smaller paddocks to regenerate. At this time, there are no plans for this to become an expansion area for the boarding of horses.

At some point in the future, a polo field may be constructed on a portion of the new fenced pasture area. At most, the polo field would be a seasonal use of the pasture area, possibly on a concession or licensed basis to an independent operator. The grassed pasture/polo field will not affect the leach filed or alter the intermittent flow of runoff from the areas inland.

As the clean-up of the future City park area is completed to mitigate the occasional inundation of The Flats, an additional fenced, multi-horse pasture may be an option for the most flood prone area of the Ranch, just inland of the frontage along Farrington Highway. The additional multi-horse pasture will be used for the rotation of horses to enhance regeneration of the individual paddocks and as an alternate pasture site during the polo season. This area is not intended to become a permanent pasture for the boarding of horses and will not be irrigated.

As part of the upgrades to the Ranch, the office and related buildings at the Equestrian Center will be renovated. The existing training facilities will also be upgraded to provide more areas for simultaneous multi-horse activities. To facilitate the foregoing, new fencing will be erected to create separate areas for specialized training, such as dressage.

Two new improvements planned for the area of the Equestrian Center are a feed barn, to replace the present use of a tent, and a *horspital* to permit certain treatments to be performed on-site. The *horspital* will enable sick or injured animals to be isolated while they are being treated. The *horspital* will also contain a small office for use by veterinarians and a separate room where minor procedures can be done on site. These facilities will significantly improve the services offered as part of the boarding operation to further differentiate Dillingham Ranch from other stables.

In total, improvements to the paddocks, pasture areas and the Equestrian Center will amount to about $1,897,500, with all of the upgrades to be in place in 2008. Additional improvements to the on-site water system are anticipated to cost $575,000, with other upgrades and improvements to be done to the makai area at a cost of $617,000.

Other Activities

Income from the sale of coconuts, horse shows and Pony Club events is anticipated to remain steady. With the development of the agricultural community, an additional source of revenue for the working ranch will come from the provision of pasture management services to the individual owners of the Subdivided Lots. While still in an embryonic stage, pasture management is contemplated to encompass monitoring the health of the pasture grass, maintenance of the irrigation system, cycling of the areas to be irrigated and tending to the livestock (including a feeding program), particularly when the owner cannot be present. The fees for these services have not been established at this stage.

Revenue from commercial filming, photo shoots and special events at the Dillingham House will drop in the near term while the facility is being restored.

In addition, restoration of the Dillingham House and the grounds will enable DRA to actively market the Ranch to the Japanese wedding market, solely for wedding ceremonies.

Due to the high cost of weddings in Japan, Hawai'i has become an attractive destination for young couples to come for their exchange vows.

The restoration work required for the historically significant Dillingham House will be extensive, with costs anticipated to reach $2,119,000. Renovations necessary for the kitchen area to handle special events (catered), such as receptions, is projected to cost an additional $778,000. Earlier in 2007, the old cesspool was upgraded to a state-of-the-art aerobic treatment system and leach field meeting the requirements of the State Department of Health at a cost of $250,000. The new treatment system has been sized to accommodate the larger occasional special events planned to be held at the restored Dillingham House.

The Agricultural Community

The agricultural community is an integral part of the Agriculture Plan, as the capital infusion required to refurbish and upgrade existing infrastructure systems and fund other improvements for the working ranch will be recovered from the sale of the Subdivided Lots. The in-place income received by a landowner for the long-term commitment of land to agricultural activities is modest and alone does not support the up-front commitment of the funds necessary to restructure the working ranch.

The creation of an agricultural community, the "80 Five Acre Lots" noted in the prior Agricultural Feasibility Study, is a critical component of the Agriculture Plan contained herein (Note: the updated Preliminary Map has a total of 77 Subdivided Lots). The sale of the Subdivided Lots is the mechanism by which DRA will recover its significant, upfront expenditure of capital for the improvements necessary to reposition the working ranch and in turn contribute to increased future revenues from all current income sources (as well as association dues for those amenities shared by the individual members of the agricultural community).

The Subdivided Lots that comprise the agricultural community will be ranching oriented. This is in keeping with the long history of Dillingham Ranch in the Mokūle'ia community, which has always been in cattle and horses, not in the cultivation of sugarcane or other farming activities. Ranching, the grazing of cattle, pasturing of horses and livestock propagation, is a bone fide agricultural activity. Pursuant to the provisions of Chapter 205, Hawaii Revised Statutes ("HRS"), the property will be subject to recorded covenants requiring that the Subdivided Lots be used for agricultural activities.

Development of the agricultural community will be a major undertaking. The costs associated with the provision of roadway access and related off-site and on-site infrastructure improvements to support the Subdivided Lots are high due to the distance from the highway, topography, and the limited utility service available in this rural area. In compliance with the Subdivision Rules & Regulations, all infrastructure improvements will be designed and constructed to City standards.

Conclusion

Dillingham Ranch has suffered a prolonged period of decline since the height of the plantation era of the early 1900s. The lack of reinvestment in the Ranch by a series of prior owners has left the working ranch operating on seriously deteriorated infrastructure where years of neglect are evident.

The acquisition of the property by DRA is based on recognition of the unique opportunity to reposition the Ranch as the heart of the Mokūleʻia community. While part of this effort will repair and upgrade the physical infrastructure and other facilities of the property, the larger task involves the restructuring of the "working ranch" to ensure its long-term viability.

In addition to a significant investment in the facilities at the Ranch, the Agriculture Plan is premised on a revamping of the core activities of the working ranch, rather than attempting to launch new and unfamiliar ventures. The focus maximizes the value of existing expertise and is directed at achieving more efficient day-to-day operations, enhancing the quality of the goods and services offered by the Ranch and tapping into new and expanded markets for existing products.

Implementation of the Agriculture Plan will require a significant up-front expenditure of capital by DRA. Such outlays cannot be recovered by the existing operations of the working ranch – cattle, trees, boarding and special events. This is the reason the subdivision and sale of five acre agricultural lots within an agricultural community on the Ranch is an integral component of the Agriculture Plan. This is the critical element that will generate the capital necessary to make implementation of the Plan a reality.

The core activities of the working ranch are in compliance with the provisions of Section 205.45, HRS, and the City's Land Use Ordinance (LUO), both of which regulate uses and activities on agricultural land. The creation of managed pasture, orchards or other crops on the five acre Subdivided Lots has been covered in a previous Agricultural Feasibility Report prepared for DRA.

Based on the foregoing, the proposed consolidation/resubdivision action to create the Ranch Lots and the Grazing Lot for the working ranch and the 77 Subdivided Lots in the agricultural community forms the foundation for generating the capital necessary to reposition the Dillingham Ranch for the future.

Potential for Secondary Impacts

The proposed agricultural plan and subdivision will constitute the continuation of agricultural uses that will be substantively similar to ranching activities that were once practiced by the original owners of the property dating to the 1900s. The potential for adverse secondary impacts associated with the continued agricultural use of property and the proposed T-intersection to support access to the property are not anticipated. As required, all continued activities involving upgrades to the infrastructure and facilities of the Dillingham Ranch and subdivision will be in accordance with state and county laws and regulations.

2.3.2 Rockfall Potential Evaluation

Background

In February 2008, a Rockfall Potential and Hillside Slope Evaluation Report was prepared to evaluate the potential for rockfall exposure associated with the Dillingham Ranch Agricultural Subdivision (Geolabs, Inc., February 15, 2008). This report superseded an earlier version of the report dated August 13, 2007, to address comments from the DPP concerning the need for sufficient protection of the lots planned for the Dillingham Ranch Agricultural Subdivision. The following summarizes the major report findings including comments from the DPP (**Appendix G**).

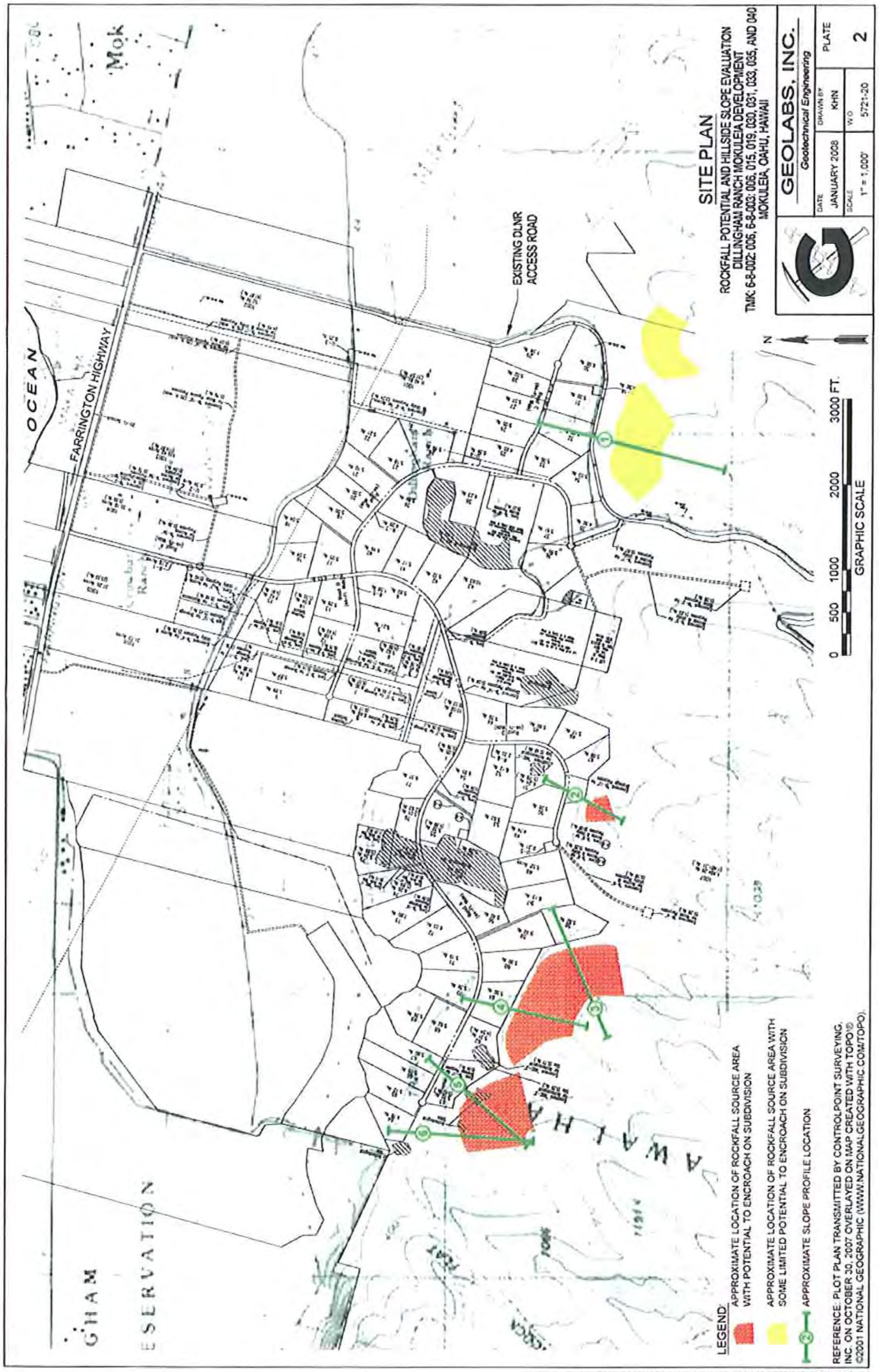
The purpose of the report was to conduct geological reconnaissance and evaluation of the existing hillslope conditions to develop a generalized data set to analyze and formulate a preliminary rockfall hazard assessment including rockfall hazard mitigation measures. The report provided for the following tasks (Geolabs, Inc., 2008):

1. Research and review available development plans and in-house (Geolabs, Inc.) soils and geological information, including aerial photographs from the project site and vicinity.
2. Perform a geological reconnaissance (visual observations) of the project site to evaluate the existing hillslope conditions and surface exposures of rock outcroppings and boulders by Geolabs, Inc., geologists.
3. Engineering analyses of the field data, including the performance of preliminary potential rockfall simulation modeling using the computer-based Colorado Rockfall Simulation Program (CRSP) to develop a statistical basis for the rockfall hazard assessment.
4. Prepare a letter report presenting preliminary findings and recommendations.
5. Coordinate all work on the project with the project geologist.
6. Provide quality assurance of the overall work on the project and the client/design team consultation with the Geolabs, Inc., principal engineer.
7. Miscellaneous work effort involving administration of the project.

Existing Potential Rockfall Conditions

Based on the site reconnaissance and evaluation, 9 proposed lots (identified as Lot Nos. 47 and 58 through 65) appear to have a moderate to high risk for potential rockfall encroachment from adjacent high mountain slopes outside of the development boundary. These higher risk lots are along and adjacent to the southern development boundary at the western and central portions of the site as shown on the Site Plan, Plate 2 (refer to report for detailed graphic). The 9 lots reside along alternating ridge and valley topography associated with the Waianae Range. In general, the areas of potential rockfall hazard are fronting the ridgeline nose and side slopes of the mountain ridges. (Geolabs, Inc., 2008).

5 lots (identified as Lot Nos. 30, 31, 32, 34, and 35) appear to have a low risk for potential rockfall encroachment from adjacent mountain slopes outside of the development boundary. The 5 lots reside along the flatter terrain of the lower elevation flanking mountain slopes. These lower risk lots are along the southern development boundary at the eastern end of the project site downslope and adjacent to the existing Department of Land and Natural Resources (DLNR) access road, as shown on the Site Plan, Plate 2. (Geolabs, Inc., 2008).



Source: Rockfall Potential and Hillside Slope Evaluation, Dillingham Ranch Mokuleia Development, Geolabs, Inc., 2008.

Notes: See Report in Appendix G for additional detail.

The report indicated that other proposed lots below the adjacent mountain slopes (including Lot Nos. 46, 48 through 50, and 57) is not anticipated to be affected by rockfall encroachment because of the following observed conditions (Geolabs, Inc., 2008):

1. The limited source of upslope boulders and rock outcroppings;
2. The lots are at a greater distance from the observed potential rockfall source areas;
3. Gentle hill slopes provide natural buffering terrain; and,
4. Some existing natural topographic barriers such as ravines.

A large volume of widely scattered boulders in generally stable ground surface settings were observed throughout the project site interior. The boulders represent old alluvial and colluvial deposits from the early erosion and geological evolution of the Wai'anae Range. It is believed that the old boulder deposits within the subdivision development have a low potential for producing hazardous rockfall conditions due to the gently sloping and generally stable depositional terrain. Boulders are expected to be encountered during the grading and development of the individual lots. The individual lot owners should therefore be advised to obtain the services of a competent geotechnical engineer to evaluate existing boulder deposits within their lots for potential instability and possible rockfall hazard mitigation. (Geolabs, Inc., 2008).

Based on the Geolabs, Inc., observations, some broad trends in the rockfall hazard potential and level of rockfall hazard risk with respect to the lots along the southern development boundary were identified. In general, the potential for rockfall activity to encroach upon the development increases from east to west across the southern development boundary. This is based on the following (Geolabs, Inc., 2008):

1. Upslope mountain ridges (rockfall source region) gradually steepen toward the west.
2. Foothill pediment slopes (probable rockfall run-out region encompassed by the lots) gradually steepen towards the west.
3. The distribution and relief of source rock outcrops increases toward the west.
4. The distribution of existing non-embedded surface boulders increases toward the west.

The existing ground surfaces within the lots along the upslope development boundary are composed of mixed soils containing an appreciable volume of basaltic cobbles and boulders. Surface boulders ranging between 3 and 12 feet in dimension were observed in generally stable ground settings within the lots. The larger surface boulders were generally encountered at the upper elevations of the western end of the project site. Most of the surface boulders encountered are partly embedded and are believed to be erosional remnants of old regional colluvial fan deposits that had accumulated a very long time ago. However, the distribution of non-embedded surface boulders (potentially more recent fallen rock) appears to increase toward the southwestern corner of the project site, in the vicinity of Lot Nos. 58 through 63. The greater distribution of existing surface boulders towards the southwestern corner of the development (vicinity of Lot Nos. 58 through 63) appears to correlate with the observed increased occurrence of upslope rock outcroppings consisting of higher relief, fractured rock. (Geolabs, Inc., 2008).

Existing Slope and Drainage Conditions

A number of existing well-established drainage ravines emanate from the large inland valleys. These substantial drainage ravines transect from south to north through the proposed development. The incised ravines provide near-surface exposures of the colluvial/alluvial fan deposits including scoured exposure of localized basalt rock formation in some upslope locations. The normally dry drainage ravines are believed to transmit appreciable runoff derived from the interior mountains during periods of high rainfall. As a result, the ravines should be considered as potential flash-flood conduits and future building sites should be set back at appropriate distances from the established channels. Hydrologic study should be performed as a basis for the designation of the infrastructure set backs from the drainage ravines. (Geolabs, Inc., 2008).

Overt visible signs of active, large-scale ground instability were not revealed within the project site. Because the drainage ravines incise the colluvial/alluvial fan deposits composed of unconsolidated and semi-consolidated hard cobbles and boulders, the existing ravine slopes appear to be naturally armored by the rocky and semi-consolidated deposits. However, some erosion and raveling of the natural stream banks composed of soils and rocky deposits should be anticipated; therefore, appropriate setback restrictions for future structures, roadways, and other improvements should be established by the project geotechnical engineer. (Geolabs, Inc., 2008).

Geological evidence related to the occurrence of other natural hazards such as recent debris flow and landslide activity was not encountered. Historic documentation or records of past occurrences of these natural hazards at the project site was not revealed. (Geolabs, Inc., 2008).

Discussion and Recommendation

Site reconnaissance and literature review was performed to assist in the evaluation of the existing project site conditions with respect to natural hazards such as rockfall potential, hill slope stability, and debris flowflash flood potential. In addition to the reconnaissance and literature review, computer simulation and statistical analysis was performed of potential rockfall activity using CRSP (CRSP) Version 4. (Geolabs, Inc., 2008).

Based on the evaluation of the existing project site conditions with respect to potential natural hazards such as rockfall, slope instability, and debris flow, it was the opinion of Geolabs, Inc., that the site is suitable for residential subdivision development and is feasible from a geotechnical point-of-view provided that the recommendations are implemented. Once the final grading plans for the project are available and have been reviewed, Geolabs, Inc., will render an opinion addressing the stability of slopes in the post-development condition. (Geolabs, Inc., 2008).

Rockfall Simulation Analysis

The CRSP is a computer program that is a widely accepted engineering tool used to estimate potential rockfall behavior by simulating probable rockfall activity based on input parameters that are assigned on a site-specific basis. Information obtained from the CRSP analysis includes the predicted falling rock velocity, bouncing height, kinetic energy, and roll-out distance. The output information is useful to assist in the site-specific design of various rockfall mitigation schemes such as rockfall impact barriers or other rockfall containment systems. (Geolabs, Inc., 2008).

Six selected hill slope model profiles identified as Slope Profiles 1 through 6 were developed for the CRSP analysis. The approximate locations of the six slope profiles used in our analysis are shown on the Site Plan, Plate 2. (Geolabs, Inc., 2008).

The CRSP analysis was performed using spherical shaped boulders (conservative rolling scenario) ranging in size from 2 to 8 feet in dimension rolling from the source area(s) identified during the field reconnaissance. For each simulation run, 1,000 source rocks were utilized to develop a statistical distribution of the results. (Geolabs, Inc., 2008).

The rockfall protection criterion is defined as the probable interception and catchment of 90 percent of possible rockfall hazards assessed by the computer rockfall simulation analysis (CRSP). The 90 percent catchment criteria is a target that is commonly used in engineering practice for evaluation criteria that can be quantified by a statistical and probability analysis using model data for natural occurrences such as rockfall activity. Since the analyses are based on statistics and probability, a 100 percent criterion is impractical to achieve. (Geolabs, Inc., 2008).

Based on the analysis (Geolabs, Inc., 2008):

- Rockfall encroachment at Lot Nos. 30 through 35 is anticipated to be limited and of low risk due to the existing gently sloping terrain adjacent to the development and the presence of the existing DLNR access road between the observed potential rockfall source area and the subdivision lots. Less than 2 percent of the simulated rockfall could encroach beyond the DLNR roadway corridor upslope of the development.

- No rockfall encroachment at Lot Nos. 46, 48 through 50, and 57 is anticipated.

- At Lot No. 47, the western half of the lot is exposed to potential rockfall hazards from the north and east facing slopes of the hillside bordering the lot. Approximately 50 to 85 percent of the simulated rockfall could encroach into the western side of Lot No. 47.

- For Lot Nos. 58 through 65, the lots are exposed to potential rockfall hazards from the adjacent northerly facing mountain slopes. Approximately 25 to 100 percent of simulated rockfall could encroach upon the lots, depending on the location along the mountain slopes.

Conceptual Rockfall Mitigation System

Nine (9) lots (Lot Nos. 47, and 58 through 65) were identified as exposed to moderate to high levels of risk for potential rockfall encroachment. For these 9 lots, Geolabs, Inc., recommends the construction of an appropriate rockfall containment system such as a rockfall impact barrier fence on the hillside above the affected lots to reduce the potential for rockfall encroachment. (Geolabs, Inc., 2008).

Five (5) other lots are believed to have some limited exposure to potential rockfall hazards from the hill slopes outside of the subdivision boundary. The 5 low risk lots include Lot Nos. 30, 31, 32, 34, and 35. For these 5 lots the recommendation is to construct an appropriate rockfall containment system such as a low capacity rockfall impact barrier fence or chain link fencing adjacent to and above the existing DLNR roadway corridor to minimize the potential for rockfall encroachment. (Geolabs, Inc., 2008).

The proposed rockfall containment system would consist of specialized rockfall impact barrier fences and associated graded access trails within land owned by DRA above the subdivision lots. The construction of graded access trails along the higher capacity rockfall impact barrier alignments was also recommended to facilitate the heavy barrier construction and the future maintenance of the barriers, which will traverse rough and irregular terrain containing many existing large boulders. At the eastern end of the development above Lot Nos. 30 through 35, the recommendation is to construct a low capacity rockfall impact barrier fence (or chain link fencing where appropriate) on the upslope side of the existing DLNR access road. Because of the existing access provided by the DLNR roadway, a graded access trail along the fence alignment may not be necessary if construction access to the site could be granted via the existing paved DLNR roadway. (Geolabs, Inc., 2008).

Rockfall Impact Barrier

Rockfall impact barriers are used worldwide as an effective rockfall mitigation and protection system. Rockfall impact barriers are commonly constructed on hillsides where the protection of down slope areas from varied and widespread sources of falling rock is necessary.
Rockfall impact barriers are considered to be a viable rockfall protection measure where a specific and limited source of potential rockfall cannot be readily identified and stabilized, or

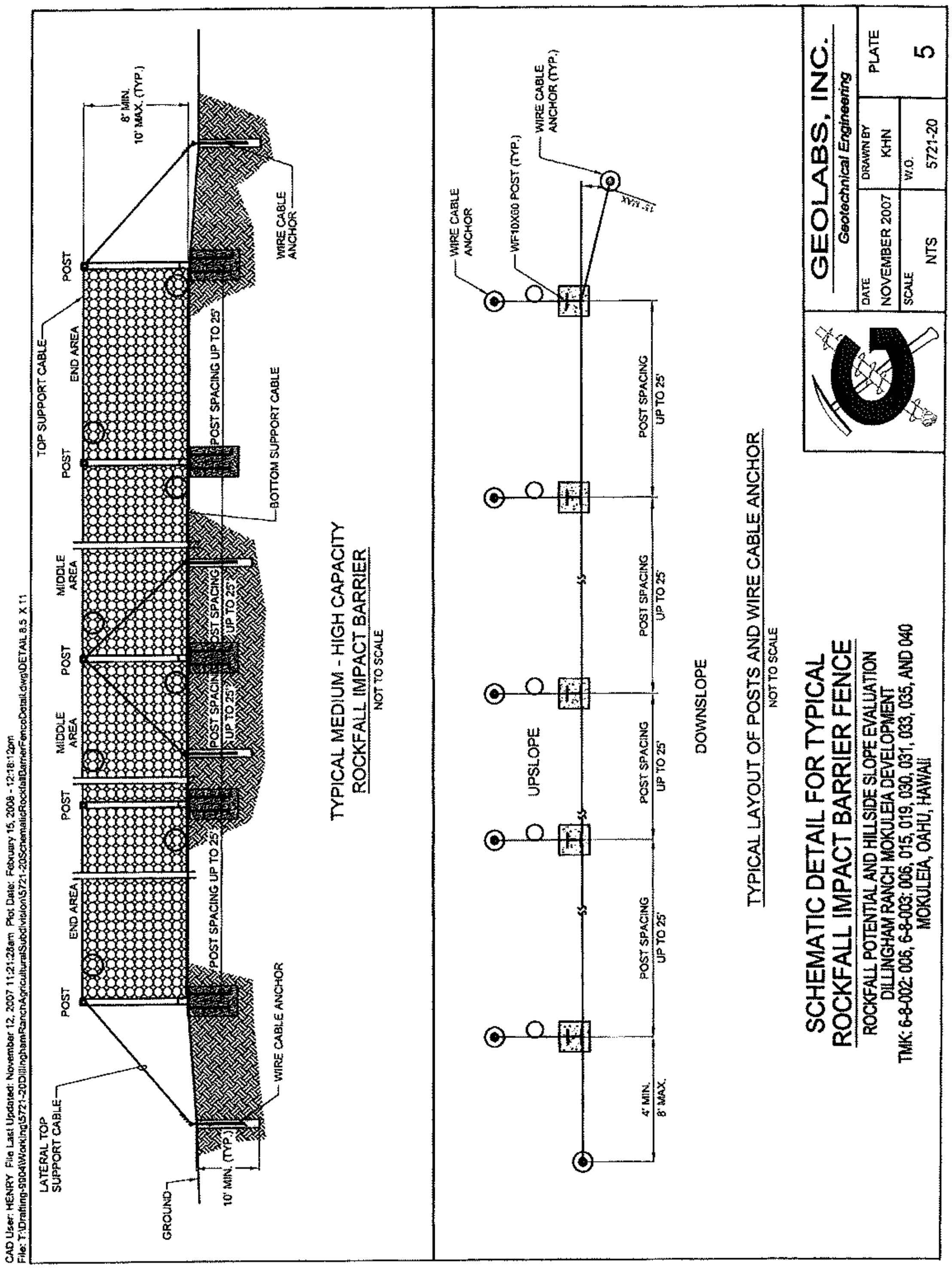
where the source area may encompass disturbance-sensitive land that makes other mitigation measures impractical to implement. (Geolabs, Inc., 2008).

Rockfall impact barriers are specially designed fences consisting of steel support beams linked by wire rope (cable) or steel wire ring nets, which are designed to flex and absorb rockfall impact energy. Rockfall barrier fences require periodic inspection and possible future maintenance to remove accumulated boulder debris and replace worn components. Portions of the barrier may require repair or replacement following a very large impact where severe deformation of the system is experienced. Ultimately, the rockfall barrier will require replacement of components affected by natural environmental degradation such as corrosion. (Geolabs, Inc., 2008).

The roughly estimated effective life of the steel barrier system in the Mokuleia near coastal environment would be approximately 30 to 40 years, at which time replacement of components such as nets, ground anchors and support beams may be required to maintain the desired level of protection. Stainless steel components and special surface coatings are available to increase resistance to corrosion but at a significant extra cost. A schematic of a typical medium-high capacity rockfall impact barrier is presented on Plate 5 (refer to report for detailed graphic). (Geolabs, Inc., 2008).

Rockfall Protection at Lot No. 47

A rockfall impact barrier is recommended to protect the western side of Lot No. 47 and a short segment of the subdivision Road "D" fronting the nose of a mountain ridge. The southern and western lot lines at Lot No. 47 are proposed based on a recent visual assessment of the area to allow for the provision of a rockfall impact barrier on suitable terrain upslope of the lot boundary. A ground topographic survey will be conducted in the project design phase to verify the constructability of a rockfall barrier at the desired location above Lot No. 47 and the subdivision roadway. (Geolabs, Inc., 2008).



Source: Rockfall Potential and Hillside Slope Evaluation, Dillingham Ranch Mokuleia Development, Geolabs, Inc., 2008.
Notes: See Report in Appendix G for additional detail.

If suitable terrain for an effective rockfall barrier cannot be identified by the topographic survey along the western side of Lot No. 47, the lot may be further reduced in size to accommodate an appropriate rockfall barrier to protect Lot No. 47 and the adjacent subdivision roadway. In the unlikely event that Lot No. 47 is eliminated from the development plan, the portion of the proposed rockfall impact barrier for Lot No. 47 could be reduced in length and replaced with a section of rockfall impact barrier along a limited segment of the proposed Road "D."

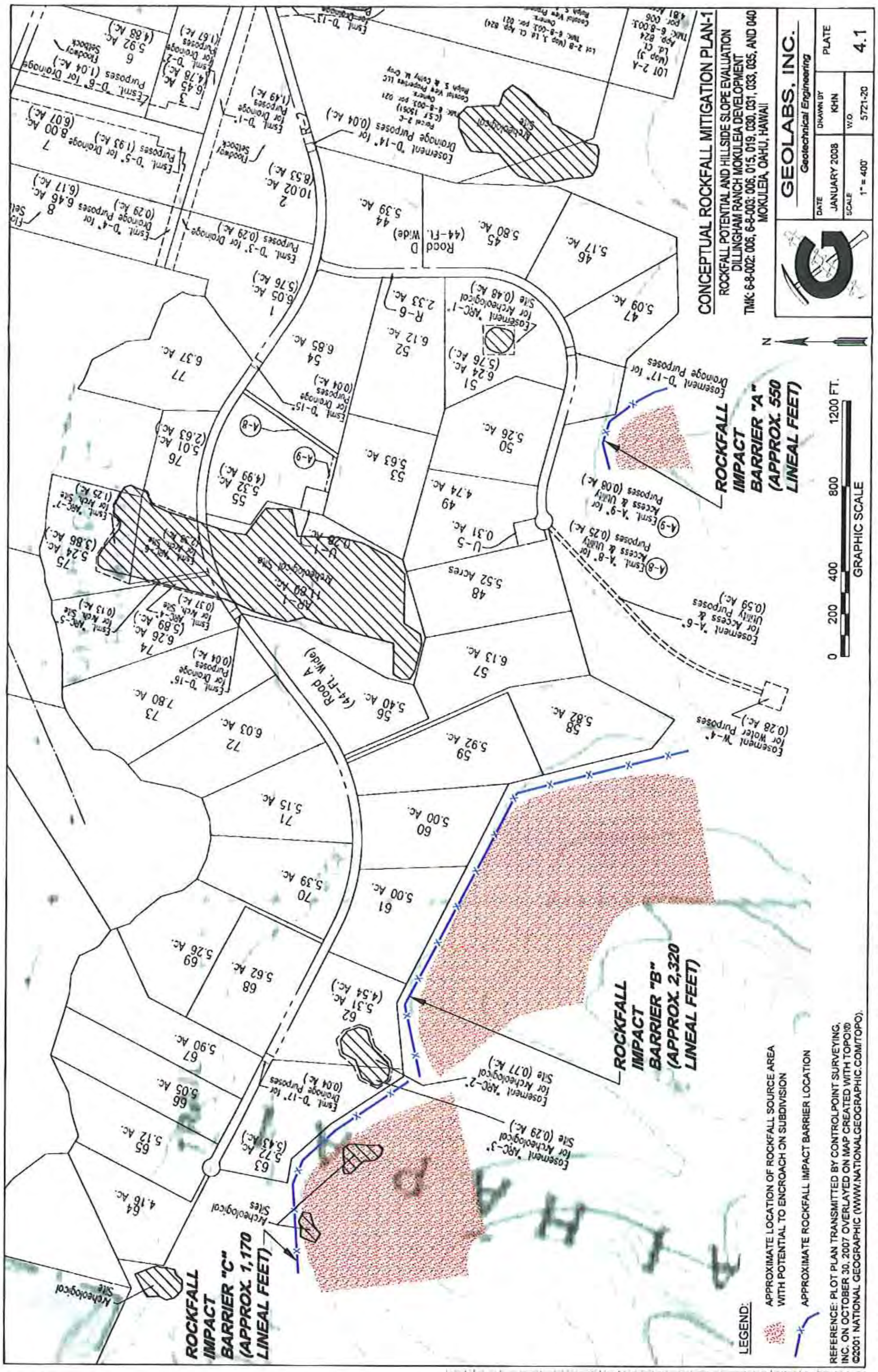
Based on the preliminary CRSP analysis, an 8 to 10-foot high rockfall impact barrier is estimated to be approximately 550 lineal feet in length with a capacity of about 100 to 150 foot-tons. The approximate location of Rockfall Impact Barrier "A" at Lot No. 47 and the adjacent subdivision roadway is shown on the Conceptual Rockfall Mitigation Plan 1, Plate 4.1 (refer to report for detailed graphic). (Geolabs, Inc., 2008).

To facilitate the construction and future maintenance of the rockfall impact barrier fence, a graded access trail should be constructed along the barrier alignment. A conceptual typical section for the rockfall barrier and access trail construction is presented on Plate 6 (refer to report for detailed graphic). (Geolabs, Inc., 2008).

Rockfall Protection at Lot Nos. 58 through 65

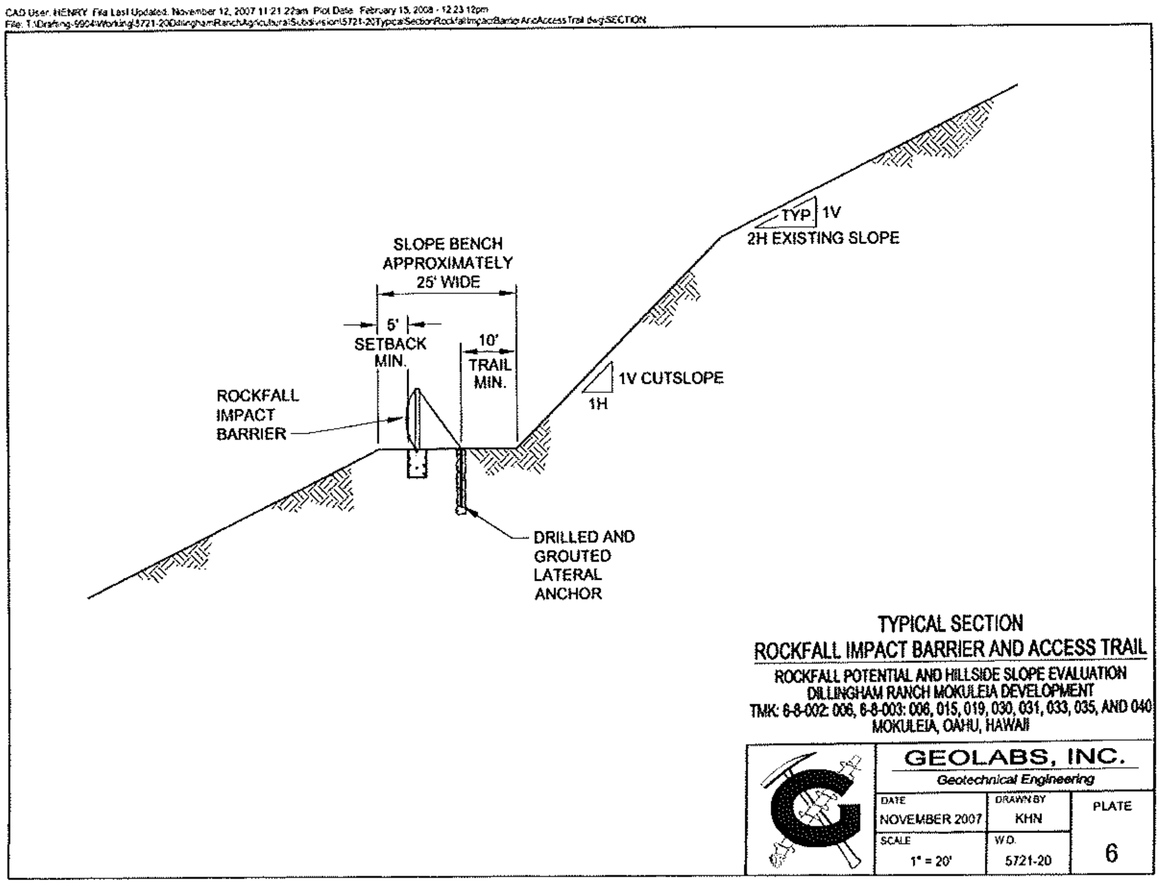
A rockfall impact barrier is recommended to protect the lots from potential rockfall encroachment from the adjacent high mountain slopes. The approximate and preliminary location of the rockfall barrier was identified by field reconnaissance. A ground topographic survey will be conducted along the barrier alignment in the project design phase to assist in the design of the improvements.

The rockfall impact barrier above Lot Nos. 58 through 65 could consist of two segments of barrier fencing with a break provided for the existing drainage gulch in the vicinity of Lot Nos. 62 and 63. The approximate location of Rockfall Impact Barriers "B" and "C" for Lot Nos. 58 through 65 is shown on the Conceptual Rockfall Mitigation Plan 1, Plate 4.1.



Source: Rockfall Potential and Hillside Slope Evaluation, Dillingham Ranch Mokuleia Development, Geolabs, Inc., 2008.

Notes: See Report in Appendix G for additional detail.



Source:
Rockfall Potential and Hillslope Evaluation, Dillingham Ranch Mokuleia Development, Geolabs, Inc. 2008.
Notes:
See Report in Appendix F for additional detail.

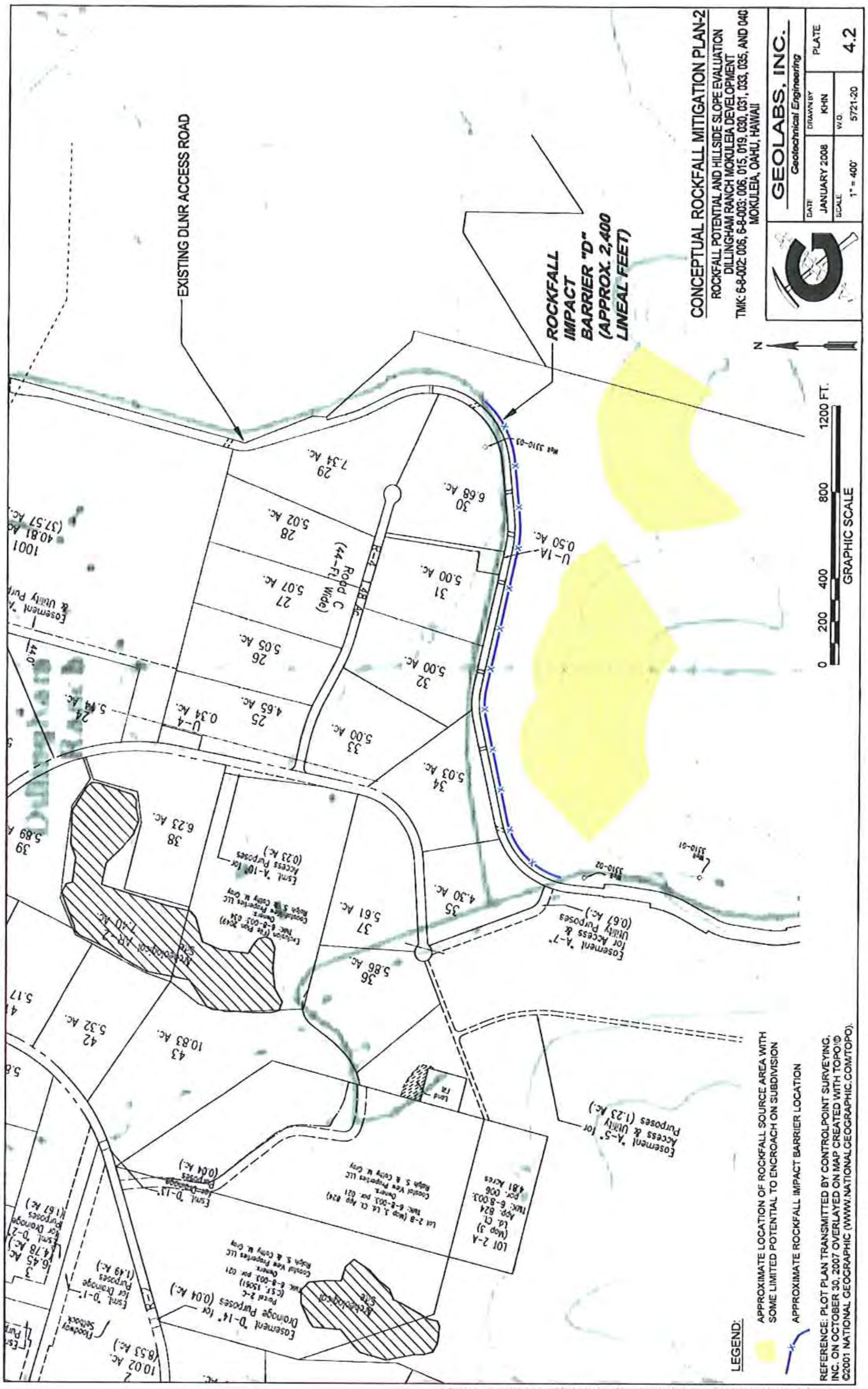
Based on the preliminary CRSP analyses, an approximately 8 to 10-foot high Rockfall Impact Barrier "B" and "C" would be an estimated 3,490 lineal feet in length with a capacity of about 200 to 250 foot-tons. To facilitate the construction and future maintenance of the rockfall impact barrier fence, a graded access trail should be constructed along the barrier alignment. A conceptual typical section for the rockfall barrier and access trail construction is presented on Plate 6.

Rockfall Protection at Lot Nos. 30, 31, 32, 34, and 35

Geolabs, Inc., previously recommended "Dwelling Location Restrictions" for these lots due to the relatively low risk and large lot sizes. However, the current development concept does not include "Dwelling Location Restrictions".

Based on evaluation of the existing site conditions in the vicinity of Lot Nos. 30 through 35 and the existing DLNR roadway, a low capacity rockfall impact barrier (or chain link fencing at appropriate non-critical locations) is recommended to reduce the risk for potential rockfall encroachment at the lots. Based on the preliminary design concept, the fence could be constructed approximately 10 to 20 feet upslope from the existing DLNR road Right-of-way within land owned by DRA. A ground topographic survey should be conducted in the project design phase to verify the constructability of the fencing at the desired location. Some clearing of existing boulders along the fence alignment may be necessary to facilitate the construction of the barrier structure.

Based on the preliminary CRSP analysis, the recommended 6 to 8-foot high rockfall impact barrier would be approximately 2,400 lineal feet in length with a capacity of about 30 foot-tons or less. The approximate location of Rockfall Impact Barrier "D" for Lot Nos. 30 through 35 and the adjacent DLNR roadway is shown on the Conceptual Rockfall Mitigation Plan 2, Plate 4.2 (refer to report for detailed graphic). (Geolabs, Inc., 2008).



Source: Rockfall Potential and Hillside Slope Evaluation, Dillingham Ranch Mokuleia Development, Geolabs, Inc., 2008.

Notes: See Report in Appendix G for additional detail.

According to the report, the recommended rockfall hazard mitigation scheme should significantly reduce the potential for dangerous rockfall activity to affect downslope development at the proposed DRA project site. While there are no guarantees in the professional engineering and architectural design fields with respect to potential rockfall hazards, the construction of rockfall impact barriers as described in the conceptual-level context of the report should provide a high level of safety against rockfall hazard based on past applications of similar mitigation methods.

Potential Drainage and Debris Flow Hazards

A number of large natural drainage ravines emanating from the upland valleys transect the proposed development. The ravines are capable of transmitting appreciable runoff through the development, especially during widespread storm runoff conditions. A rapid increase in stream flow during storm conditions (flash-flood conditions) should be anticipated in the normally dry drainage channels. The stream flow hydrology should be assessed by a qualified engineering consultant to address possible safety setback requirements for development adjacent to the stream channels.

No record or documentation of previous debris flow activity at the project site is known; however, the potential for transmission of debris flow materials within the larger valley draining stream channels is considered to be a possibility due to the well-developed character of the primary drainage ravines and extensive area of the upslope off-site drainage basins. Field evidence of past debris flow activity resulting from slope instability occurring within the project limits and adjacent to the upslope development boundary were not encountered.

Phase II Rockfall Mitigation Design

According to Geolabs, Inc., the recommended rockfall mitigation plan offers a comprehensive and cost effective mitigation scheme to provide a high level of rockfall protection for development downslope of the rockfall protection improvements shown on the Conceptual Rockfall Mitigation Plans 1 and 2, Plates 4.1 and 4.2.

Following the acceptance of the conceptual rockfall mitigation plan by the owner, the design of the rockfall mitigation improvements may proceed. A topographic ground survey should be performed at the locations surrounding the probable barrier construction sites to obtain detailed topographic information necessary for design and construction. Additional rockfall simulation using the CRSP should be performed to obtain more detailed information for the design of the rockfall impact barriers. Design of the grading for the rockfall impact barrier access trails along the barrier alignments should be performed by the project civil engineer with input provided by Geolabs, Inc.

Response to Rockfall Potential and Hillside Slope Evaluation Report

On February 29, 2008, the DPP responding to the contents of the report identified the following conditions (*italicized* for convenience) for the approval of the subdivision (**Appendix A**):

Condition 1
Submittal of a "Final" Geotechnical Engineering Exploration Report and Phase II Rockfall Potential and Hillside Slope Evaluation Report. These reports shall be submitted concurrently with the grading and construction plans (Refer to Item 3).

Comment: DRA acknowledges and will comply with this requirement.

Condition 2
The owner of Lot 1007 shall be responsible for inspecting, maintaining, repairing and removing accumulated talus debris along Rockfall Impact Barriers "A, "B" and "C" as shown on Plate 4.1 of the subject report. In addition, Dillingham Ranch 'Āina LLC, the owner of TMK: 6-8-003: 005, shall be responsible for inspecting, maintaining, repairing and removing accumulated talus debris along Rockfall Impact Barrier "D" as shown on Plate 4.2 of the report.

These conditions shall be incorporated into restrictive covenants running with the land. Draft covenants shall be submitted concurrently with the grading and construction plans (Refer to Item 3) for review and approval.

Comment: DRA acknowledges and will comply with this requirement. Furthermore, these conditions will be incorporated into the restrictive covenants and a draft of the covenants will be submitted by DRA with the grading and construction plans to the DPP for review and approval.

Condition 3
Submittal and approval of grading and construction plans in accordance with Section 6-601 of the Subdivision Rules and Regulations. The plans shall incorporate and be in general conformance to the recommendations of the reports mentioned under Item 1. If the subdivision application is granted tentative approval, then submit these plans, one copy each of the reports mentioned under Item 1 and a copy of the draft restrictive covenants to the Subdivision Branch for processing.

Comment: DRA acknowledges and will comply with this requirement in accordance with Section 6-601, Subdivision Rules and Regulations, relating to Construction Plans. Furthermore, upon granting of the tentative approval for subdivision the following will be submitted to the DPP: (1) the grading and construction plans; (2) the restrictive covenants; and (3) the "Final" Geotechnical Engineering Exploration Report and Phase II Rockfall Potential and Hillside Slope Evaluation Report.

Condition 4
Upon completion of the mitigation work, submittal of a final assessment report (FAR) prepared by a licensed geotechnical engineer, in accordance with Section 14-5.1(n)(2) [SIC, reference should be 14-15.1(n)(2)] of the Revised Ordinances of Honolulu (ROH). The FAR shall contain verification that the mitigation improvements were constructed in accordance with the approved plans.

Comment: DRA acknowledges and will comply with this requirement stipulating the submittal of a Final Assessment Report (FAR) in accordance with Section 14-15.1 (n)(2), which states:

Article 15. Grading, Grubbing and Stockpiling; Section 14-15.1 Conditions of permit; "(n) Report After Grading. (1) When grading involves cuts or fills for which an engineer's soils report was required, the permittee shall submit a final report, prepared by an engineer, upon the completion of such work. This report shall contain: (A) A description of materials used in the fill and its moisture content at the time of compaction, the procedure used in depositing and compacting the fill, the preparation of original ground surface before making the fill, but not limited to benching and subsurface drainage, and a plan or tabulation showing the general location and elevation of compaction tests made in the fill together with a tabulation of relative compaction densities obtained at each location, the location of subdrains and other pertinent features of the fill necessary for its stability. (B) A certification that the work was done in conformity to this chapter, the approved plans and specifications and the engineer's soils report."

The close of the response letter notes: *"Since future development of the proposed lots would require further geotechnical investigation and consultation by a licensed, geotechnical engineer, you shall be responsible for disclosing this to future property owners."*

Comment: DRA acknowledges that future development of the proposed lots may require additional geotechnical investigation and consultation by the purchasers of the lots. Future prospective purchasers of the lots will be provided with this notification as an item of full disclosure.

Potential for Secondary Impacts

The potential for rockfall hazards exists within a portion of the planned subdivision. In order to address this potential a rockfall hazard investigation and revised update were prepared identifying mitigation measures and practices to reduce or eliminate the potential for significant adverse impacts to property and human life. While the proposed T-intersection is designed to support access to the planned subdivision, it does not in itself constitute or create the conditions for secondary impacts relating to rockfall hazards. In as much as the potential for rockfall hazards are a known and existing concern, it has been sufficiently and appropriately addressed to maintain the safety and security of the site. No adverse impacts, including secondary impacts associated with the proposed T-intersection, are anticipated.

2.3.3 Waste Water Systems

Background

Treatment of wastewater from the planned Dillingham Ranch agricultural subdivision will be addressed with the use of Individual Wastewater Systems (IWS) in accordance with the Agricultural District farm dwelling provisions of the City & County of Honolulu Land Use Ordinance.

Department of Health Review of IWS System for Dillingham Ranch

On March 9, 2007, Best Industries USA, on behalf of DRA submitted an application to the DOH, Wastewater Branch, for installation of an Individual Wastewater System (IWS) to handle wastewater flows from the approximately 77 lot agricultural subdivision (**Appendix H**). An important purpose for the submittal of the IWS application was to support DRA's filing of the application for subdivision that was under review by governmental agencies.

The proposed IWS system is designed to provide sufficient wastewater treatment for the planned agricultural subdivision based on the following design criteria:

- The wastewater treatment is based on a unit flow of 1,000 gallons per day (gpd) from each dwelling (each containing a maximum of 5-bedrooms).
- The IWS selection is based on a total of 80 units (lots) with a maximum flow of 1,000 gpd per unit.
- The disposal system design involves use of a centralized absorption bed located

below the "No Pass" underground injection control line as required by the DOH.

The IWS system is based on:

Percolation Rate: 12 minutes/inch

Required Absorption Area per Unit:

(175 square feet (sf)/200 gpd) x 1,000 gpd/unit = 875 sf/unit

Required Absorption Area of Centralized Disposal System:

875 sf/unit x 80 units = 70,000 sf = 1.61 acres

Absorption Bed Dimensions = 250 feet x 400 feet

Available Absorption Area = 250 feet x 400 feet = 100,000 sf = 2.3 acres

Required Land Area for Subdivision =

(10,000 sf/IWS unit) x (80 IWS units) = 800,000 sf

Available Land Area of Subdivision = 433.9 acres or 18,900,684 sf

Department of Health Response to IWS Application

On February 25, 2008, the DOH responded to the proposed subdivision, concurring with the planned use of the IWS system (see **Appendix A** for a copy of the DOH letter). DOH noted that their concurrence would be contingent on each of the lots subject to deed restrictions requiring the installation of the IWS; that the DOH would not sign off on any building permits until the deed restrictions are properly recorded; and that the DOH reserves the right to review the detailed wastewater plans (construction documents) for conformance with Hawai'i Administrative Rules (HAR), Chapter 11-62, Wastewater Systems, and other applicable requirements.

Potential for Secondary Impacts

The potential for adverse environmental effects due to wastewater treatment of the planned subdivision are not anticipated. The application for use of the IWS system has been approved in principle by the DOH through the granting of the subdivision contingent on the completion of the conditions as noted above. DRA will commit to fulfilling these conditions and ensuring that appropriate notifications to prospective lot owners are made.

While the proposed T-intersection is designed to support access to the planned subdivision, the potential for secondary impacts as a result of providing wastewater treatment to the planned subdivision will be addressed through compliance with the requirements of HAR, Chapter 11-62.

Potential for adverse effects from improper wastewater treatment will be sufficiently addressed and no adverse impacts, including secondary impacts associated with the proposed T-intersection, are anticipated.

2.3.4 Water System

Background

The North Shore Water Company (NSWC), a quasi-public entity owned by DRA, provides water for all private users west of the DRA property. Water service by the Honolulu Board of Water Supply (BWS) is not possible because the end of the existing BWS water main is located along the Farrington Highway near the eastern boundary of the DRA property. In order to provide water service to the planned agricultural subdivision and other private users it is necessary to upgrade the existing NSWC water system identified as Public Water System (PWS) No. 326.

On January 17, 2008, the Preliminary Water System Report for the Dillingham Ranch Agricultural Subdivision was completed and submitted to the DOH to evaluate the water system requirements for the planned agricultural subdivision and other water system users served by the DRA (**Appendix I**). The report provided water system upgrade recommendations for PWS No. 326, and included the following analyses: (1) calculation of sizes required for the private water system mains;
(2) calculation of the requirements for water reservoirs; and (3) identification of the water sources needed to support the planned subdivision. (RMTC, 2008).

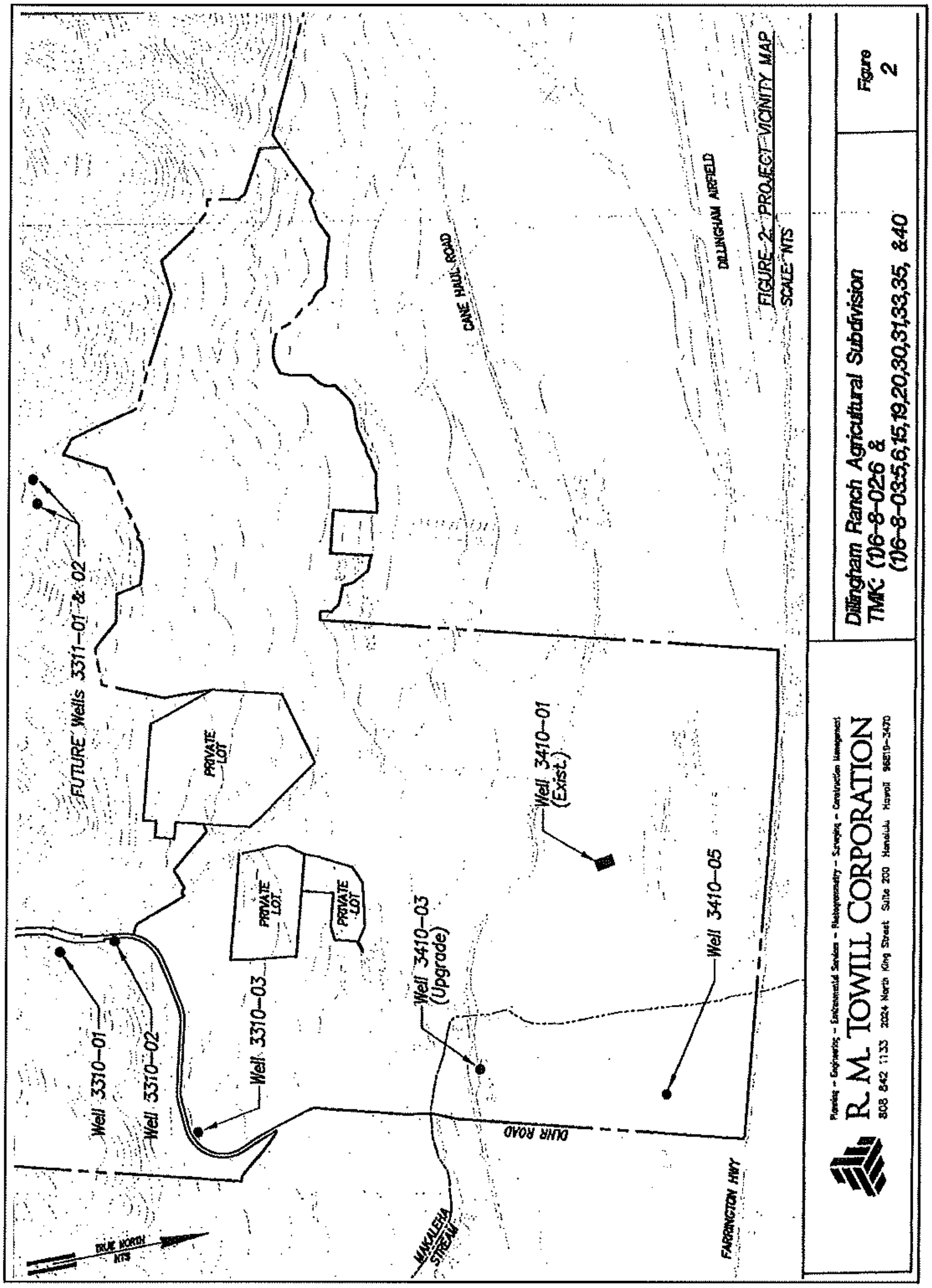
The following is a summary of the report findings and recommendations.

Existing Water Infrastructure

Well No. 341 0-01

Well No, 3410-01 is an existing water source that will be upgraded. The well was drilled sometime prior to 1911 and is located 1,800 feet mauka of the Farrington Highway. Records state the well has a 6-inch casing which extends to a depth of 388 feet below sea level, with 25 feet of open hole to a depth of 417 feet below sea level. The well had a reported head of 18.2 feet when it was first developed. Figure 2 of the report identifies the locations of the wells. (RMTC, 2008).

See Figure 2, Well Location Map, for the location of wells as provided in the report.



Source: Preliminary Water System Report, Dillingham Ranch Agricultural Subdivision, Mokuleia, Oahu, Hawaii, R. M. Towill Corporation 2008.
Notes: See Report in Appendix I for additional detail.

This well has 4 pumps; two 3 horsepower (hp), one 7.5 hp, and one 15 hp pump. Pump testing resulted in normal operation at 400 gallons per minute (gpm) at 50 pounds per square inch (psi). The existing piping is a current limitation and the well pumps and piping will be upgraded to increase pumping capacity. (RMTC, 2008).

The water use permit for this well allows for a drawdown of up to 0.5 million gallons per day (mgd) for domestic, livestock, and irrigation use (approved 9/11/81 and transferred to Metropolitan Mortgage and Securities Co., Inc. on 2/10/03). (RMTC, 2008).

Well No. 3410-03

Well No. 3410-03 will be an additional source of supply for the expansion of PWS No. 326. The construction of this well occurred sometime after Well 3410-01, although the exact date is unknown. The well has 398 feet of 10-inch casing and 105 feet of open hole below the casing. The depth of the well is 498 feet, with its bottom at 468 feet below sea level. (RMTC, 2008).

The semi-confined groundwater tapped by this well has a piezometric head of about 17 feet above sea level and very low salinity. Pump testing in August 2007 resulted in less than three feet of drawdown at 800 gpm. Authorized use of the well by the Commission on Water Resource Management is 1.5 mg (Water Use Permit No. 779 issued in September 1981). The well pump was installed in August 2007. (RMTC, 2008).

Design Criteria for Upgrade of PWS No. 326

The design criteria for the upgraded water system is based on the Water Supply Standards (for O'ahu), State of Hawai'i, 2002 (WSS). The design criteria generally follows the WSS with the following augmentation (RMTC, 2008):

1. Pipeline Sizing Basis. The average daily demand of 500 gallons per unit (Residential) in addition to 1,145 gallons per acre for irrigation will be applied to each lot. The average daily demand of 5,080 gallons per lot, instead of 4,000 gallons per acre (Agricultural zoning), is assumed to irrigate a 4-acre lot and provide residential usage.

2. Pipeline Sizing Basis: The maximum daily demand of 750 gallons per unit (Residential multiplied by max demand factor of 1.5) in addition to 2,085 gallons per acre for maximum irrigation will be applied to each lot. The maximum daily demand of 9,090 gallons per lot is assumed to irrigate a 4-acre lot and provide residential usage. The maximum irrigation rate of 2,085 gallons per acre is also applied to peak hour demand scenarios.

3. The well pump capacity has an operating time of 24 hours instead of 16 hours.

Design Analysis

PWS No. 326, served by existing Well No. 3410-01, will be upgraded to create two service zones within the subdivision site. Currently, the existing water system serves 56 existing meters (120 residence units) along Farrington Highway. These users include the Mokuleia Beach Colony's 52 condominium units, and Camp Mokuleia. (RMTC, 2008).

During the interim period Well No. 3410-01 and Well No. 3410-03 will initially serve the proposed subdivision, the Dillingham Ranch House, and other users along Farrington Highway. An application to convert Well No. 3410-03 to a potable well is being filed with the State DOH by DRA. (RMTC, 2008).

The existing users of PWS No. 326 and 52 lots of the proposed subdivision will receive water from the lower zone served by a reservoir with a 310-foot elevation spillway. The upper zone will serve 25 lots of the subdivision with a reservoir with a 500-foot elevation spillway. In total, the water system will serve all 77 lots of the agricultural subdivision. The sizing of the reservoirs is summarized in the following (RMTC, 2008):

	Flowrates for Design		
	Average Day (gpd)	Max Day (gpd)	Fire Flow (gpm)
Upper Zone			
500-Foot Elevation Reservoir Demand*	12,500	18,750	1,000
Lower Zone			
310-Foot Elevation Reservoir Demand**	118,000	177,000	2,000

*New water system users

**Existing and new water system users

Ultimately, the subdivision will be served by future potable Well No. 3311-01 and Well No. 3311-02 located next to the 500-ft spillway elevation reservoir. Until this occurs, existing Well Nos. 3410-01 and 3410-03 (with upgraded pumps) will meet the required demand. Together these wells will need to meet the maximum daily domestic demand along with the maximum irrigation requirement for a 24 hour period. (RMTC, 2008).

Future potable Well No. 3311-01 and Well No. 3311-02 will each be outfitted with pumps capable of providing the maximum daily demand in a 16 hour period. Combined, these wells will provide the maximum daily demand along with the maximum irrigation requirement in a 24 hour period. (RMTC, 2008).

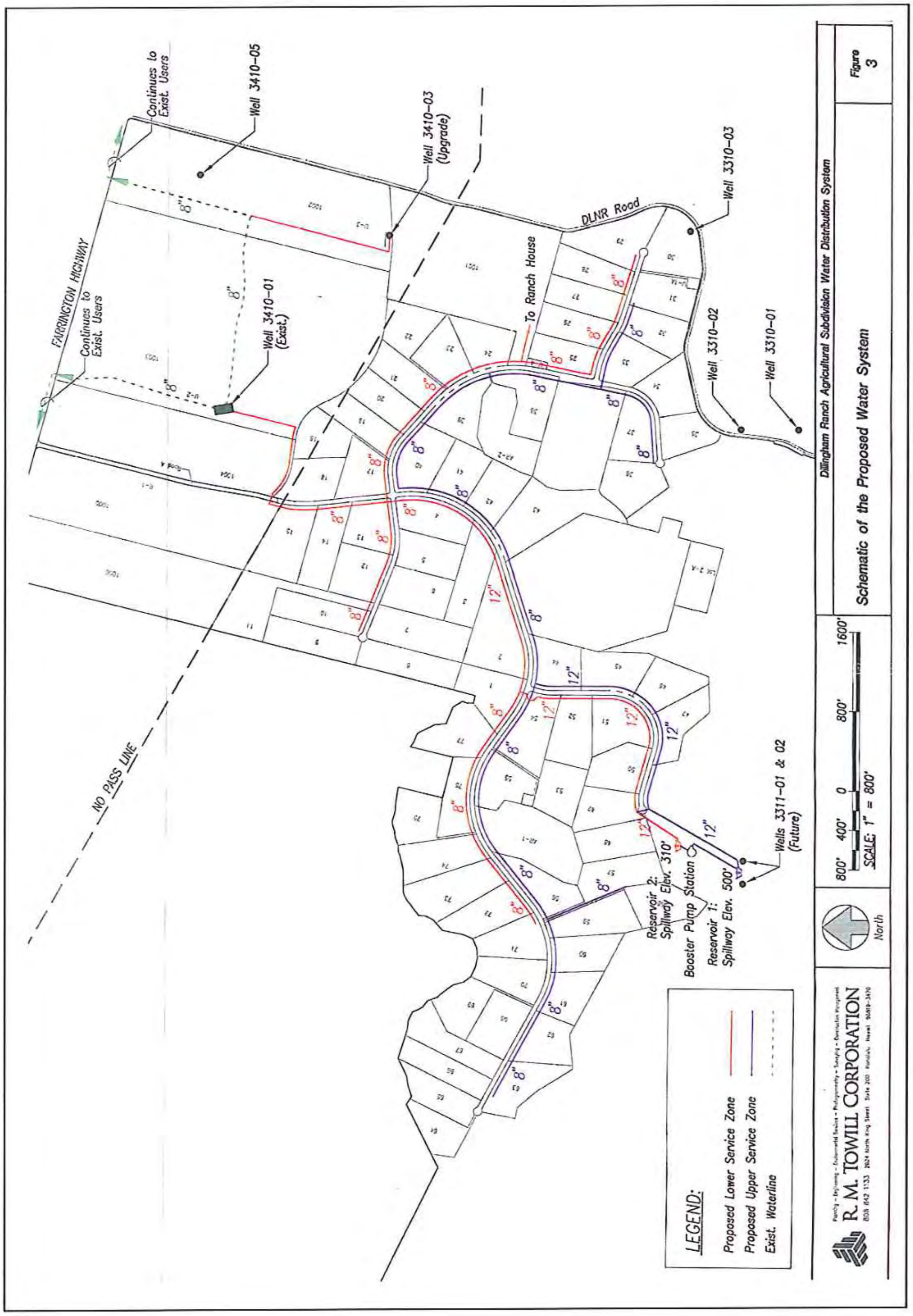
Analysis and design of the water system for this report were completed using a water distribution modeling software system, WaterCAD by Haestad Methods, Inc. This program allows the designer to develop a hydraulic model of a pressurized pipe system and was used for this report to perform the following analyses (RMTC, 2008):

1. Steady-state analysis of the water system, including pipes and reservoirs;
2. Extended period simulation to analyze the system under varying supply and demand conditions; and
3. Fire flow analysis.

The proposed distribution system is shown in Figure 3 of the report (refer to report for detailed graphic) and is comprised of nodes or pressure junctions that connect or end multiple pipe segments. Demands were assigned to the nodes based on the number of lots that are being sewed at that particular node. (RMTC, 2008).

Department of Health Review of Dillingham Ranch Agricultural Subdivision Preliminary Water System Report

On January 28, 2008, the DOH responded to the proposed water system upgrades and provided the following comments (see **Appendix A** for a copy of the DOH letter):



Source: Preliminary Water System Report, Dillingham Ranch Agricultural Subdivision, Mokuleia, Oahu, Hawaii, R. M. Towill Corporation 2008.
Notes: See Report in Appendix I for additional detail.

1. The infrastructure of the existing Dillingham Ranch Public Water System (System No. 326) will be upgraded and expanded to provide water to the new Dillingham Ranch Agricultural Subdivision.
2. The Dillingham Ranch Public Water System will continue to provide water to its existing customers. In the April 7, 2007 proposal, the Dillingham Ranch Public Water System would stop water service to its customers and turn over this service to the Honolulu Board of Water Supply.
3. A new public water system for the Dillingham Ranch Agricultural Subdivision as previously indicated in the April 7, 2007, and the November 30, 2007 proposals, will not be created.

In summary, according to DOH, the planned water system upgrades and expansion to provide water service to the planned subdivision will not affect the water system's status as an existing community public water system. The DOH noted,

> "As such, the Dillingham Ranch Public Water System will not be required to implement the Federal and State technical, managerial, and financial capacity regulations which are required for new public water systems."

> "The upgrade and expansion of the existing Dillingham Ranch water system infrastructure will require Department of Health (DOH) approval of the construction plans in accordance with HAR, Section 11-20-30 [relating to new and modified public water systems]. The conversion of the irrigation well (Well No. 3410-03) to drinking water will require DOH approval in accordance with HAR 11-20-29 [relating to use of new sources of raw water for public water]." (DOH Letter to RMTC, January 28, 2008).

Potential for Secondary Impacts

The potential for adverse environmental effects due to upgrades to PWS No. 326 to serve the planned agricultural subdivision and other private water system users are not anticipated. However, the construction documents for the proposed upgrades will require review and approval by the BWS in accordance with HAR, Section 11-20-30, relating to new and modified public water systems. DRA will commit to the filing of these construction documents as required by the BWS in order to address any concerns regarding the proper design, installation, and operation of the system.

While the proposed T-intersection is designed to support access to the planned subdivision, the potential for secondary impacts as a result of providing water system upgrades to support the planned subdivision is not expected. Sufficient water supply is available from the North Shore Water Company. No adverse impacts, including secondary impacts associated with the proposed T-intersection, are anticipated.

Section 3
Project Alternatives

3.1 Alternatives to the Proposed Project

Three alternatives to the proposed project were considered: (1) the No Action and Delayed Action Alternative; (2) an Alternative Location for the T-Intersection; and (3) the Preferred Alternative.

3.2 No Action and Delayed Action

The No Action Alternative would involve no further action to develop the project. Inasmuch as the intersection improvements would support access to the planned Dillingham Ranch Agricultural Subdivision, the proposed project is a necessary requirement of the City & County of Honolulu Subdivision Standards and the State Department of Transportation, for providing a safe point of entry and exit from Farrington Highway. While the No Action Alternative would avoid the expenditure of resources for design and construction of the facility, it would fail to provide for the required traffic improvements. For this reason, it is not considered a viable option.

The Delayed Action Alternative differs from taking no action in that the proposed project would be undertaken, but at a later point in time. Delayed action to construct the intersection improvements would adversely affect the completion of the agricultural subdivision. Because the project is intended to support the subdivision with access to the Farrington Highway in compliance with requirements, the delayed action alternative would similarly fail to accomplish the purpose of the project. For this reason, it is also not considered a viable option.

3.3 Alternative Location for the T-Intersection

The planned location for the project is based on existing and future proposed land uses of the Dillingham Ranch ʻĀina property. The intersection improvements will be located on an existing access road that presently serves the Dillingham Ranch providing access to the equestrian facilities, administrative offices, and field offices and facilities used to manage the property. This configuration provides a rational and efficient means of entry to the planned agricultural subdivision based on existing uses that will not have to be immediately relocated, demolished, or otherwise removed.

An alternative location for the T-intersection may be possible along other portions of the Dillingham Ranch property, but is considered an optimal approach given existing land uses that include diversified agriculture, a pond, equestrian and corral facilities, and maintenance facilities. Thus, while an alternative location is possible, major disruption to existing land uses and operations would result while the planned T-intersection improvements would require essentially the same construction effort.

3.4 Preferred Alternative

The preferred alternative involves the design and construction of the T-intersection at its present location at its intersects with the Farrington Highway. Factors that support this decision include:

(1) Area residents are already aware of this entry to the Dillingham Ranch property. Directly adjacent to the existing entry is a clearly marked crosswalk crossing Farrington Highway, and horse crossing signage posted in both directions along the highway.

(2) The proposed location will minimize disruption to the existing operations of the Dillingham Ranch. While the planned agricultural subdivision is anticipated to require future changes in land that is used by the Dillingham Ranch, these changes will be more easily made with the integration of a planned intersection improvement with existing and future land uses.

(3) The traffic assessment conducted for the proposed project indicates there will be limited and minimal traffic impacts associated with the intersection improvements. No major impacts to local or transiting motorists to the area are anticipated or expected.

(4) Sufficient measures and practices to address the potential for adverse environmental impacts have been considered and can be implemented for the project. With the implementation of the mitigation measures as described in this document, no adverse environmental impacts are anticipated or expected.

Section 4
Relationship to State and City & County Land Use Plans and Policies

4.1 Hawai'i State Plan and Functional Plans

4.1.1 Hawai'i State Plan

The Hawai'i State Plan, Chapter 226, Hawai'i Revised Statutes (HRS), serves as a written guide for the future long range development of the State. The Plan identifies statewide goals, objectives, policies, and priorities.

The proposed project is consistent with the following provisions of the State Plan:

> Section 226-7 Objective and policies for the economy-agriculture. (a) Planning for the State's economy with regard to agriculture shall be directed towards achievement of the following objectives: (2) Continued growth and development of diversified agriculture throughout the State. (b) To achieve the agriculture objectives, it shall be the policy of this State to:
> (5) enhance agricultural growth by providing public incentives and encouraging private initiatives.

The proposed project involves the construction of transportation improvements by a private party to serve a planned agricultural subdivision. The planned subdivision will allow for new diversified agricultural activities and in so doing, would contribute to its continued growth and development, maintaining consistency with the State Plan.

> Section 226-17 Objectives and policies for facility systems-transportation.
> (b) To achieve the transportation objectives, it shall be the policy of this State to:
> (3) Encourage a reasonable distribution of financial responsibilities for transportation among participating governmental and private parties.

The proposed intersection improvements will be entirely financed by a private party who will be responsible for the cost of design and construction. In this regard, the proposed project will address the State Plan objective of encouraging the reasonable distribution of financial responsibility for ensuring completion of the project by the private sector.

4.1.2 State Functional Plans

The State Functional Plans are designed to implement the broader goals, objectives, and policies of the State Plan through specific actions identified as Implementing Actions (IA). While the proposed project is not specifically identified as an IA, the project maintains consistency with the Transportation and Agricultural Functional Plans through the following:

State Transportation Functional Plan
Objective I.F: Improving and enhancing transportation safety
Objective III.A: Expansion of revenue bases for transportation improvements.
Policy III.A.2. Pursue private sector participation in the financing of transportation systems, developments and projects.

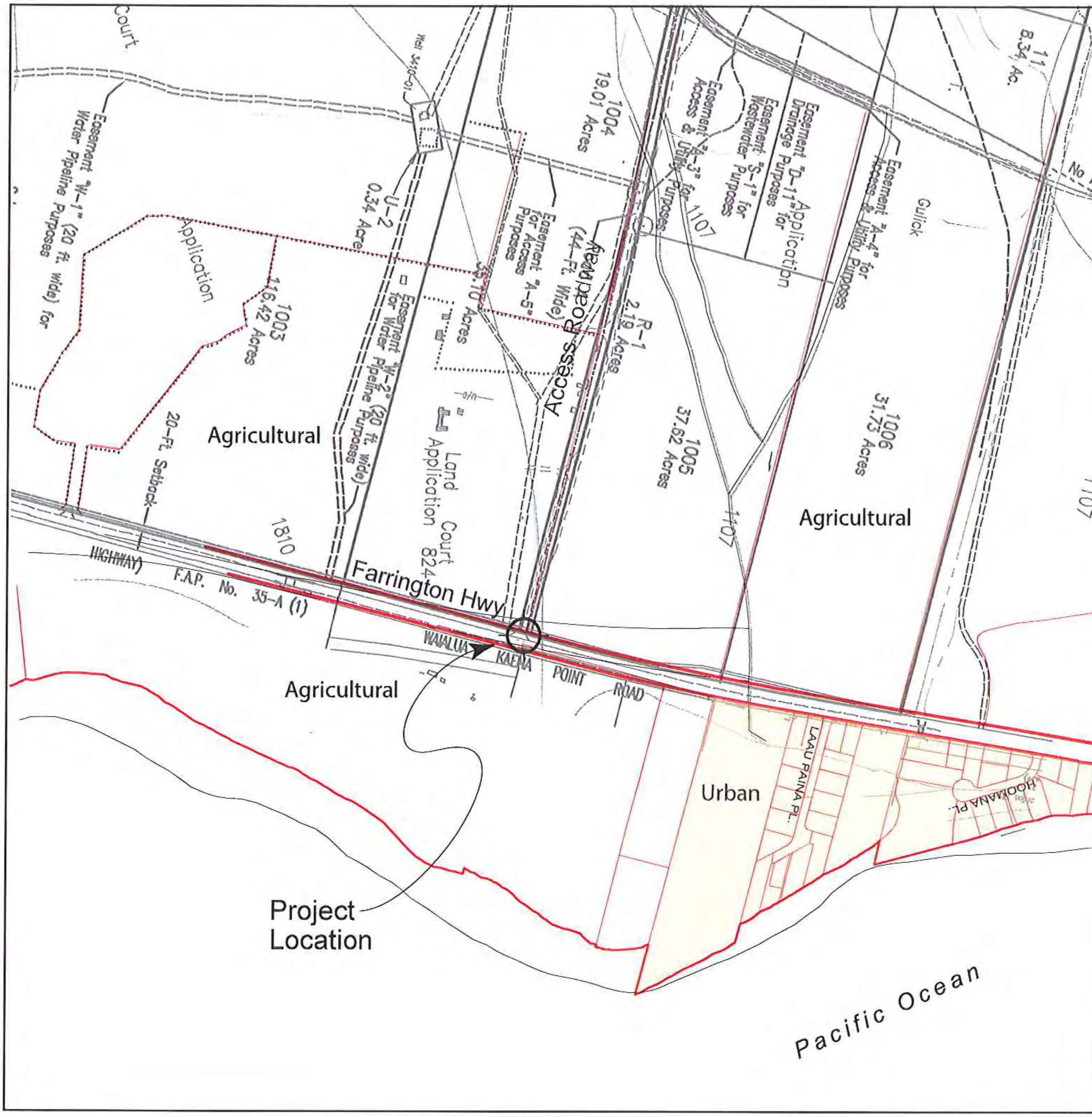
The proposed project involves the design and construction of a privately financed intersection improvement along Farrington Highway that will serve an agricultural subdivision. The project will comply with State and City & County of Honolulu requirements to meet safety of the driving public.

State Agricultural Functional Plan
Objective B: Achievement of an orderly agricultural marketing system through product promotion and industry organization. Policy B(2): Encourage the development of Hawai'i's agricultural industries.

Although the proposed project does not directly involve the promotion of the agricultural industry, it represents an important supporting feature that will facilitate the development of an agricultural subdivision. The subdivision in turn, will provide for greater land opportunities for the growth of diversified agriculture.

4.2 State Land Use District

The project site and the surrounding land use is within the State Agricultural District. The use of the Farrington Highway and the proposed intersection improvements project is consistent with this land use designation. See **Figure 9**, State Land Use District.



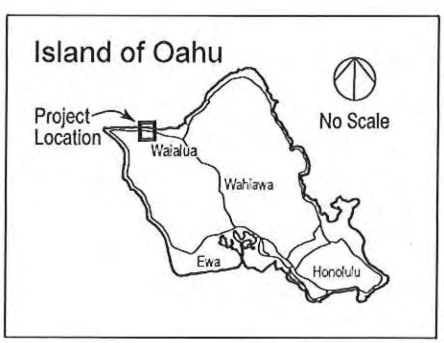


Figure 9 State Land Use District
Intersection Improvements
Dillingham Ranch ʻĀina, LLC

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4.3 General Plan

The current edition of the General Plan for the City & County of Honolulu was adopted in 1977, revised in 1992, and was last updated in October 2006. The Plan is a comprehensive statement of objectives and policies for the future development of Honolulu. The proposed project is consistent with the following objectives and policies of the City and County of Honolulu's General Plan:

Transportation & Utilities

The objectives and policies for transportation related improvements are stated in Section V, Transportation & Utilities.

> Objective A: To create a transportation system which will enable people and goods to move safely, efficiently, and at a reasonable cost; serve all people, including the poor, the elderly, and the physically handicapped; and offer a variety of attractive and convenient modes of travel.
>
> Policy 5: Improve roads in existing communities to reduce congestion and eliminate unsafe conditions.

The planned intersection improvements will constitute an improvement and upgrade over existing conditions by providing new paving, striping and signage. These improvements will be in accordance with the requirements of the City & County of Honolulu, and State DOT, that promote the safe and efficient transportation of residents and users along this segment of the Farrington Highway.

> Objective D: To maintain transportation and utility systems which will help Oahu continue to be a desirable place to live and visit.
>
> Policy 4: Evaluate the social, economic, and environmental impact of additions to the transportation and utility systems before they are constructed.

The proposed project is under review of these factors as part of the environmental review process stipulated by Chapter 343, HRS. Based on the analysis undertaken for the subject document, social, economic, and environmental factors will be reviewed and evaluated to ensure that sufficient mitigative measures will be provided prior to the construction of the project.

4.4 North Shore Development Plan/Sustainable Communities Plan

The project site is designated as Agriculture in the North Shore Development Plan Land Use, Open Space, and Public Facilities Maps. While the proposed project at its intersection with the Farrington Highway (designated a "minor arterial") is not specifically identified, the project is consistent with the North Shore Development Plan, Section 4.1.5, General Policies, through the following:

- "Provide adequate access between residences, jobs, shopping, and recreation areas on the North Shore. Improve access to adjacent areas, especially to Central Oahu."

The proposed intersection improvements will promote adequacy and sufficiency of service to and from the planned Dillingham Ranch Agricultural Subdivision to the Farrington Highway.

- "Approve new residential and commercial development in the North Shore only if the State Department of Transportation and the City Department of Transportation Services certify that adequate transportation access and services can be provided."

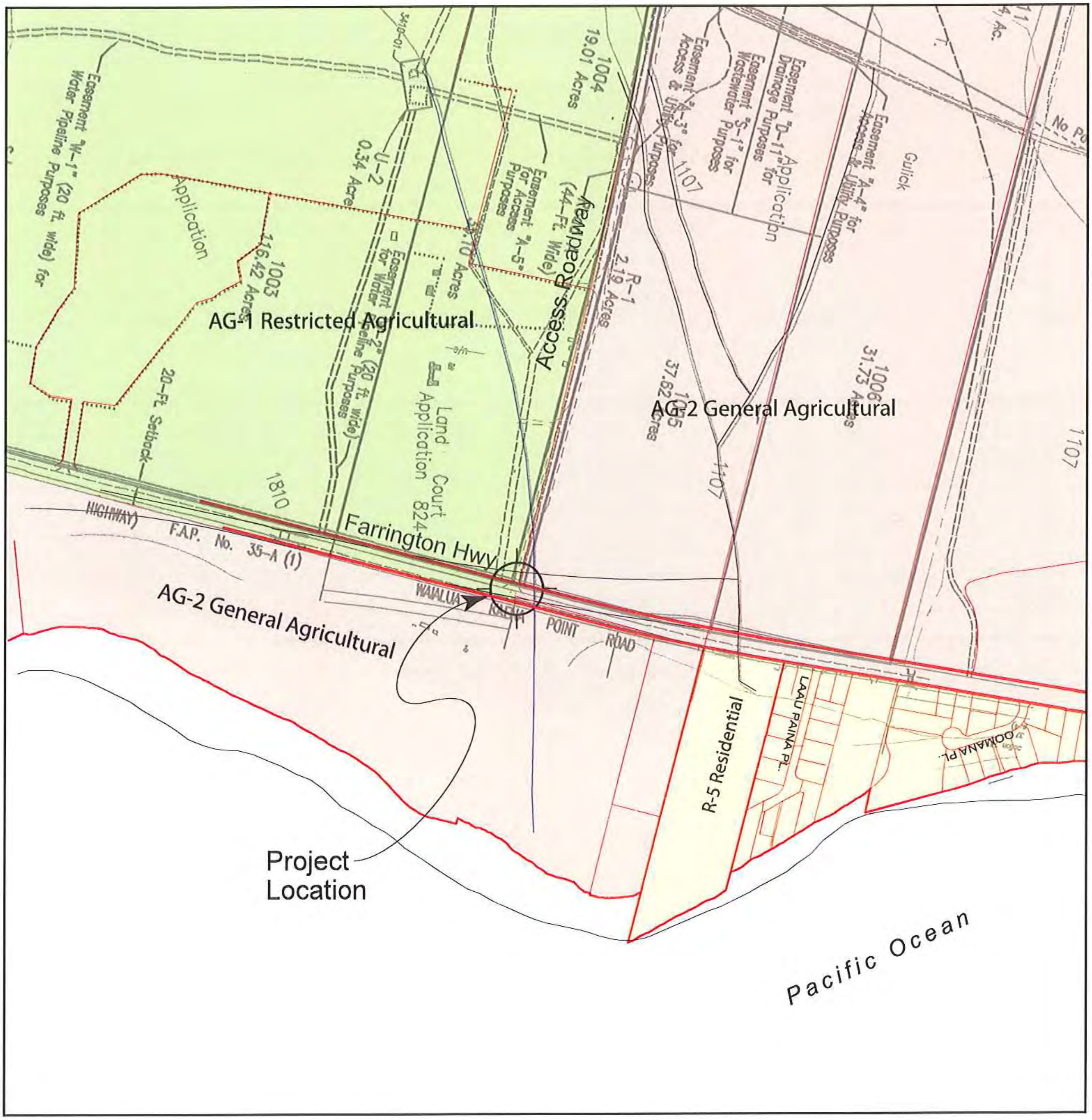
The proposed intersection improvements will address and meet the requirements of the State DOT and the City & County of Honolulu for the construction the intersection. The intersection improvements have been further evaluated with respect to capacity and the ability to provide access along Farrington Highway without adverse impacts to existing traffic conditions (Julian Ng, Inc., 2007).

See **Appendix A**, relating to conditional letters for the Subdivision Application from DOT, Highways Division, February 21, 2007, December 24, 2007, and February 25, 2008.

4.5 City & County of Honolulu Zoning

The project site is within the AG-2, General Agricultural District. See **Figure 10,** Zoning. According to Chapter 21, Land Use Ordinance, Section 21-3.50 Agricultural Districts, Purpose and Intent:

> (a) The purpose of the agricultural districts is to maintain a strong agricultural economic base, to prevent unnecessary conflicts among incompatible uses, to minimize the cost of providing public improvements and services and to manage the rate and location of physical development consistent with the city's adopted land use policies. To promote the viability and economic feasibility of an existing agricultural operation, accessory agribusiness activities may be permitted on the same site as an adjunct to agricultural uses. These accessory activities must be compatible with the on-site agricultural operation and surrounding land uses;



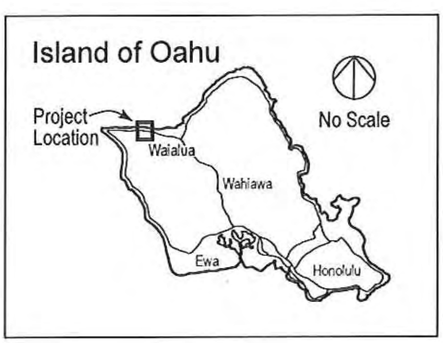


Figure 10 Zoning
Intersection Improvements
Dillingham Ranch ʻĀina, LLC

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(d) The intent of the AG-2 general agricultural district is to conserve and protect agricultural activities on smaller parcels of land; and

(e) The following guidelines shall be used to identify lands which may be considered for the AG-2 general agricultural district:
(1) Lands which are in the state-designated agricultural or urban district and designated agricultural by adopted city land use policies;
(2) Lands which are predominantly classified as other under the agricultural lands of importance to the State of Hawaii system; and
(3) Lands which are used or are suitable for agricultural purposes and where a substantial number of parcels are less than five acres in size. (Added by Ord. 99-12; Am. Ord. 02-63).

The proposed project will address the City & County of Honolulu and State DOT requirements for the design of an adequate and sufficient intersection improvement serving the Dillingham Ranch Agricultural Subdivision. In this regard, the proposed project will help to maintain existing agricultural land uses of the area consistent with the AG-2 zoning of the site.

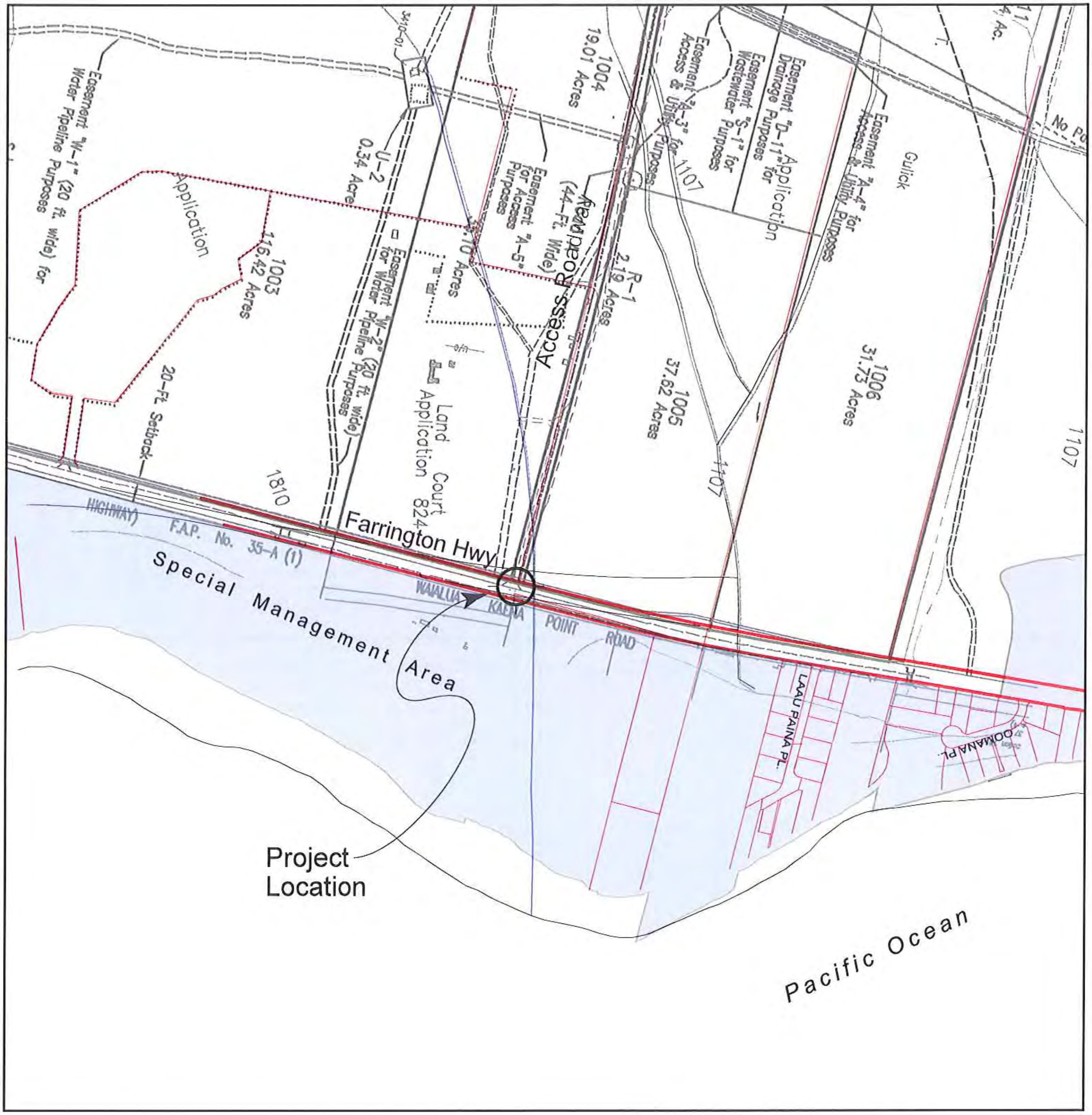
4.6 Special Management Area

The City and County of Honolulu has designated the shoreline and certain inland areas of Oahu as being within the Special Management Area (SMA). SMA areas are designated sensitive environments that should be protected in accordance with the State's Coastal Zone Management policies, as set forth in Chapter 25, Shoreline Management, ROH, and Section 205A, Coastal Zone Management, HRS.

The proposed project site and the proposed agricultural subdivision is located outside of the designated SMA zone as shown in **Figure 11**, Project Site in Relation to SMA.

4.7 Coastal Zone Management, HRS 205(A)

The State of Hawai'i designates the Coastal Zone Management Program (CZMP) to manage the intent, purpose and provisions of the federal Coastal Zone Management Act, and HRS, Chapter 205(A)-2, as amended, for the areas from the shoreline to the seaward limit of the State's



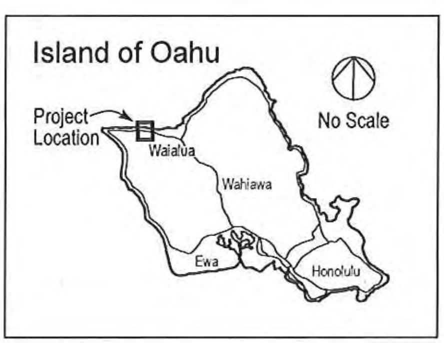


Figure 11 Project Site in Relation to Special Management Area
Intersection Improvements
Dillingham Ranch ʻĀina, LLC

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jurisdiction, and any other area which a lead agency may designate for the purpose of administering the CZMP.

The following is an assessment of the project with respect to the CZMP objectives and policies set forth in Section 205(A)-2.

1. Recreational resources
Objective: Provide coastal recreational opportunities accessible to the public.
Policies:
A) Improve coordination and funding of coastal recreational planning and management; and
B) Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:
(i) Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas;
(ii) Requiring replacement of coastal resources having significant recreational value including, but not limited to, surfing sites, fishponds, and sand beaches, when such resources will be unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable;
(iii) Providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value;
(iv) Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;
(v) Ensuring public recreational uses of county, state, and federally owned or controlled shoreline lands and waters having recreational value consistent with public safety standards and conservation of natural resources;
(vi) Adopting water quality standards and regulating point and nonpoint sources of pollution to protect, and where feasible, restore the recreational value of coastal waters;
(vii) Developing new shoreline recreational opportunities, where appropriate, such as artificial lagoons, artificial beaches, and artificial reefs for surfing and fishing; and
(viii) Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the land use commission, board of land and natural resources, and county authorities; and crediting such dedication against the requirements of section 46-6.

Discussion:

Recreational and shoreline facilities, and public access to the shoreline will not be affected by the project. The proposed project area is located along the Farrington Highway, a State transportation facility.

2. Historic resources
Objective: Protect, preserve, and, where desirable, restore those natural and manmade historic and prehistoric resources in the coastal zone management area that are significant in Hawaiian and American history and culture.
Policies:
(A) Identify and analyze significant archaeological resources;
(B) Maximize information retention through preservation of remains and artifacts or salvage operations; and

(C) Support state goals for protection, restoration, interpretation, and display of historic resources.

Discussion:

No adverse impacts to archaeological or historic resources associated with construction or operation of the proposed project are expected. However, in the event that unidentified archaeological remains or deposits are uncovered during construction, work will cease in the immediate area and the State Historic Preservation Office will be contacted. As appropriate, mitigative measures will be proposed and coordinated with State Historic Preservation Division (SHPD), Department of Land and Natural Resources, prior to the resumption of work.

The potential for adverse impacts to cultural practices or resources are not expected as a result of the proposed project. The immediate project site has been utilized for vehicular entry to the Dillingham Ranch property, is located along a developed and designated transportation facility, and is not identified with traditional or cultural gathering practices.

3. Scenic and open space resources

Objective: Protect, preserve, and, where desirable, restore or improve the quality of coastal scenic and open space resources.

Policies:

(A) Identify valued scenic resources in the coastal zone management area;

(B) Ensure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural land forms and existing public views to and along the shoreline;

(C) Preserve, maintain, and, where desirable, improve and restore shoreline open space and scenic resources; and

(D) Encourage those developments that are not coastal dependent to locate in inland areas.

Discussion:

The proposed project will involve the use of a stop sign, striping on pavement surfaces, and other signage advising motorists of an intersection ahead. These project requirements are based on vehicular safety considerations and are not expected to adversely affect scenic and open space resources.

4. Coastal ecosystems

Objective: Protect valuable coastal ecosystems, including reefs, from disruption and minimize adverse impacts on all coastal ecosystems.

Policies:

(A) Exercise an overall conservation ethic, and practice stewardship in the protection, use, and development of marine and coastal resources;

(B) Improve the technical basis for natural resource management;

(C) Preserve valuable coastal ecosystems, including reefs, of significant biological or economic importance;
(D) Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing water needs; and
(E) Promote water quantity and quality planning and management practices that reflect the tolerance of fresh water and marine ecosystems and maintain and enhance water quality through the development and implementation of point and nonpoint source water pollution control measures.

Discussion:

The proposed project is not expected to have any adverse effect on coastal ecosystems or resources. The project location is in an area that is not subject to coastal processes and will be undertaken in a manner that will minimize or otherwise avert the potential for environmental impacts.

5. Economic uses

Objective: Provide public or private facilities and improvements important to the State's economy in suitable locations.
Policies:
(A) Concentrate coastal dependent development in appropriate areas;
(B) Ensure that coastal dependent development such as harbors and ports, and coastal related development such as visitor industry facilities and energy generating facilities, are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the coastal zone management area; and
(C) Direct the location and expansion of coastal dependent developments to areas presently designated and used for such developments and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when:
(i) Use of presently designated locations is not feasible;
(ii) Adverse environmental effects are minimized; and
(iii) The development is important to the State's economy.

Discussion:

The proposed project has been assessed for potential social, visual, and environmental impacts. With the implementation of the mitigation measures identified in this document, no adverse impacts are expected to result.

The County zoning designation for the project site is AG-2, General Agricultural District. The proposed traffic improvement project will be in compliance with the LUO requirements for this zoning district.

While an alternative site for the proposed project was investigated by the applicant, the proposed location is considered to be optimal for the planned intersection improvements and is consistent with the surrounding agricultural related land uses along the Farrington Highway.

6. Coastal hazards
Objective: Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence, and pollution.
Policies:
(A) Develop and communicate adequate information about storm wave, tsunami, flood, erosion, subsidence, and point and nonpoint source pollution hazards;
(B) Control development in areas subject to storm wave, tsunami, flood, erosion, hurricane, wind, subsidence, and point and nonpoint source pollution hazards;
(C) Ensure that developments comply with requirements of the Federal Flood Insurance Program; and
(D) Prevent coastal flooding from inland projects.

Discussion:

The subject property is located along Farrington Highway in the Waialua District of O'ahu. According to FEMA FIRM Map No. 15003C0085F, the project site is in an area designated as Zone AE. See **Figure 8,** FEMA FIRM Map.

The development of the project will be in compliance with the requirements of the Federal Flood Insurance Program, the City & County of Honolulu Drainage, Grading and Development standards for Flood Hazard Districts, and the LUO, Section 21-9.10, Flood Hazard Districts.

7. Managing development
Objective: Improve the development review process, communication, and public participation in the management of coastal resources and hazards.
Policies:
(A) Use, implement, and enforce existing law effectively to the maximum extent possible in managing present and future coastal zone development;
(B) Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements; and
(C) Communicate the potential short and long-term impacts of proposed significant coastal developments early in their life cycle and in terms understandable to the public to facilitate public participation in the planning and review process.

Discussion:

The project site is within the State Agricultural Land Use District. Land uses within this designation are subject to regulation by the City & County of Honolulu. The county's zoning designation is AG-2, General Agricultural District.

All improvement activities will be conducted in compliance with State and County environmental rules and regulations. This EA document is prepared to identify and, where necessary, propose mitigation measures to address the potential for impacts anticipated from the construction and operation of the project. This document will be published for public review in compliance with procedures set forth by the Office of Environmental Quality Control (OEQC), Chapter 343, HRS, and Chapter 11-200, Hawai'i Administrative Rules (HAR).

8. Public participation;
Objective: Stimulate public awareness, education, and participation in coastal management.
Policies:
(A) Promote public involvement in coastal zone management processes;
(B) Disseminate information on coastal management issues by means of educational materials, published reports, staff contact, and public workshops for persons and organizations concerned with coastal issues, developments, and government activities; and
(C) Organize workshops, policy dialogues, and site-specific mitigation to respond to coastal issues and conflicts.

Discussion:

Public involvement in the project will consist of public notice of the proposed action in the OEQC Bulletin. See Section 8, Agencies, Organizations, and Individuals Consulted for a list of the agencies, organizations and individuals that have been or will be consulted for this project. All written public comments will be provided with a written response. Where appropriate, mitigation measures will be developed to address issues and concerns raised during public review of the project.

9. Beach protection;
Objective: Protect beaches for public use and recreation.
Policies:
(A) Locate new structures inland from the shoreline setback to conserve open space, minimize interference with natural shoreline processes, and minimize loss of improvements due to erosion;
(B) Prohibit construction of private erosion-protection structures seaward of the shoreline, except when they result in improved aesthetic and engineering solutions to erosion at the sites and do not interfere with existing recreational and waterline activities; and
(C) Minimize the construction of public erosion-protection structures seaward of the shoreline.

Discussion:

The proposed project is not located in proximity to the beach and will have no effect on beach or shoreline processes.

10. Marine resources
Objective: Promote the protection, use, and development of marine and coastal resources to assure their sustainability.
Policies:
(A) Ensure that the use and development of marine and coastal resources are ecologically and environmentally sound and economically beneficial;
(B) Coordinate the management of marine and coastal resources and activities to improve effectiveness and efficiency;

(C) Assert and articulate the interests of the State as a partner with federal agencies in the sound management of ocean resources within the United States exclusive economic zone;
(D) Promote research, study, and understanding of ocean processes, marine life, and other ocean resources in order to acquire and inventory information necessary to understand how ocean development activities relate to and impact upon ocean and coastal resources; and
(E) Encourage research and development of new, innovative technologies for exploring, using, or protecting marine and coastal resources.

Discussion:

The proposed project will have no effect on marine resources. The scope and scale of the project will be limited to the installment of pavement surfacing and traffic controls to ensure safety and security of the intersection.

Section 5
Permits and Approvals that May be Required

5.1 City & County of Honolulu

Subdivision Approval (Tentative Approval granted on April 18, 2008, see **Appendix A** for documentation regarding coordination with governmental agencies).

Grading Permit

Building Permit

5.2 State of Hawaiʻi

Department of Transportation Approval of Construction Plans & Specifications

Department of Transportation Permit to Perform Work Upon State Highways

Section 6
Cultural Impact Assessment Evaluation

6.1 Impacts to Traditional/Cultural Resources

The use of the site for traditional or cultural practices is not expected based on the location of planned project next to the existing Farrington Highway and Dillingham Ranch equestrian facility driveway intersection. The modified condition of the project area includes the presence of introduced plant species not normally associated with cultural gathering or use activities. The plants present at the site include ironwood and other introduced tree species, grasses contained within the adjacent equestrian facility and polo field located across the Farrington Highway, and various other low laying weed and grass species located along the roadway.

The developed and paved condition of the area is also not conducive to the presence of wahi pana (storied place) or other sites associated with the gathering of important native species that may include tī, flowering plants, or other species bearing fruit.

Potential Impacts and Mitigation

The potential for adverse impacts to traditional and cultural practices is not anticipated based on the location and existing use of the site as an intersection along the Farrington Highway. Across the Farrington Highway, the use of an existing polo field may be affected by the temporary generation of noise. However, all work practices will be in accordance with noise regulations of the State and City & County of Honolulu.

As noted in Section 2.1.6, Historic and Archaeological Resources, should iwi or other cultural remains may be uncovered by earthwork or grading activities all work will be temporarily halted and the SHPD immediately notified at (808) 692-815 for further instructions. Work will only be allowed to be resumed upon appropriate notification to do so by the SHPD.

Section 7
Agencies, Organizations and Individuals Consulted

The following agencies, organizations, and individuals were/will be contacted regarding the preparation of the Environmental Assessment for this project.

7.1 City & County of Honolulu

Department of Planning and Permitting

Department of Environmental Services

Department of Design and Construction

Fire Department

Police Department

7.2 State of Hawaiʻi

Department of Health

Department of Land and Natural Resources

- Land Division
- State Historic Preservation Division

Department of Transportation - Highways Division

7.3 Federal Government

U.S. Army Corps of Engineers

U.S. Fish and Wildlife Service

National Marine Fisheries Service

7.4 Organizations and Individuals

Mokūleʻia Community Association

North Shore Neighborhood Board No. 27

Councilman Donovan M. Dela Cruz

Honolulu City Council

Section 8
Summary of Impacts and Significance Determination

8.1 Short Term Impacts

Short term impacts are expected to be limited and will last for only the duration of construction. The construction contractor will access the project site via Farrington Highway and noise will be generated from construction and related mobilization of equipment.

Construction equipment is expected to include a compactor, grader, bulldozer, concrete mixer, delivery trucks, and powered hand tools. All equipment will be muffled in accordance with standard engine operating practices. The work will be limited to weekday daylight hours and engine exhausts will be governed in accordance with applicable state and county regulations. Upon construction completion, noise levels will return to ambient levels.

Dust and associated nuisance problems are expected to be slight to insignificant due to the limited scope and scale of the project. Fugitive dust will be controlled with the use of dust screens and/or regular wetting of the soil by the contractor.

Construction activity will temporarily disturb soils. To minimize soil erosion, silt fences, berms and other applicable erosion control devices will be utilized to prevent construction-related soil and silt from leaving the active work area. If required, exposed soils will be covered with PVC sheet plastic or similar material to prevent inadvertent contact and mixing with storm water.

All necessary environmental permit applications and building permit approvals will be secured prior to initiation of construction activities.

8.2 Long Term Impacts

Long term benefits derived from this project include the provision of an intersection improvement that will be constructed in compliance with State and City & County standards. No long term adverse impacts are anticipated. Upon completion, all construction equipment used on-site will be demobilized and all debris and waste materials will be disposed of at an approved refuse facility.

8.3 Significance Criteria

Based on the significance criteria set forth in HAR, Title 11, Chapter 200, Environmental Impact Statement Rules, the proposed project is not anticipated to result in significant environmental impacts. The findings and reasons supporting the determination for a Finding of No Significant Impact (FONSI) are summarized as:

1. *Involves an irrevocable commitment to loss or destruction of any natural or cultural resource*

The proposed project will not result in the adverse loss of natural or cultural resources. There are no threatened or endangered species of plants or wildlife that inhabit the immediate area of the project site. Given the transportation related use of the site, historic or archaeological sites are not known to be present. However, in the unlikely event of a discovery of significant historic or archaeological resources, the SHPD, DLNR, will be immediately notified for appropriate action and treatment.

2. *Curtails the range of beneficial uses of the environment*

The subject property is utilized for transportation related purposes. The proposed use is consistent with the industrial designation of the site and will be contained entirely within the property. The proposed action does not curtail beneficial uses of the environment.

3. *Conflicts with the State's long-term environmental policies or goals and guidelines as expressed in Chapter 343, HRS, and any revisions thereof and amendments thereto, court decisions, or executive orders*

The proposed project is consistent with the environmental policies, goals and guidelines expressed in HRS, Chapter 343. Potential sources of adverse impacts have been identified and appropriate measures have been developed to either mitigate or minimize potential impacts to negligible levels.

4. *Substantially affects the economic and social welfare of the community or state*

The proposed project will not affect the economic and social welfare of the community or state. However, the proposed intersection improvements will constitute a new facility promoting safety of motorists transiting the Farrington Highway in the area of the project. The construction of the facility will be regulated in accordance with City & County of Honolulu and State regulations.

5. *Substantially affects public health*

Factors affecting public health, including air quality, water quality, and noise levels, are expected to be only minimally affected, or unaffected. The proposed project does not pose a direct threat to public health and safety. Potential impacts will be mitigated in accordance with regulations.

6. *Involves substantial secondary impact, such as population changes or effects on public facilities*

The proposed activity is expected to have little to no secondary or indirect impacts such as population changes or effects on public facilities based on the limited scope and scale of the project.

7. *Involves a substantial degradation of environmental quality*

Impacts to air and water quality, noise levels, natural resources, and land use associated with the planned improvements are anticipated to be minimal. Mitigation measures will be employed as practicable to further minimize potentially detrimental effects to the environment. The proposed project does not involve substantial degradation of environmental quality.

8. *Is individually limited but cumulatively has considerable effect upon the environment or involves a commitment for larger actions*

Although the proposed T-intersection is itself individually limited, the Dillingham Ranch Agricultural Subdivision, exclusive of the T-intersection providing connection of the proposed 77 lot subdivision with the Farrington Highway, could be considered as providing the context for "larger actions." Mitigation measures to address the potential for these "larger actions" have been provided within the Application Process for Tentative Subdivision Map Approval by the Department of Planning and Permitting, City & County of Honolulu. Mitigation measures to address the subdivision are materially provided within this EA document and include an evaluation of the areas of archaeology, continued agricultural viability, rockfall and slope concerns, waste water, flora, fauna, and traffic for the planned subdivision as well as the planned T-intersection.

9. *Substantially affects a rare, threatened or endangered species*

There are no rare, threatened or endangered plants or animal species at the subject project site. Other project activities associated with the planned subdivision are not located near avifauna located in the area of the pond.

10. *Detrimentally affects air or water quality or ambient noise levels*

On a short-term basis, ambient air and noise conditions may be affected by construction of the proposed facility improvements, but these are short-term and can be controlled by the mitigation measures as described in this EA. Once the project is completed, air and noise in the project vicinity will be allowed to return to preconstruction conditions.

11. *Affects or is likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters*

A portion of the project area is located within an area determined by the Federal Emergency Management Agency to be within the 1-percent annual chance floodplain. The proposed action is not expected to have a significant impact on flood conditions.

12. Substantially affects scenic vistas and viewplanes identified in county or state plans or studies

Minimal to no impacts to scenic vistas and viewplanes are expected. The project will involve the use of a stop sign and may include other signs advising motorists of an intersection ahead. The use of these signs and striping of the pavement will not adversely affect scenic views or view planes.

13. Requires substantial energy consumption

Construction and daily activities associated with the proposed site improvements will not require substantial amounts of energy.

Section 9
Findings

In accordance with the provisions set forth in HRS, Chapter 343, and the significance criteria in HAR, Section 11-200-12 of Title 11, Chapter 200, it is anticipated that the proposed project will have no significant adverse impacts, including secondary or cumulative impacts, to water quality, air quality, existing utilities, noise levels, social welfare, archaeological sites, or wildlife habitat. All anticipated impacts are expected to be temporary in duration and will not adversely impact the environmental quality of the area. An Environmental Impact Statement (EIS) will not be required and a Finding of No Significant Impact (FONSI) will therefore be issued for this project.

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Appendix A

Documentation Regarding Application for Subdivision
Dillingham Ranch Agricultural Subdivision
Mokūle'ia, O'ahu, Hawai'i

Appendix A
Documentation Regarding Application for Subdivision

No.	Subject	Agency	Division/Branch	Date
1	Water System Report	DOH	Safe Drinking Water Branch	January 28, 2008
2	Rockfall Hazard Evaluation	DPP	Site Development Division	February 29, 2008
3	Transportation Issues	DOT	Highways Division	February 21, 2007
4	Transportation Issues	DOT	Highways Division	December 24, 2007
5	Transportation Issues	DOT	Highways Division	February 25, 2008
6	Wastewater Issues	DOH	Wastewater Branch	February 25, 2008
7	Agricultural Feasibility	DOA	Office of the Chair	January 11, 2008
8	Agricultural Feasibility	DOA	Office of the Chair	January 25, 2008
9	Archaeological Review	DLNR	State Historic Pres. Division	January 23, 2008
10	Subdivision Tentative Approval	DPP	Subdivision Branch	April 18, 2008

1

LINDA LINGLE
GOVERNOR OF HAWAII

CHIYOME L. FUKINO, M.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O.BOX 3378
HONOLULU, HAWAII 96801-3378

In reply, please refer to:
EMD/SDWB

January 28, 2008

Mr. Harold Takemoto, P.E.
Project Coordinator
R.M. Towill Corporation
2024 North King Street
Honolulu, HI 96819-3494

Dear Mr. Takemoto:

SUBJECT: DILLINGHAM RANCH AGRICULTURAL SUBDIVISION
PRELIMINARY WATER SYSTEM REPORT

We received the Preliminary Water System Report for the Dillingham Ranch Agricultural Subdivision and the following changes in the project from previous proposals, dated April 7, 2007, and November 30, 2007, were noted:

1. The infrastructure of the existing Dillingham Ranch Public Water System (System No. 326) will be upgraded and expanded to provide water to the new Dillingham Ranch Agricultural Subdivision.

2. The Dillingham Ranch Public Water System will continue to provide water to its existing customers. In the April 7, 2007, proposal, the Dillingham Ranch Public Water System would stop water service to its customers and turn over this service to the Honolulu Board of Water Supply.

3. A new public water system for the Dillingham Ranch Agricultural Subdivision as previously indicated in the April 7, 2007, and the November 30, 2007, proposals, will not be created.

The Dillingham Ranch Public Water System upgrade and expansion to provide water to the Dillingham Ranch Agricultural Subdivision and improve the water service to existing customers as proposed in the Preliminary Water System Report, will not affect the Dillingham Ranch water system's status as an existing community public water system. As such, the Dillingham Ranch Public Water System will not be required to implement the Federal and State technical, managerial, and financial capacity regulations which are required for new public water systems.

The upgrade and expansion of the existing Dillingham Ranch water system infrastructure will require Department of Health (DOH) approval of the construction plans in accordance with HAR 11-20-30. The conversion of the irrigation well (Well No. 3410-03) to drinking water will require DOH approval in accordance with HAR 11-20-29.

If there are any questions, please call Don Yasutake at 586-4258.

Sincerely,

STUART YAMADA, P.E., CHIEF
Safe Drinking Water Branch
Environmental Management Division

DY:cb

c: Mr. Jeffrey Lee
Department of Planning and Permitting
Subdivision Branch
City and County of Honolulu
650 S. King Street
Honolulu, HI 96813

Mr. Tom Nance
Tom Nance Water Resource Engineering
680 Ala Moana, Suite 406
Honolulu, HI 96813

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
PHONE: (808) 768-8000 • FAX: (808) 527-6743
DEPT. WEB SITE: www.honoluludpp.org • CITY WEB SITE: www.honolulu.gov

MUFI HANNEMANN
MAYOR

HENRY ENG, FAICP
DIRECTOR

DAVID K. TANOUE
DEPUTY DIRECTOR

2008/ELOG-473 (df)

February 29, 2008

Mr. Clifford Smith
Dillingham Ranch Aina, LLC
9601 Wilshire Boulevard, Suite 220
Beverly Hills, California 90210

Dear Mr. Smith:

Subject: February 15, 2008 Rockfall Potential and Hillside Slope Evaluation Report for Dillingham Ranch Agricultural Subdivision, Mokuleia, TMK: 6-8-003: 040 (various)

We understand that the subject report is intended to supersede the August 13, 2007 Rockfall Potential and Hillside Slope Evaluation Report (Soils Report No. 3846) that our department accepted on October 8, 2007 (Ref.: 2007/ELOG-2357).

After reviewing the subject report prepared by Geolabs, Inc., we have no further comments and are accepting the report for our files.

The conditions that were stated in our October 8, 2007 letter are no longer applicable. Please be advised that approval of the subdivision will now be subject to the following conditions, which may include but are not limited to:

1. Submittal of a "Final" Geotechnical Engineering Exploration Report and Phase II Rockfall Potential and Hillside Slope Evaluation Report. These reports shall be submitted concurrently with the grading and construction plans (Refer to Item 3).

2. The owner of Lot 1007 shall be responsible for inspecting, maintaining, repairing and removing accumulated talus debris along Rockfall Impact Barriers "A", "B" and "C" as shown on Plate 4.1 of the subject report. In addition, Dillingham Ranch Aina LLC, the owner of TMK: 6-8-003: 005, shall be responsible for inspecting, maintaining, repairing and removing accumulated talus debris along Rockfall Impact Barrier "D" as shown on Plate 4.2 of the report.

These conditions shall be incorporated into restrictive covenants running with the land. Draft covenants shall be submitted concurrently with the grading and construction plans (Refer to Item 3) for review and approval.

3. Submittal and approval of grading and construction plans in accordance with Section 6-601 of the Subdivision Rules and Regulations. The plans shall incorporate and be in general conformance to the recommendations of the reports mentioned under Item 1. If the subdivision application is granted tentative approval, then submit these plans, one copy each of the reports mentioned under Item 1 and a copy of the draft restrictive covenants to the Subdivision Branch for processing.

4. Upon completion of the mitigation work, submittal of a final assessment report (FAR) prepared by a licensed geotechnical engineer, in accordance with Section 14-5.1(n)(2) of the Revised Ordinances of Honolulu (ROH). The FAR shall contain verification that the mitigation improvements were constructed in accordance with the approved plans.

Since future development of the proposed lots would require further geotechnical investigation and consultation by a licensed, geotechnical engineer, you shall be responsible for disclosing this to future property owners.

If there are any questions, please contact Mr. Don Fujii of the Site Development Division at 768-8107.

Very truly yours,

for Henry Eng, FAICP, Director
Department of Planning and Permitting

HE:ky
[599349]
cc: Subdivision Branch (Ref. 2007/SUB-167)
Geolab
R.M. Towill Corp.

LINDA LINGLE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

BARRY FUKUNAGA
INTERIM DIRECTOR

Deputy Directors
FRANCIS PAUL KEENO
BRENNON T. MORIOKA
BRIAN H. SEKIGUCHI

IN REPLY REFER TO:

HWY-PS
2.3671

February 21, 2007

Mr. James Yamamoto
R. M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96817

Dear Mr. Yamamoto:

Subject: Dillingham Ranch Aina, LLC, 80-Lot Ag-Residential Subdivision, Mokuleia
TMK: 6-8-003: 15, 19, 40

We have the following comments on the subject proposed subdivision:

1. The proposed subdivision is not anticipated to have a significant impact to Farrington Highway, our State facility.

2. The access road approach to Farrington Highway within our highway rights-of-way should have the lanes widened to standard 12-foot wide widths plus paved shoulders.

3. The proposed 8 unit Ag subdivision at TMK: 6-8-003:21, which is seeking a zone change from F-1 to Ag-2, should be allowed access from this subdivision's access road.

4. We defer at this time, but reserve the option to require that a channelized intersection with a left-turn storage lane be constructed should traffic conditions make it necessary. In any event, the construction of the access connection to Farrington Highway must conform to State Highway Design Standards. Plans for said construction work within the State highway rights-of-way shall be submitted for our review and approval.

5. As this access road services an agricultural subdivision, every reasonable effort must be undertaken to prevent the tracking of mud and deposition of other agricultural debris on the State highway. Any deposition of such material is the responsibility of the subdivision owners to remove in a timely fashion and at their expense.

If you have any questions, please contact Ronald Tsuzuki, Head Planning Engineer, at 587-1830. Please reference file review number 06-345 in all contacts and correspondence regarding these comments.

Very truly yours,

for BRENNON T. MORIOKA, Ph.D., P.E.
Deputy Director - Highways

bc: STP, HWY-R, HWY-T, HWY-PS (06-345; #3 refers to 06-385 - separate subdivision)

RI:th

4

LINDA LINGLE
GOVERNOR

BRENNON T. MORIOKA
ACTING DIRECTOR

Deputy Directors
MICHAEL D. FORMBY
FRANCIS PAUL KEENO
BRIAN H. SEKIGUCHI

IN REPLY REFER TO:

HWY-PS
2.6441

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

DEC 24 2007

Mr. Henry Eng, FAICP, Director
Department of Planning and Permitting
City and County of Honolulu
650 South King Street, 7th Floor
Honolulu, HI 96813

Dear Mr. Eng:

Subject: Subdivision 2007/SUB-167, Dillingham Ranch Aina, LLC
TMK: 6-8-002: 006; 6-8-003: vars.

Our attached comments (HWY-PS 2.3671, dated February 21, 2007) remain applicable and valid with respect to the proposed subdivision, provided your department's confirmation that the requirements for environmental review in accordance with Chapter 343, Hawaii Revised Statutes are provided prior to final subdivision approval. The Hawaii Department of Transportation (HDOT) is not authorized to give final approval for the proposed subdivision without compliance with Chapter 343, HRS. Since the proposed action primarily involves land use outside the State highway right-of-way, the HDOT will not be the accepting authority for any environmental review document, if one is necessary.

If there are any questions, please contact Ronald Tsuzuki, Head Planning Engineer, Highways Division, at (808) 587-1830. Please reference file review number 07-366 in all contacts and correspondence regarding these comments.

Very truly yours,

BRENNON T. MORIOKA, Ph.D., P.E.
Acting Director of Transportation

Attachment

c: Mr. Clifford R. Smith, Kennedy Wilson
Mr. James Yamamoto, R.M. Towill Corporation

5

LINDA LINGLE
GOVERNOR

BRENNON T. MORIOKA
INTERIM DIRECTOR

Deputy Directors
MICHAEL D. FORMBY
FRANCIS PAUL KEENO
BRIAN H. SEKIGUCHI

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

IN REPLY REFER TO:
HWY-PS
2.7172

February 25, 2008

Mr. Henry Eng, FAICP
Director
Department of Planning and Permitting
City and County of Honolulu
650 South King Street, 7th Floor
Honolulu, Hawaii 96813

Dear Mr. Eng:

Subject: Subdivision (2007/SUB-167), Dillingham Ranch Aina, LLC
Oahu, Waialua District, Mokuleia, TMK: (1) 6-8-2: 6; 6-8-3: vars.

The Department of Transportation is retracting HWY-PS 2.6441 dated December 24, 2007. We have no objections or requirements for tentative approval of the preliminary subdivision map. Our attached comments (HWY-PS 2.3671 dated February 21, 2007) remain applicable and valid with respect to final approval of the proposed subdivision.

Very truly yours,

BRENNON T. MORIOKA, Ph.D., P.E.
Interim Director of Transportation

Enclosure

bc: HWY-PS (07-366)

DM:cn

6

LINDA LINGLE
GOVERNOR OF HAWAII

CHIYOME LEINAALA FUKINO, M.D.
DIRECTOR OF HEALTH

Post-it® Fax Note 7671	Date 2/26/08 # of pages ▸ 1
To Jim Yamamoto	From T. See
Co./Dept. RM Towill	Co. DOH-WWB
Phone #	Phone #
Fax # 842-1937	Fax #

HAWAII
OF HEALTH
3378
WAII 96801

In reply, please refer to:
EMD / WB

LUD – 06 8 002 006

February 25, 2008

To: Mr. Henry Eng, Director
Department of Planning & Permitting
City and County of Honolulu

From: Tomas S. See, Chief, Wastewater Branch
Department of Health

Subject: **City & County of Honolulu Subdivision Application for the Dillingham Ranch Subdivision – Revised Map, Mokuleia, Waialua, Oahu, Hawaii**
TMK: (1) 6-8-002: 006
(1) 6-8-003: 005, 006, 016, 019, 030, 033, 035 and 040
Total Area: 2,772.49 acres

Thank you for allowing us the opportunity to review the proposed subdivision. The owner's representatives provided additional information to the Department of Health (Department) on February 19, 2008.

The information provided satisfies the Department's concerns and we can now concur with the proposed subdivision provided that the deed restrictions submitted to the Department are included and recorded for all the 77 residential lots.

The Declaration of Restrictive Covenants and Maintenance Service Contracts agreed to by the original property owner shall be made part of each subdivided lot and recorded and executed immediately after the subdivision. The subject documents (See attachment) were provided by White & Tom on February 19, 2008 and October 22, 2007 to the Department to address our concerns on the treatment and disposal of wastewater generated by the subject development.

Furthermore, the Department will not sign off on any building permits for these lots until the deed restrictions are recorded with the Bureau of Conveyance.

All wastewater plans must conform to applicable provisions of the Hawaii Administrative Rules, Chapter 11-62, "Wastewater Systems." We do reserve the right to review the detailed wastewater plans for conformance to applicable rules.

Should you have any questions, please contact the Planning & Design Section of the Wastewater Branch at telephone (808) 586-4294.

Attachment

We noted the comprehensiveness of the information contained in the original agricultural feasibility report regarding the subdivided lot management plan, crop options, soils, names and contact information of specialists and the benefits of building farm buildings contiguously and that this information was to be made available to prospective purchasers. **We recommend** this information in the original be integrated with the subject report in a manner that would further facilitate the agricultural use of the subdivided lots.

SUMMARY OF SUBDIVISION PROPOSAL:
The subdivision involves approximately 443 acres in the middle of the 2,722-acre property.

- 77 agricultural subdivision lots are proposed with an average lot size of 5 acres. The existing zoning of this specific area (AG-2) permits a 2-acre minimum lot size so the developer is not developing the property to the maximum allowed.
- The proposed agricultural use for these 77 lots is improved and irrigated (average of 2,940 gallons/day) pasture (page 21, first paragraph and page 23, fifth paragraph). Currently, there are about 137 head of cattle in this area producing 70-80 calves per year.
- Additional agricultural uses are encouraged and detailed information on the range of crops, incomes, costs, restrictive covenants, and relationship to the existing ranch is included in the original agricultural feasibility report.
- The Land Study Bureau shows the area to be subdivided is on the Mokuleia foothills and consists of mostly stony "D" and "E" soils and about 50 acres of "B" and "C" soils. According to the Natural Resources Conservation Service (formerly Soil Conservation Service) Soil Survey, the "B" and "C" rated area has stony and/or wet characteristics that limit their use for agricultural production.
- Nine additional lots encompass the existing uses, which include:
    1. The two existing agricultural operations found nearest to Farrington Highway (6,500-tree Dillingham Ranch Plan Tree Farm and 130-horse Dillingham Ranch Stables and Equestrian Center) are situated on 314 acres, possess the best soil productivity potential in the entire project area, and will be retained without subdivision.
    2. The 1,900-acre Dillingham cattle ranch occupying the area immediately mauka of the proposed 77-lot subdivision is currently unused.

The applicant's proposal is to increase the cattle herd from the current 137 head to 235 (220 cows, 15 bulls), fence and create 3 pasture areas in the mauka grazing lands, and extend water lines to the mauka grazing lands for cattle drinking water.

The 75-acre tree farm is to be expanded by 15-20 acres.

The horse boarding and equestrian area will retain the same acreage (125 acres), but will be re-fenced and paddocks redone to standard configuration. The leach field for the subdivision development will be used for horse pasture and on occasion, a polo field.

SUBDIVIDED LOTS FOR IMPROVED PASTURE

The Dillingham Ranch will offer pasture management services to the subdivided lot owners (page 18, fourth paragraph) which include monitoring the health of the pasture grass, maintenance of the irrigation system, and tending to the livestock. Method of payment could either be structured as part of the monthly assessment by the lot owners' association or direct payment to the Ranch.

ORGANIZATIONAL RELATIONSHIP OF THE EXISTING MAKAI LOTS, THE MAUKA CATTLE RANCH, AND THE SUBDIVIDED LOTS:

The makai lots and the mauka cattle ranch will be operated by the developer/landowner. A separate agricultural subdivision lot owners' association will be established to address issues specific to the agricultural subdivision. Both the developer/landowner and the agricultural subdivision lot owners will be part of a master association that will be responsible for roads, drainage, and commonly-owned landscaped areas. The lot owners, individually or as an association, will have opportunity to establish a formal working relationship with the existing ranch to undertake the pasturing of cattle on their respective lots as individual lot owners or throughout the subdivision as a unified operation. Easements are to be established within the agricultural subdivision to accommodate mauka-to-makai access (pages 10-11). **We recommend** that the subject Report study the feasibility of little or no fencing separating individual subdivided lots to encourage maximal utility for the pasturing of cattle.

The development of a working relationship is very important to the success of the pasturing of cattle in the agricultural subdivision lot portion of the project and should be one of the first items considered by the lot owners' association and the master association. Therefore, **we recommend** that the opportunity, benefits, and likely structure for a formal working relationship between the existing ranch and agricultural subdivision lot owners be further explained, the information made available to potential lot purchasers, and a requirement within the Declaration of Restrictive Covenants document that the master association consider the establishment of a working relationship.

AVAILABILITY OF IRRIGATION WATER AND RATES:

A detailed water master plan for irrigation and potable water is not yet available. Dillingham Ranch owns a total of four wells of which two are producing water. All four have CWRM permits and water allocations. Two of the four wells are awaiting to be outfitted for production. The water rates for agricultural irrigation will be competitive with the Board of Water Supply rate schedule (page 25, fifth paragraph). The water budget for irrigated pasture is 2,940 gallons/day/acre. Additional water will be needed to irrigate other crops grown on the subdivided lots.

COVENANTS, CONDITIONS AND RESTRICTIONS:
The draft Declaration of Restrictive Covenants (Appendix C) appears to contain the necessary provisions, however, **we recommend** that specific reference be made to Section 205-4.6, Hawaii Revised Statutes, that prohibits private restrictions that limit/prohibit ag use/activity. As **we recommended** earlier, there should be a requirement within the Declaration of Restrictive Covenants that the master association consider the establishment of a formal working relationship between the existing ranch and agricultural subdivision lot owners. Also, we take this opportunity to recommend that the City establish the authority and responsibility to monitor and/or enforce compliance.

CONCLUSION:
The existing agricultural operations, their organizational and operational connection with the 77 subdivided lots, sufficient irrigation water resources, information to be made available to potential lot purchasers to assist in their selection of agricultural activities and understand their responsibilities improves the likelihood that substantial and meaningful agricultural use can be implemented and maintained in consonance with Chapter 205, Hawaii Revised Statutes.

Should you have any questions, please contact Earl Yamamoto at 973-9466, or email at earl.j.yamamoto@hawaii.gov.

Sincerely,

Sandra Lee Kunimoto
Chairperson, Board of Agriculture

LINDA LINGLE
Governor

SANDRA LEE KUNIMOTO
Chairperson, Board of Agriculture

DUANE K. OKAMOTO
Deputy to the Chairperson

State of Hawaii
DEPARTMENT OF AGRICULTURE
1428 South King Street
Honolulu, Hawaii 96814-2512
Phone: (808) 973-9600 Fax: (808) 973-9613

January 25, 2008

Mr. Henry Eng, FAICP
Director
Department of Planning and Permitting
City and County of Honolulu
650 South King Street 7th Floor
Honolulu, Hawaii 96813

Attention: Mr. Jeff Lee

Dear Mr. Eng:

Subject: Supplemental Agriculture Feasibility Report
Proposed Consolidation/Resubdivision of Agricultural Land
Dillingham Ranch Agricultural Subdivision (2007/SUB-167)
TMK: 6-8-02: 6
6-8-03: various

The Department of Agriculture has reviewed the Dillingham Ranch Supplemental Agriculture Feasibility Report (dated November 2007) and our findings and recommendations are summarized in the Department's letter of January 11, 2008 to Mr. Robert Miyasato of Development Strategies, LLC (copy attached).

We have also received a letter from Ms. Marie E. Riley (dated January 23, 2008) that specifies how every one of our recommendations had been or will be carried out. With the understanding that the applicant will fully carry out our recommendations as specified in Ms. Riley's letter, the Department of Agriculture accepts the Supplemental Agriculture Feasibility Report that contains sufficient evidence that substantial and meaningful agricultural use can be implemented and maintained throughout the entire property and in consonance with Chapter 205, Hawaii Revised Statutes.

Should you have any questions, please contact Earl Yamamoto at (808) 973-9466, or email him at earl.j.yamamoto@hawaii.gov.

Sincerely,

Sandra Lee Kunimoto
Chairperson, Board of Agriculture

Attachment

c: Mr. Robert Miyasato
Development Strategies, LLC
1432 Kalaepohaku Street, Suite 260
Honolulu, Hawaii 96816

dillinghamranchsupplementalreport3.e07

7

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
601 KAMOKILA BOULEVARD, ROOM 555
KAPOLEI, HAWAII 96707

January 23, 2008

Henry Eng
Department of Planning and Permitting
City and County of Honolulu
650 South King Street
Honolulu HI 96813

LOG NO: 2007.4040
DOC NO: 0801LM09
Archaeology

Dear Mr. Eng:

SUBJECT: **Chapter 6E-42 Historic Preservation Review –Proposed Agricultural Subdivision for Dillingham Ranch; Consolidation and Re-subdivision of Parcels 6-8-002: 006, 015, 019, 030, 031, 033, 035, and 040 into 92 lots; 1 to 77**
Auku'u, Kikahi, and Kawaihāpai Ahupua'a, Waialua District, Island of O'ahu
TMK: (1) 6-8-002:006, 015, 019, 030, 031, 033, 035, and 040

Thank you for the opportunity to review the Department of Planning and Permitting proposed subdivision request, which we received on November 16, 2007. We apologize for the delay in our review. The proposed action is a paper action and as such will not adversely affect historic properties identified within the proposed subdivision. An Archaeological Inventory Survey was conducted of the property and has been reviewed and accepted by our division Log No. 2007.2421 Doc No. 0712LM03. At this time we are awaiting the submission of the Preservation Plan for the historic sites identified during the Inventory Survey.

We determine that **no historic properties will be affected** by this undertaking because:

- ☐ Intensive cultivation has altered the land
- ☐ Residential development/urbanization has altered the land
- ☐ Previous grubbing/grading has altered the land
- ☐ An accepted archaeological inventory survey (AIS) found no historic properties
- ☐ SHPD previously reviewed this project and mitigation has been completed
- ☒ Other: *Because the subject action is a "paper transaction" for the proposed zone change and no ground disturbing activities will occur at this time, we believe that the current undertaking will have "no effect" on historically-significant resources.*

Please contact Lauren Morawski (O'ahu Archaeologist) at (808) 692-8015 if you have any questions or concerns regarding this letter.

Aloha,

Nancy McMahon
Acting Archaeology Branch Chief and Kaua'i Archaeologist
State Historic Preservation Division

LM

Cc: Cliff Smith

DEPARTMENT OF PLANNING AND PERMITTING

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET * HONOLULU, HAWAII 96813
Phone: (808) 768-8000 * Fax: (808) 527-6743

MUFI HANNEMANN
MAYOR

HENRY ENG, FAICP
DIRECTOR

DAVID K. TANOUE
DEPUTY DIRECTOR

SUBDIVISION		
File Number	:	2007/SUB-167
Project	:	SUB / Mokuleia--Farrington Hwy. (Dillingham Ranch Agricultural Subdivisi
Location	:	
Tax Map Key	:	6-8-003:040 (various)
Owner	:	Dillingham Ranch Aina LLC, a Delaware ltd. liablity company
Surveyor	:	ControlPoint Surveying, Inc.
Agent	:	ControlPoint Surveying, Inc.

Description of the Proposal: Revised consolidation and resubdivision of Lots 1-A (Map 2) and 2-A, 2-C and 2-D (Map 3) of Land Court Application 824; Lots C-1-B (Map 4) and 1 to 5 (Map 5) of Land Court Application 1107; Lots 2 and 3 (Map 1), 1-A-1 (Map 8), 1-B and 1-C (Map 5) of Land Court Application 1810; Lot 1 of File Plan 2049; and TMK 6-8-02: 06, also being various R.P. and L.P. Grants, into 77 agricultural lots (Lots 1 to 77) with areas from 4.30 acres to 10.83 acres; 7 ranch and tree farm lots (Lots 1001 to 1007) with areas from 31.73 acres to 1488.87 acres; 2 archaeological sites (Lots AR-1 and AR-2) of 11.72 acres and 7.40 acres, together with 44-foot wide right-of-way (Lots R-1 to R-6); the designation of various easements and the cancellation of Easement 28 as shown on Map 13 of Land Court Application 1107.

The Honolulu Fire Department (HFD) has no objections to the proposed subdivision. However, the applicant will be required to comply with the HFD's requirements prior to any sale and/or development of the parcels (see attached comments).

Tentative Approval was granted to the proposal. Final action will be subject to the following:

1. Construction of improvements, utilities and drainage facilities, and water system improvements to include reservoir, transmission and source, all in compliance with City standards.

2. Receipt of written confirmation that the State Department of Transportation (SDOT) has no objections to the approval of the final subdivision map.

3. Compliance by the applicant with the recommendations from the State Department of Agriculture as stated in their letter dated January 11, 2008, including the submission for review and acceptance, and subsequent recordation of an acceptable declaration of restrictive covenants referencing Section 205-4.6, HRS. The covenants are subject to review and acceptance by the Department of Planning and Permitting, the City Department of the Corporation Counsel, and the State Department of Agriculture.

4. Compliance with our Building Division's certification requirement including compliance with the provisions of the Land Use Ordinance. Should you have any questions regarding this requirement, please contact Mr. Dennis Maielua of our Building Division at 768-8128.

5. Submission of the final subdivision map information on a 3-1/2" diskette in a DXF file or ARC/INFO format.

6. Filing of 15 copies of the final survey maps without showing the structures and contours.

   The diskette and final maps shall only be submitted when all of the other conditions have been met.

Section 3-302(a) of the Subdivision Rules and Regulations states that the tentative approval shall be for a period of one year from the date of this action, unless a written request for an extension of time is submitted to the Director of Planning and Permitting prior to the expiration of the one-year period. The subdivision application will automatically expire and become null and void if the one-year period passes without a request for an extension of time. Any further action will require the submission of a new application including 20 prints of the map, a new filing fee and necessary documents.

This copy is notification of the action taken and the date it was signed.

	For DIRECTOR	*April 18, 2008*
SIGNATURE	TITLE	DATE

This action does not constitute approval of any other required permits, such as building or sign permits. Should you have any questions, please call Mr. Jeff Lee at 768-8099 or Mr. Dennis Silva at 768-8101.

Process Edit

Record HFD comments

Job 026391295-001 (2007/SUB-167)

Assigned To	Status	Outcome	Scheduled Start	Scheduled Completed	Actual Start	Actual Completed
STEPHEN KISHIDA	Complete	Recorded				Mar 19, 2008 10:56:4

Details

Comments:

Since the subdivision roads are to remain private, HFD will now comment on this subdivision application.

The Honolulu Fire Department (HFD) has no objections to the proposed subdivision at this time. However, the HFD requires that the following be complied with prior to any sale and/or development of the parcels:

1. Provide a fire apparatus access road for every facility, building, or portion of a building hereafter constructed or moved into or within the jurisdiction when any portion of the facility or any portion of an exterior wall of the first story of the building is located more than 150 feet (45 720 mm) from fire apparatus access as measured by an approved route around the exterior of the building or facility. (1997 Uniform Fire Code, Section 902.2.1)

*Fire apparatus access shall be to each subdivided parcel.

2. Provide a water supply, approved by the county, capable of supplying the required fire flow for fire protection to all premises upon which facilities or buildings, or portions thereof, are hereafter constructed or moved into or within the county.

On-site fire hydrants and mains capable of supplying the required fire flow shall be provided when any portion of the facility or building is in excess of the 150 feet (45 720 mm) from a water supply on a fire apparatus access road, as measured by an approved route around the exterior of the facility or building. (1997 Uniform Fire Code, Section 903.2 as amended)

*Onsite fire hydrants shall pertain to each subdivided parcel and shall be in relation to the fire apparatus access road.

3. Submit civil drawings to the HFD for review and approval.

4. In addition to the fire apparatus access and fire hydrant requirements to each subdivided parcel, the HFD requires the installation of an approved automatic fire sprinkler system in all dwellings that are constructed in excess of 150 feet from the fire apparatus access road.

The automatic fire sprinkler system shall be in accordance with National Fire Protection Association 13D, Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings.
D
The fire sprinkler plans shall be stamped by a licensed mechanical engineer.

*It is not the intent of this requirement to mandate the installation of an automatic fire sprinkler system in every case.

APPLICANT'S COPY

Appendix B

Botanical survey in support of an environmental assessment document for intersection improvements Dillingham Ranch Agricultural Subdivision Mokūle'ia, O'ahu, Hawai'i

Botanical survey in support of an environmental assessment document for intersection improvements, Dillingham Ranch Agricultural Subdivision, Mokule'ia, O'ahu, Hawai'i[1]

January 24, 2008 *AECOS* 1165

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Introduction

This report is submitted in support of an Environmental Assessment (EA) for intersection improvements related to the Dillingham Ranch Agricultural Subdivision. The Dillingham Ranch covers some 2,700 ac (1,092 ha) of land at Mokule'ia on the north shore of O'ahu (Fig. 1), but the majority of this land is undeveloped uplands. This report discusses botanical resources and potential impacts on these resources of a planned Farrington Highway intersection improvement project for the planned agricultural subdivision. The subdivision involves approximately 300 ac (121 ha), or roughly one-third, of the 900 ac (364 ha) of level to moderately sloping ground on the coastal plain and foothills along the north face of the Wai'anae Mountain that is the active ranch property. The subdivision area covers most of the land *mauka* of a former cane haul road that crosses the ranch property from east to west (Fig. 2). The intersection improvements are to service an access roadway connecting the agricultural subdivision with Farrington Highway and located at the existing main entrance to the ranch.

Survey Methods

A botanical survey of the site was undertaken on January 4, 8 and 17, 2008. The survey proceeded by walking over the approximately 900-ac (364-ha) property and identifying plants growing there. The use of such wandering transects is a standard approach to assessing the vegetation, allowing for observations to be made in a

[1] Report prepared for R. M. Towill Corp. to be utilized in preparation of an environmental assessment for the construction of intersection improvements for an agricultural subdivision at the Dillingham Ranch property. This report will become part of the public record.

wide range of environments and enhancing the likelihood of encountering uncommon species. For this report, the subdivision portion was more intensely surveyed. Reported abundance estimates of the plants observed using this method are subjective and intended to be semi-quantitative at best. In essence they reflect the likelihood of encountering a particular species, not necessarily an actual number of plants of that species present on the property.

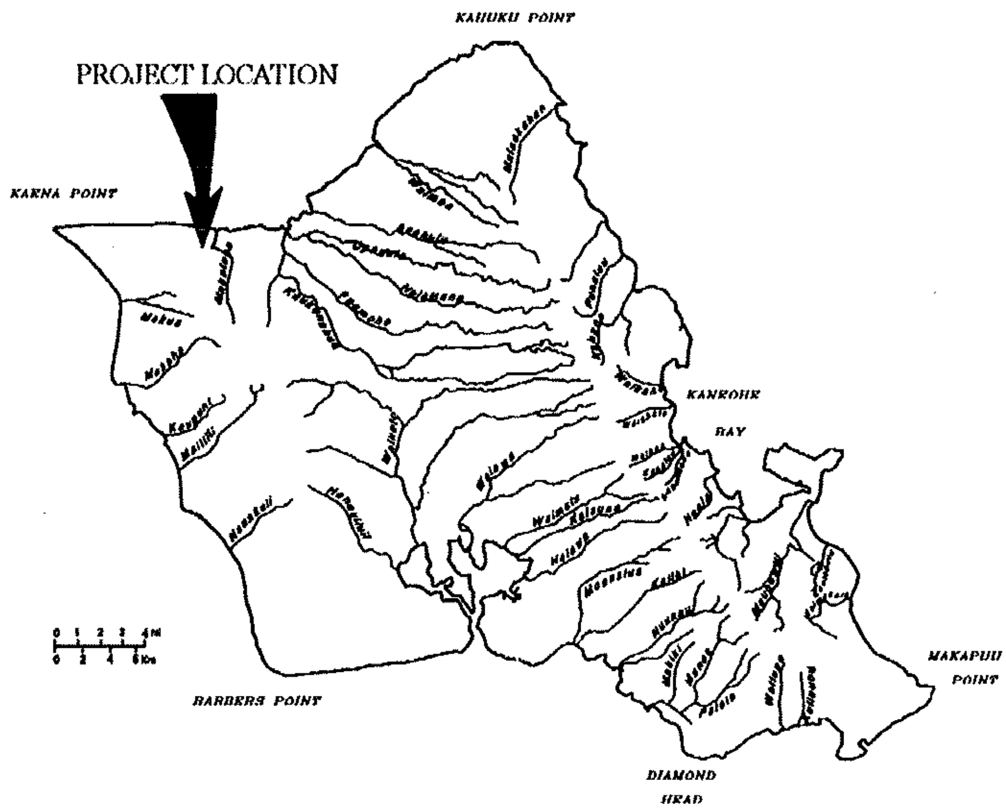

Figure 1. Project location on the Island of O'ahu, Hawaiian Islands.

Much of the lower portion of the Dillingham Ranch property is developed as a stables and horse ranch, with other areas utilized for pasturing cattle or as residences on agricultural lots. As this lower or *makai* area is not part of the agricultural subdivision (with the exception of the road improvement), only limited survey time was spent here and around the wetlands. Further, plantings of ornamentals around developed facilities (houses, stables, corrals) were ignored, although special attention was paid to the area of the intersection improvements at Farrington Highway. The highway marks the northern or *makai* boundary of the ranch property, and improvements at the point where the ranch access road connects to the state highway are responsible for the preparation of an EA as required by the state Department of Transportation (DOT).

We caution that any botanical survey conducted at a specific point in time, is limited to the plants thriving at the time of the survey, and the possibility that some species present might be dormant. The time period of this survey can be regarded as good for locating and identifying annuals and perennials because it was undertaken well into the wet season following a couple months of adequate rainfall. Plants found in the area had strong vegetative growth and most were in flower. However, much of the site is maintained (regularly mowed and or grazed by horses), making some identifications difficult (for example, lawn and pasture grasses that were not in flower). Plant names used herein follow *Manual of the Flowering Plants of Hawaiʻi* (Wagner, et al., 1990) and as updated in the supplement (Wagner and Herbst, 1999). Names for ornamental species come from Staples and Herbst (2005).

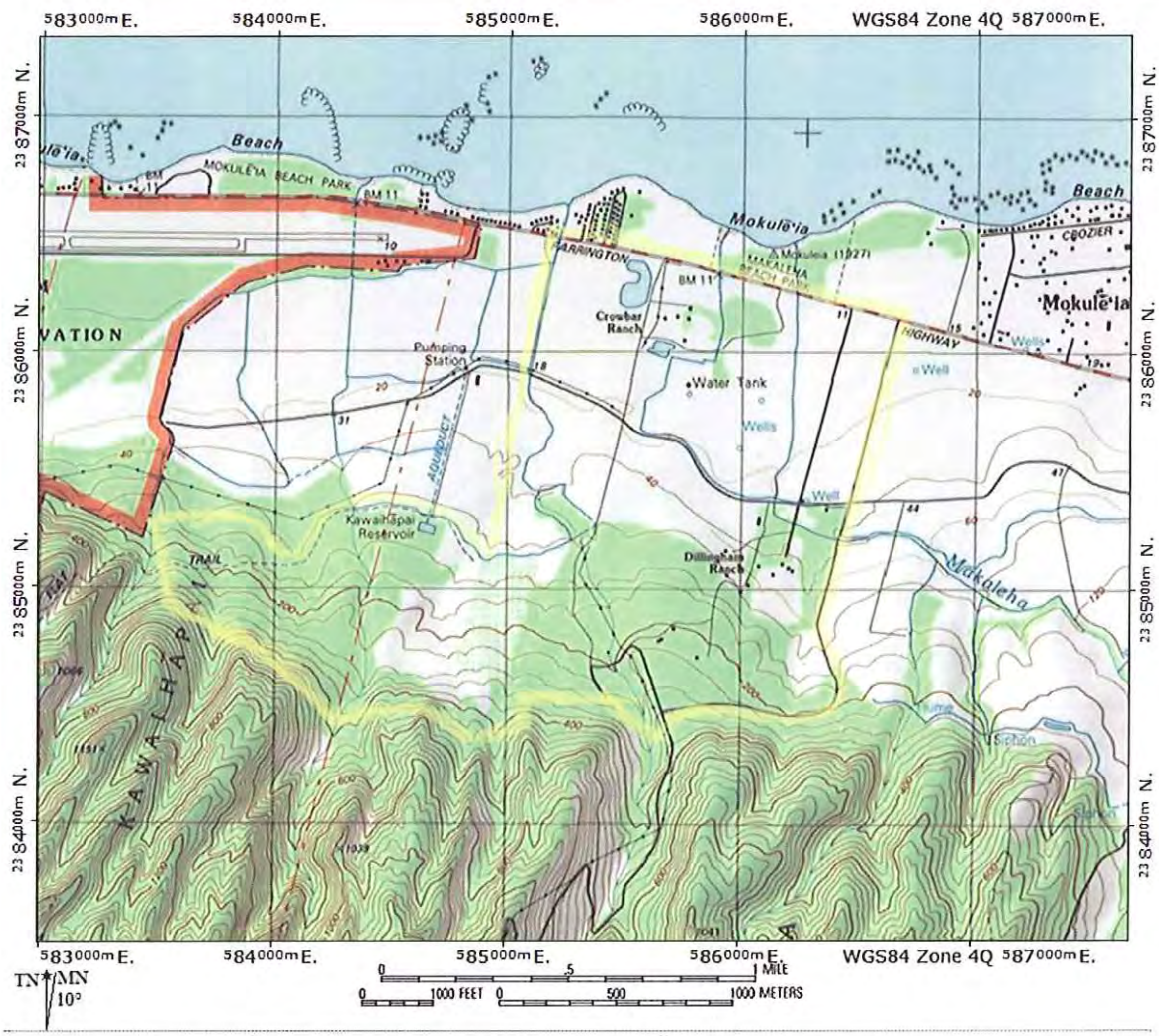

Figure 2. Topographic map of Dillingham Ranch and vicinity with the ranch area outlined in light yellow. Dillingham Airfield is shown on the west.

Site Description

Dillingham Ranch is located on the north shore of Oʻahu directly east of Dillingham Airfield (see Fig. 2 above). The property also extends westward upslope from the airfield, with the coastal plain portion here actively farmed and the alluvial foreslopes utilized as pasture for cattle. The elevation range in the survey area is from a few feet above sea level to roughly the 400-ft (122-m) elevation contour. The proposed development of roads and subdivision of agricultural lots would be on the alluvial slopes, terminating in most cases at or a little below or above the line of contact with steeper erosional slopes of the Waianae Mountain. Four intermittent streams cross the property, in addition to Makaleha Stream, which arises on the north side of Mt. Kaʻala, the highest point on Oʻahu. The latter stream is also intermittent (a dry wash with maintained channel) in the project area. Most of the coastal plain, with its scattered wetlands, is not part of the proposed project. Undeveloped areas on the coastal plain were, however, included in the present survey.

The Dillingham Ranch has been surveyed for botanical resources several times in the past. We had access to a survey by Whistler (1991) undertaken in December 1991, and Whistler cites two surveys preceding his that included listings of plants: one by Char and Linney (1986) and another by Warren Corporation (1973). We have not seen these now more than 20-year old reports and Whistler made only the following comparison:

> The majority of species recorded by Char and Linney (1986) were also found during the present survey, as well as a number of other species not listed in the earlier study. The differences between the checklists of the two studies are due to different boundaries for the 1986 and the present study, chance, and different seasons of sampling (the 1986 survey was carried out in late spring).

Whistler prepared a map of vegetation zones that he defined based upon his field observations. Six vegetation types were recognized: (1) Wetlands; (2) Managed land; (3) *Panicum* grassland; (4) Koa haole scrub forest; (5) Kiawe woodland; and (6) Riparian forest. Whistler further divided the wetlands category into *Hibiscus* thicket, coastal marsh, and pond margins. The 1991 map of these vegetation zones on the Dillingham Ranch property is presented herein as Fig. 3. Shown on this map (lower right) is a portion of a *mauka* parcel that was part of the 1991 survey area but not included in the agricultural subdivision area.

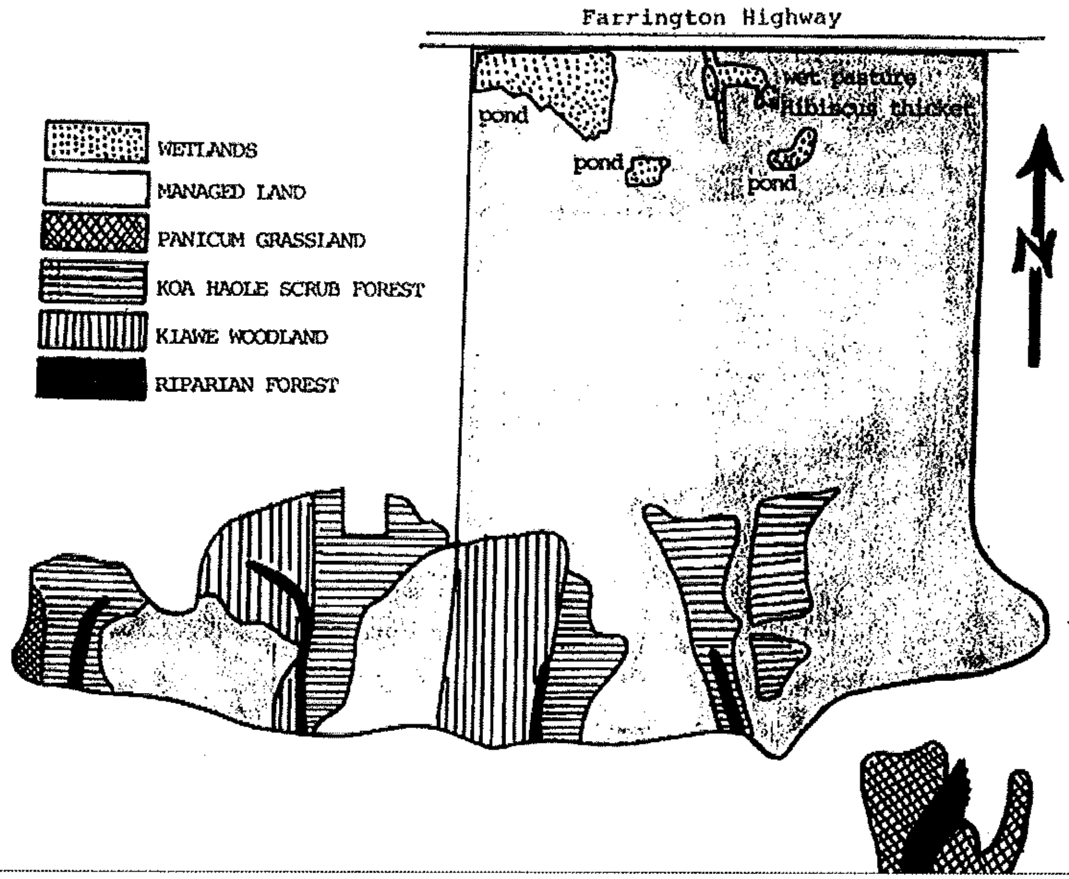

Figure 3. Vegetation map of the Dillingham Ranch property prepared by Whistler based on a 1991 botanical survey (altered from the original with respect to orientation).

Survey Results

Vegetation

Whistler's 1991 description of the vegetation remains generally pertinent today, 16 years later. However, we would describe the vegetation zones somewhat differently in a couple of cases, and we also note some boundary changes have occurred over time. First, with respect to "managed lands", we observed that cattle ranching on the more upland fields has been minimal in recent years, with the result that these pastures are now densely covered by Guinea grass (*Urochloa maxima*, formerly known as *Panicum maximum*). The result of this minimal "management" is that these areas are now better mapped as "*Urochloa* grassland" type. That is, the "*Panicum* grassland" of Whistler is now more extensive within the area of the planned subdivision, although this fact does not at all mean that the list of species

Whistler recorded from *Panicum* grassland applies. Apparently, the reason Whistler described *Panicum* grassland as somewhat unique (despite the ubiquitous occurrence of Guinea grass across all of the upland areas) relates to the fact that these small areas on the western tip and the separated *mauka* parcel were not, in the decades prior to 1991 (if ever), used as pasture. This is not the case today, where our mapping of *Urochloa* grassland (Fig. 4) includes former "managed land" (pasture) of Whistler's vegetation classification. This distinction is important because, as discussed further on, a majority of the native plants recorded by Whistler were found in his *Panicum* grassland, most particularly associated with rock outcrops on the isolated, *mauka* parcel.

Figure 4. Vegetation zones as mapped for the present survey. ML = managed land; Ugs = *Urochloa* grassland/savanna; Rf = Riparian forest; stippled = koa-haole forest and scrublands; vertical stripes = kiawe woodland.

The remaining vegetation zones of Whistler are pretty much today what they were in 1991. Managed land (ML in Fig. 4; see Fig. 5) was then and remains a kind of catchall for a range of environments including cattle pasture, horse pasture and stable areas, open residential areas, orchards, and extensive palm groves. The latter is an extensive vegetation type in the northeast sector. The coconut (*Cocos nucifera*) grove must be one of the largest remaining on O'ahu. Although Whistler did not make note of it, a sizeable portion of the palm grove on the west side is actually royal palms (*Roystonia* cf. *regia*), not coconut palms. Further, there are present similar dense plantings of Manila (*Veitchia merrillii*) and fishtail (*Caryota mitis*) palms, perhaps as part of a former or on-going commercial nursery venture. And a portion of the area is devoted to a fruit tree orchard (mostly oranges and tangerines).

Figure 5. View north towards the intersection of the ranch entrance road (left) and Farrington Highway (background).

In addition, the managed land includes coastal lands that are characterized by sandy soils and, while much disturbed, are not managed. The low elevation and unique edaphic (soil) characteristics suggest these areas would support a somewhat different assemblage of plants than other managed areas or upland disturbed sites. The wetlands on the property occur in this area outside the agricultural subdivision area, and are given only cursory treatment in our survey. These features are described in more detail in Whistler (1991). The mouth and lower segment of Makaleha Stream is, in January 2008, a recently graded channel lacking vegetation. Standing water is present at the highway bridge. The other drainage channel to the west is a wetland with distinct estuarine vegetation: pickleweed (*Batis maritima*) and seashore paspalum (*Paspalum vaginatum*) on the *makai* side of the highway bridge, seashore paspalum, hau (*Hibiscus tiliaceus*), and (a short distance further upstream) dense California grass (*Urochloa mutica*) on the *mauka* side. Red mangrove (*Rhizophora mangle*) is starting to invade the estuary just up from the bridge. Indian sourbush (*Pluchia indica*) lines the banks, along with scattered ironwood and milo (*Thespesia populnea*) trees.

One area of managed land was looked at more carefully: the proposed intersection of the access road improvements with Farrington Highway. The access road would follow the existing ranch entrance road seen in Fig. 4 skirting the east side of the large pond. The pond itself is a depression presumably created by an old sand mining operation (i.e., a quarry; Warren Corporation, 1973). The jurisdictional status of the water body may need to be established if roadway improvements impinge on the shore, although sufficient room exists for this not to occur. The intersection consists of a tree-lined (ironwoods; *Casuarina equisetifolia*) verge (Fig. 5, above) that is maintained (mowed) on both sides of the highway (the Mokule'ia Polo Field occupies land across the highway from the ranch entrance).

The survey area/property boundary is outlined in white in Fig. 4. The upland portion of the property—essentially the area south of the Managed land (ML)—constitutes the agricultural subdivision area. On our map, the *mauka* "property boundary" follows the agricultural subdivision lot boundaries, and thus differs slightly from the *mauka* (south) boundary shown in Whistler (1991). The areas covered by patches of Koa haole forest and scrubland (horizontal stripes in Fig. 3; stippled in Fig. 4) appear to have expanded somewhat between 1991 and when the satellite photo was made (~2003), generally at the expense of Managed land. The latter is treated as *Urochloa* grassland/savanna (Ugs) on our vegetation map because of minimal use as rangeland and "savanna" is a more appropriate vegetation type in most areas here characterized by grassland with scattered trees (Fig. 6). As was the case in 1991 (Whistler, 1991), the dominant species today is Guinea grass. In the lowlands, most other herbaceous species are associated with disturbed areas: roads, vehicle tracks, cattle trails, corrals, recently graded sites, etc. Where the land becomes steeper and more rocky, or more shaded by trees, the grassland supports annuals and shrubs in greater abundance, especially lion's ear (*Leonotis nepetifolia*), comb hytis (*Hyptis pectinata*), *Sidastrum micranthum*, glycine (*Neonotonia wightii*), and popolo (*Solanum americanum*), in addition to Guinea grass.

The Kiawe woodland (vertical striped in Fig. 4) differs from the savanna (where kiawe [*Prosopis pallida*] is also the most abundant tree species) only in that the shading within the woodland reduces the undergrowth of Guinea grass. Still, some areas of *Urochloa* grassland/savanna can be seen to support an open forest, particularly in the lower elevation portions of this vegetation type. This latter area supports a scattered growth of native wiliwili trees (*Erythrina sandwicensis*), in addition to koa haole, silk oak (*Grevilea robusta*), African tulip (*Spathodea companulata*), and Java plum (*Syzygium cuminii*) trees that occur throughout the upland area in all the vegetation types. On the east, monkeypod (*Samanea saman*) and another large, spreading Fabaceae (?*Albizia* sp.), along with date palms (*Phoenix dactylifera*) comprise the main trees of the pasture/savanna. In general, silk oak is more common in the higher elevation *Urochloa* grassland/savanna, whereas African tulip and Java plum are more common in the lowland savanna and Kiawe woodland.

Figure 6. *Urochloa* grassland/savanna showing tall (to 2 m or 6 ft) Guinea grass and scattered kiawe trees on formerly managed land.

The Koa haole scrub forest (stippled in Fig. 4) occupies scattered areas across the property that are dominated by koa haole (*Leucaena leucocephala*) growth. The plants tend to be scrubby at the higher elevations and moderately tall trees (Fig. 7) in the lowlands and along the swale bottoms. Some areas of Koa haole scrub forest correspond to archaeological reserves, suggesting that fencing cattle out has encouraged the growth of this alien species. In fact, damage to koa haole is very evident in the *Urochloa* grassland/savanna where cattle continue to be grazed on a limited basis. Thus, it is not surprising that this vegetation type in particular has expanded at the expense of pasture as ranching on the property has declined.

Figure 7. Koa haole forest. Note the stunted but high cover of Guinea grass on the rocky forest floor.

An interesting area of Koa haole forest occurs on the western end of the survey area. On these somewhat rocky slopes, the forest is dominated by koa haole and Guinea grass, but includes silk oak and native alaheʻe (*Canthium odoratum*). Whistler noted native wiliwili trees and gray knickers or kākalaioa (*Caesalpinia bonduc*) as also present in this vegetation type.

The Riparian forest (Rf in Fig. 4) grows along the valleys and swales coming out of the steep uplands. This vegetation type is more prominent above the subdivision area, and is dominated by Java plum, koa haole, and kukui (*Aleurites moluccana*). Through the ranch property, the stream beds remain visible as bolder strewn channels, but these tend to become more diffuse downslope, and the vegetation (typically either Kiawe woodland or Koa haole scrub forest) is not especially distinguished along the channels. The native plumbago (ʻilieʻe or *Plumbago zeylanica*), although far from abundant, was seen to be associated with rock outcrops in the Riparian forest.

Flora

The flora of a project or survey area refers to the plant species that are present. Given the diversity of environments present on Dillingham Ranch property, the varied disturbances to the vegetation, and the large area (over 900 ac), it is not surprising that the listing of species (Table 1) is a long one. Our listing includes most of the species reported by Whistler (1991) along with our findings in 2008. For species previously listed by Whistler (1991), two notes are provided in our table: note (1) - a species also observed in 2008; and note (2) - a species not observed in 2008. Species from the Whistler flora listing not included in our Table 1 are those species specifically mentioned in his report text as having been seen only in the southeast "*Panicum* grassland" area that was not part of the 2008 survey area. All other species recorded by Whistler as seen in this plant community in 1991 are marked with an asterisk (*) in the notes column. A small part of this community was mapped in the southwest corner of the property that was part of the 2008 survey, and in the absence of additional information, it is assumed these "asterisk" species could have been present in that area.

A total of 211 species of flowering plants (plus 4 ferns and 1 gymnosperm) were recorded from the survey area in the vegetation surveys of December 1991 and January 2008. Many more species are present as ornamentals within the managed land area, although ornamentals persisting in abandoned former house lots and prominent trees and shrubs in the managed lands are included. For comparison, 48 species (22%) were seen in 1991 but not recorded in 2008; 47 species (22%) were seen in 2008 but not recorded in 1991. At least some of the species recorded by us as "new" were clearly present in 1991 and for whatever reason left off the 1991 list: several species of *Eucalyptus* trees in the upland pastures and managed lands, and the several different palm trees (including royal and coconut) found in the lowland palm grove.

The majority of the plant species growing on the property and in the project area are considered exotics naturalized in this area. Only 12 species (5.6%) in the listing are native plants (indigenous or endemic species). Several of these—Cretan brake (*Pteris cretica*), kākalaioa (*Caesalpinia bondoc*), and nehe (*Lipochaeta lobata*)—were not observed in 2008, although previously reported by Whistler from both the koa haole scrub and riparian forest areas. The percentage of native species is substantially less than the 12.3% reported by Whistler. This difference can be attributed to 1) the inclusion in the 1991 survey of a separate upland parcel that added a number of natives not observed by Whistler or by us in the agricultural subdivision or intersection improvement areas, and 2) the larger species list combining results of both surveys, adding mostly non-native species.

Table 1. Listing of plants (flora) for Dillingham Ranch Mokule'ia, O'ahu, January 2008.

Species	Common name	Status	Abundance AREA	Abundance CODE	Notes
FERNS					
POLYPODIACEAE					
Phymatosorus scolopendria (Burm.) Pic.-Ser.	*laua'e*	Nat.	--	--	(2)
PTERIDACEAE					
Adiantuim hispidulum Sw.	rough maidenhair fern	Nat.	--	--	(2)
Pteris cretica L.	Cretan brake	**Ind.**	--	--	(2)
THELYPTERIDACEAE					
Christella parasitica (L.) Lev.	oak fern	Nat.	--	--	(2)
GYMNOSPERMS					
ARAUCARIACEAE					
Araucaria columnaris (G. Forst.) D. Hooker	Cook Island pine	Orn.	2	O	(1)
FLOWERING PLANTS					
DICOTYLEDONE					
ACANTHACEAE					
Asystasia gangetica (L.) T. Anderson	Chinese violet	Nat.	1-4	O	(1)
Dicliptera chinensis (L.) Juss.		Nat.	2	U	(1)
AIZOACEAE					
Tetragonia tetragonioides (Pall.) Kuntze	New Zealand spinach	Nat.	2	R	
AMARANTHACEAE					
Achyranthes aspera L.	---	Nat.	1	R	(1)
Alternanthera pungens Kunth	khaki weed	Nat.	1-3	U	(1)
Amaranthus spinosus L.	spiny amaranth	Nat.	1-3	O3	(1)
Amaranthus viridis L.	slender amaranth	Nat.	2-3	U	(1)
Gomphrena celosioides Mart.		Nat.	--	--	(2)
ANACARDIACEAE					
Mangifera indica L.	Mango	Nat.	2-3	U2	(1)
Schinus terebinthefolius Raddi	Christmas berry	Nat.	1-4	U	(1)
APIACEAE					
Ciclospermum leptophyllum (Endl.) Sprague	fir-leaved celery	Nat.	2-3	C	(1)*
APOCYNACEAE					
Plumeria rubra L.	frangipani, plumeria	Orn.	2	R	
ARALIACEAE					
Schefflera actinophylla (Endl.) Harms	octopus tree	Nat.	2-3	R	(1)
ASCLEPIADACEAE					
Calotropis gigantea (L.) W.T. Aiton	crown flower	Orn.	2	R1	

Table 1. (continued)

Species	Common name	Status	Abundance AREA	CODE	Notes
ASTERACEAE (COMPOSITAE)					
Ageratina riparia (Regel) R. King & H. *Robinson*		Nat.	--	--	(2)
Ageratum conyzoides L.	ageratum	Nat.	1-3	O3	(1)
Ambrosia artemisiifolia L.	commom ragweed	Nat.	--	--	(2)
Bidens alba L.	*Ki*	Nat.	1	U	
Bidens pilosa L.	*Ki*	Nat.	1-3	O	(1)*
Calyptocarpus vialis Less.	---	Nat.	1-4	A	(1)
Conyza bonariensis (L.) Cronq.	hairy horseweed	Nat.	1	R	(1)*
Crassocephalum crepidioides (Benth.) S. Moore	---	Nat.	1-2	R	(1)
Eclipta prostrata (L.) L.	false daisy	Nat.	--	--	(2)
Emilia fosbergii Nicolson	*pualele*	Nat.	1-3	U	(1)*
Flaveria trinervia (Spreng.) C. Mohr	---	Nat.	1	R1	
Galinsoga parviflora Cav.	---	Nat.	3	R1	(1)*
Lactuca serriola L.	prickly lettuce	Nat.	1	R	
Lipochaeta lobata (Gaud.) DC	*nehe*	**End.**	--	--	(2)*
Montanoa hibiscifolia Benth.	montanoa	Nat.	--	--	(2)
Pluchea carolinensis (Jacq.) G. Don	sourbush	Nat.	1-3	U	(1)
Pluchea indica (L.) Less.	Indian sourbush	Nat.	1	O3	(1)
Pluchia x fosbergii Cooperr. & Galang	hybrid pluchea	Nat.	1	U2	
Sigisbeckia orientalis L.	small yel. crown-beard	Nat.	2-3	R1	
Sonchus oleraceus L.	sow thistle	Nat.	1-3	U	(1)
Sphagneticola trilobata (L.) Pruski	wedelia	Nat.	1	U2	
Synedrella nodiflora (L.) Gaertn.	nodeweed	Nat.	2-4	U	(1)
Verbesina encelioides (Cav.) Benth. & Hook.	golden crownbeard	Nat.	1	R	(1)
Vernonia cinerea (L.)	little ironweed	Nat.	--	--	(2)
Xanthium strumarium L.	cocklebur	Nat.	1-3	O1	(1,3)
BIGNONIACEAE					
Spathodea campanulata P. Beauv.	African tulip tree	Nat.	4	O	(1)
BORAGINACEAE					
Heliotropum procumbens Mill.	---	Nat.	2-3	U	(1)
BRASSICACEAE					
Capsella rubella Reut.	shepherd's purse	Nat.	2	R	
Cardamine flexuosa With.	bittercress	Nat.	3	R	
Coronopus didymus (L.) Sm.	swinecress	Nat.	2-3	U	(1)
Lepidium oblongum Small	pepperwort	Nat.	--	--	(2)
Lepidium virginicum L.	pepperwort	Nat.	2	R	
Raphinus sativus L.	wild radish	Nat.	--	--	(2)

Table 1. (continued)

Species	Common name	Status	Abundance AREA	Abundance CODE	Notes
CACTACEAE					
Opuntia ficus-indica (L.) Mill.	*panini*	Nat.	--	--	(2)*
CARICACEAE					
Carica papaya L.	papaya	Nat.	--	--	(2)
CARYOPHYLLACEAE					
Cerastium fontanum Baumg.	mouse-eared chickweed	Nat.	2-3	R3	
Spergularia marina (L.) Griseb.	saltmarsh sand spurry	Nat.	--	--	(2)
indet.		Nat.	1	R1	
CASUARINACEAE					
Casuarina equisetifolia L.	ironood	Nat.	1-2	C	(1)
CHENOPODIACEAE					
Chenopodium caranatum R. Br.	---	Nat.	1-2	U	
Chenopodium murale L.	---	Nat.	1-2	U1	(1)
COMBRETACEAE					
Terminalia cattapa L.	tropical almond	Nat.	2	R	
CONVOLVULACEAE					
Ipomoea alba L.	moon flower	Nat.	--	--	(2)
Ipomoea cairica (L.) Sweet	---	Nat.	--	--	(2)*
Ipomoea obscura (L.) Ker-Gawl.	---	Nat.	2-3	U	
Ipomoea triloba L.	pink bindweed	Nat.	2-3	U	(1)
Merremia aegyptica (L.) Urb.	hairy merremia	Nat.	3	R	(1,3)
Merremia tuberosa (L.) Rendle	woodrose	Nat.	--	--	(2)
Stictocardia tiliifolia (Desr.) H. Hallier	*pilikai*	Nat.	--	--	(2)
CUCURBITACEAE					
Coccinia grandis (L.) Voigt	scarlet-fruited gourd	Nat.	2-3	O	(1)
Cucumis dipsaceus Ehrenb. ex Spach.	wild cucumber	Nat.	3	U	(1)
Sicyos pachycarpus Hook. & Arnott.	*kupala*	**End.**	3-4	U	(1,3)
EUPHORBIACEAE					
Aleurites moluccana (L.) Wild.	*kukui*	Pol.	2	U	(1)
Chamaesyce hirta (L.) Millsp.	garden spurge	Nat.	2	U	(1)
Chamaesyce hypercifolia (L.) Millsp.	graceful spurge	Nat.	--	--	(2)
Chamaesyce hyssopifolia (L.) Small	---		--	--	(2)
Chamaesyce prostrata (Aiton) Small	prostrate spurge	Nat.	2-3	R2	(1)
Euphorbia heterophylla L.	*kaliko*	Nat.	2-3	R	(1)
Phylanthus debilis Klein ex Willd.	niruri	Nat.	2-3	U3	(1)*
Ricinus communis L.	castor bean	Nat.	1-4	C3	(1)
FABACEAE					
Acacia confusa Merr.	Formosan koa	Nat.	--	--	(2)*
Acacia farnesiana (L.) Wild.	*klu*	Nat.	3-4	O	(1)

Table 1. (continued)

Species	Common name	Status	Abundance AREA	Abundance CODE	Notes
FABACEAE (continued)					
Albizia-like tree	---	Orn.	3	R2	(1,3)
Caesalpinia bonduc (L.) Roxb.	*kākalaioa*, gray nickers	**Ind.**	--	--	(2)
Cassia sp.	shower tree	Orn.	2	R1	(3)
Chamaecrista nictitans (L.) Moench	partridge pea	Nat.	2-3	R	(1)*
Crotalaria incana L.	fuzzy rattlepod	Nat.	2-3	R	(1,3)
Crotalaria pallida Aiton	smooth rattlepod	Nat.	--	--	(2)*
Desmanthus pernambucanus (L.) Thellung	virgate mimosa	Nat.	1-3	U2	(1)
Desmodium incanum DC	Spanish clover	Nat.	--	--	(2)*
Desmodium triflorum (L.) DC	beggarweed	Nat.	--	--	(2)*
Erythrina sandwicensis Deg.	*wiliwili*	**End.**	3	U	(1)
Indigofera hendecaphyla Jacq.	creeping indigo	Nat.	2-3	O	(1)
Indigofera suffruticosa Mill.	indigo	Nat.	1-3	U2	(1)
Leucaena leucocephala (Lam.) deWit	*koa haole*	Nat.	1-4	A	(1)
Macroptilium atropurpureum (DC) Urb.	---	Nat.	2-3	U1	
Macroptilium lathyroides (L.) Urb.	*cow pea*	Nat.	3	U1	(1)*
Medicago cf. *polymorpha* L.	bur clover	Nat.	2-3	U3	(1,3)
Mimosa pudica L.	*sensitive plant*	Nat.	2-3	U1	(1)
Neonotonia wightii (Wight & Arnott) Lackey	---	Nat.	1-4	C	(1)
Pithecellobium dulce (Roxb.) Benth.	*`opiuma*	Nat.	--	--	(2)
Prosopis pallida (Humb. & Bonpl. Ex Willd.) Kunth	*kiawe*	Nat.	3	A	(1)
Samanea saman (Jacq.) Merr.	monkeypod	Nat.	2	C	(1)
Senna occidentalis (L.) Link	coffee senna	Nat.	2-3	U	(1)
Senna pendula (Humb. & Bonpl. ex Willd.) H. Irwin & Barneby	---		--	--	(2)
Senna surattensis (N.L. Burm.) H. Irwin & Barneby	*kolomana*	Nat.	2	R	(1)
Stylosanthes scabra Vogel	---	Nat.	3	R	(1)*
Tamarindus indicus L.	tamarind			--	(2)
LAMIACEAE					
Hyptis pectinata (L.) Poir.	comb hyptis	Nat.	2-3	C3	(1)
Leonotis nepetifolia (L.) R.Br.	lion's ear	Nat.	2-3	C3	(1)
Ocium gratissimum L.	wild basil	Nat.	3-4	O	(1)
Stachys arvensis L.	staggerweed	Nat.	3	O3	
LAURACEAE					
Persea americana Mill.	avocado	Nat.	2	U	
MALVACEAE					
Abutilon grandifolium (Willd.) Sweet	hairy abutilon	Nat.	3-4	O	(1)
Hibiscus rosa-sinensis L.	Chinese hibiscus	Orn.	2	U2	(1)
Malva parviflora L.	cheese weed	Nat.	1-3	O2	(1)

Table 1. (continued)

Species	Common name	Status	Abundance AREA	Abundance CODE	Notes
MALVACEAE (continued)					
Malvastrum coromandelianum (L.) Garck	false mallow	Nat.	1-3	A	(1)
Sida ciliaris L.	---	Nat.	1	R1	
Sida rhombifolia L.	Cuba jute	Nat.	1-3	O2	(1)
Sida spinosa L.	---	Nat.	1-3	O	(1)
Sidastrum micranthum (St. Hil.) Fryx.	---	Nat.	3	A	(1)
Thespesia populnea (L.) Sol ex Correa	milo	**Ind.**	1	R	
MELIACEAE					
Melia azedarach L.	Chinaberry tree	Nat.	2-3	U	(1)
MORACEAE					
Artocarpus atilis (Z) Fosberg	breadfruit tree	Pol.	2	R	
Ficus microcarpa L. fil.	Chinese banyan	Nat.	2-4	O2	(1)
Ficus rubiginosa Desf.	Port Jackson fig		1-2	R	(1)
Morus alba L.	white mulberry	Nat.	--	--	(2)
MYRTACEAE					
Eucalyptus citriodora Hook.	lemon gum	Nat.	2-3	U1	(3)
Eucalyptus cf. *crebra* F. v. Muell.	narrow-leaved ironbark	Nat.	3	R2	(3)
Eucalyptus sp.	---	Nat.	3	R1	(3)
Psidium guajava L.	guava	Nat.	3	R	(1)
Syzygium cumini (L.) Skeels	Java plum	Nat.	2-4	C	(1)
NYCTAGINACEAE					
Boerhavia coccinea Mill.	false alena	Nat.	--	--	(2)
Bougainvillea spectabilis Willd.	bougainvillea	Orn.	2	U	
Mirabilis jalapa L.	marvel of Peru	Nat.	3	R	(1)
OXALIDACEAE					
Oxalis corniculata L.	yellow wood sorrel, *'ihi'ae*	**Ind.**	3	R2	(1)
Oxalis corymbosa DC	pink wood sorrel	Nat.	2	R	(1)
PASSIFLORACEAE					
Passiflora edulis Sims	passionfruit	Nat.	--	--	(2)
PHYTOLACCACEAE					
Rivina humils L.	coral berry	Nat.	2-4	R	
PIPERACEAE					
Peperomia leptostachya Hook. & Arnott	*'ala'alawainui*	**Ind.**	--	--	(2)*
PLANTAGINACEAE					
Plantago major L.	common plantain	Nat.	3	R2	(1,3)
Plantago lanceolata L.	nrw-leaved plantain	Nat.	1-2	O	
PLUMBAGINACEAE					
Plumbago zeylanica L.	*'ilie'e*	**Ind.**	4	U	(1,3)

Table 1. (continued)

Species	Common name	Status	Abundance AREA	CODE	Notes
POLYGONACEAE					
Antigonon leptopus Hook. & Arnott	Mexican creeper	Nat.	2	R	(1)
PORTULACACEAE					
Portulaca oleracea L.	pigweed	Nat.	1-2	R	(1)
Portulaca pilosa L.	---	Nat.	3	R2	
PRIMULACEAE					
Anagallis arvensis L.	scarlet pimpernel	Nat.	3	R	
PROTEACEAE					
Grevilia robusta A. Cunn. Ex R. Br.	silk oak	Nat.	3-4	O	(1)
Macadamia ternifolia F. Muell.	macadamia	Orn.	2	R2	(1)
RHIZOPHORACEAE					
Rhizophora mangle L.	red mangrove	Nat.	1	R	
RUBIACEAE					
Canthium odoratum (G. Forst.) Seem.	*alahe'e*	**Ind.**	4	U2	(1)
Spermacoce assurgens Ruiz & Pavon	buttonweed	Nat.	3	R	(1)
RUTACEAE					
Citrus maxima (J. Burm.) Merr.	pummelo	Orn.	2	R	
Citrus reticulata Blanco	Mandarin orange	Orn.	2	R2	
Citrus sinensis (L.) Osbeck	orange	Orn	2	R2	
Murraya paniculata (L.) Jack.	mock orange	Orn.	4	R	(1)
SOLANACEAE					
Capsicum frutescens L.	chili pepper	Nat.	--	--	(2)
Nicandra physalodes (L.) Gaertn.	apple of Peru	Nat.	2-3	C3	(1)
Solanum americanum Mill.	*popolo*	**Ind.**	2-4	C3	(1)
Solanum linneanum Hepper & Jaegar	Sodom apple	Nat.	3	R	(1)
Solanum mauritianum Scop.	---	Nat.	--	--	(2)*
Solanum lycopersicum var. *cerasiforme* (Dunal) Spoone, Anderson, & Jansen	cherry tomato	Nat.	2-3	U	(1)
Solanum seaforthianum Andr.	---	Nat.	--	--	(2)
STERCULIACEAE					
Waltheria indica L.	*'uhaloa*	**Ind.**	1	U1	(1)
TILIACEAE					
Triumfetta semitriloba Kuth.		Nat.	3	U	(1)
VERBENACEAE					
Lantana camara L.	lantana	Nat.	2	U1	(1)
Lantana montevidensis (Spreng.) Briq.	---	Nat.	3	R1	
Stachytarpheta australis Moldenke	---	Nat.	3	R	(1)
Stachytarpheta jamaicensis (L.) Vahl.	Jamaican vervain	Nat.	2-3	U	(1)
Stachytarpheta cayennensis (Rich.) Vahl	---	Nat.	--	--	(2)

Table 1. (continued)

Species	Common name	Status	Abundance AREA	Abundance CODE	Notes
VERBENACEAE (continued)					
Verbena littoralis Kunth.	*'owi*	Nat.	--	--	(2)*
MONOCOTYLEDONES					
ARECACEAE					
Caryota mitis Lour.	fishtail palm	Orn.	2	R2	
Cocos nucifera L.	*niu*, coconut	Pol.	1-3	O3	
Phoenix dactylifera L.	date palm	Nat.	1-3	U	(1)
Roystonia cf. *regia* (Kunth) O.F. Cook	royal palm	Orn.	2	C3	
Veitchia merrillii (Beccari) H.E. Moore	Manila palm	Orn.	2	R3	
COMMELINACEAE					
Commelina benghalensis L.	hairy dayflower	Nat..	2-4	R	(1)
Commelina diffusa N.L. Burm.	dayflower	Nat.	--	--	(2)
CYPERACEAE					
Cyperus involucratus Rottb.	umbrella sedge	Nat.	1	U3	(1)
Cyperus difformis L.	---	Nat.	3	R2	
Cyperus gracilis R. Br.	McCoy grass	Nat.	--		(2)
Cyperus rotundus L.	nut grass	Nat.	1	R1	(1)
Schoenoplectus lacustris (L.) A. Camus	great bulrush	Nat.	--	--	(2)
POACEAE (GRAMINEAE)					
Andropogon sp.	---	Nat.	--	--	(2)
Bothriochloa pertusa (L.) A. Camus	pitted beardgrass	Nat.	3	R	(1)
Cenchrus ciliaris L.	buffel grass	Nat.	2-3	U	(1)
Cenchrus echinatus L.	bur grass	Nat.	1-2	R	(1)
Chloris radiata (L.) Sw.	radiate fingergrass	Nat.	1	R1	(1)
Chloris barbata (L.) Sw.	swollen fingergrass	Nat.	1-3	O2	(1)
Chloris divaricata R. Br.	star grass	Nat.	2	U1	(1)
Chloris gayana Kunth	Rhodes grass	Nat.	1	R	(1)
Chrysopogon aciculatus (Retz.) Trin.	golden beardgrass	Nat.	1	R	(1)
Cynodon dactylon (L.) Pers.	Bermuda grass	Nat.	1-3	C	(1)
Digitaria ciliaris (Retz.) Koeler	Henry's crabgrass	Nat.	3	R	
Digitaria insularis (L.) Mez ex Ekman	sourgrass	Nat.	2-3	C	(1)
Digitaria violescens (L.) Mez ex Ekman	---	Nat.	--	--	(2)*
Echinochloa colona (L.) Link	jungle-rice	Nat.	1-3	U3	
Echinochloa crus-galli (L.) P. Beauv.	barnyard grass	Nat.	--	--	(2)
Eleusine indica (L.) Gaertn.	beach wiregrass	Nat.	1-3	C	(1)
Eragrostis amabilis (L.) Wight & Arnott	lovegrass	Nat.	2	R	(1)
Eragrostis pectinacea (Michx.) Nees	Carolina lovegrass	Nat.	1-2	R	
Eragrostis sp.	---	---	2	R	

Table 1. (continued)

Species	Common name	Status	Abundance AREA	Abundance CODE	Notes
POACEAE (continued)					
Eriochloa punctata (L.) Desv. ex W. Ham.	cupgrass	Nat.	3	U2	
Melinus minutiflora P. Beauv.	molasses grass	Nat.	--	--	(2)*
Melinus repens (Willd.) Zizka	Natal redtop	Nat.	--	--	(2)*
Panicum repens L.	torpedo grass	Nat.	1-3	O2	(1)
Paspalum conjugatum Bergius	Hilo grass	Nat.	2	O	(1)
Paspalum fimbriatum Kunth	fimbriate paspalum	Nat.	2-3	R	
Paspalum vaginatum Sw.	seashore paspalum	Nat.	1	U3	(1)
Pennisetum purpureum Schumach.	elephant grass	Nat.	1	O3	(1)
Setaria verticillata (L.) P. Beauv.	bristly foxtail	Nat.	2	R	(1)
Sporobolus africanus (Poir.) Robyns & Tournay	African dropseed	Nat.	--	--	(2)
Urochloa maxima (Jacq.) Webster	Guinea grass	Nat.	1-4	AA	(1)
Urochloa mutica (Forsk.) Webster	para grass	Nat.	1	C2	(1)
Urochloa subquadripara (Trin.) Webster	---	Nat.	3	R	(1)
TYPHACEAE					
Typha latifolia L.	cattail	Nat.	1	U3	(1)

Legend to Table 1

Status = distributional status
- **End.** = endemic; native to Hawaii and found naturally nowhere else.
- **Ind.** = indigenous; native to Hawaii, but not unique to the Hawaiian Islands.
- Nat. = naturalized, exotic, plant introduced to the Hawaiian Islands since the arrival of Cook Expedition in 1778, and well-established outside of cultivation.
- Orn. = exotic, ornamental or cultivated; plant not naturalized (not well-established outside of cultivation).
- **Pol.** = Polynesian introduction before 1778.

Abundance = occurrence ratings for plants by area in January, 2008 (AREA 1 =weedy areas and wet areas of coastal lowlands (part of Managed land) ; AREA 2 = developed and maintained lowland (Managed land) areas; AREA 3 = pasture areas (upland Managed land and *Urochloa* grassland); AREA 4 = forested areas (Koa haole forest and scrub, Kiawe woodland, and Riparian forest)

- R – Rare - only one or two plants seen.
- U - Uncommon - several to a dozen plants observed.
- O - Occasional - found regularly, but not abundant anywhere.
- C - Common - considered an important part of the vegetation and observed numerous times.
- A - Abundant - found in large numbers; may be locally dominant.
- AA - Abundant - abundant and dominant; defining vegetation type.
- P – Present - noted just outside of study area; abundance not recorded.

Notes:

(1) Previously observed and reported by Whistler (1991).
(2) Previously reported by Whistler (1991), but not observed in 2008.
(3) Vegetative tissues only; no flowers or fruit observed in January 2008.
* Reported by Whistler only from his limited *Panicum* grassland community.

Some of the species listed in the table are on the property as plantings, either ornamental or agricultural, generally limited to the low elevation, managed land. Many more species are present in this area than included in the list, but landscaping plants were mostly ignored in our survey. The several species of

Eucalyptus noted growing higher up near the south boundary of the subdivision area are old ranch plantings.

Discussion

The subject property has a long history of ranching and the present-day vegetation upslope of the managed lands remains partly in grassland/savanna and partly in secondary forest growth overwhelmingly dominated by introduced species, particularly koa haole. The latter species tends to dominate lowland, somewhat dry environments on O'ahu and many other islands in the Pacific on lands that have been disturbed and then abandoned. Some elements of the native flora are present and these plants (especially wiliwili and alahe'e) are deserving of preservation in place, although not especially rare on O'ahu and not protected species. A more diverse native flora is anticipated to be present on the steep slopes starting above the proposed subdivision lots based on Whistler's 1991 survey that included an area with this steeper topography above 400 ft.

The part of the ranch property and state property that will be disturbed by planned improvements to Farrington Highway to establish a vehicular connection to the planned subdivision is a maintained roadway verge of trees (ironwood), shrubs (Chinese hibiscus or *Hibiscus sinensis*), several grasses and annual herbs (Fig. 8). No botanical resources of significance exist in this area.

No plant species listed by the state or federal governments as threatened or endangered (DLNR, 1998; Federal Register, 2005; USFWS, 2005, 2007) were encountered during the present or during past (Char and Linney, 1986; Whistler, 1991) surveys on the property. However, *Lipochaeta lobata* requires further elaboration. This species was observed by Whistler in his *Panicum* grassland, but it is not mentioned in his text as limited to habitats in the southeast ("isolated") parcel. He describes it as a Hawai'i endemic, but not as a listed species or a candidate for listing. However, *Lipochaeta lobata* var. *leptophylla* is a listed variety (Federal Register, 1991). The more widely distributed *Lipochaeta lobata* var. *lobata* is not listed and has been observed by this author before during a survey in open koa haole forest on east O'ahu. The following discussion was presented in a report of that observation (AECOS, 2006, p. 7-8):

> This herbaceous shrub with yellow, daisy-like flowers belongs to a genus with 20 species endemic to the Hawaiian Islands (Wagner, Herbst, and Sohmer, 1999). Seven species are recorded from O'ahu, and of these, three are from the Waianae Range only (*L remyi*, *L. tenuifolia*, and *L. tenuis*), one is very rare on O'ahu (*L.*

succulenta), and one is now extinct (*L. ovata*). *Lipochaeta integrifolia* is widespread throughout all the main islands and on Kure and Laysan. Two varieties of *L. lobata* are recognized (Wagner, Herbst, and Sohmer, 1999): *L. lobata* var. *lobata* and *L. lobata* var. *leptophylla*; these have distinctive differences in leaf shape and *L. lobata* var. *leptophylla* is very rare and known only from Kolekole Pass and Kanehoa at Lualualei in the Waianae Mountains. Further, this latter variety is listed as endangered (Federal Register, 1991) along with *L. tenuifolia*. The plants in Kalama Valley are not a USFWS (federally) listed species or variety of *Lipochaeta*, although *L. l.* var. *lobata* is rare and listed in Wagner, Bruegmann, Herbst, and Lau (1999) as a plant presently "apparently secure", although according to IUCN, "vulnerable" or potentially at risk (Walter & Gillett, 1998). The Hawaii Natural Heritage Program (HINHP) ranking is T2: "Imperiled globally; 6-20 occurrences and/or 1,000-3,000 individuals remaining, or more abundant but facing serious threats range-wide". This variety also occurs on Ni'ihau and West Maui.

Figure 8. Farrington Highway looking west in the area of the proposed intersection improvements. The white car on the left marks the ranch entrance.

We did not observe *L. lobata* at the Dillingham Ranch site. Whistler's reference to it in 1991 is incomplete, and we are left uncertain where the plant was actually seen (other than in association with the *Panicum* grassland). In as much as *L. l.* var. *tenuifolia* was officially a listed as endangered species at the time he conducted his survey, it is probably safe to conclude that the plant he observed was *L. l.* var. *lobata.*

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Appendix C

Avifaunal and Feral Mammal Field Survey
of the Proposed Dillingham Ranch Subdivision
Mokūle‘ia, O‘ahu

AVIFAUNAL AND FERAL MAMMAL FIELD SURVEY OF THE PROPOSED DILLINGHAM RANCH SUBDIVISION, MOKULEI'A, OAHU

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INTRODUCTION

The purpose of this report is to present the findings of a two (4, 10 January 2008) day field survey of the birds and mammals found on or near the Dillingham Ranch, Mokule'ia, Oahu. In addition, pertinent published and unpublished sources of information on the fauna in this region of Oahu are also noted to supplement the field data. Bruner (1992) is used extensively for comparative purposes. The goals of the field survey were:

1- To document what species of birds and mammals currently occur on and near the property, with special attention to any native or migratory species.
2- Note any natural resources important to native and migratory species.

SITE DESCRIPTION

The following habitats can be found on this site: pasture/ranch land, residential, second growth alien forest, ephemeral stream drainages/irrigation ditches, and man-made ponds. The topography is mostly flat except for the mauka portions.

SURVEY METHODS

The property was surveyed for birds and mammals by driving and walking the entire area during early morning and late afternoon when birds are most active and detectable. All species of birds seen or heard were noted and relative abundance estimates of alien birds (Table One) were determined from eight minute counts made in all habitats. The count stations were at or near the sites used in a previous survey I conducted on this property (Bruner 1992). Observations of feral mammals were restricted to visual sightings and tracks. No attempts were made to trap mammals in order to obtain relative abundance estimates for each species. Such an effort was impractical and unnecessary given the scope of the survey. An evening search for the endangered Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) was made using a Pettersson Elektronik AB Ultrasound Detector D 100. The weather during the survey was partly cloudy with little or no wind. Scientific names used in this report follow Pyle (2002) and Honacki et al. (1982). These sources employ the taxonomy used in the current scientific literature.

RESULTS AND DISCUSSION

Native land Birds:

No native land birds were recorded on the survey. The only possible species that might on occasion forage in this area is the Short-eared Owl or Hawaiian Owl known as Pueo in Hawaiian (*Asio flammeus sandwichensis*). This species is listed as endangered by the State of Hawaii on the island of Oahu. They range over a wide array of habitats including forest (both native and second growth) as well as agricultural/ranch lands. They nest on the ground in areas of tall grass (Pratt et al. 1987, Hawaii Audubon Society 2005).

Native Waterbirds:

Three Black-crowned Night Heron or 'Auku'u (*Nycticorax nycticorax hoactli*) were observed on 10 January at the large pond near the entry road to the property. 'Auku'u are the only native waterbird that is not listed as endangered or threatened. Three endangered waterbirds, the Hawaiian Coot or 'Alae Ke'oke'o (*Fulica alai*), Hawaiian Moorhen or 'Alae 'ula (*Galllinula chloropus sanvicensis*) and Hawaiian Duck or Koloa (*Anas wyvilliana*) were also observed on this same large pond. An average of 8.5 coot and 2.5 moorhen and 10.5 Koloa were tallied over the 2 days of the survey. The endangered Black-necked Stilt or Ae'o (*Himantopus mexicanus knudseni*) was not recorded on the survey but will forage in flooded areas following heavy rains. Bruner

(1992) recorded 10 Hawaiian Coots, 2 Hawaiian Moorhens, 8 Black-crowned Night-Herons and 2 Black-necked Stilt on this property in 1992.

Seabirds:

Two seabirds species were observed flying over the property, the Great Frigatebird or 'Iwa (*Fregata minor palmerstoni*) and White-tailed Tropicbird or Koa'ekea (*Phaethon lepturus dorotheae*). A juvenile Koa'ekea was recently found on the property and was photographed and turned over to Sea Life Park, Oahu for care until it could be released (Chrissy Morris an employee at Dilligham Ranch pers. comm.) This species nests on the cliffs above Mokule'ia (pers. observ.) None of the Seabirds observed are listed as endangered or threatened. At nearby Kaena Point Wedge-tailed Shearwater (*Puffinus pacificus*) and Laysan Albatross (*Phoebastria immutabilis*) are now nesting with increasing success.

Migratory Birds:

Three species of migratory shorebirds were recorded, the Pacific Golden-Plover or Kolea (*Pluvialis fulva*), Ruddy Turnstone or Akekeke (*Arenaria interpres*) and Wandering Tattler or Ulili (*Heteroscelus incanus*). These birds arrive from their arctic breeding grounds in August and depart back to the arctic in late April. The most extensively studied of the three species is Kolea (Johnson et al. 191, 1989, 1993, 2001a, 2001b). All of these migratory shorebirds are protected by the Migratory Bird Treaty

Act. They are not listed as threatened or endangered. An average of 39.5 plover and 15.5 turnstone were tallied over the course of the survey. Only 1 Wandering Tattler was observed. Sixty-eight plover were previously tallied on the property (Bruner 1992). One migratory Northern Pintail Duck (*Anas acuta*) was also seen on the Bruner (1992) survey. This species was not recorded on this 2008 survey but is one of the two most common migratory ducks wintering in Hawaii (Hawaii Audubon Society 2005).

Alien (Introduced) Birds:

A total of 26 alien species were recorded on the survey compared with 17 species tallied by Bruner (1992). Table One gives the names of these species and information on their relative abundance. None of these alien birds are listed as threatened or endangered. The array of alien birds was typical of this type of habitat in this region of Oahu (Bruner 1982, 1986, 1991, 1992, 1993, 2003, Pratt et al. 1987, Hawaii Audubon Society 2005).

Feral Mammal:

The only feral mammals observed on the survey were 4 pigs (*Sus scrofa*) and 2 cats (*Felis catus). Roof Rat (*Rattus rattus*) and House Mouse (Mus musculus*) likely occur in this area. The endangered Hawaiian Hoary Bat or Ope'ape'a (*Lasiurus cinereus semotus*) was not seen despite an evening search using an ultrasound detector. Ope'ape'a are infrequently reported on Oahu. They are not restricted to native forest but can be seen foraging for flying insects in urban and agricultural areas as well as over bays and ponds. They roost solitarily in trees (Tomich 1986, Kepler and Scott 1990).

EXECUTIVE SUMMARY

This property has been significantly altered from its natural state by years of agricultural and ranching activity. Three endangered waterbirds (Hawaiian Coot, Hawaiian Moorhen, Hawaiian Duck) and one non-endangered waterbird (Black-crowned Night Heron) were found on the survey. Two indigenous seabirds and 3 migratory shorebirds species were also observed. The endangered Hawaiian Owl was not seen but could occur in this area. An abundance of alien (26 species) birds were tallied. Feral mammals seen included cats and pigs. The endangered Hawaiian Hoary Bat was not detected. This species is infrequently seen on Oahu. The most valuable habitat for native waterbird are the ponds. The actively grazed pastures are important foraging habitat for migratory shorebirds (Pacific Golden-Plovers and Ruddy Turnstones).

TABLE 1

Alien (introduced) birds recorded at Mokuleia, Oahu. (1992, 2008)

Common Name	Scientific Name	Relative Abundance 1992	Relative Abundance 2008
Cattle Egret	*Bubulcus ibis*	U= 4	R= 7
Domestic Duck	Spp. (Hybrids)	R= 1	A= 12
Gray Francolin	*Francolinus pondicerianus*	---	C= 7
Black Francolin	*Francolinus francolinus*	---	C= 6
Erckel Francolin	*Francolinus erckelii*	---	R= 2
Red Jungle Fowl	*Gallus gallus*	---	C= 6
Ring-necked Pheasant	*Phasianus colchicus*	R= 3	R= 2
Common Peafowl	*Pavo cristatus*	---	R= 8
Spotted Dove	*Streptopelia chinensis*	C= 8	C= 7
Zebra Dove	*Geopelia striata*	A= 12	A= 14
Barn Owl	*Tyto alba*	---	R= 1
Red-vented Bulbul	*Pycnonotus cafer*	A= 13	A= 15
Japanese Bushwarbler	*Cettia diphone*	C= 8	U= 4
White-rumped Shama	*Copsychus malabaricus*	C= 6	U= 2
Japanese White-eye	*Zosterops japonicus*	A= 15	A= 12
Common Myna	*Acridotheres tristis*	C= 9	C= 8
Saffron Finch	*Sicalis flaveola*	---	R= 5
Red-crested Cardinal	*Paroaria coronata*	A= 10	C= 6
Northern Cardinal	*Cardinalis cardinalis*	C= 5	U= 3
House Finch	*Carpodacus mexicanus*	A= 10	A= 13
House Sparrow	*Passer domesticus*	R= 18	C= 6
Common Waxbill	*Estrilda astrild*	A= 28	A= 20
Red Avadavat	*Amandava amandava*	U= 4	---
Nutmeg Mannikin	*Lonchura punctulata*	A= 14	U= 3
Chestnut Munia	*Lonchura atricapilla*	---	R= 4
Java Sparrow	*Padda oryzivora*	---	C= 7

KEY TO TABLE 1

Relative (estimate) abundance = Number of times observed during survey or average number on eight minute counts in appropriate habitat.

A = abundant (ave. 10+)

C = common (ave. 5-10)

U = uncommon (ave. less than 5)

R = recorded (seen or heard at times other than on 8 min. counts or on one count only). Number which follows is the total number seen or heard over the duration of the survey.

--- = not recorded

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Appendix D

Archaeological Inventory Survey of an
Approximately 75-Acre Portion of the Proposed
861-Acre Dillingham Ranch Development Project
Waialua District, Island of O‘ahu

Archaeological Inventory Survey of an Approximately 75-Acre Portion of the Proposed 861-Acre Dillingham Ranch Development Project Auku‘u, Kikahi, and Kawaihāpai Ahupua‘a, Waialua District, Island of O‘ahu TMK: [1] 6-8-002:006 por.; 6-8-003:006 por.

Prepared for
Avalon Development Company, LLC

Prepared by
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Management Summary

Reference	Archaeological Inventory Survey of an Approximately 75-Acre Portion of the Proposed 861-Acre Dillingham Ranch Development Project, Auku'u, Kikahi, and Kawaihāpai Ahupua'a, Waialua District, Island of O'ahu (TMK: [1] 6-8-002:006 por.; 6-8-003:006 por.) (Tulchin and Hammatt 2007)
Date	June 2007
Project Number (s)	Cultural Surveys Hawai'i (CSH) Job Code: MOKUL 4
Investigation Permit Number	The fieldwork component of the archaeological inventory survey investigation was carried out under archaeological permit numbers 06-05 and 07-19, issued by the Hawai'i State Historic Preservation Division/Department of Land and Natural Resources (SHPD/DLNR), per Hawai'i Administrative Rules (HAR) Chapter 13-282.
Project Location	The approximately 861-acre Dillingham Ranch project area is located immediately *mauka* (south) of Farrington Highway, between the Mokulē'ia residential community to the east and the Dillingham Airfield to the west. The project area extends *mauka* to approximately 200 m (650 ft.) elevation and includes the foothills of the Wai'anae Mountain Range, up to the base of the coastal cliffs.
Project Funding and Land Jurisdiction	Private, Dillingham Ranch Aina, LLC
Agencies	State Historic Preservation Division / Department of Land and Natural Resources (SHPD/DLNR)
Project Description	The proposed Dillingham Ranch development plan includes improvements to the existing ranch infrastructure in the *makai* (northern) portion of the project area and possible subdivision of the *mauka* (southern) portion of the project area into agricultural lots, ranging from approximately 5 to 9 acres in size. Associated infrastructure, such as roads, utilities, and water tanks, are also included in the development plan. Minimally, land disturbing activities would include grubbing and grading, excavations for subsurface utilities, and dwelling construction.
Project Acreage	Approximately 861-acres

Area of Potential Effect (APE) and Survey Acreage	The APE is defined as the entire approximately 861-acre project area, including the approximately 75-acre inventory survey area. Following the pedestrian inspection of an approximately 78-acre study area, the boundaries of the 861-acre Dillingham Ranch project area were adjusted to exclude historic properties identified along the periphery of the project area. This approximately 3-acre portion of the study area will not be affected by the current development project.
Historic Preservation Regulatory Context	Approximately 787-acres of the 861-acre Dillingham Ranch project area were covered by a previous archaeological inventory survey associated with prior plans to develop portions of the Dillingham Ranch property (Drolet and Schilz 1992). The inventory survey report was reviewed and accepted by SHPD in 1992 (Log No. 5155, Doc No. 0682t) (see Appendix A). The current inventory survey investigation was conducted on adjacent *mauka* lands that were not covered by the Drolet and Schilz (1992) inventory survey, but are included as part of the current Dillingham Ranch development plan. This document was prepared to support the proposed project's historic preservation review under Hawai'i Revised Statutes (HRS) Chapter 6E-42 and Hawai'i Administrative Rules (HAR) Chapter 13-284. In consultation with the Hawai'i State Historic Preservation Division (SHPD), the archaeological inventory survey investigation was designed to fulfill the State requirements for an archaeological inventory survey per HAR Chapter 13-13-276.
Fieldwork Effort	The fieldwork component of the archaeological inventory survey investigation was primarily accomplished over a two-week period from August 15-30, 2006, with additional fieldwork completed on October 11, 2006, November 15, 2006, February 16, 2007, and May 10, 2007. The CSH field crew consisted of Todd Tulchin, B.S., Owen O'Leary, M.A., Jon Tulchin, B.A., and Kulani Jones, B.S., under the general supervision of Hallett H. Hammatt, Ph.D. The fieldwork required 53 person-days to complete.
Number of Historic Properties Identified	A total of six historic properties were identified by the current study. Two historic properties (i.e. State Inventory of Historic Properties (SIHP) #s 50-80-03-6884 and 50-80-03-6885) are located within the 75-acre inventory survey area. Four historic properties (i.e. SIHP #s 50-80-03-416, 50-80-03-6886, 50-80-03-6887, and 50-80-03-6888) are located outside of the 75-acre inventory survey area. Portions of SIHP # 50-80-03-416 were previously identified in an adjacent property (Rosendahl 1977; Moblo 1991).

Historic Properties Recommended Eligible to the Hawai'i Register of Historic Places (Hawai'i Register)	SIHP # 50-80-03-416, agricultural complex composed of walls, terraces, mound, recommended Hawai'i Register-eligible under Criteria C and D SIHP # 50-80-03-6884, 4 historic, ranch related stone walls, recommended Hawai'i Register-eligible under Criterion D SIHP # 50-80-03-6885, pre-contact/early historic agricultural complex including terraces and a retaining wall, recommended Hawai'i Register-eligible under Criteria C and D SIHP # 50-80-03-6886, pre-contact/early historic agricultural complex consisting of terraces and mounds, associated with McAllister Site 192 "Hidden Waters," recommended Hawai'i Register-eligible under Criteria D and E SIHP # 50-80-03-6887, modified overhang shelter, historic with possible pre-contact usage, recommended Hawai'i Register-eligible under Criterion D SIHP # 50-80-03-6888, pre-contact/early historic agricultural complex consisting of mounds, associated with McAllister Site 192 "Hidden Waters," recommended Hawai'i Register-eligible under Criteria D and E
Historic Properties Recommended Ineligible to the Hawai'i Register	None
Project Effect	The 75-acre archaeological inventory survey investigation identified two historic properties within the 861-acre Dillingham Ranch project area. SIHP #s 50-80-03-6884 and 50-80-03-6885 will likely, or potentially, be affected by the proposed project. CSH's project-specific effect recommendation is "effect, with proposed mitigation commitments." The recommended mitigation measures will reduce the project's potential adverse effect on these significant historic properties. SIHP #s 50-80-03-416, 50-80-03-6886, 50-80-03-6887, and 50-80-03-6888 are located outside of the 861-acre Dillingham Ranch project area. These four historic properties are beyond the APE and will not be affected by the proposed development project.

Mitigation Recommendations	SIHP# 50-80-03-6884 historic, ranch-related stone walls. No further work is recommended. Sufficient information regarding the location, function, age, and construction methods of the stone walls has been generated by the current inventory survey investigation to mitigate any adverse effect caused by proposed development activities. SIHP # 50-80-03-6885 agricultural complex includes distinctive remnants of Mokulē‘ia and Kawaihāpai's pre-contact/early historic land use and are potential resources for future archaeological research. Preservation, in the form of avoidance and protection, is recommended for the agricultural complex. Due to the close proximity of SIHP #s 50-80-03-416, 50-80-03-6886, 50-80-03-6887, and 50-80-03-6888 to the project area boundaries, mitigation recommendations are provided to prevent potential inadvertent damage to these significant historic properties during future development activities. SIHP # 50-80-03-416 agricultural complex includes distinctive remnants of Mokulē‘ia and Kawaihāpai's pre-contact/early historic land use and are potential resources for future archaeological research. Preservation, in the form of avoidance and protection, is recommended for the agricultural complex. SIHP # 50-80-03-6886 agricultural complex, has high cultural significance due to possible association of the site with the legendary springs of Kawaihāpai. Preservation, in the form of avoidance and protection, is recommended for the agricultural complex. SIHP # 50-80-03-6887 modified overhang shelter, is a potential resource for future archaeological research due to possible association with agricultural sites in the vicinity of McAllister Site 192 "Hidden Waters." Preservation, in the form of avoidance and protection, is recommended for the overhang shelter. SIHP # 50-80-03-6888 agricultural complex, has high cultural significance due to possible association of the site with the legendary springs of Kawaihāpai. Preservation, in the form of avoidance and protection, is recommended for the agricultural complex. It is also recommended that a cultural resource preservation plan be prepared for the proposed 861-acre Dillingham Ranch development project, in accordance with Hawai‘i Administrative Rules (HAR) 13-277-3 to address buffer zones and protective measures for all historic properties recommended for preservation. This preservation plan should detail the short- and long-term preservation measures that will safeguard the historic properties during project construction and subsequent use of the project area.

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Section 1 Introduction

1.1 Project Background

At the request of Avalon Development Company, LLC., Cultural Surveys Hawai'i, Inc. (CSH) completed an archaeological inventory survey of an approximately 75-acre portion of the proposed 861-acre Dillingham Ranch development project, Auku'u, Kikahi, and Kawaihāpai Ahupua'a, Waialua District, Island of O'ahu (TMK: [1] 6-8-002:006 por.; 6-8-003:006 por.). The Dillingham Ranch project area is located immediately *mauka* (south) of Farrington Highway, between the Mokulē'ia residential community to the east and the Dillingham Airfield to the west (Figures 1-3). The project area extends *mauka* to approximately 200 m (650 ft.) elevation and includes the foothills of the Wai'anae Mountain Range, up to the base of the coastal cliffs.

The lands within the project area are privately owned by Dillingham Ranch Aina, LLC. The project area is currently an active horse and cattle ranch. Much of the level coastal plain (northern) portion of the project area is used for equestrian stables and activity areas. The sloping foothills of the project area are used as pasture for grazing cattle. A few existing private residences are also located within the *mauka* (southern) portion of the overall project area boundary, but these are understood to be independently owned and excluded from the 861-acre Dillingham Ranch development project.

Approximately 787-acres of the 861-acre Dillingham Ranch project area were covered by a previous archaeological inventory survey associated with prior plans to develop portions of the Dillingham Ranch property. The archaeological inventory survey was conducted by ERC Environmental and Energy Services Co. (ERCE) and detailed in a report titled *Archaeological Inventory Survey and Evaluation, Mokulē'ia, Waialua District, O'ahu (TMK 6-8-03 and 6-8-02)* (Drolet and Schilz 1992). The inventory survey report was reviewed and accepted by SHPD in 1992 (Log No. 5155, Doc No. 0682t) (see Appendix A). The current inventory survey investigation was conducted on adjacent *mauka* lands that were not covered by the Drolet and Schilz (1992) inventory survey, but are included as part of the current Dillingham Ranch development plan.

The initial study area for the current archaeological inventory survey consisted of approximately 78 acres. Following the pedestrian inspection of the 78-acre study area, the boundaries of the 861-acre Dillingham Ranch project area were adjusted to exclude historic properties identified along the periphery of the project area. As a result, the archaeological inventory survey area for this report is defined as approximately 75 acres. The approximately 3-acre portion of the study area excluded from the 861-acre Dillingham Ranch project area will not be affected by the current development project. The relationship between the 75-acre inventory survey area and the additional 3-acre study area is shown on Figure 4. This archaeological inventory survey report includes documentation of all identified historic properties, including two historic properties in the 75-acre inventory survey area and four historic properties outside of the 75-acre inventory survey area.

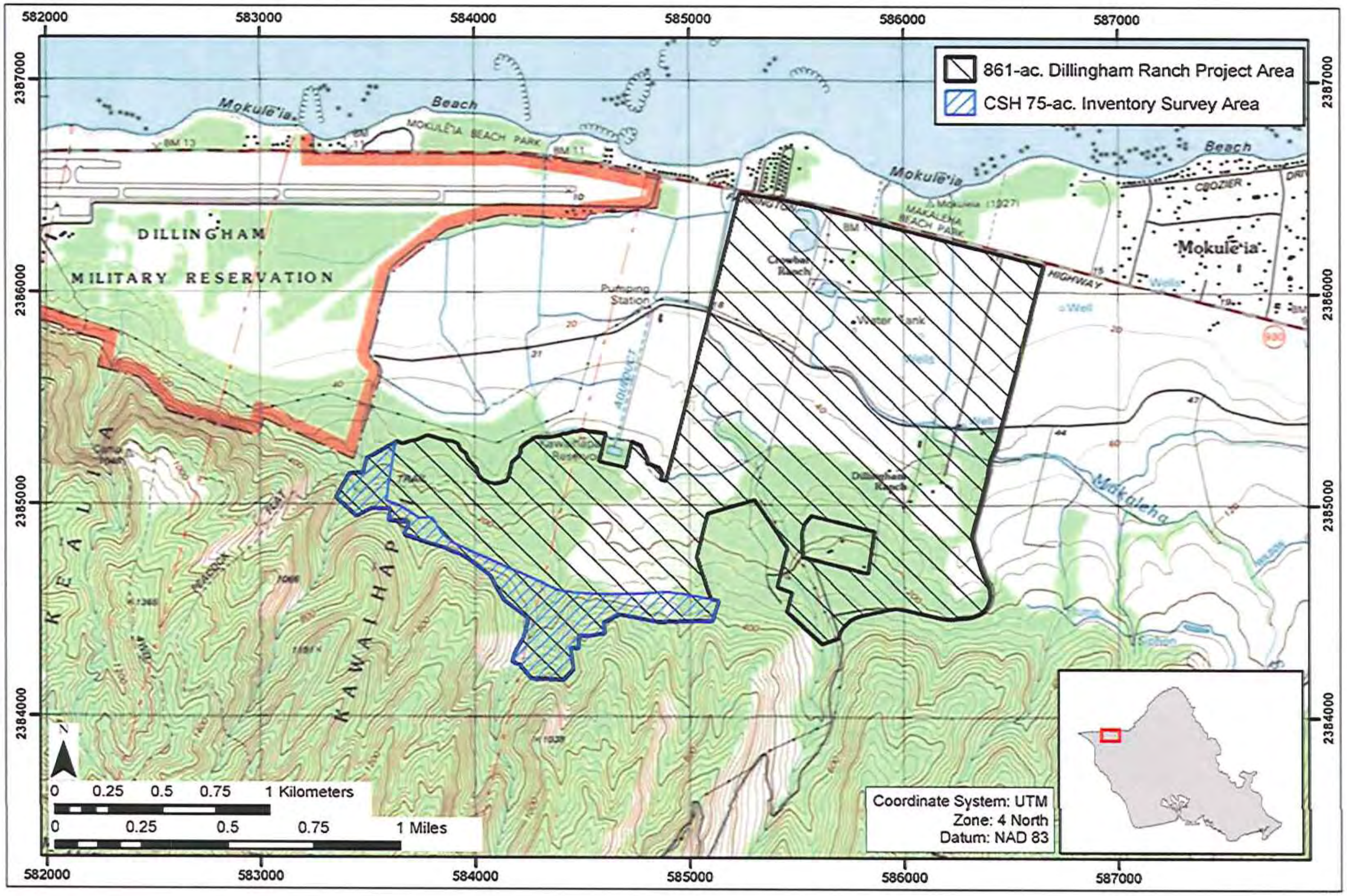


Figure 1. Portion of USGS 7.5 Minute Series Topographic Map, Ka'ena Quadrangle (1998), showing the location of the CSH 75-acre inventory survey area and the 861-acre Dillingham Ranch project area

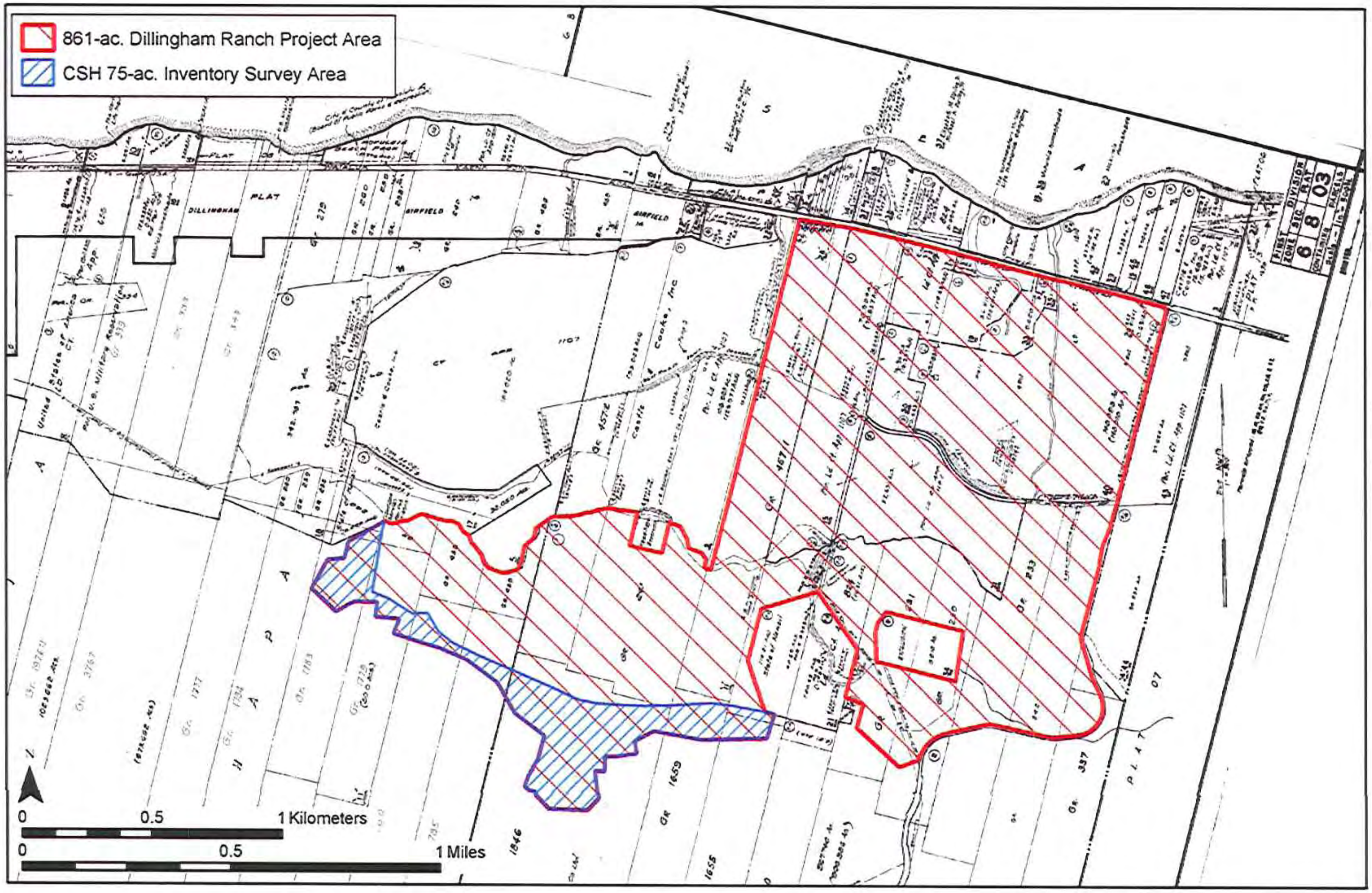


Figure 2. Combined portions of TMKs [1] 6-8-002 and 6-8-003, showing the location of the CSH 75-acre inventory survey area and the 861-acre Dillingham Ranch project area

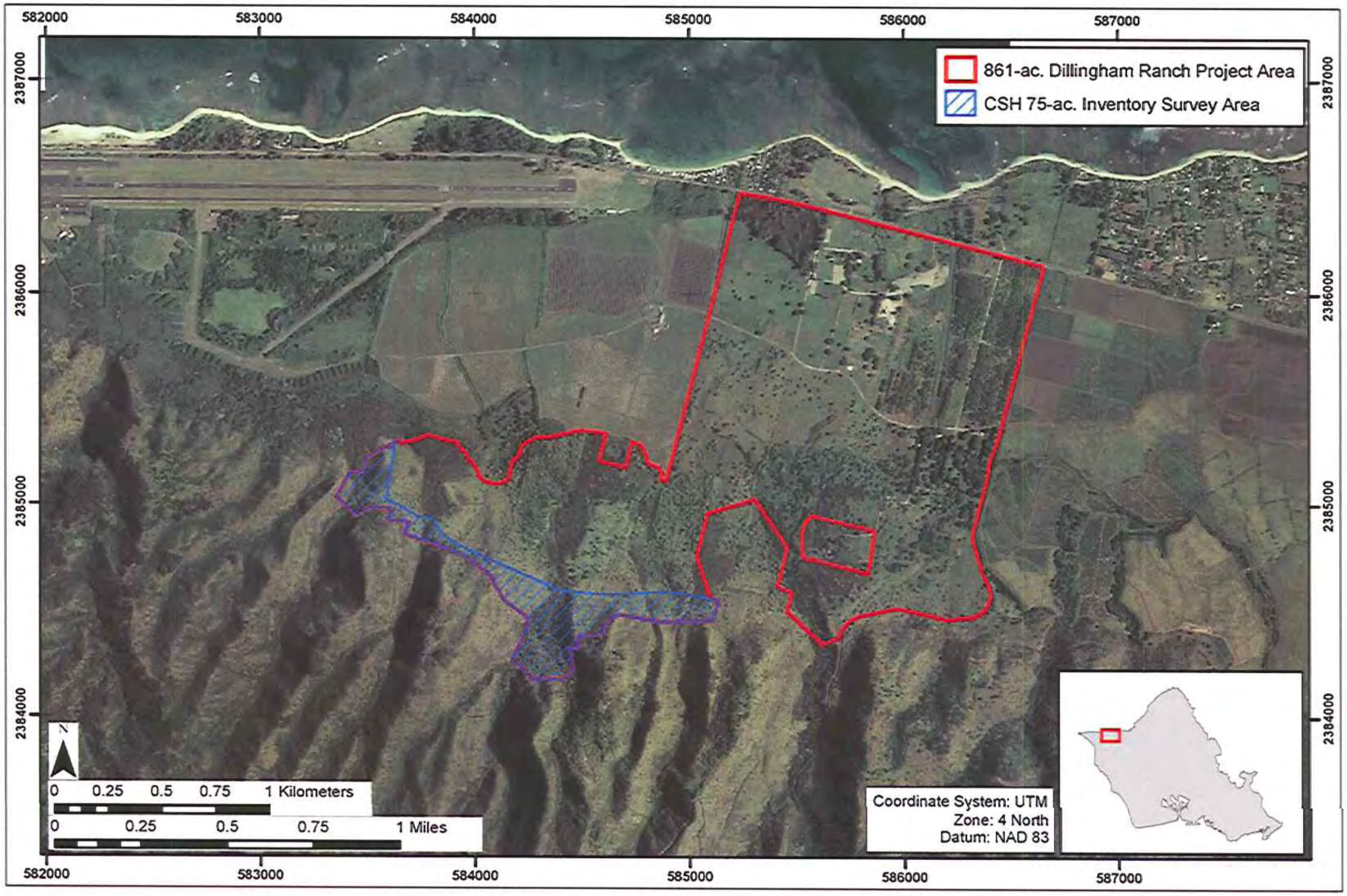


Figure 3. Aerial photograph, showing the location of the CSH 75-acre inventory survey area and the 861-acre Dillingham Ranch project area (source: USGS Orthoimagery 2005)

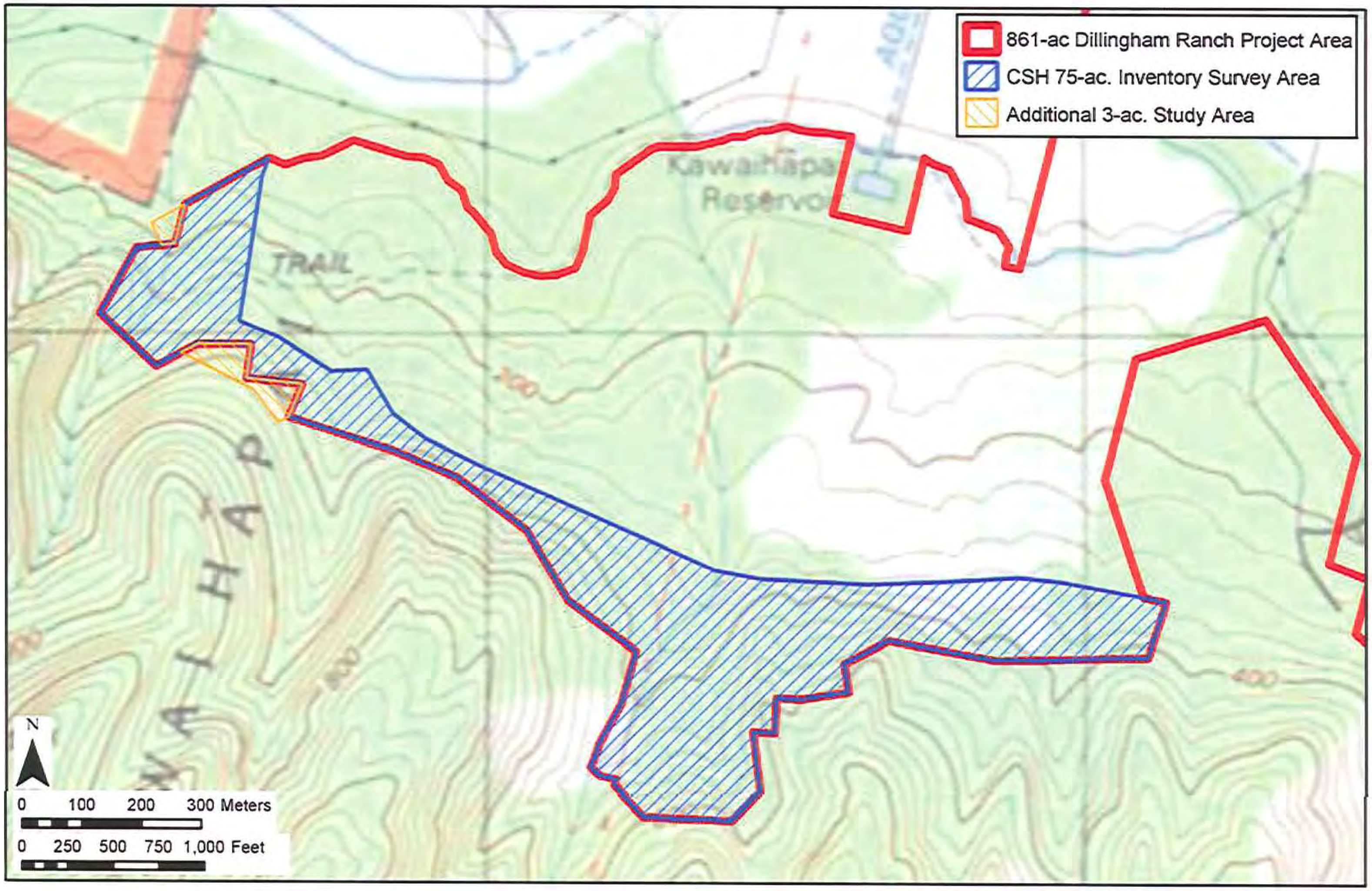


Figure 4. Portion of USGS 7.5 Minute Series Topographic Map, Ka'ena Quadrangle (1998), showing the relationship between the CSH 75-acre inventory survey area and the additional 3-acre study area that was excluded from the 861-acre Dillingham Ranch project area

The proposed Dillingham Ranch development plan includes improvements to the existing ranch infrastructure in the *makai* (northern) portion of the project area and possible subdivision of the *mauka* (southern) portion of the project area into agricultural lots, ranging from approximately 5 to 9 acres in size (Figure 5). Associated infrastructure such as roads, utilities, and water tanks, are also included in the development plan. Minimally, land disturbing activities would include grubbing and grading, excavations for subsurface utilities, and dwelling construction. The area of potential effect (APE) is defined as the entire approximately 861-acre project area, including the approximately 75-acre inventory survey area.

This document was prepared to support the proposed project's historic preservation review under Hawai'i Revised Statutes (HRS) Chapter 6E-42 and Hawai'i Administrative Rules (HAR) Chapter 13-284. In consultation with the Hawai'i State Historic Preservation Division (SHPD), the archaeological inventory survey investigation was designed to fulfill the State requirements for an archaeological inventory survey per HAR Chapter 13-13-276. CSH completed the fieldwork component of the archaeological inventory survey under SHPD permit numbers 06-05 and 07-19, per Hawai'i Administrative Rules (HAR) Chapter 13-13-282.

1.2 Scope of Work

The archaeological inventory survey and its accompanying report documented all historic properties within the study area. The following scope of work satisfies State and County requirements for an archaeological inventory survey [per HAR 13-13-276]:

1. Consultation with community members as part of the inventory survey process. This consultation required contacting knowledgeable members of the community and requesting information on historic and cultural issues related to the property.
2. A complete ground survey of the 78-acre study area for the purpose of historic property identification and documentation. All historic properties were located, described, and mapped with evaluation of function, interrelationships, and significance. Documentation included photographs and scale drawings of all historic properties. All historic properties were assigned State Inventory of Historic Properties (SIHP) numbers. All historic properties were also located with GPS survey equipment.
3. Limited subsurface testing to determine if subsurface deposits were located in archaeological sites within the current survey area, and, if so, evaluate their significance. Samples from these excavations were analyzed for chronological information.
4. Research on historic and archaeological background, including search of historic maps, written records, and Land Commission Award documents. This research focused on the project area with general background on the *ahupua'a* and district, and emphasizes settlement patterns.
5. Preparation of this inventory survey report including the following:
    a. A topographic map of the survey area showing the locations of all historic properties;
    b. Results of consultation with knowledgeable community members about the property and its historical and cultural issues;

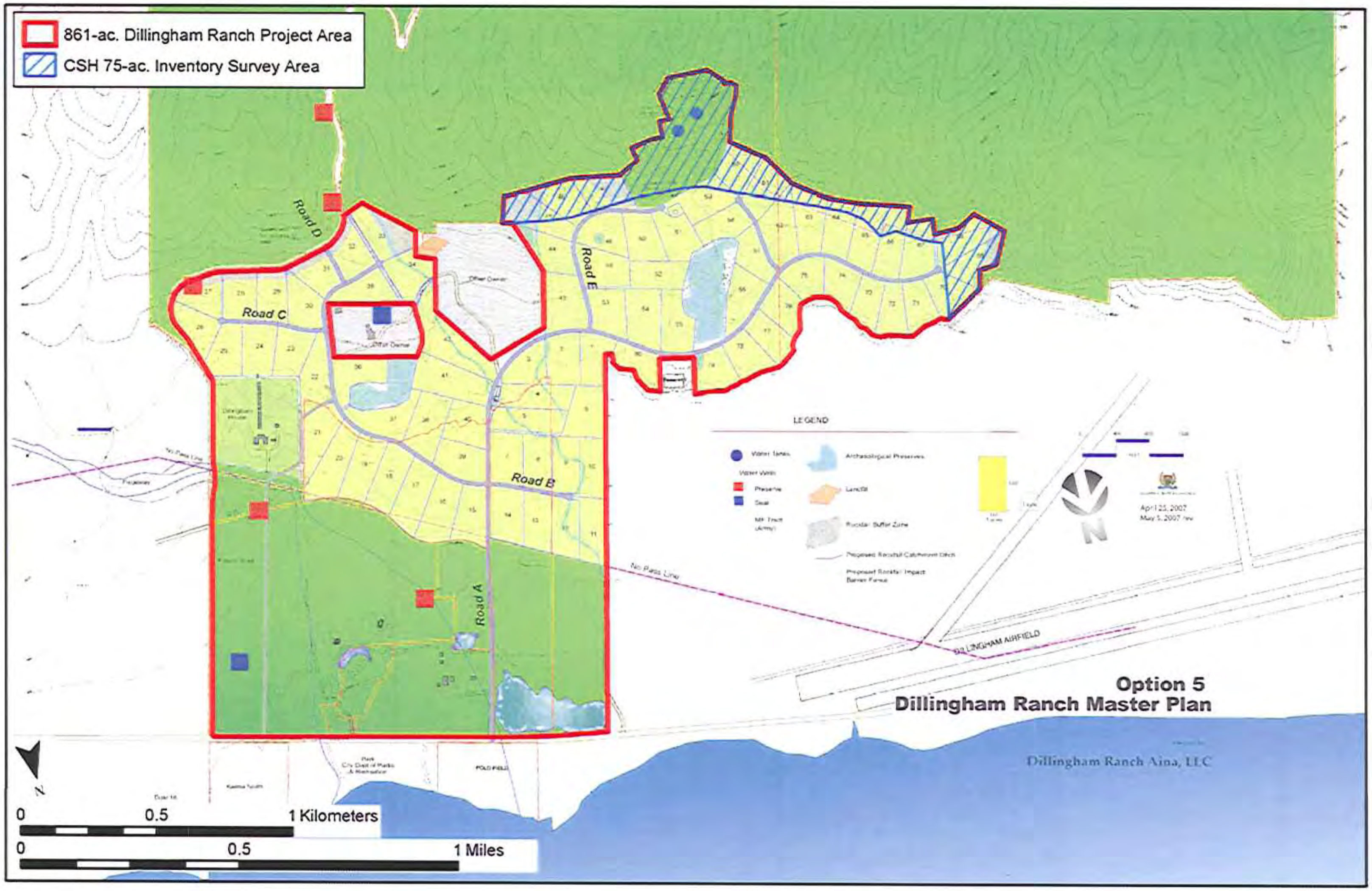


Figure 5. Proposed Dillingham Ranch Master Plan, showing the location of the CSH 75-acre inventory survey area and the 861-acre Dillingham Ranch project area

c. Description of all historic properties with selected photographs, scale drawings, and discussions of function;

d. Historical and archaeological background sections summarizing prehistoric and historic land use as they relate to the project area's historic properties;

e. A summary of historic property categories and their significance in an archaeological and historic context;

f. Recommendations based on all information generated that will specify what steps should be taken to mitigate impact of development on the project area's significant historic properties - such as data recovery (excavation) and preservation of specific areas. These recommendations were developed in consultation with the client and the State agencies.

This scope of work also includes full coordination with the State Historic Preservation Division (SHPD), and the City and County of Honolulu relating to archaeological matters. This coordination takes place after consent of the landowner or representatives.

1.3 Environmental Setting

1.3.1 Natural Environment

The 861-acre Dillingham Ranch project area includes lands within the level coastal plain of Mokulē'ia and the lower foothills of the Wai'anae Mountain Range. The foothills consist of gently to moderately sloping lands dissected by multiple seasonal drainage gullies. Vertical exposed basalt cliffs are also common along the *mauka* (southern) boundary of the project area. Elevations within the project area range from approximately 1-200 m (3-650 ft.) a.m.s.l.

Soils within the *makai* portion of the 861-acre Dillingham Ranch project area primarily consist of Pulehu Clay Loam (PsA), with smaller areas of Pearl Harbor Clay (Ph) and Mokulē'ia Clay Loam (Mt) (Figure 6). Soils of the Pulehu Series consist of "well-drained soils on alluvial fans and stream terraces and in basins...developed in alluvium washed from basic igneous rock" (Foote et al. 1972). Soils of the Pearl Harbor Series consist of "very poorly drained soils on nearly level coastal plains on the island of Oahu...developed in alluvium overlying organic material" (Foote et al. 1972). Soils of the Mokulē'ia Series consist of "well-drained soils along the coastal plains...formed in recent alluvium deposited over coral sand" (Foote et al. 1972).

Soils within the *mauka* portion of the 861-acre Dillingham Ranch project area include Ewa Silty Clay Loam (EaC), Ewa Stony Silty Clay (EwC), Helemano Silty Clay (HLMG), Kaena Clay (KaB), Kaena Stony Clay (KaeB)(KaeC), Kaena Very Stony Clay (KanE), Kawaihapai Clay Loam (KIA), Kawaihapai Stony Clay Loam (KIaA)(KIaB), Kemoo Silty Clay (KpF), and Pulehu Stony Clay Loam (PuB) (Figure 6). Areas of Rock Land (rRK) and Stony Steep land (rSY) were also located at the *mauka* edge of the project area. Soils of the Ewa Series consist of "well-drained soils in basins and on alluvial fans...developed in alluvium derived from basic igneous rock" (Foote et al. 1972). Soils of the Helemano Series consist of "well-drained soils on alluvial fans and colluvial slopes on the sides of gulches...developed in alluvium and colluvium derived from basic igneous rock" (Foote et al. 1972). Soils of the Kaena Series consist of "very deep, poorly drained soils on alluvial fans and talus slopes...developed in alluvium and colluvium from basic igneous material" (Foote et al. 1972). Soils of the Kawaihapai Series consist of "well-drained soils in drainageways and on alluvial fans on the coastal plains...formed in alluvium derived from basic igneous rock in humid uplands" (Foote et al. 1972). Soils of the Kemoo Series consist of "well-drained soils on uplands...developed in material weathered from basic igneous rock" (Foote et al. 1972).

Soils within the 75-acre inventory survey area primarily consist of Rock Land (rRK), with additional areas of Ewa Silty Clay Loam (EaC), Kaena Clay (KaB), Kaena Stony Clay (KaeB), Kaena Very Stony Clay (KanE), Kawaihapai Stony Clay Loam (KIaB), Kemoo Silty Clay (KpF), and Helemano Silty Clay (HLMG) (Figure 6).

The 861-acre Dillingham Ranch project area receives an average of approximately 800-1000 mm (31-39 in.) of annual rainfall (Giambelluca et al. 1986). Vegetation in the equestrian portions of the project area generally consists of exotic grasses, ironwood (*Casuarina spp.*), monkeypod (*Samanea saman*), coconut (*niu*, *Cocos nucifera*), and other landscaping species. Vegetation within the active and former pasture areas primarily consists of exotic grasses and weeds, *koa haole* (*Leucaena leucocephala)*, *kiawe* (*Prosopis pallida)*, Java plum (*Syzygium cumini*), and *klu* (*Acacia farnesiana)*. Additional species include *wiliwili* (*Erythrina sandwicensis*), *'a'ali'i* (*Dodonaea viscosa*), *'ilie'e* (*Plumbago zeylanica*), *naio* (*Myoporum sandwicense*), silk oak (*Grevillea robusta*), guava (*Psidium guajava*), strawberry guava (*Psidium cattleianum*), Christmas berry (*Schinus terebinthifolius*), and *kukui* (*Aleurites moluccana*).

1.3.2 Built Environment

The *makai* (northern) portion of the 861-acre Dillingham Ranch project area, along the level coastal plain, is currently used for equestrian activities. Existing structures include stables, fenced activity areas, ranch office structures, ranch employee residences, and the historic Dillingham residence. A commercial plant nursery for palm trees is also located in the *makai* portion of the project area. The *mauka* (southern) portion of the project area is largely undeveloped, with limited ranch-related infrastructure, including fences, walls, water troughs, and a corral.

The surrounding area is rural, primarily consisting of pasture lands for grazing livestock and cultivated diversified agricultural lands. The Dillingham Airfield and glider port is located approximately 1 km (0.6 mi.) west of the project area. The residential community of Mokulē'ia is located approximately 0.25 km (0.15 mi.) east of the project area. Lands to the south (*mauka*) of the project area include the undeveloped Mokulē'ia Forest Reserve. *Makai* (north) of the project area is Farrington Highway, the Mokulē'ia Polo Field, and shoreline.

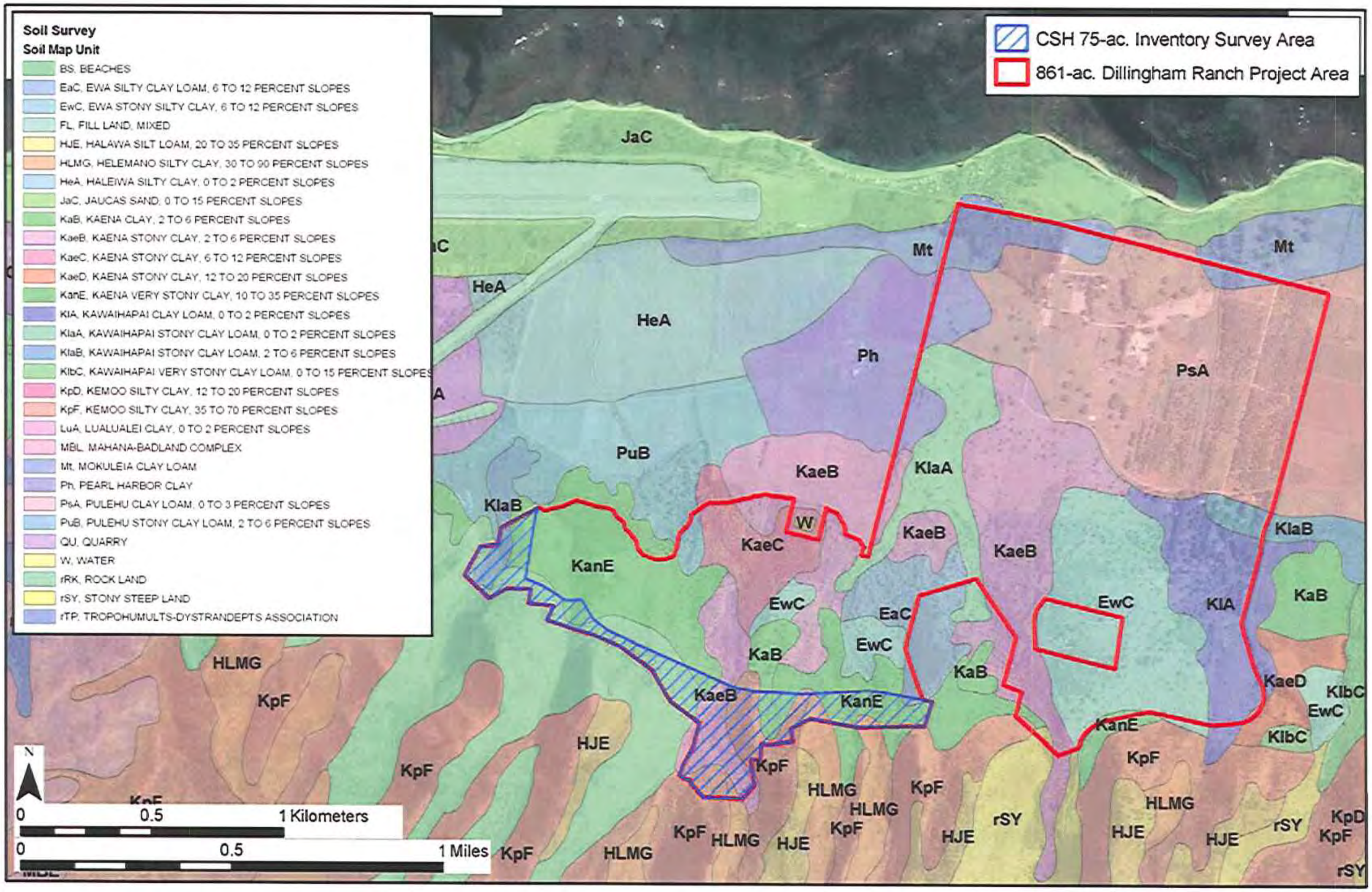


Figure 6. Overlay of Soil Survey of the State of Hawai'i (Foote et al. 1972), indicating soil types within the 861-acre Dillingham Ranch project area.

Section 2 Methods

2.1 Field Methods

The fieldwork component of the archaeological inventory survey investigation was primarily accomplished over a two-week period from August 15-30, 2006, with additional fieldwork completed on October 11, 2006, November 15, 2006, February 16, 2007, and May 10, 2007. The CSH field crew consisted of Todd Tulchin, B.S., Owen O'Leary, M.A., Jon Tulchin, B.A., and Kulani Jones, B.S., under the general supervision of Hallett H. Hammatt, Ph.D. The fieldwork required 53 person-days to complete. Fieldwork consisted of a 100% coverage pedestrian inspection of the approximately 78-acre study area and limited subsurface testing at select archaeological sites. The pedestrian inspection of the study area was accomplished through systematic sweeps. The interval between the archaeologists was generally 5-10 m. All historic properties encountered were recorded and documented with a written field description, scale drawings, photographs, and each site was located using Trimble Pro XR GPS survey technology (accuracy +/- 1 m).

Subsurface testing consisted of the partial excavation, by hand, of selected surface archaeological features located during the pedestrian survey. The purpose of the subsurface testing was to aid in determining the function of located surface sites, as well as to possibly obtain datable materials for later radiocarbon dating. All excavated material was sifted through a 1/8 in. wire mesh screen to separate out the soil matrix, then all cultural material was collected for analysis in the lab. Each test excavation was documented with a scale section profile, photographs, and sediment descriptions. Sediment descriptions included characterizations of Munsell color designations, compactness, texture, structure, inclusions, cultural material present, and boundary distinctness and topography.

2.2 Laboratory Methods

Laboratory analyses of material recovered from limited subsurface testing within the project area included:

1. Preparation and submittal of datable material, such as charcoal, to Beta Analytic for radiocarbon AMS dating.
2. Identification of invertebrate midden. Common marine shells were identified and analyzed at the Cultural Surveys Hawai'i laboratory in Kailua, Hawai'i.
3. Identification of vertebrate faunal material. All vertebrate faunal material was identified and analyzed at the Cultural Surveys Hawai'i.

2.3 Document Review

Historic and archival research included information obtained from the UH Hamilton Library, the State Historic Preservation Division Library, the Hawai'i State Archives, the State Land Survey Division, and the Archives of the Bishop Museum. Previous archaeological reports for the area were reviewed, as were historic maps and primary and secondary historical sources.

Information on Land Commission Awards was accessed through Waihona Aina Corporation's Māhele Data Base (<www.waihona.com>).

2.4 Community Consultation

A community consultation effort was undertaken as a component of the current archaeological inventory survey investigation. The community consultation was made in conjunction with an associated preservation plan (Tulchin and Hammatt, in progress) being completed for historic properties within the 861-acre Dillingham Ranch project area recommended for preservation by the current study, as well as the Drolet and Schilz (1992) study. Per HAR Chapter 13-13-276, the community consultation effort for the archaeological inventory survey involved "notifying interested organizations and individuals that a project could affect historic properties of interest to them; seeking their views on the identification, significance evaluations, and mitigation treatment of these properties; and considering their views in a good faith and appropriate manner during the review process."

The community consultation was conducted by CSH cultural anthropologist Kehaulani Souza, B.A. Following the fieldwork component of the archaeological inventory survey, the Office of Hawaiian Affairs (OHA), as well as knowledgeable persons with long family ties to the Mokulē'ia and Kawaihāpai areas, were informed of the historic properties identified within the project area, as well as preliminary significance evaluations and proposed mitigation recommendations for each of the identified historic properties. The individuals contacted were previously contacted by CSH in association with development projects in the vicinity. These individuals were therefore known to be knowledgeable of the history of the vicinity of the project area, and familiar with the historic preservation review process.

The organizations and individuals contacted are summarized in Table 1. The consultation request letter to the Office of Hawaiian Affairs, along with OHA's response letter, are provided in Appendix B and Appendix C respectively. In general, OHA and the community contacts agreed with the preliminary significance evaluations for the historic properties identified within the study area. Neither OHA nor the community contacts expressed knowledge of any additional archaeological sites in the vicinity that were not documented by the current study or the Drolet and Schilz (1992) study. OHA and the community contacts were also pleased with the proposed recommendation of preservation of all traditional Hawaiian sites located within the project area boundaries. The primarily concern expressed was in regards to the protection of sites that are located outside of the project area boundaries, in particular SIHP #s 50-80-03-6886, 50-80-03-6887, and 50-80-03-6888. The contacts indicated that these historic properties have a high cultural significance due to the possible association of the sites with the legendary springs of Kawaihāpai (i.e. McAllister Site 192 "Hidden Waters").

In response to the comments made by the community contacts and OHA, formal mitigation recommendations for SHIP #s 50-80-03-416, 50-80-03-6886, 50-80-03-6887, and 50-80-03-6888 are included in this report. The project area boundaries were adjusted to exclude these historic properties from the project area, with a minimum 50 ft. buffer. However, due to concerns for potential inadvertent damage to the sites during future development activities, these significant historic properties are being recommended for preservation. Protective measures will be detailed in a Preservation Plan, which is recommended to be prepared and implemented prior to any land disturbing activities.

Table 1. Community Contact List

Reference	**Background / Affiliation**	**Comments**
Mr. Kai Markell for Mr. Clyde Nāmu'o	Office of Hawaiian Affairs	OHA recommends formal mitigation recommendations for identified sites that are outside of the project area (i.e. SIHP #s 50-80-03-416, -6886, -6887, and -6888) OHA also requests assurances that appropriate agencies are notified if during project associated construction human remains or other cultural deposits are discovered
Mr. Dan Gora	Mr. Gora was born in 1927 and raised in Paukawila, Waialua District. His *'ohana* lived in Kawaihāpai for many years	Mr. Gora did not express knowledge of any additional archaeological sites. Mr. Gora agrees with the preliminary significance evaluations and recommendations of preservation of all traditional Hawaiian sites within the project area.
Mr. William Aila	Mr. Aila is a prominent community member with family ties to Kawaihāpai Ahupua'a	Mr. Aila did not express knowledge of any additional archaeological sites. Mr. Aila agrees with the preliminary significance evaluations and recommendations of preservation of all traditional Hawaiian sites within the project area.

Section 3 Background Research

3.1 Traditional and Historical Background

3.1.1 Mythological and Traditional Accounts

The district of Waialua is rich in legends, stories, proverbs, and myths. Waialua, literally translated as "two waters" (Clark 2002) may refer to the two large stream drainages (Anahulu and Helemano-Poamoho-Kaukonahua) that were once used to irrigate extensive taro fields in the *ahupua‘a* of Kamananui, Pa‘ala‘a, and Kawailoa, the more populous *ahupua‘a* on the eastern side of the district. The *ahupua‘a* of Keālia, Kawaihāpai, and Mokulē‘ia, on the western side of the district, were more arid, and were not as well-watered as the three eastern *ahupua‘a*. However, these western lands were famed for their warm climate, cooling breezes, plant resources, and especially marine resources.

3.1.1.1 References to the Environment

Kūali‘i was a legendary 18th-century chief of O‘ahu (Cordy 2002:32). A chant, or *mele*, on his genealogy (Fornander 1986 IV-II:374) includes a description of his lands on O‘ahu and Kaua‘i:

Kaena is a point,	*He lae Kaena,*
Kahuku is hala-wreathed, covered with dew is the back of Kaala;	*He hala o Kahuku He kuamauna hono i kehau Kaala*
There below doth Waialua sit,	*Noho mai ana Waialua i lalo-e–*
That is Waialua.	*O Waialua ia.*
Mokuleia with its dish of Kahala;	*O Mokuleia, Kahala ka ipu*
A fish-pond, like cooked shark,	*Ka loko ia mano lalawalu,*
The tail of the hammer-headed shark is Kaena,	*Hiu lalakea o Kaena,*
The shark that travels at the bottom of Kauai,	*Mano hele lalo o Kauai-e–*
At the bottom of Kauai my land;	*Olalo o Kauai, kuu aina,*

In this chant, the general aspect of the land in Waialua and the vicinity is illustrated. Ka‘ala is the tallest peak in the Wai‘anae Range, and its sharp ridgeline resembles the tail of a shark, running down to the sea. The sloping tablelands at the foothills of the mountains in Mokulē‘ia resemble a bowl or pond.

In the legend of Pele and Hi‘iaka (Emerson 1993), Hi‘iaka, the sister of the volcano goddess Pele, travels around the islands. In one instance, Hi‘iaka's canoe is beached on the sands of Mokulē‘ia. Hi‘iaka leaves her companions to pay her respects to her ancestor, Pōhaku-o-Kaua‘i, and to her ancestral divinity Ka‘ena. She passes Ka‘ena Point on O‘ahu, and enters the hot and arid region of Waialua. As she climbs up into the Wai‘anae Mountains above the lands of Keālia and Kawaihāpai, she offers the following chant (Emerson 1993:157-158):

Ka'ena's profile fleets through the calm,	*Kunihi Kaena, holo i ka malie:*
With flanks ablaze in the sunlight –	*Wela i ka La ke alo o ka pali;*
A furnace heat like Kilauea;	*Auamo mai i ka La o Kilauea;*
Ke-awa-ula shelters in heat;	*Ikiiki i ka La na Ke-awa-ula,*
Kohala-lele revives in the breeze,	*Ola i ka makani Kai-a-ulu Kohola-lele–*
That breath from the sea, Kai-a-ulu.	*He makani ia no lalo*

The offshore winds of Mokulē'ia are also mentioned in the legend "The Wind Gourd of La'amaomao" (Nakuina 1992). In this story, a special gourd contained all the winds of Hawai'i, which could be summoned by calling their names. This gourd was an embodiment of Lono, the Hawaiian god of fertility and agriculture, who was also associated with winds, clouds, and rain. The gourd was passed down from La'amaomao, the Hawaiian wind goddess, to her granddaughter, who then passed it down through their line to Pāka'a and his son Kā'a Pāka'a, attendants to the high chief, Keawenuiaumi. On windless days, one could open the gourd, call the name of the wind, and cause this wind to blow. The winds of Waialua were named thus (Nakuina 1992:51):

> The wind of Ka'ena turns in two directions,
> Hinakokea is of Mokule'ia,
> The winds of Waialua blow,
> Moving silently at the cape of Ka'ena

3.1.1.2 References to Plant Resources

Although not as extensively cultivated as the more populous eastern portion of the district, there were several smaller streams and springs within Kawaihāpai and Mokulē'ia that could be used to irrigate crops. Kawaihāpai literally translates as "the carried water" (Pukui et al. 1974:99), with the origin of the place name described by the following passage:

> Life on this land in the olden days was a life of plenty until trouble came, for plants died because of the lack of water. Everybody thought of going and leaving the land.
>
> There were two old men who belonged to the priestly class of old, and they remained, setting up the kapu with prayers and after praying they saw a hog shaped cloud coming directly from Kahuku point and they guessed that it was going to rain, that their prayers were heard. They were waiting for rain and heard the splashing of raindrops on the cliff. When they went to look they saw water pouring from the cliff and they told everybody to stay for water was found.
>
> This place where this strange water created by God is on the hill facing the length and breadth of the district of land called Kawaihapai that lies between Waianae and Waialua, Oahu.

> Because God created this water on the cliff, the name of the land from old was called Ka-wai-hapai (Lifted-water) because this water was lifted up and placed above and because no one knew the source of this water it is called Ka-wai-kumu-ole-i-ka-pa-i. (Water–without-source-on-the-cliff) to this day (Liokakele 1911, cited in Sterling and Summers 1978:99)

Research on the meaning of Mokulē'ia produced two different translations concerning cultivation. According to *Place Names of Hawai'i,* Mokulē'ia means "isle [of] abundance" (Pukui et al. 1974:155). The second translation, which may be of relatively modern origin, has the name as *moku-leia,* from the saying "*Moena pāwehe o Mokulē'ia*"-the patterned map of Mokulē'ia. This refers to the pattern of agricultural fields on the lowlands of Mokulē'ia in the early post-contact period (Pukui 1983:161).

Although wetland cultivation in Keālia is not mentioned, several legends refer to specific plants in the area. Keālia means "the salt bed" (Clark 1977:105). There is no salt pond at Keālia, but an association with salt is mentioned in a legend concerning Pele, the Hawaiian volcano goddess, and another of her sisters, Ka'ōhelo. Ka'ōhelo told her son that when she died, she wanted him to take her body to the top of Kīlauea, the home of her sister Pele. When he took the body to Kīlauea, her flesh became the creeping vine portion of the *'ōhelo* plant (*Vaccinium reticulatum*), and the bones became the bush-plant portion of the *'ōhelo.* Pele "retained Ka'ōhelo's head, which became the smoldering fire in the volcano; the rest of the body was thrown over to Haleakalā, Maui and to salty Keālia, O'ahu; some of it was thrown on Kaua'i, and some of it was left on Hawaii" (Fornander 1985:576). The *'ōhelo* plant grows at high elevations, and was considered a sacred offering to the goddess Pele.

In the legend of Kalelealuaka (Thrum 1998:94-100), the hero uses his miraculous powers to fly to different parts of the island of O'ahu and wreathes himself in plants peculiar to that region. At the start of one battle, he flies to Wai'anae and covers himself with the fine-leaved *maile* (*Maile lauli'i*). Before the second battle, he flies to Waialua to array himself "in the rough and shaggy wreaths of *uki* (native sedges) from the lagoons of 'U'koa (a fishpond in eastern Waialua) and of *hinahina* (*Heliotropium anomalam*) from Keālia" (Thrum 1998:98). Before the third battle, he flies to Kahuku and adorns himself in a wreath of the pandanus fruit and flowers of the sugar cane. The heliotrope from Keālia is a low, spreading beach plant with small, white fragrant flowers.

3.1.1.3 References to Marine Resources

Several legends about Mokulē'ia concern marine resources, fishing practices, and ceremonial rites related to fishing. In an archaeological survey of the Mokulē'ia area conducted in the 1920s and 1930s, four surviving *ko'a* were recorded (McAllister 1933). *Ko'a* are usually natural boulders or rock mounds, used as shrines where fishermen could beseech the gods for a good catch or place offerings to thank the gods. One of the gods honored by the Hawaiians was Kāne'aukai, who first revealed himself to the people in Waialua. The following passage describes the appearance of Kāne'aukai to two fisherman, who were tasked with praying to him for a plentiful supply of fish:

> One morning on going out upon the seashore they found a log of wood, somewhat resembling the human form, which they took home and set in a corner of their lowly hut, and continued their habit of praying to Kaneaukai. One evening, after having prepared a scanty supper of poi and salt, with perhaps a few roasted kukui-nuts, as a relish, and a couple of cocoanut cups of awa as their usual drink, they saw a handsome young man approaching, who entered their hut and saluted them. He introduced himself by saying, "I am Kaneaukai to whom you have been praying, and that which you have set up is my image; you have done well in caring for it."
>
> He sat down, after the Hawaiian custom, as if to share their evening meal, which the two old men invited him to partake of with them, but regretted the scanty supply of awa. He said: "Pour the awa back into the bowl and divide into three." This they did and at once shared their meal with their guest.
>
> After supper Kaneaukai said to the two old men, "Go to Keawanui and you will get fish enough for the present." He then disappeared, and the fishermen went as instructed and obtained three fishes; one they gave to an old sorceress who lived near by, and the other two they kept for themselves.
>
> Soon after this there was a large school of fish secured by the fishermen of Mokuleia. So abundant were the fish that after salting all they could, there was enough to give away to the neighbors; and even the dogs had more than they desired. (Thrum 1998:251)

The two fishermen also described the variety of marine resources found at Mokulē'ia:

> The fish that frequented the waters of Mokuleia are the *aweoweo* [bigeyes; *Priacanthus* sp.], *kala* [surgeonfish; *Naso* sp.], *manini*, [surgeonfish; *Acanthurus* sp.] and many other varieties that find their habitat inside the coral reefs. Crabs of the white variety burrowed in the sand near the seashore and were dug out by the people, young and old. The squid also were speared by the skillful fishermen, and were eaten stewed, or salted and sun-dried and roasted on the coals. (Thrum 1998:250)

The wooden idol described in the previous passage was eventually moved to Waimea Valley, O'ahu and placed next to a stone idol also representing the god Kāne'aukai. The stone idol was still in place when Thrum recorded this tale in 1907, but the wooden idol had long disappeared. Thrum speculated that it may have been destroyed on one of Ka'ahumanu's trips around the island, when she spread the word of Christianity and ordered all idols of the Hawaiian gods to be burned (Thrum 1998:253).

In the legend of Māikoha, the types of fish resources associated with certain *ahupua'a* are mentioned (Fornander V:II 1974). This legend concerns a man named Māikoha and his four sisters. Māikoha was sent away by his father for breaking several *kapu* (taboos). He left his family and settled in Kaupō, Maui. His four sisters later went in search of him, and found that he had changed into a *wauke* (paper mulberry; *Broussonetia papyrifera*) plant. After they had found him, they left again on a journey to O'ahu. The first sister, Kaihuopala'āina, met a man named

Kapapa'apuhi in Honouliuli, 'Ewa. She married him, settled down, and eventually changed into a fishpond still present in the area. As the remaining three sisters traveled on, the second sister, Kaihukoa met a man named Ka'ena in Wai'anae, and decided to marry him. She settled in the area and changed into a fishing ground directly out from Ka'ena Point, famous for its *ulua* (trevally or jack), *kahala* (amberjack, *Seriola* sp.), and the *mahimahi* (dolphin fish; *Coryphaena hippurus*). The remaining two sisters traveled on to Waialua, where Ihukoko met a man named Kawailoa. They married and settled in the area, and Ihukoko was accompanied to the area by the fish *āholehole* (Hawaiian flagtail; *Kuhlia malo*). The final sister traveled to Lā'ie where she married a man named Laniloa. She brought with her the *'ama'ama* (mullet) (Fornander V:II, 1974:270-272).

A continuation of the legend of Māikoha contains another variation on the legend of the fishing god, Kāne'aukai:

> After the sisters were all married and had been living with their husbands on Oahu for some time, Kaneaukai their oldest brother came in search of them. This man's body was in the shape of a log of wood, and after he had floated on the surface of the ocean for several days, it drifted to the seashore at Kealia in Mokuleia, Kawaihapai, Waialua, where it was carried in and out by the tide. After being in this form for some time it changed into a human being and journeyed to Kapaeloa, where two old men were living.
>
> When he approached the home of the two old men, he saw them watching an umu (oven), and after it was covered up they set out to the beach to do some fishing. After fishing for some time without success Kaneaukai called out to them: "Say, you old men, which god do you worship and keep?" The old men replied: "We are worshiping a god, but we do not know his name." Kaneaukai then said: "You will now hear and know his name. When you let down your net again, call out, "Here is the food and fish, Kaneaukai, that is the name of the god." The old men assented to this, saying: "Yes, this is the first time that we have learned his name." Because of this fact, Kaneaukai is the fish god worshiped by many to this day, for Kaneaukai became their fish god, and from them others, if they so desired. (Fornander 1974: 272)

The *kahala* (amberjack [*Seriola dumerili*) of Mokulē'ia are mentioned often in stories, such as the Legend of Kūali'i and the Legend of Māikoha, presented above. According to the "Hawaiian Dictionary: Revised and Enlarged Edition," the word *mokulē'ia* itself is a rarely used alternate name for this fish (Pukui and Elbert 1986:252). This species, the amberjack, is a deep water species that was caught on a hooked line at depths of 400-500 feet. It is a large, meaty fish that can reach a length of six feet (Tinker 1978:256-257). *Kahala* were commonly cooked in the *imu* (earth oven) or cubed and eaten raw with salt by native Hawaiians (Titcomb 1972:83).

The legend of The Hinalea Fish Basket also takes place in Mokulē'ia, which attests to the abundance of marine resources in the area (Kamakau 1870, cited in Sterling and Summers 1978:101-103). In this legend, Kalamainu'u, a *mo'o* or goddess, resides in a cave in the Waile'a valley, west of the valley of Makaleha in Mokulē'ia. Kalamainu'u, in search of a husband, lures Puna'aikoa'e, a chief of Kapa'a, Kaua'i, out to sea while he was surfing. Puna'aikoa'e is taken by Kalamainu'u from Kaua'i to her cave in Mokulē'ia. The following passage describes the abundance of both land and marine resources at Makaleha:

> They went to her home in Makaleha where sweet potatoes and both the kihi and lapa varieties of taro grew abundantly and there was plenty of poi, 'awa and bananas. The woman supplied the fish of that land that was usually caught by torching, the kumu, the uhu (lobster), and all kinds of fish. (Kamakau 1870, cited in Sterling and Summers 1978:101)

The legend continues with Puna'aikoa'e observing the breaking surf along the Waialua shoreline. Longing for the surf of his homeland, Puna'aikoa'e asks the permission of Kalamainu'u to surf. Kalamaiu'u granted him permission, as long as he did not speak to anyone on the way to the shoreline. Puna'aikoa'e is then caught speaking to two farmers, which leads Kalamainu'u to attempt to kill the two men. The men escape to a crack in the sea floor, where Kalamainu'u is unable to reach them. Kalamainu'u, exhausted and lying on the beach is approached by two women, who teach her how to trap the two men:

> "...They like the sand crabs on this beach to eat with the sweet potatoes which they cultivate in Kanoa, Keone'ae, and the uplands of Makaloha, but they are unskilled in torch fishing. This how you can catch them. Go gather some 'inalua vines under tapu and on your return weave (them into a trap), beginning at the opening. When the part that goes inward is formed, bend (the 'inalua) back to shape the basket. Add some 'inalua to increase the size of the basket as you work downward, and when you see that it is large enough then decrease the 'inalua that are standing upright and keep on decreasing. In that way the bottom of the basket is shaped and finished. When the weaving of the basket is finished the tapu is freed. Then dig sand crabs; carry the basket into the sea, weighted down with pebbles from the sea pools, and set it up in a favorable place where there is a depression so that the sea runs in and out, and remove the stones until it is properly balanced. Then go to a rock in the sea and chew the sand crabs, dive into the sea and place them in the basket, then return to some distance. After an interval, dive again. Hinale and Akilolo will have come to eat their favorite food, and when you come you will find your enemies in the basket." Kalamainu'u heard and heeded these words. All went as they had said. She killed her enemies and tore them into pieces, and the pieces into which she tore them became hinalea fish. From that time down to the overthrow of the tapus those who wove baskets to trap hinalea fish observed these tapu rules; and there were always plenty of hinalea caught in the baskets during that period, so many that a stench arose from the frames where they were drying, from the water of Kumalaekawa to the cape of Ka'ena. Kalamainu'u became an 'aumakua for basket fishing in these places. (Kamakau 1870, cited in Sterling and Summers 1978:102-103)

3.1.1.4 Other Legendary References

The plains of Mokulē'ia were said to have once been inhabited by cannibal chiefs, as told in "The Legend of Oahunui" (Thrum 1998). These cannibal chiefs from the South Seas were:

> ...driven from the plains of Mokuleia and Waialua by the inhabitants of those districts; for the people had been exasperated by the frequent requisitions on the *kama'ainas* (original inhabitants) by the stranger chiefs to furnish material for their cannibal feasts. (Thrum 1998:140)

Kawaihāpai was also known to be one of the places that the lights of the *menehune* (legendary little people) could be seen. These lights have been described as:

> Here in the arm of Haleiwa Bay, strange things can be seen at night. Looking over toward the point to the right, when the night is dark, rows of twinkling light show upon the water. It is the menehunes at their fishing, working fast against the coming of the dawn. (Raphaelson 1925, cited in Sterling and Summers 1978:100)

3.1.2 Early Historic Period

3.1.2.1 Early Descriptions

A picture of pre-contact Hawai'i is painted by the recorded accounts of early foreign explorers. After the death of Captain James Cook on the Island of Hawai'i, the crew of the *Resolution* continued to sail toward O'ahu under the leadership of Captain Charles Clerke. Clerke, after anchoring in Waimea Bay, describes the highly populated and lush northwest coast of O'ahu:

> I stood into a Bay just to the Wtward [Westward] of this point the Eastern Shore of which was by far the most beautifull Country we have yet seen among these Isles, here was a fine expanse of Low Land bounteously cloath'd with Verdure, on which were situate many large Villages and extensive plantations; at the Water side it terminated in a fine sloping, sand Beach...This Bay, its Geographical situation consider'd is by no means a bad Roadsted, being sheltered from the NEbN [Northeast by North] SEterly [Southeasterly] to SWbW [Southwest by West] with a good depth of Water and a fine firm sandy Bottom; it lays on the NW [Northwest] side of this Island of Wouahoo [O'ahu]...surrounded by a fine pleasant fertile Country. (Beaglehole 1967:569)

In 1813, Waialua was described by John Whitman, an early missionary visitor, as:

> ...a large district on the N.E. extremity of the island, embracing a large quantity of taro land, many excellent fishing grounds and several large fish ponds one of which deserves particular notice for its size and the labour bestowed in building the wall which encloses it. (Holt 1979:78)

Another missionary, Levi Chamberlain, described the vicinity of Kawaihāpai in 1826:

> At 11 o'ck [sic] we set out and walked along a path leading over an extended plain covered with high grass. After walking about 3 miles we took a path leading over a marshy tract to the mountains which we were designing to cross in order that we might avoid a bad piece of traveling along the western shore. The mountains here run in nearly a N.W. and N.E. direction being somewhat circular.

> We ascended by a rough & difficult path, shrubs, long grass, wild plants and bushes sprung up grew luxuriantly among the rocks being plentifully moistened by little streams which trickled down the steep sides of the mountains. After ascending several hundred feet, we came to a beautiful little run of water conducted by sprouts [*sic*] furnishing sufficient moisture for a number of taro patches below. I was told that the water never failed and the district into which it passes is called Kawaihapai (Water lifted Up) on account of the water's being conducted from such an elevation.
>
> The prospect from the acclivity is very fine. The whole district of Waialua is spread out before the eye with its cluster of settlements, straggling houses, scattering trees, cultivated plats & growing in broad perspectives the wide extending ocean tossing its restless waves and throwing in its white foaming billows fringing the shores all along the whole extent of the district (Chamberlain 1823-1827, cited in Alameida 1993:14-15).

3.1.2.2 Economic Changes

About A.D. 1720-1740, the island of O'ahu was united under the high chief Kūali'i after a series of battles with the chiefs of Kona and 'Ewa. Kūali'i continued his wars of conquest by carrying out raids on the islands of Moloka'i and Hawai'i. This began a time period of intra-island and inter-island wars, referred to as the Conquest Period, that culminated in the conquest of O'ahu by the Hawai'i Island chief, Kamehameha, in A.D. 1795 (Sahlins 1992:36). In 1804, the Hawaii chiefs who supported Kamehameha occupied O'ahu, taking control of the lands of the former ruling chiefs. In 1806, Kamehameha traveled around the island of O'ahu to encourage people to rebuild their war-ravaged agricultural fields and fishponds by his own example.

> Kamehameha stayed for only one day to farm at Wai'anae, then went to Waialua. He stayed at least 3 or 4 days with the chiefs and people of Waialua working in the *lo'i* [irrigated fields] which extended from the famous *pawehe* (geometric patterns) mats [of Mokulē'ia] to the waters of Waimea. From Waialua he went to Laie and farmed there (*Ka Nai Aupini,* newspaper article, cited in Alameida 1993:39).

Kamehameha not only encouraged his people to rebuild areas devastated by the wars, but also to expand into new areas. "He cleared the land at Waikiki, Honolulu, Kapalama, Kapa'auki, Keone'ula, Kapa'eli, and all the other places, and when all the lands were under cultivation he cultivated *mauka* in Nu'uanu as far as Keawewawapu'ahanui" (Kamakau 1961:192). This passage indicates that there may have been an intensification of agriculture after 1804, which included expanding the irrigation system into new lands upland (*mauka*) of the former pre-contact fields (Sahlins 1992:52). Some of these agricultural endeavors may be connected to the new trade that developed with visiting foreign ships. During the Conquest Period, food and other provisions were sold to visiting ships involved in the Canton trade. Ships would travel to the Northwest Coast for furs, stop in Hawaii for provisions, and journey on to Canton, China to trade the furs for luxury goods, such as fine ceramics and silk (Sahlins 1992).

Kamehameha died in 1819, and his son Liholiho and wife Ka'ahumanu shared the duties of ruling the new kingdom. In 1823, Liholiho addressed a gathering of chiefs at Maui and told them that he wished to visit England. He selected his younger brother Kauikeaouli to be his chief during his absence and heir in the event that he did not return. Both Liholiho and his wife died in 1824 while in England, and Kauikeaouli, later known as Kamehameha III, became the king at the age of nine, with a guardian Kahalai'a as his *kahu* (personal attendant). This took place during the Sandalwood Period (A.D. 1812-1830), when the *ali'i* (high chiefs) made enormous demands upon the common people to gather sandalwood in the upland forests. The wood was sold to foreigners in trade for Western luxury goods (Sahlins 1992:82).

> Kau-i-ke-aouli's assumption of control was marked by the selection of a group of young chiefs and children of important persons, of resident foreigners, and of commoners, to become his favorites, friends, members of his household, and soldiers and sailors to form his bodyguard. After Kahala'ia's death all repaired to the uplands of Waialua adjoining Waimea, to upper Kolokini, Wao'ala, 'Aikanaka, Kaloka in upper Makaleha, and to upper Mokule'ia to cut sandalwood. Kau-i-ke-aouli was but a boy in his thirteenth year while cutting at upper Wao'ala and lower Maeaea, but he attended to the work himself and when he sailed in his two-masted boat to Mokule'ia or other places after sugarcane, sweet potatoes, melons, pigs, and fowl, he handled the boat in true sailor fashion, dressed in his sailor blouse and cap. (Kamakau 1992:278-279)

This period ended in the exhaustion of the sandalwood on the islands. Trade continued with visiting whaling ships during the Whaling Period (A.D. 1830-1848) for provisions, but this did not generate the same profits for the *ali'i* as did the early sandalwood trade. The *ali'i* became greatly indebted to Western merchants, and made increasing demands upon the common people for goods and work to pay off these debts and to buy yet more goods (Sahlins 1992:108).

Between 1830 and 1850, the demands of the *ali'i* on the *maka'āinana* (common people) were severe. The missionary, John Emerson, commenting on the burdensome taxes on the people, wrote that the ruling chiefs "get hungry often and send a vessel to Waialua for food quite as often as it is welcomed by the people" (MsL: 10 Feb 1834, cited in Sahlins 1992:145). The chiefs also demanded food be brought to them:

> Last Sat some 2 or 300 men went from this place to H[onolulu] to carry food for the chiefs and this [is] often done...Each man carried enough food to maintain 4 persons one week & will cost each man beside the time spent in [indecipherable] and cooking it 4 days time and 70 miles travel to get it to H[onolulu], and yet each man's load would only bring 50 cts. (Locke, journal, 26 June 1837; cf. MsL: Emerson, 11 Jan 1835, cited in Sahlins 1992:145)

John Emerson also began growing sugarcane on his land in Waialua as early as 1836. He "made his own molasses, grinding a few bundles of cane in a little wooden mill turned by oxen, and boiling down the juice in an old whaler trypot" (*The Friend*, cited in Condé and Best 1973:340). This early sugarcane plantation later passed through several hands, including the Levi and Warren Chamberlain Sugar Company, established 1865, Halstead & Gordon, and the Halstead Brothers.

3.1.2.3 Population Decline

In the pre-contact period, villages in the Waialua District were concentrated along the coast and the well-watered valleys of the *ahupua'a* on the eastern side of the district. The population of these *ahupua'a* had been estimated at 6,000 to 8,000 people before Western Contact (Sahlins 1992:20).

In 1832, the missionary Ephraim Walter Clark reported that:

> Waialua on the eastern part of the island is a populous region. A mission can be located at a central point in this vicinity, [and] by preaching at different places that are within 5 or 6 miles of each other & of easy access, [we] would probably have 3,000 or 4,000 bearers [followers] (Letter from E. W. Clark 1932, cited in Alameida 1993:4).

A small school was also established at Kawaihāpai in 1839, near Kawaihāpai Stream.

The first missionary census of the district, in 1831-32, recorded 2,640 people in Waialua, probably down 20-30 percent from the first decade of the century. The population continued to decline in the first part of the nineteenth century, and by 1848, the population was down to 1,616 persons. Much of this decline was due to a high death rate from newly introduced diseases, such as smallpox, typhus, and venereal diseases.

In 1850, the missionary Emerson wrote:

> I went to Kawaihapai, distant about 6 miles to preach to a small congregation. Found many sick on the road calling for medicine; & when [I] arrived at the place of meeting I found two unburned corpses, but a few steps from the schoolhouse & other sick-apparently nigh unto death...The past epidemic has been of a very strange character. Many were taken with violent pains in the head or stomach, which would soon spread over the whole system; & some times in one or two days the patient would die, but more frequently he would linger along six or ten days (Emerson 1850, cited in Alameida 1993:84; Letter, Emerson to Anderson. May 22, 1850. Hawaiian Mission Children's Society Library).

The adult to child ratio in 1831-32 was three to one (Schmitt 1973:9). This is not only a reflection of the low birth rate during these years, but also indicates that many young people were moving out of the district. They left to escape the increasing demands of the *ali'i* during the Sandalwood Period and to seek a better life in the new urban centers of the islands. This trend in population decline continued until 1866, when the population reached a low of 851 persons (Schmidt 1977: 13-14).

3.1.3 Mid- to late-1800s

Following the death of Ka'ahumanu's father, Ke'eaumoku, in 1804, Ka'ahumanu's brother Kahekili Ke'eaumoku, also known as George Cox, became the *ali'i 'ai moku* (governing high chief) of Waialua. In 1824, Kahekili Ke'eaumoku died and his sister, Lydia Kekuapi'ia Nāmāhana, also known as Pi'ia, inherited the entire *moku* (district) of Waialua. When she died, her husband La'anui was confirmed as the *luna* (landlord or supervisor) by Ka'ahumanu, who was again considered the owner. Ka'ahumanu, who died in 1832, willed all of her lands to her niece, Kīna'u. After Kīna'u's death in 1839, the *kalana* (land division smaller than a *moku*) within Waialua was inherited by her daughter, Victoria Kamāmalu, along with many other lands in the islands (Kame'eleihiwa 1992:106,120-124).

In 1845, the Board of Commissioners to Quiet Land Titles, also called the Land Commission, was established "for the investigation and final ascertainment or rejection of all claims of private individuals, whether natives or foreigners, to any landed property" (Chinen 1985:8). This led to the *Māhele*, the division of lands between the king of Hawaii, the *ali'i*, and the common people, which introduced the concept of private property into the Hawaiian society. In 1848, Kamehameha III divided the land into four divisions: certain lands to be reserved for himself and the royal house were known as Crown Lands; lands set aside to generate revenue for the government were known as Government Lands; lands claimed by *ali'i* and their *konohiki* (supervisors) were called Konohiki Lands; and habitation and agricultural plots claimed by the common people were called *kuleana* (Chinen 1985:8-15).

Upon the confirmation of a land claim, the *ali'i* were required to pay a commutation to the government. This commutation (meaning a substitution of one form of payment or charge for another) could be satisfied with a cash payment or the return of land of equal value. This payment was usually one-third of the value of the unimproved land at the date of the award (Chinen 1985:9-12). Victoria Kamāmalu gave up all of her lands in Kamananui, Mokulē'ia, Kawaihāpai, Keālia, and Ka'ena, all within the Waialua District, to the Government to satisfy the one-third-commutation requirement in order to claim all of her other extensive land titles. These *ahupua'a* then became Government Lands. In 1848, Government Lands became available for purchase, ". . . in lots of from one to fifty acres in fee simple, to residents only, at a minimum price of fifty cents per acre" (Chamberlain, no date). These costs did not include the survey fee, which was to be paid by the interested buyer.

Many of the native Hawaiians living in the area bought the lands they lived and worked on through the Waialua land agent, the missionary John Emerson. Emerson had encouraged the natives of these five *ahupua'a* in western Waialua to withdraw from the *Māhele* and not prosecute their claims through the Kuleana Act of 1850. Instead, he encouraged them to buy the lands they worked. In this way they could not only obtain house and agricultural lots, but also pasturage and upper forest lands, which were usually not awarded as *kuleana* claims (Sahlins 1992:168).

A total of 27 land grants were purchased in the *ahupua'a* of Mokulē'ia and 16 in the *ahupua'a* of Kawaihāpai (Figure 7). Portions of twenty land grants are located within the 861-acre Dillingham Ranch project area, granted from 1850-1855 (Table 2). The land grants in the area generally consisted of long, narrow rectangular pieces of land, with the long axis running *mauka-makai* (upslope-downslope). There were also two rows of land grants extending from the shoreline to the forest reserve line. The *makai* (seaward) row included the coastal plains and lower foothills. The *mauka* (upland) row consisted of the upper mountainous areas.

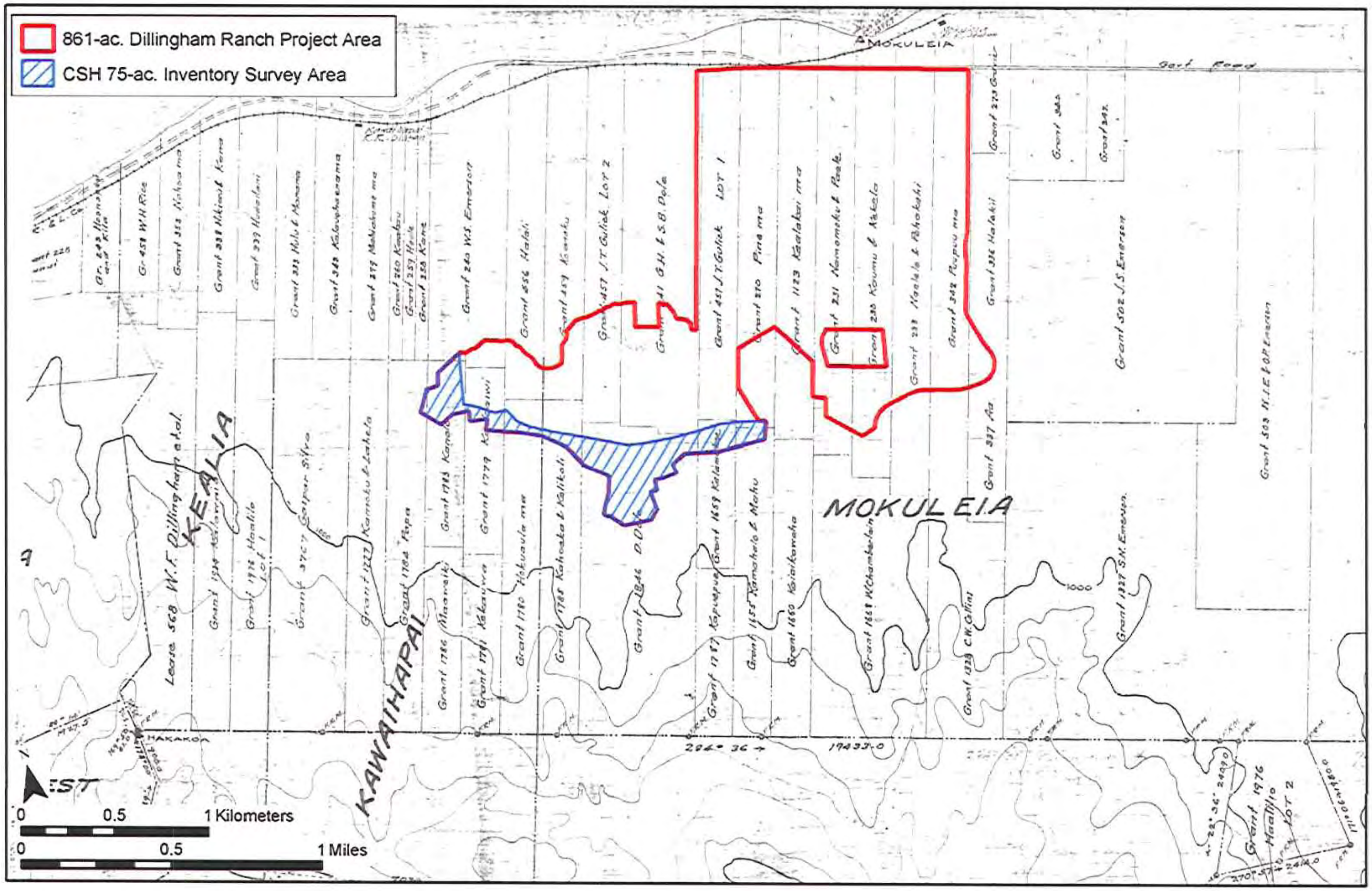


Figure 7. 1918 Mokulē'ia Forest Reserve Map, Walter E. Wall surveyor, showing the distribution of land grants in the vicinity of the 861-acre Dillingham Ranch project area

Table 2. Land Grants located within the 861-acre Dillingham Ranch project area

Grant #	Grantee	Year	Location
230	Kaumu and Kekela	1850	Mokulē'ia
231	Namoku and Paele	1850	Mokulē'ia
233	Pohakahi and Naelele	1850	Mokulē'ia
240*	Wm S Emerson	1850	Kawaihāpai
241	Geo H Dole and S B Dole	1850	Mokulē'ia
270*	Pine Pao and Mahiai	1850	Mokulē'ia
336	Haleki	1850	Mokulē'ia
337	Aa	1850	Mokulē'ia
342	Puupuu et al.	1850	Mokulē'ia
456	I Halali	1850	Kawaihāpai
457	John T Gulick	1850	Mokulē'ia
459	Koanaku et al.	1850	Mokulē'ia
1123	Makahi et al.	1853	Mokulē'ia
1655*	Mahu and Kamahalo	1855	Mokulē'ia
1659*	Kalamaku	1855	Mokulē'ia
1779*	Kauloaiwi	1855	Kawaihāpai
1780*	Hokuaulani and Kaawelu	1855	Kawaihāpai
1783*	Kanalu	1855	Kawaihāpai
1784*	Papa	1855	Kawaihāpai
1785*	Kahoeka C Kolikoli	1855	Mokulē'ia
1846*	Daniel Dole	1855	Mokulē'ia

* Located within the CSH 75-acre inventory survey area

In 1850, a law was passed that allowed foreigners to buy land fee-simple. Two descendants of missionaries, William Emerson and John T. Gulick, were the first foreigners to buy land in Mokulē'ia and Kawaihāpai. Over the next few years, Emerson continued to buy land from the original grantees or later owners until he owned a total of 2,605 acres in Waialua (Alameida 1993:xii).

In 1852, the first Chinese were brought to the islands to work in the sugar cane fields. Some of these Chinese later moved to Waialua to begin rice cultivation. A market for rice in California had developed as increasing numbers of Chinese laborers immigrated there since the mid-19th century. Similarly, as Chinese immigration to the islands also accelerated, a domestic market for rice developed:

> By 1876 there was still a considerable amount of former taro land available for rice farming. The great demand for rice land brought disused taro patches into requisition – especially because water rights attached to them...
>
> As the demand for rice continued, it became profitable to bring into use land hitherto unused. The land most easily rendered fit for rice cultivation was swamp or marsh land of which there was a large amount in the islands. At Waialua on Oahu, about three hundred acres of swamp land were reclaimed for rice farming (Coulter and Chun 1937:11).

In 1892, there were 180 acres of land under cultivation for rice in the Waialua District; these rice fields were located in the *ahupua'a* of Mokulē'ia, Kamanaui, and Kawailoa (Coulter and Chun 1937:12, 21). The immigrant Chinese may account for the rise in the Waialua District population during the last quarter of the 19th century. In 1866, the population of Waialua had reached a low of 851 persons. This trend reversed in 1878, with a small increase to 939 people and a count of 1,349 in 1886 (Schmidt 1977: 13-14).

3.1.4 1900s

By the early 1900s, sugarcane plantations and large ranches came to dominate the lands of western Waialua. Cattle were known to have grazed on the lowlands of Waialua as early as the 1840s (Sahlins 1992:148). In 1897, B.F. Dillingham purchased the Kawailoa Ranch in Mokulē'ia. The ranch included over 2000 head of cattle and over a hundred horses and mules on 10,000-acres of land (Yardley 1981:193). Dillingham also leased additional property in Mokulē'ia, including the Gaspar Silva Ranch, the James Gay Estate, and other lands in the area that he could secure. Dillingham's plan was to later sublease or sell the land at a profit, as the lands had potential for being developed into large-scale sugar plantations. He anticipated the land would become valuable once extensive irrigation systems were in place, and when the O'ahu Railway and Land Co. (O.R. & L.) railroad was constructed around Ka'ena Point and along the north shore to Kahuku.

By 1898, the O.R. & L railroad was constructed through the Waialua District, with stations in both Kawaihāpai and Mokulē'ia. Soon thereafter, Dillingham began selling off or subleasing much of his lands in western Waialua. However, Dillingham retained as his personal ranch "a great strip of mountainside and beaches with flat land in between and a homestead in the middle" (Yardley 1981:206). This land would remain ranch land, with sugar plantations located to the east and west. The Dillingham Ranch was developed into a horse ranch, including stables, pastures, equestrian areas, and a polo field, along with a large, wood-framed house for the Dillingham family (Yardley 1981:193-194).

Also in 1898, the Halstead Brothers had a small sugar cane plantation and mill at Waialua town. B. F. Dillingham believed that the Halstead Brothers' land could be turned into a profitable sugar plantation, especially since there was now a rail line to Honolulu. The Waialua Agricultural Company was established in 1898 by J.B. Atherton, E.D. Tenney, B.F. Dillingham, W.A. Bowen, H. Waterhouse and M.R. Robinson (Moblo 1991:4), and was incorporated by the company Castle & Cooke (Dorrance and Morgan 2000:47). They bought the Halstead Brothers' land and mill, and began to buy or lease the adjacent lands, many owned by native Hawaiians. They acquired many of the former irrigated taro lands in order to control the water rights of the region.

Ditches to control water flow began to be built around 1902 in Waialua. The Ito Ditch, built after 1911, diverted water from Kaukonahua Stream to the Mokulē'ia sugar cane fields. The Waialua Agricultural Company was famous for its system of flume irrigation. The portable concrete flumes were set around the fields in a herringbone pattern and water was released to the field by small tin gates (Wilcox 1996:110). In addition, various artesian wells, pumping stations, reservoirs, and associated water control infrastructure were constructed to support the growing sugar plantations.

Land for a new railroad that would carry cane from the fields to the mill began to be surveyed in 1898, and by 1908 the new railroad connected the plantation lands in Waialua, Helemano and Kawailoa. In 1910, it was reported in the *Louisiana Planter*:

> Waialua is reached either by railroad, a distance from Honolulu of 58 miles, or wagon road, 28 miles. The plantation lands extend along the seacoast 15 miles and 10 miles back toward the mountains. The plantation has a good railway system.
>
> There are nearly 600 cane cars and five locomotives: with 30 miles of permanent track and eight of portable track. One stretch of road is nine miles long (cited in Conde and Best 1973:341).

A 1913 Fire Control Map (Figure 8) illustrates the extent of plantation development in the vicinity of the 861-acre Dillingham Ranch project area. In general, cane lands extend from the O.R. & L./Government Road that parallels the shoreline, to the base of the foothills of the Wai'anae Range. The *mauka* (upslope) extent of plantation cultivation appears to be the Ito Ditch, which is indicated crossing east-west through the *mauka* (upslope) portion of the Dillingham Ranch project area, along the base of the foothills. Various fence lines are indicated *mauka* (upslope) of the ditch, as these areas remained pasture for grazing livestock.

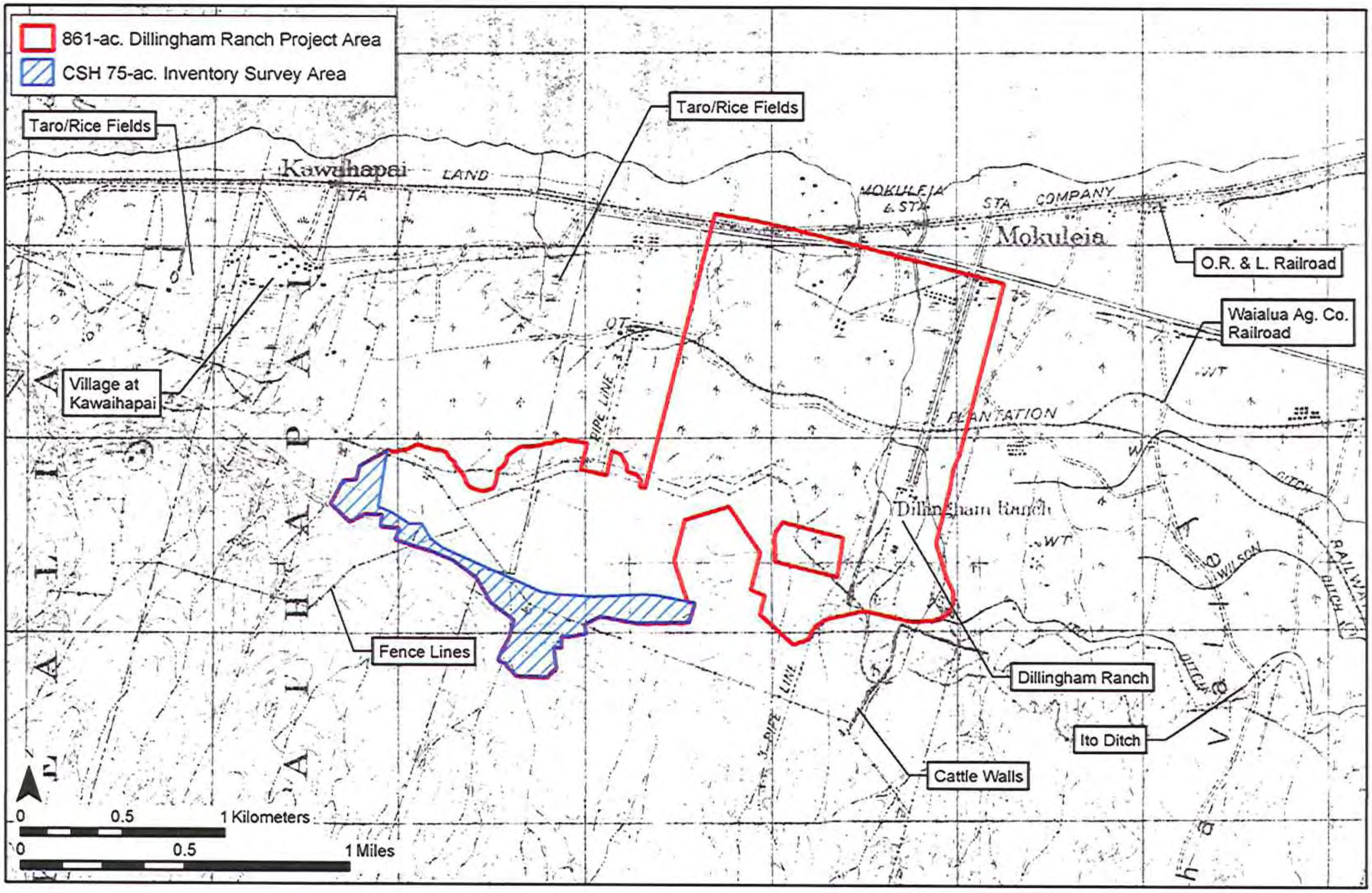


Figure 8. 1913 Fire Control Map, Ka'ena Quad., showing the extent of plantation development in the vicinity of the 861-acre Dillingham Ranch project area

There are several structures indicated on the 1913 map, most of which are regularly spaced around the railroad tracks. These may be worker's houses and camps, or other structures associated with the sugar plantation. Structures are also clustered near the coast at Kawaihāpai. These possible houses and walls are adjacent to three delineated areas of marsh, bounded by stone walls and fencing. These may be fields used to grow taro or rice, which may have been irrigated. The 1913 map also indicates the extent of Dillingham's personal ranch (labeled "Dillingham Ranch"), which was not cultivated in cane. The narrow strip of land extends from the Government Road up into the foothills and is bordered by fence lines. Cattle walls are also indicated near the *mauka* (southern) end of the Dillingham Ranch. Fence lines are the only infrastructure indicated within the 75-acre inventory survey area.

In 1918, the Waialua plantation railroad lines were connected to the main O.R. & L. lines. In 1927, the rail line was extended to the upper levels of the cane fields. Water flumes had been used to transport the cane in these upper fields to the lower tracks, but the use of these flumes caused a serious depletion of the water supply, and it was considered more economical to build more tracks.

The 1928-29 series USGS maps (Figure 9) continue to show the various plantation ditches, railroad lines, and various other plantation related structures in the vicinity of the project area. The Kawaihāpai Reservoir is now indicated, suggesting a need for additional irrigation infrastructure for the expanding sugar plantation lands. Also of note are two large cattle paddocks located in the western portion of the 861-acre Dillingham Ranch project area. These rectangular paddocks are indicated to be bordered on three sides by stone walls, which must have been fairly large structures to be indicated on the topographic map, that extend from the foothills down to the plantation ditch fed by the Kawaihāpai Reservoir. The locations of these paddocks correspond to the *mauka* (southern) boundaries of Land Grant 457, Lots 1 and 2 to J.T. Gulick (see Figure 7). At this time, Dillingham's personal ranch lands appear to remain confined to the strip of land along the eastern end of the 861-acre Dillingham Ranch project area, bordered by cattle walls and fence lines.

Major land use changes occurred in western Waialua when the U.S. military began development in the area. Kawaihāpai Military Reservation was established c. 1927 at the site of the present Dillingham Airfield. Following the entrance of the U.S. into World War II, Kawaihāpai Military Reservation was expanded and became known as Mokulē'ia Airfield (Payette 2003). A small sand and grass runway was built and in use within a week after the attack on Pearl Harbor. The airfield was a training base for fighter planes, P-38s and later, P-51s. The continuation of the war required the expansion of the airfield, and by April 1942, the airfield had become an 8,000-foot runway, later expanded to 9,500 feet. It was the longest in the Hawaiian Islands at that time (Allen 1971:226-227). Also located at Mokulē'ia Airfield was Battery Dillingham, in use from 1942-1944. Battery Dillingham included a series of naval gun emplacements located both along the beach and further inland, and served as a field artillery training range (Payette 2003). Mokulē'ia Airfield was renamed Dillingham Air Force Base when the U.S. Air Force was formed in 1947. In 1948, the base was deactivated, but continued to be used for training activities by the U.S. Army. The site was also used as a NIKE missile base during the 1950s (Payette 2003).

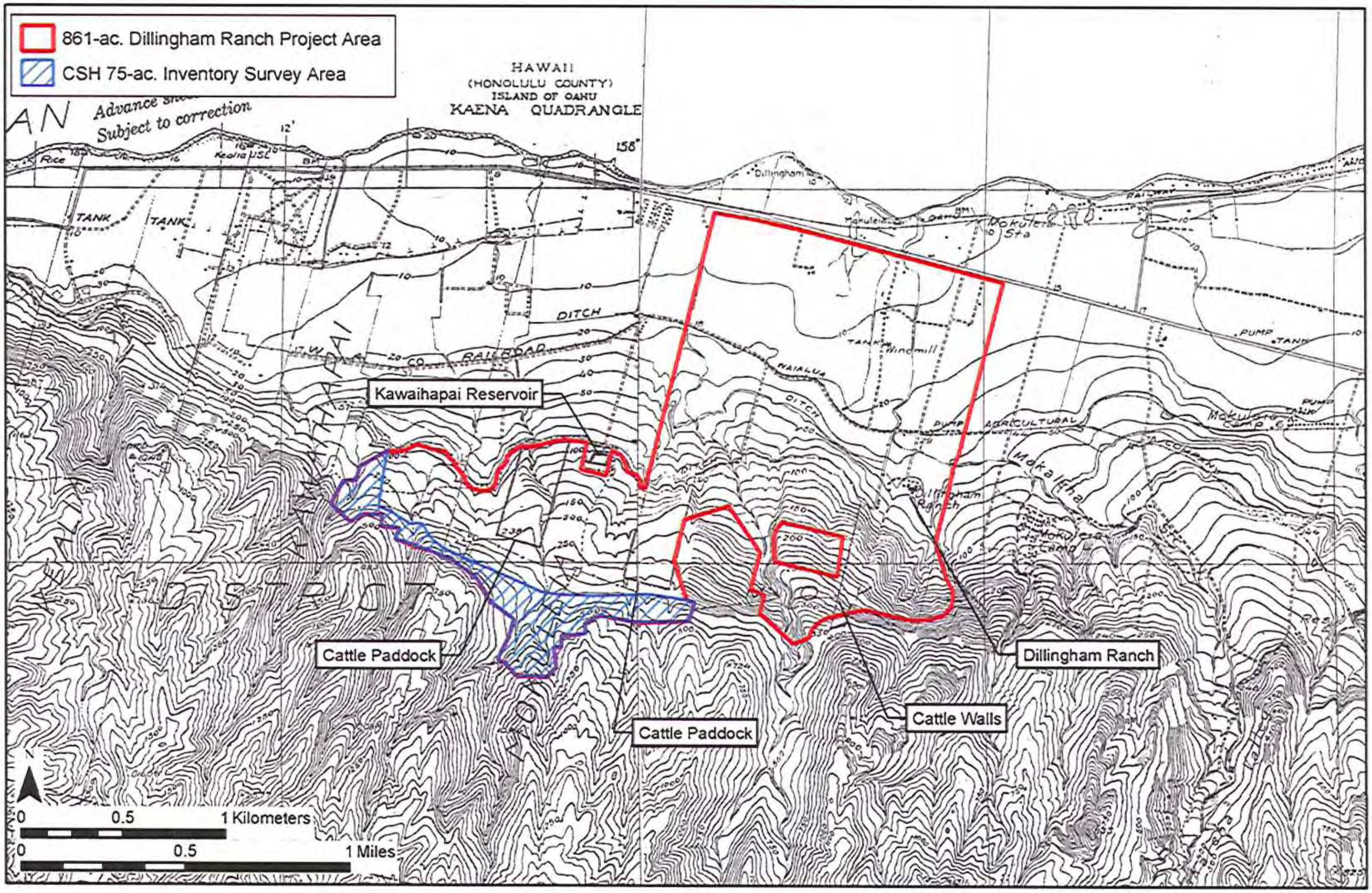


Figure 9. 1928-29 USGS Topographic Map, Ka'ena and Haleiwa Quads, showing development in the vicinity of the 861-acre Dillingham Ranch project area

Mokulē'ia Military Reservation, including Battery Mokulē'ia, was also established in 1942 and consisted of four gun emplacements located two miles inland (Payette 2003). The extent of military development in the vicinity of the 861-acre Dillingham Ranch project area is shown on the 1943 War Department map (Figure 10). Dillingham Airfield is shown to dominate the landscape of coastal Kawaihāpai, though ranching and plantation agriculture remain throughout the vicinity of the 861-acre Dillingham Ranch project area.

In 1946, Robert P. Patterson, Secretary of War of the United States, executed a "Declaration of Taking," which stated that the land of Mokulē'ia, Auku'u, Kawaihāpai, Keālia, and Ka'ena, Waialua, O'ahu, Territory of Hawaii; Mokulē'ia Ranch and Land Company, Limited, et al. "is taken...to provide for a military airfield, an ordnance storage area, and related military purposes incident thereto. The said land has been selected by me for acquisition by the United States for use in connection with such purposes, and for such other uses as may be authorized by Congress or by Executive Order, and is [r]equired for immediate use." Several of the native Hawaiian families, who had retained their small plots of land through the 19th and early 20th centuries, now lost the lands through this confiscation (Alameida 1993:113).

3.1.5 Modern Land Use

With the announcement of the Oahu Railway and Land Company's decision to discontinue service in 1947, the Waialua Agricultural Company began to switch to truck transportation. The change was slowly made, until the last railroad line was closed in 1952. Subsequent historic maps and aerial photographs indicate a general lack of development in the area through the 1970s. The 1964 USGS map (Figure 11) indicates the Crowbar and Campbell ranches in the coastal portion of the 861-acre Dillingham Ranch project area, north of the Dillingham Ranch. The railroad lines have been replaced by roads, though much of the plantation infrastructure remains in use. A 1977 aerial photograph (Figure 12) clearly depicts the various land use areas within and in the vicinity of the 861-acre Dillingham Ranch project area. Lands in the *makai* (northern) portion of the project area consist of improved pasture and ranch activity areas, including the Dillingham family residence and other smaller residences. Lands in the *mauka* (southern) foothills portion of the 861-acre Dillingham Ranch project area generally appear to be unimproved pasture areas. To the east and west of the project area are extensive sugar plantation fields.

The lands occupied by the Crowbar Ranch, Campbell Ranch, and Dillingham Ranch were later consolidated under the control of the Mokulē'ia Land Company. At present, the project area, again known as the Dillingham Ranch, is an active horse and cattle ranch. Much of the level coastal plain portion of the project area is used for equestrian stables and activity areas. The sloping foothills of the project area are used as pasture for grazing cattle. The historic Dillingham residence remains on the property, as well as a coconut and palm tree farm.

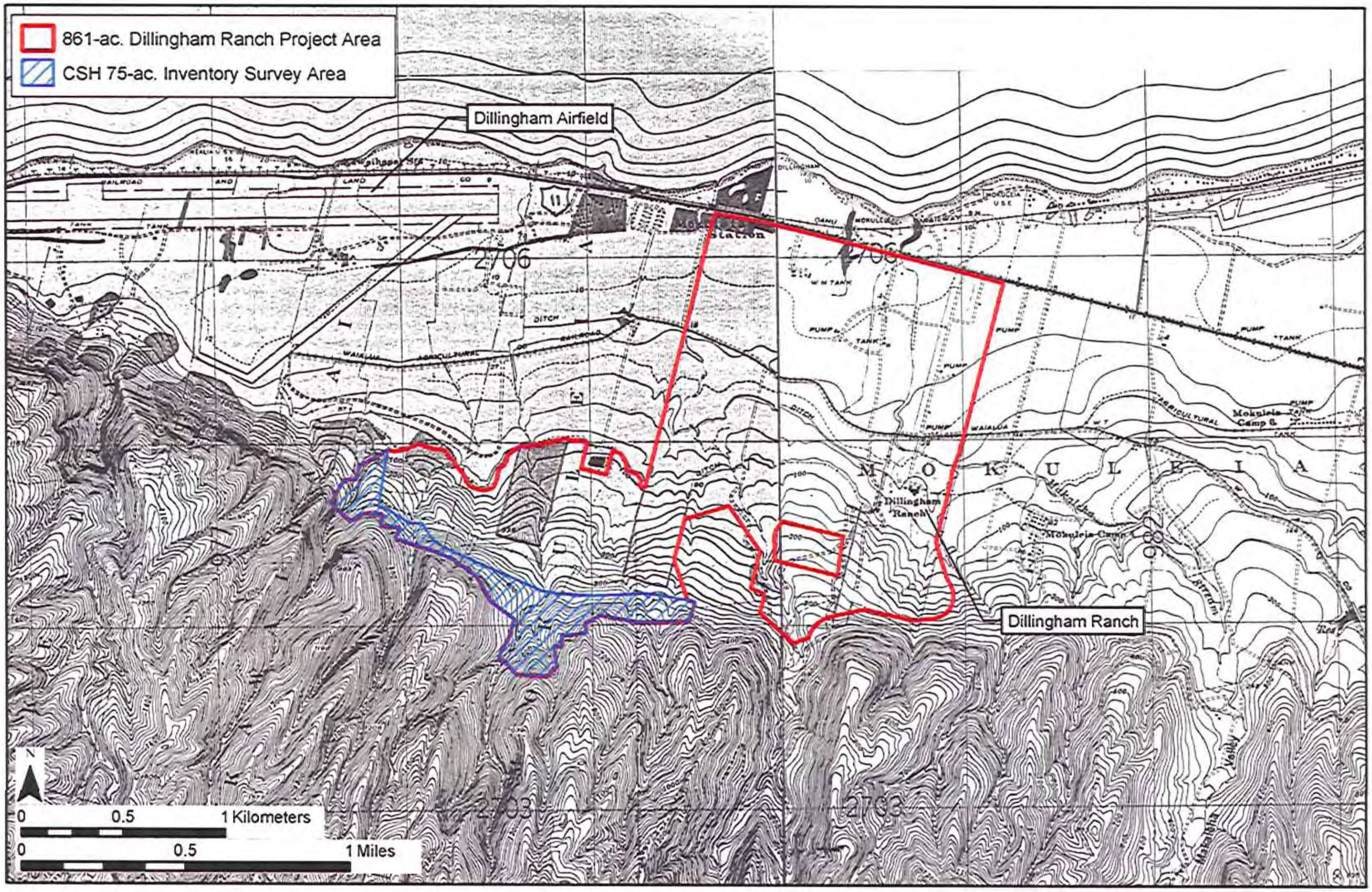


Figure 10. Portions of 1943 War Department Topographic Maps, Ka'ena and Haleiwa Quads, showing development in the vicinity of the 861-acre Dillingham Ranch project area.

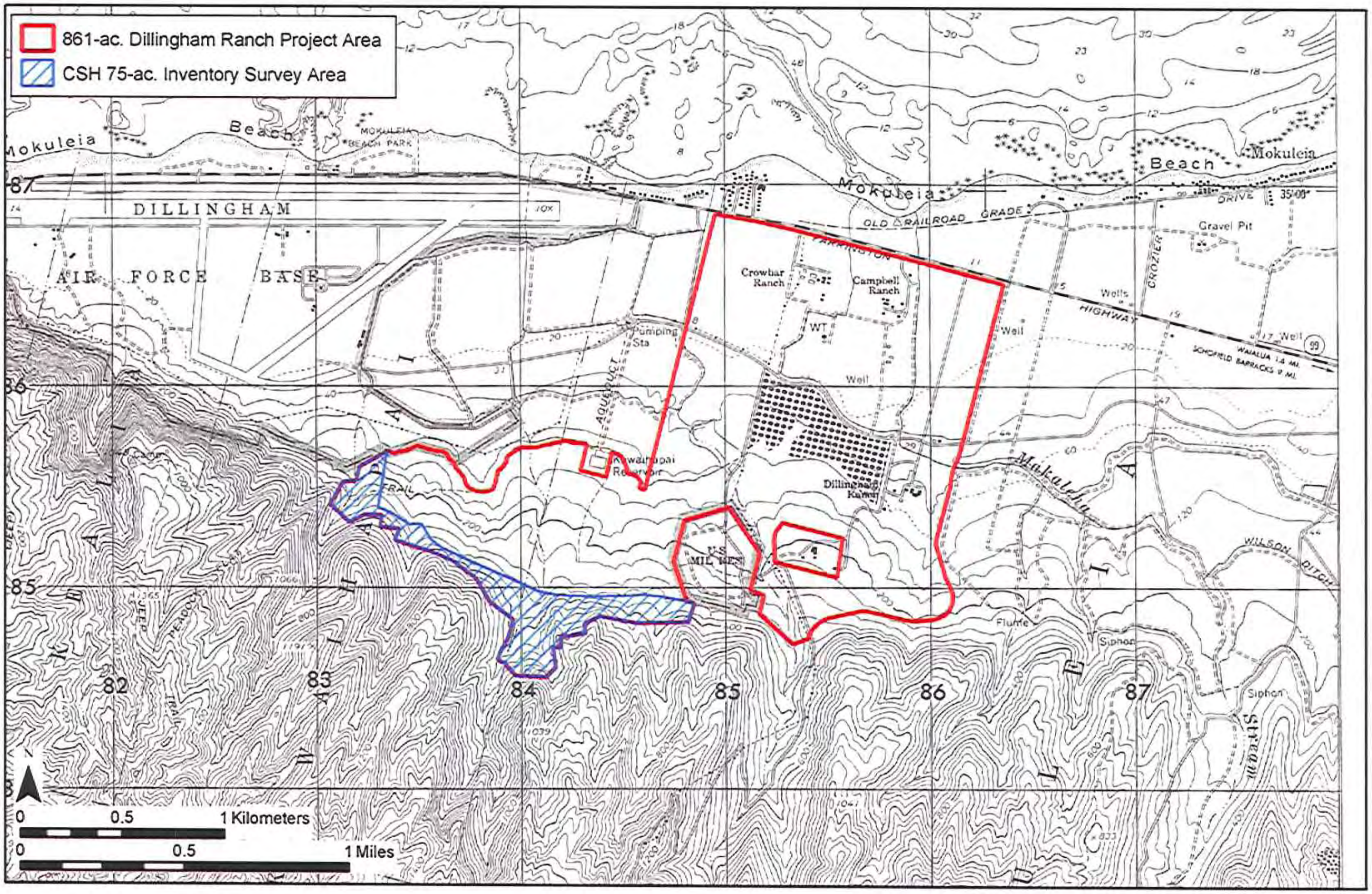


Figure 11. Portion of 1964 Defense Mapping Agency Topographic Map, Ka‘ena Quad., showing development in the vicinity of the 861-acre Dillingham Ranch project area

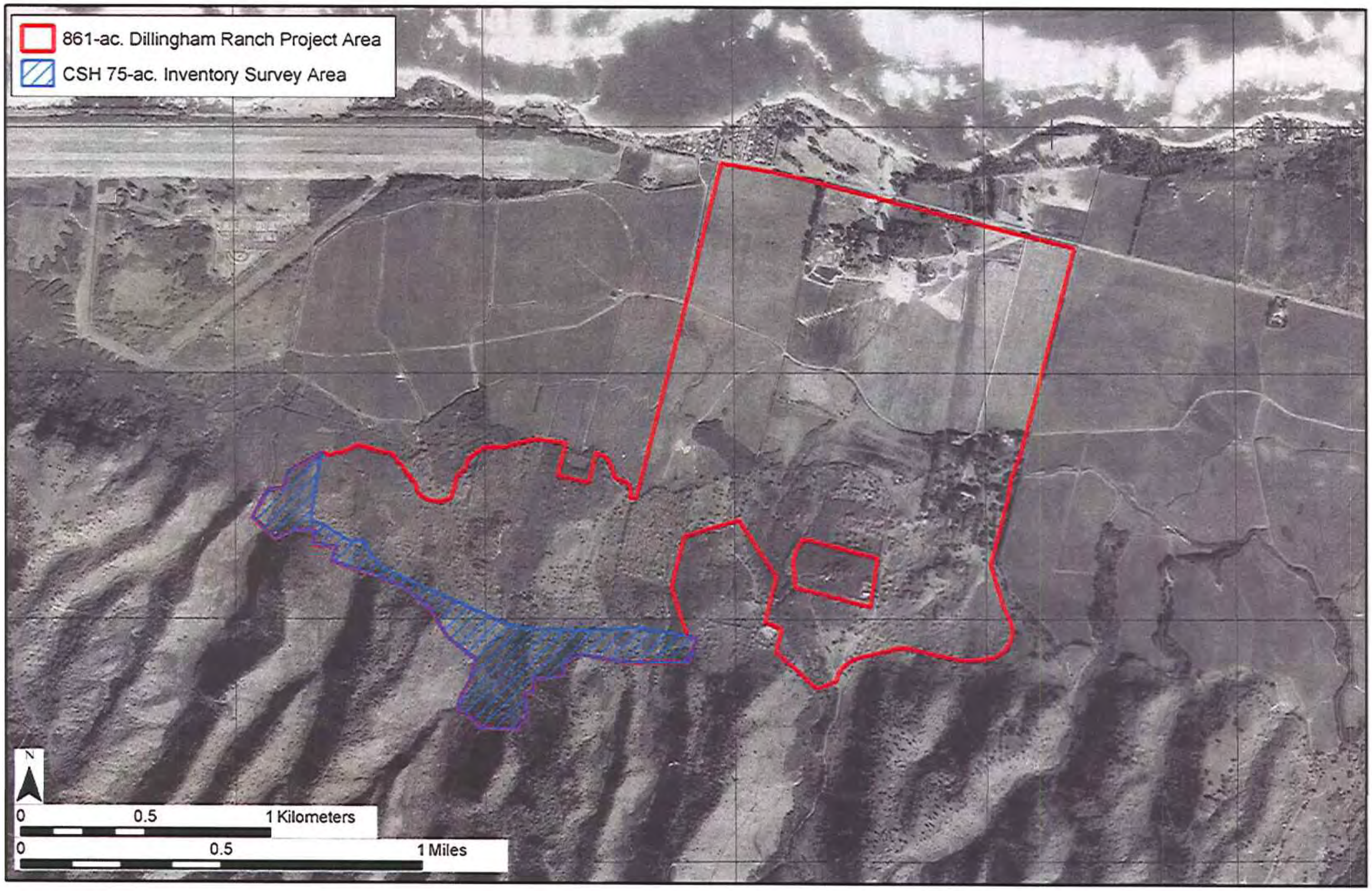


Figure 12. Portion of 1977 USGS Orthophotoquad, Ka'ena Quad., showing development in the vicinity of the 861-acre Dillingham Ranch project area

3.2 Previous Archaeological Research

Archaeological studies in the vicinity of the 861-acre Dillingham Ranch project area have largely been limited to the inadvertent finds of burial remains along the beach and short, one or two-day reconnaissance surveys in the inland areas. Figure 13 illustrates project areas and site locations, and Table 3 presents the findings of the archaeological studies in the vicinity of the project area. Several of these studies have focused on relocating archaeological sites first identified by Gilbert McAllister in his island-wide survey conducted in the 1920s to 1930 (McAllister 1933).

McAllister (1933) identified eight sites within Mokulēʻia and Kawaihāpai Ahupua'a, in the vicinity of the 861-acre Dillingham Ranch project area. Four sites were located along the coast and consisted of *ko'a*, or fishing shrines. Sites -190, -193, -195, and -201 were described as follows:

> Site 190, Puʻu o Hekili *Ko'a*
>
> Puʻu o Hekili, an ahua which was once located on the beach below the Kawaihāpai [railroad] station. According to Hookala, an ahua is "bent instead of angular in construction" and was evidently a type of fishing shrine (koʻa). Unfortunately nothing remains of the site. [McAllister 1933, cited in Sterling and Summers 1978:99]
>
> Site 193. Fishing Shrine (destroyed)
>
> Kuakea fishing shrine (koʻa), Kawaihapai, was formerly located on the beach in a direct line with Kawailoa heiau. Nothing marks the site. [McAllister 1933, cited in Sterling and Summers 1978:100]
>
> Site 195. Kolea fishing shrine (koʻa), Mokuleia, Fishing Shrine (Destroyed)
>
> The shrine is located on the beach in a direct line with the Dillingham stables. The stones have been removed and only an indistinct line of stones 15 by 30 feet remains to mark the foundation. A stone in the water in front of Kolea was known as Mokupaoa. [McAllister 1933, cited in Sterling and Summers 1978:101]
>
> Site 201. Fishing Shrine
>
> Keauau fishing shrine was once located on the beach at Puuiki, at the Kaena end of a long row of ironwood trees. Nothing remains of the site. [McAllister 1933, cited in Sterling and Summers 1978:105]

The presence of four *ko'a* in the immediate area attests to the abundance of marine resources, as described in traditional and historic accounts (see Section 3.1: Traditional and Historical Background).

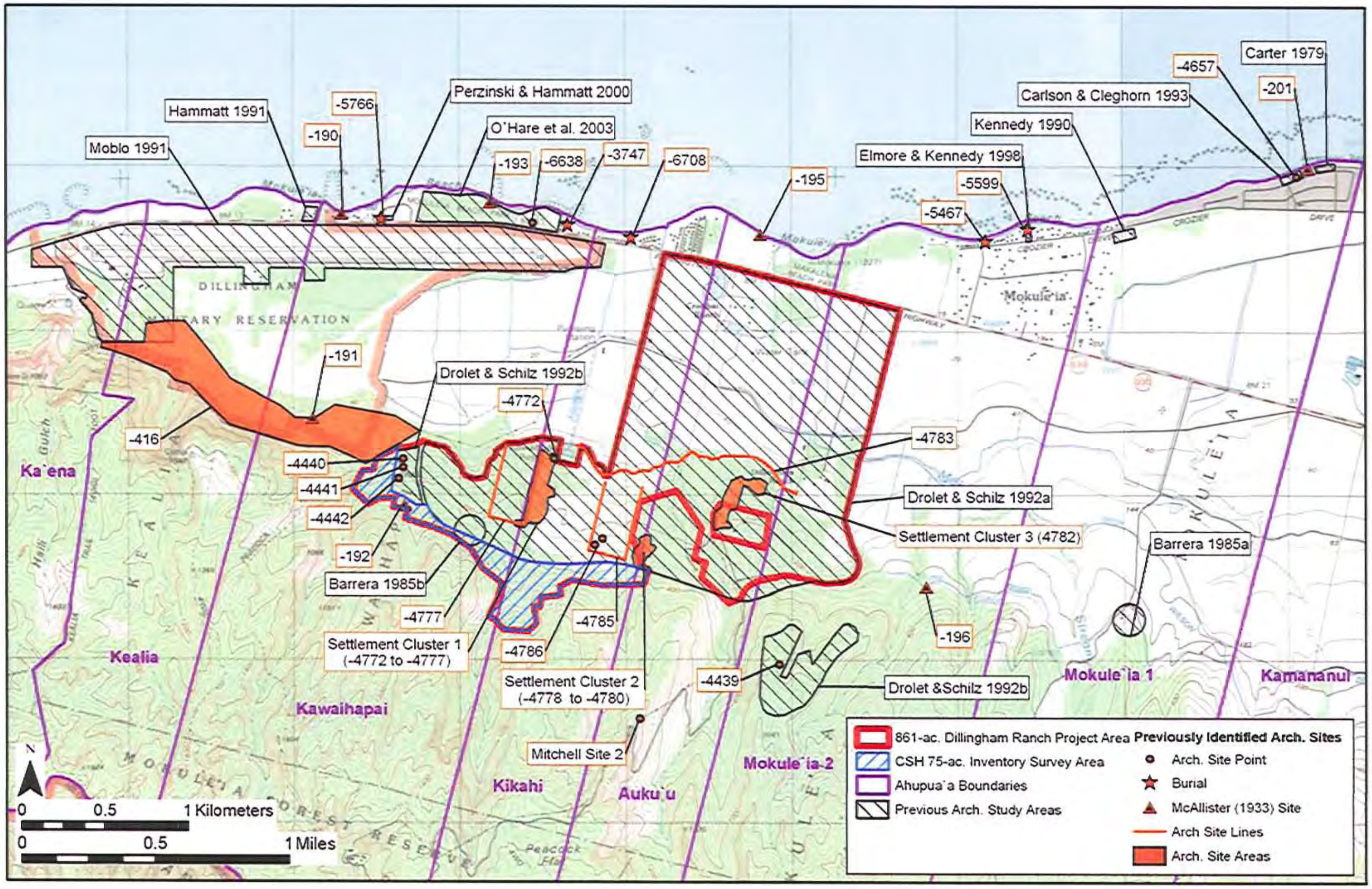


Figure 13. Locations of previous archaeological studies and identified archaeological sites in the vicinity of the 861-acre Dillingham Ranch project area

Table 3. Previous Archaeological Studies in the Vicinity of the 861-acre Dillingham Ranch Project Area

REFERENCE	LOCATION	SIHP # 50-80-03-	DESCRIPTION AND RESULTS
Thrum 1907	Kawaihāpai	191	**Heiau Documentation**: Thrum listed one *heiau* in Kawaihāpai, Kawailoa *Heiau.*
McAllister 1933	Kawaihāpai	190, 191, 192, 193	**Island-Wide Survey**: McAllister recorded four sites in Kawaihāpai: Site 190, Pu'u o Hekili *ko'a*; Site 191, Kawailoa *Heiau*; Site 192, Hidden Waters natural springs; Site 193, Kuakea *ko'a*
McAllister 1933	Mokulē'ia	194, 195, 196, 201	**Island-Wide Survey**: McAllister recorded four sites in Mokulē'ia: Site 194, Poloaiae Heiau; Site 195 Kōlea *ko'a*; Site 196, village in Mokulē'ia; Site 201, Keauau *ko'a*
Handy 1940	Keālia and Kawaihāpai	416	**Ethnographic Study**: Handy noted agricultural terraces in the lowlands of Kawaihāpai, extending into Keālia.
Rosendahl 1977 Yoshinaga 1977	Dillingham Military Reservation, Keālia and Kawaihāpai Mokulē'ia Army Beach, Keālia and Kawaihāpai	416	**Archaeological Survey and Inventory of Sites** in the Dillingham Military Reservation: Sixty-five acres (10%) of the airfield were surveyed. SIHP # 50-80-03-416, the Keālia-Kawaihāpai Complex of agricultural terraces, first noted by Handy (1940), was relocated. A search was made for McAllister's Site 191 (Kawailoa *Heiau*), but it could not be found. Rosendahl concluded that it was probably outside of the installation boundary. Rosendahl mentioned that the Hauone *ko'a*, described by McAllister as *makai* of Ulehule *Heiau* (Site 189), may once have been in the military reservation, but that McAllister stated that it been destroyed prior to 1930. **Archaeological Survey and Inventory of Sites** at the Mokulē'ia Army Beach: No sites were recorded in this area.
Carter 1979	Oceanside Park Development, Mokulē'ia		**Archeological Reconnaissance Survey**: No surface features were noted in this coastal parcel.
Barrera 1985a	Mokulē'ia I (II) Well Location, Mokulē'ia		**Archaeological Survey**: No archaeological or historical features were recorded at this inland area.
Barrera 1985b	Kawaihāpai Well Location, Kawaihāpai		**Archaeological Survey**: No archaeological or historical features were recorded at this inland area.

REFERENCE	LOCATION	SIHP # 50-80-03-	DESCRIPTION AND RESULTS
Barrera 1986	Dillingham Ranch Property, Kawaihāpai and Mokulē'ia	4439, 4785	**Archaeological Reconnaissance Survey**: Two sites were recorded within the Dillingham Ranch Property; a wall south of Dillingham Ranch and a paddock wall southeast of Kawaihāpai Reservoir. These sites were relocated during the ERCE survey (Drolet and Schilz 1992a; Drolet and Schilz 1992b) and designated SIHP # 50-80-03-4439 and -4785, respectively.
Bath and Pietrusewsky 1987 Pietrusewsky 1988	Camp Mokulē'ia, Kawaihāpai	3747	**Inadvertent Find of Human Remains:** Human bones were disturbed during the excavation of a boathouse at Camp Mokulē'ia. Osteological analysis by Michael Pietrusewsky identified 13 adults and 8 sub-adults from the recovered remains. The site location was designated SIHP # 50-80-03-3747.
Kennedy 1987	Dillingham Ranch Property, Kawaihāpai and Mokulē'ia	190-196, 4785, 4786	**Archaeological Literature Review and Reconnaissance Survey**: The report presented an inventory of previously identified sites known within the 2,800-acre Dillingham Ranch property, including sites located by McAllister (1933) and Barrera (1986). The reconnaissance survey relocated the stone wall southeast of the Kawaihāpai Reservoir previously identified by Barrera (1986). In the vicinity of the wall, Kennedy (1987) noted the presence of two platforms which he thought may be *heiau* structures. These sites were relocated during the ERCE survey (Drolet and Schilz 1992a) and designated SIHP # 50-80-03-4785 and -4786, respectively.
Mitchell 1987	Dillingham Ranch Property, Kawaihāpai and Mokulē'ia	416, 4439, 4772 to 4777, 4785, 4786	**Archaeological Reconnaissance Survey:** Made on horseback within the proposed development area within the Dillingham Ranch property. Site 1 was a rock wall along a ridge south of Dillingham Ranch, previously identified by Barrera (1986) and later relocated by Drolet and Schilz (1992b) and designated SIHP # 50-80-03-4439. Site 2 was a wall, possibly also a WWII construction. Site 3 was a large stone wall enclosure and two interior platforms, previously identified by Barrera (1986) and Kennedy (1987) and later relocated by Drolet and Schilz (1992a) and designated SIHP # 50-80-03-4785 and -4786. Site 4 referred to McAllister (1933) Site 192, Hidden Waters. Site 5, not seen by the author, was described to him as a long wall with many rock structures, later relocated by Drolet and Schilz (1992a) and designated Settlement Cluster 1 (SIHP # 50-80-03-4772 to -4777). Site 6, also not personally seen, was described as a cluster of rock terraces, likely referring to terracing originally described by Handy (1940) and designated SIHP # 50-80-03-416 by Rosendahl (1977).
Kennedy 1990	Lot 2C, Crozier Drive, Mokulē'ia		**Subsurface Testing**: Seven trenches were excavated in a property (TMK 6-8-06:15) which the owner wished to mine. No cultural remains were found in the trenches.

REFERENCE	LOCATION	SIHP # 50-80-03-	DESCRIPTION AND RESULTS
Drolet and Schiltz 1992a	Dillingham Ranch Property Kawaihāpai and Mokulē'ia	194, 4772 to 4786	**Archaeological Inventory Survey**: The archaeologists surveyed an 840-acre parcel, which extended from Farrington Highway to elevations of approximately 320 ft AMSL. They recorded 15 sites with 40 component features. The majority of the sites were located in three "settlement clusters". The clusters were agricultural fields with associated habitations. One site, Site 4772, may be Poloaiea Heiau, originally designated Site 194 by McAllister (1933).
Drolet and Schiltz 1992b	Dillingham Ranch Property Kawaihāpai and Mokulē'ia	4439 to 4442	**Addendum Archaeological Inventory Survey**: Survey of an additional 53-acres of the Dillingham Ranch property, which documented four sites. SIHP # 50-80-03-4439 is an approximately 300 m long stone wall oriented in a north-south direction along a ridge, previously identified by Barrera (1986) and later designated Site 1 by Mitchell (1987). SIHP # 50-80-03-4440 consisted of a remnant stone wall, disturbed by stream cuts. SIHP # 50-80-03-4441 consisted of an approximately 200 m long stone wall and associated barbed wire fence, interpreted to be a historic cattle wall. SIHP # 50-80-03-4442 consisted of a terrace, with damage due to erosion and stream cuts
Hammatt 1991	Keālia coastal subdivision		**Subsurface Testing**: Hand and Backhoe trenches were excavated around two 1940s houses. Boulder fill was found to 110 cm (centimeters) below surface. No cultural remains were found.
Moblo 1991	Dillingham Airfield, Ka'ena, Keālia, Kawaihāpai, and Mokulē'ia	416	**Literature Review and Archaeological Reconnaissance Survey**: No newly identified pre-contact sites were found, but several sugar plantation features, such as walls and irrigation channels were recorded in the southwest corner of the project area. The author also noted several large depression areas and marshes, which could have been former taro or rice terraces. Moblo also noted that a few rock features on the southwest corner of the project area could be an extension of Site –416.
Carlson and Cleghorn 1993	'Āweoweo Beach Park, Mokulē'ia	50-80-04-4657	**Archaeological Inventory Survey**: One site (SIHP # 50-80-04-4657), a subsurface cultural deposit 42 cm below surface was identified. A small amount of midden, one basalt flake and a charcoal sample were recovered. The charcoal was dated to A. D. 1440-1700.
Collins 1996	Mokulē'ia Beach, Mokulē'ia		**Inadvertent Find of Human Remains**: The remains were of a child 2-4 years old, found on Mokulē'ia Beach. The burial was not given a site number, nor was it located on any map.

REFERENCE	LOCATION	SIHP # 50-80-03-	DESCRIPTION AND RESULTS
Kapeliela 1996	68-711 Crozier Drive, Mokulē'ia	5467	**Inadvertent Find of Human Remains:** Two cranial fragments were found in a sand berm subject to heavy erosion from high surf. The SHPD surveyed the area (TMK 6-8-04:2), but could not find any other remains. The location of the cranial fragments was designated SIHP # 50-80-03-5467.
Kapeliela 1998 Elmore and Kennedy 1998 Pietrusewsky 1998	63-639 Crozier Drive, Mokulē'ia 2nd	5599	**Inadvertent Find of Human Remains:** Human remains were found at 68-639 Crozier Drive (TMK 6-8-04:2) during the excavation of a house foundation and reported to the SHPD (Kapeliela 1998). Additional remains in three locations were found, and the SHPD decided that a burial treatment plan needed to be implemented (Elmore and Kennedy 1998). Seven individuals were eventually identified (Pietrusewsky 1998), all of probable Hawaiian ancestry. Glass trade beads were found with one burial, suggesting an early post-contact date. The remaining six burials are probably pre-contact. The area was designated SIHP # 50-80-03-5599.
Dagher 1999 Perzinski and Hammatt 2000	Mokulē'ia Beach Park, Kawaihāpai	5766	**Inadvertent Find of Human Remains:** Human remains of an adult of probable Hawaiian ancestry were found during the installation of a leach field at Mokulē'ia Beach Park (TMK: 6-8-02:01) and designated SIHP # 50-80-03-5766. The burial was initially inspected by Cathleen Dagher (1999), staff archaeologist for the SHPD, and later reported in full by Perzinski and Hammatt (2000). A possible posthole was the only other cultural remain noted in the test trench walls.
O'Hare et al. 2003	Mokulē'ia Beach Park, Kawaihāpai	6638	**Archaeological Inventory Survey:** One site (SIHP # 50-80-03-6638), a subsurface cultural layer, was identified. Subsurface features included fire pits and post holes. One basalt flake and charcoal samples were recovered. The charcoal from a fire pit was dated to A. D. 1280-1440.
Gregg and Kennedy 2004	68-681 Farrington Hwy., Mokulē'ia	6708	**Inadvertent Find of Human Remains:** Partial remains of one individual were encountered during excavations for the repair of a seawall at 68-681 Farrington Hwy., Mokulē'ia (TMK 6-8-10:18), and designated SIHP # 50-80-03-6708. No *in situ* remains were recovered. Based on the burial location in a sand matrix, the remains were suggested to be of a pre-contact native Hawaiian individual.

McAllister (1933) also identified four sites in the foothills above the coastal plain. Site 191 is Kawailoa Heiau, indicated to be located in the area *mauka* (south) of the present Dillingham Airfield, west of the 861-acre Dillingham Ranch project area. The following description of the site was provided:

> Only a portion of two terraces remains. The upper terrace is 66 feet long and 4 feet high, and is excellently paved with small stones a few inches in size. The southwest limits can not be discerned. On the east end is a wall 1.5 feet high which can be followed for about 10 feet. The lower terrace was 25 feet wide with a facing 2 feet high, which can only be traced a short distance. The houses (kahua hale) in which the kahunas lived were known as "Paweo", according to Hookala. This is undoubtedly the site referred to by Thrum [1909] as Paweu, "A small heiau 58 by 65 feet at the base of the hill: badly damaged by freshets." [McAllister 1933, cited in Sterling and Summers 1978:99-100]

Site 196 was identified by McAllister (1933) as a village site, indicated to be located east of the 861-acre Dillingham Ranch project area. The following description was provided:

> In the valley near the mountain side of the Greenfield house was once evidently a large Hawaiian settlement. Old coconut palms and the dead trunks of others, portions of house sites, isolated sections of terracing, can still be found, despite the inroads of roaming cattle. Water freshets have also obliterated many remains. These sites are thought to have furnished the stones for the numerous walls, probably of later construction, on the hillside and in the valley. [McAllister 1933, cited in Sterling and Summers 1978:101]

Two of McAllister's sites were indicated to be located within the 861-acre Dillingham Ranch project area. Site 192 consists of "hidden waters," or natural freshwater springs, located in the hills of Kawaihāpai. The following description was provided:

> These are the four hidden waters upon which Hiiaka called when she was refused water by the old inhabitants. Their names, as given by Hookala, are Ulunui, Koheiki, Ulehulu, and Waiakaaiea. Farther toward Kaena Point is another water known as Kawaikumuole, which is a conjunction of Kanaloa and Waihuna a Kaalai. Another hidden water, which Hookala says is mentioned in the Hiiaka chant is Kuilaau o Kealia, but he does not know its location. [McAllister 1933, cited in Sterling and Summers 1978:100]

The general location of Site 192 was provided by Sterling and Summers (1978: Waialua District Map) based on notes taken by McAllister (1933), placing it in the southwestern portion of the 861-acre Dillingham Ranch project area. This location is consistent with traditional accounts that describe the springs of Kawaihāpai up in the hills at the base of cliffs (see Section 3.1: Traditional and Historical Background).

Also indicated to be located within the 861-acre Dillingham Ranch project area is McAllister's (1933) Site 194, Poloaiae Heiau. The site, which was noted by McAllister to have been destroyed, was described as follows:

> On the Kaena side of Dillingham's ranch, near the plantation reservoir in the western part of Mokuleia, is said to be an old heiau site. The straggling stone wall near a group of rather large rocks is covered with a dense growth of lantana. It is doubtful that this site was ever of importance, as it suggests a house site rather than the location of a heiau. Poloaiae is the name given me of a former Mokuleia heiau about which nothing else is known. [McAllister 1933, cited in Sterling and Summers 1978:101]

3.2.1 Archaeological Sites Identified in the Vicinity of the 861-acre Dillingham Ranch Project Area

3.2.1.1 SIHP # 50-80-03-416, Keālia-Kawaihāpai Complex

In an ethnographic survey of Hawaiian farming, Handy noted in 1940 that there were agricultural terraces, possibly for taro, in the lowlands of Kawaihāpai extending into Keālia. Handy describes the features:

> There is a sizable area of terraces in the lowlands (now surrounded by sugar cane), watered by Kawaihapai Stream. These terraces have evidently been lying fallow for some time, though several were being plowed for rice or taro in the summer of 1935. At the foot of the cliffs, watered by a stream the name of which was not learned, are several small terraces in which taro is grown by David Keaau. He says that taro cannot be grown in the lowlands, as salt water seeps in and sometimes flows in, mingling with the fresh water in the terraces and spoiling the taro.
>
> The large area of lowland terraces between the cliff and the elevated coral, though mostly in Kawaihapai, extends a short way into Kealia. Otherwise this small *ahupua'a* offered little opportunity for cultivation, unless for sweet potatoes (Handy 1940).

These terraces were given the designation of SIHP # 50-80-03-416, and later listed as destroyed. However, the site was relocated during a 1977 survey of the Dillingham Military Reservation by the Bishop Museum (Rosendahl 1977) and the extent of these terraces was mapped. The terraces are located 2,250-4,500 ft inland, on the *mauka* edge of the military reservation, at elevations of 80-140 ft AMSL. The site was described as an "extensive complex of agricultural and associated occupation features spread over virtually entire rocky sloping area between flat land of airfield and sheer cliffs" (Rosendahl 1977:1-25). In 1987, during a day-long survey on horseback of portions of the Dillingham Ranch property, Mitchell (1987) was informed that there was "a great deal of rock terracing" in the area along the western end of the Dillingham Ranch property, which he designated as Site 6. Mitchell did not locate the site, but based on informant information, placed it in the vicinity of SIHP # 50-80-03-416 and was likely referring to components of SIHP # 50-80-03-416. An additional portion of SIHP # 50-80-03-416 was again identified in a later archaeological survey of the Dillingham Airfield (Moblo 1991).

3.2.1.2 SIHP # 50-80-04-4657, Cultural Deposit

In 1993, archaeological subsurface testing at the proposed ʻĀweoweo Beach Park at the eastern end of Mokulēʻia *Ahupuaʻa* was conducted by Carlson and Cleghorn (1993). A cultural deposit was encountered 42 cm below the surface, from which a small amount of midden and one basalt flake were recovered. Charcoal collected from the cultural deposit yielded a radiocarbon date range of AD 1440-1700. The site was designated SIHP # 50-80-04-4657 and was interpreted to be a pre-contact temporary habitation deposit. The cultural deposit was also suggested to be associated with marine exploitation, based on the midden composition, and the close proximity to the location of McAllister's Site 201, the Keauau fishing shrine.

3.2.1.3 SIHP # 50-80-04-6638, Cultural Deposit

In 2003, an archaeological inventory survey including a program of subsurface testing was conducted for the proposed expansion of Mokulēʻia Beach Park (OʻHare et al. 2003). No surface archaeological features were identified. Seventeen shovel tests were excavated along the beach bank and thirty-two backhoe trenches were excavated within the project area. A grayish cultural layer (SIHP # 50-80-04-6638) exposed on the beach bank was also found in five trenches on the east side of the project area. In two trenches, the cultural layer was also associated with five subsurface features, including two fire pits, two possible postholes, and a feature of undetermined function. Charcoal from one fire pit was dated to A.D. 1280-1440.

3.2.1.4 SIHP #s 50-80-03-3747, -5467, -5599, -5766, and -6708, Inadvertent Burial Finds

In 1987, human remains were inadvertently uncovered during the excavation of a boathouse at Camp Mokulēʻia, east of Mokulēʻia Beach Park in Kawaihāpai Ahupuaʻa (Bath and Pietrusewsky 1987). Osteological analysis by Michael Pietrusewsky identified 13 adults and 8 sub-adults from the recovered remains. The location of the remains was designated SIHP # 50-80-03-3747.

In 1996, an inadvertent burial discovery consisting of a sub-adult human mandible portion was recovered from Mokulēʻia Beach (Collins 1996). Upon examination, the remains were determined to be not recent, and therefore considered pre-contact remains. The exact location of the burial was not given, nor was the burial location assigned a state site number.

In 1996, an inadvertent burial discovery consisting of two human cranium fragments, was recovered from the water's edge in the beach area fronting 68-711 Crozier Drive, at the east end of Mokulēʻia Ahupuaʻa. No other bones were recovered, though additional remains were believed to have been washed away by heavy surf. The burial location was designated SIHP # 50-80-03-5467 (Kapeliela 1996).

In 1998, seven inadvertent burial finds were encountered at 68-637 Crozier Drive in Mokulēʻia Ahupuaʻa by a construction crew during excavations for a house foundation (Kapeliela 1998; Elmore and Kennedy 1998; Pietrusewsky 1998). The burials were found at a depth of approximately 4.5 to 5 feet. Based on osteological features and the burial location, the remains were determined to be of Hawaiian ethnicity. Six of the burials were deemed pre-contact, while the seventh burial was more likely to be from the early post-contact period based on the presence of western trade items. The burial site was designated SIHP # 50-80-03-5599.

In 1999, human remains were inadvertently discovered during excavations associated with the installation of a leach field at Mokulē'ia Beach Park, Kawaihāpai Ahupua'a (Dagher 1999; Perzinski and Hammatt 2000). The remains were determined to be from a single individual, likely native Hawaiian. Following the recovery of the remains, archaeological monitoring was conducted for the remaining leach field excavations. A possible posthole was the only other cultural feature noted in the trench walls. The burial location was designated SIHP # 50-80-03-5766.

In 2004, human remains were inadvertently encountered during excavations associated with the repair of a seawall at 68-681 Farrington Highway, in Mokulē'ia Ahupua'a (Gregg and Kennedy 2004). The partial set of fragmented human remains was determined to likely have been previously disturbed prior to the repair of the seawall. Based on the location of the remains, it was suggested to be of pre-contact, native Hawaiian origin. The burial site was designated SIHP # 50-80-03-6708.

3.2.2 Archaeological Studies within the Dillingham Ranch Property

3.2.2.1 Archaeological Reconnaissance Surveys

In addition to the two archaeological sites identified by McAllister (1933) as being located within the Dillingham Ranch property (i.e. Sites 192, Hidden Waters and 194, Poloaiae Heiau), several sites have been identified in more recent archaeological studies associated with the planned development of portions of the property (Barrera 1986; Mitchell 1987; Kennedy 1987; Drolet and Schilz 1992a; Drolet and Schilz 1992b).

The first modern archaeological reconnaissance survey of the approximately 2,800-acre Dillingham Ranch property was conducted by Barrera in 1986. The brief two-day reconnaissance identified two archaeological sites within the property. These included a stone wall on the end of the ridge south of the Dillingham Ranch, and another stone wall southeast of the Kawaihāpai Reservoir, described to be a portion of a historic paddock (Barrera 1986). Barrera did not provide a site location map. However, based on the general location information and brief site descriptions, it is believed that these two sites were later relocated in subsequent archaeological studies within the Dillingham Ranch property and are discussed further below.

The following year, Kennedy (1987) reviewed previous archaeological studies within and in the vicinity of the Dillingham Ranch, and conducted another brief two-day reconnaissance of the Dillingham Ranch property. The study was conducted to assess the archaeological potential within the property and generate recommendations for future archaeological work. The reconnaissance survey relocated the stone wall southeast of the Kawaihāpai Reservoir previously identified by Barrera (1986). In the vicinity of the wall, Kennedy (1987) noted the presence of two platforms which he thought may be *heiau* structures. The wall and platforms were later relocated by subsequent archaeological studies within the Dillingham Ranch property and are discussed further below. Based on the literature review and reconnaissance survey, Kennedy (1987) indicated the archaeological potential of the Dillingham Ranch property was high and recommended intensive survey and documentation of sites, a program of subsurface testing, and historic background research be conducted prior to any development of the property.

In 1987, Mitchell (1987) conducted an additional archaeological reconnaissance of portions of the Dillingham Ranch property that were then proposed for golf course and residential development. The reconnaissance was made on horseback and was led by local informants who directed Mitchell to archaeological sites they knew of within the Dillingham Ranch property. A total of six site areas were documented. Site 1 consisted of a stone wall situated along a ridge south of the Dillingham Ranch. This wall was first referred to by Barrera (1986) and later relocated by subsequent archaeological studies. Site 2 consisted of a large wall structure, indicated to be a possible WWII military construction, located at approximately 1100 ft elevation. Site 2 is indicated to be *mauka* (south) of subsequent proposed development areas and has not been relocated since. Site 3 included a large, rectangular wall structure and platform structures within the enclosure, located southeast of the Kawaihāpai Reservoir. These sites were previously identified by both Barrera (1986) and Kennedy (1987) and later relocated by subsequent archaeological studies. Site 4 refers to McAllister (1933) Site 192, the hidden waters springs, which Mitchell indicates "were still producing water for the reservoir" (Mitchell 1987:3). Site 5, based solely on informant information, included a large wall and many rock structures located south of the Kawaihāpai Reservoir. Site 5 was later relocated by subsequent archaeological studies. Site 6, also based solely on informant information, included "a great deal of rock terracing" located near the base of the cliffs at the western end of the Dillingham Ranch Property (Mitchell 1987:4). The informants were likely referring to the terracing located *mauka* (south) of the Dillingham Airfield, originally described by Handy (1940) later designated SIHP # 50-80-03-416 by Rosendahl (1977).

3.2.2.2 Archaeological Inventory Survey by Drolet and Schilz (1992)

In 1992, Drolet and Schilz (1992a) conducted and archaeological inventory survey of an approximately 840-acre portion of the Dillingham Ranch property proposed for golf course and residential development. The inventory survey consisted of a systematic pedestrian survey of the entire project area and a program of subsurface testing with a backhoe within the coastal plain portion of the project area. A total of twenty-eight trenches were excavated throughout the coastal testing area. No cultural material was recovered from the test excavations.

A total of 15 archaeological sites with 40 component features were identified through the pedestrian survey. Eleven (11) of the 15 sites were located within three site complexes described by Drolet and Schilz (1992a) as "settlement clusters." These settlement clusters are generally located in the foothills above the coastal plain to the base of the coastal cliffs. The sites are situated along gently sloping upland terraces adjacent to natural stream drainages, and consist of agricultural field systems with associated habitation structures, constructed during the pre-contact or early post-contact period. It was also noted that the settlement clusters were likely much more extensive than what was documented, as significant land alteration by ranching and military activities was observed in the vicinity of the sites. Drolet and Schilz (1992a) suggested the principal villages were located along the coastal plain, though ranching and plantation agriculture had removed any evidence of this. No archaeological sites were identified in the coastal plain portion of the project area.

Settlement Cluster 1, located southeast of the Kawaihāpai Reservoir, includes six historic properties (SIHP #s 50-80-03-4772 to –4777) comprised of 19 individual features. Settlement Cluster 1 measures approximately 470 m N/S by 150 m E/W, covering approximately 13 acres.

Settlement Cluster 1 was previously referred to by Mitchell (1987) as Site 5. The primary feature of Settlement Cluster 1 is SIHP # 50-80-03-4772, a large rectangular enclosure located near the southwest corner of the Kawaihāpai Reservoir property. This enclosure was interpreted to be Poloaiae Heiau, documented by McAllister (1933) as Site 194. SIHP #s 50-80-03-4773 to -4776 consist of enclosures, platforms, terraces, walls, alignments, and mounds located *mauka* (south) of the *heiau*. SIHP # 50-80-03-4777 is a long north-south (*mauka-makai*) oriented stone wall. The wall was interpreted to represent an *ahupua'a* boundary marker, dividing Mokulē'ia and Kawaihāpai *ahupuaa*. However, recent archaeological investigations associated with the current study, as well as a Preservation Plan for sites within the 861-acre Dillingham Ranch project area (Tulchin and Hammatt in progress), have determined that the wall is actually the eastern portion of a historic paddock, similar to SIHP # 50-80-03-4785 identified by Drolet and Schilz (1992a) and described below. The two historic paddocks are also indicated on historic maps of the area (see Figure 9 and Figure 10 above). The existence and location of the southern and western walls of the paddock were confirmed during fieldwork in October 2006. Apparently Drolet and Schilz (1992a) did not locate the southern and western walls of the paddock or note the location of the paddock on historic maps.

Settlement Cluster 2, located approximately 600 m southeast of Settlement Cluster 1, includes three historic properties (SIHP #s 50-80-03-4778 to –4780) comprised of 17+ individual features. Settlement Cluster 2 measures approximately 190 m N/S by 135 m E/W, covering approximately 4 acres. SIHP #s 50-80-03-4778 to –4780 consist of rectangular enclosures, terraces and platforms. Damage to the sites due to military road construction was noted.

Settlement Cluster 3, located approximately 500 m northeast of Settlement Cluster 2, includes one historic property (SIHP # 50-80-03-4782) comprised of 6 individual features. Settlement Cluster 3 measures approximately 300 m N/S by 290 m E/W, covering approximately 9 acres. SIHP # 50-80-03-4782 consists of a network of large rectangular enclosures bordered by *kuaiwi*-type field walls, mounds, terraces, and pavings.

Drolet and Schilz (1992a) also identified four sites located outside the boundaries of the three designated settlement clusters. SIHP # 50-80-03-4783 consists of a plantation-era irrigation ditch and associated stone wall and clearing mounds. SIHP 50-80-03-4784 is an earthen ditch, possibly an *'auwai,* a traditional Hawaiian ditch used to irrigate crops like taro. SIHP # 50-80-03-4785 is a large stone walled enclosure interpreted to be a historic paddock. The paddock, along with a second located approximately 450 m to the west, is indicated on historic maps of the area (see Figure 9 and Figure 10 above). SIHP # 50-80-03-4786, located within the SIHP # 50-80-03-4785 paddock, is a large, well-constructed stone platform, interpreted to be a *heiau* structure. SIHP #s 50-80-03-4785 and -4786 were originally referred to by Barrera (1986), Kennedy (1987), and later designated Site 3 by Mitchell (1987). Kennedy (1987) and Mitchell (1987) indicated the presence of at least two platforms within the enclosure, which was confirmed during recent archaeological investigations associated with the current study, as well as a Preservation Plan for sites within the 861-acre Dillingham Ranch project area (Tulchin and Hammatt in progress). Apparently Drolet and Schilz (1992a) did not locate the second platform, nor did they note the existence of two platforms based on the previous archaeological work within the project area.

Subsequent to the archaeological inventory survey of the approximately 840-acre portion of the Dillingham Ranch property, Drolet and Schliz (1992b) surveyed an additional approximately 53-acres, documented in an addendum inventory survey report. The additional lands consisted of an approximately 42-acre parcel located south of the Dillingham house, *mauka* (upslope) of the coastal cliffs, and an approximately 11-acre parcel located west of the western extent of the original survey area. One site, SIHP # 50-80-03-4439 was identified in the *mauka* parcel. SIHP # 50-80-03-4439 is an approximately 300 m long stone wall oriented in a north-south direction along a ridge. This wall was previously identified by Barrera (1986) and later designated Site 1 by Mitchell (1987). Three additional sites were located in the western parcel. SIHP # 50-80-03-4440 consisted of a remnant stone wall, disturbed by stream cuts. SIHP # 50-80-03-4441 consisted of an approximately 200 m long stone wall and associated barbed wire fence, interpreted to be a historic cattle wall. SIHP # 50-80-03-4442 consisted of a terrace, with damage due to erosion and stream cuts.

3.3 Settlement Pattern and Predictive Model

Little research has been conducted into the settlement patterns in Kawaihāpai or Mokulē'ia ahupua'a. However, extensive research has been conducted in the Anahulu Valley (Kirch 1982, 1985), which is located approximately 10 km to the east of Mokulē'ia. In Anahulu Valley, in the *ahupua'a* of Kawailoa in the eastern portion of the Waialua District, archaeological research has led to the construction of a timeline to chronicle the changes in population density, settlement patterns, agricultural intensification, and the evolution of political complexity. The pre-contact history of the Hawaiian Islands has been divided into four periods: Colonization, Developmental, Expansion, and Protohistoric. The early Post-Contact Period has been divided into three periods: Conquest, Sandalwood, and Whaling (Kirch 1992:9-17).

3.3.1 Pre-Contact Period

Colonization (A.D. 300-600) first took place in the Hawaiian Islands in well-watered areas with arable land, such as the windward coast of O'ahu from Kahana Valley to Waimānalo. Habitations were clustered along the coast and in fertile river valleys. During the Developmental Period (A.D. 600-1100), habitations and agriculture expanded into more inland areas of the river valleys and into the more favored areas of the leeward coast. In the Expansion Period (A.D. 1100-1650), there was a major expansion into all leeward areas for habitation and agriculture into even the most marginal agricultural zones. The population increased dramatically during this period, and there was an intensification in both wetland and dryland agriculture. Changes in the political system were reflected in the adaptation of the *ahupua'a* system of land control, and the beginning of intra- and inter-island warfare for the control of resources. In the Proto-historic Period (A.D. 1650-1795), all of the island of O'ahu was occupied and utilized, even arid areas like Ka'ena. In this period, many large fishponds were built, ceremonial sites become larger and more numerous, and permanent habitations along the coast and in the uplands increased in size. The increase in population led to an intensification of irrigation systems in areas upland of former fields (Kirch 1992).

3.3.2 Post-Contact Period

The post-Contact period began when the islands were first visited by Captain James Cook in A.D. 1778. The next two decades, called the Conquest Period (A.D. 1778-1812), were marked by inter-island wars, culminating in the consolidation of power by Kamehameha I after his victory in O'ahu in 1795. In 1804, the Hawai'i Island chiefs who supported Kamehameha occupied O'ahu, taking land from the former ruling chiefs. In 1812, the Hawaiian Islands were completely unified when Kaumuali'i, the chief of Kaua'i, surrendered to Kamehameha. During the Conquest Period, trade developed between the Hawaiians and foreigners, beginning with the provisioning of ships involved in the Northwest-Canton, China trade, where furs from the Northwest were sold in China for luxury goods. In the following Sandalwood Period (A.D. 1812-1830), chiefs made enormous demands upon the people to gather sandalwood so they could buy Western goods. This period ended in the exhaustion of the sandalwood for trade, and the debt of the *ali'i*. During the Whaling Period, (A.D. 1830-1848), trade switched to provisioning whaling ships. This period ends with the *Māhele*, which reaportioned the land (Kirch 1992).

3.3.3 Predictive Model for Kawaihāpai, and Mokulē'ia

On modern maps, there are fifteen *ahupua'a* in the *moku* (district) of Waialua, extending from Ka'ena on the west end to Waimea (which was only annexed to the district in 1887) on the east end. In claims to the Land Commission, only six *ahupua'a* are mentioned: Ka'ena, Kawaihāpai, Mokulē'ia, Kamananui, Pa'ala'a and Kawailoa. Some of the smaller *ahupua'a* were probably considered segments of the more traditional *ahupua'a* (Sahlins 1992:18). A typical economic pattern for *moku* on O'ahu was to have one or more lands rich in all types of resources, with other outlying, poorer lands. In Waialua, this pattern is described:

> Ka'ena on the extreme west and the area of Kapaeloa at the eastern border was occupied by small groups of people who lived mainly by fishing, supplemented by sweet potato cultivation in sandy coastal soils. Ka'ena has been judged 'probably the poorest *ahupua'a* in land resources on O'ahu, but its seaside faced out onto very rich deep-sea fishing grounds' (Handy and Handy 1972:467). In marked contrast were the economies of the three *ahupua'a* at the fertile center of Waialua: Kamananui, Pa'ala'a, and Kawailoa (Sahlins 1992:20).

In Waialua, habitations were centered around Kaiaka and Waialua Bays, and on the inland floodplains, where densely packed irrigated fields of taro were cultivated along the four major streams. The population of these *ahupua'a* has been estimated at 6,000 to 8,000 people before Western Contact (Sahlins 1992:20).

Mokulē'ia is described by Handy and Handy:

> Beyond Waialua Bay the coast juts directly westward at a sharp angle from the northerly shoreline, and the land narrows between the sea and the northwest end of the Wai'anae range. Essentially this was sweet-potato county, but there were at least two extensive *lo'i* areas in the land strip named Mokulē'ia near the sea. One of these was watered by underground flow originating in a gulch. The other received its water from Makaleha Stream, in whose valley we found an abundance of wild taro in 1935. Makaleha was once famous for its sweet

> potatoes, bananas and *'awa* [kava; *Piper methysticum*] (Handy and Handy 1972: 467).

In an interview with Beatrice Krauss, she described the probable settlement of Mokulē'ia and the surrounding areas:

> Let's say there was a stream here, the fishing village would have been established here [near the mouth of the stream]. The taro would have been grown in the overflow at the mouth of the stream because taro is a marsh plant and that's the way it grows naturally. So, with a small village and a small population they could have grown enough in that marshy land. When it became overpopulated they could have moved back into the valley. At first they would have moved up along the streams and cleared by the streams—they would have done it also in the overflow—and they would have made little lo'i next to it. Then as the population increased they would have had to go across the whole valley floor and that's when they would have made their terraces and dug out their lo'i and connected them all from the stream or spring (Krauss interview in Rosendahl 1977 Appendix B:2).

Early Colonization (A.D. 300-600) would have favored the well-watered areas of the windward coast of O'ahu, so it is unlikely that any habitation or agricultural sites from this period would be found in the district of Waialua.

There is little archaeological evidence for occupation in the Development Period (A.D. 600-1100) in upland Waialua to date, but Kirch and Sahlins (Kirch 1992:14) agree that it would be likely that the eastern section of Waialua in Anahulu, Helemano and Kamananui Valleys would have been utilized early in this period. At 'Uko'a Pond (Athens and Ward 1995:121) in Kawailoa near the coast, charcoal from three cores has suggested that initial occupation of the area took place as early as A.D. 800, and definitely by A.D. 950.

In the Expansion Period (A.D. 1100-1650), habitation and agricultural areas would have extended into the dryer western Waialua, with the plains used to grow dryland crops such as sweet potatoes and the larger streams used to irrigate taro terraces. Permanent habitation would be clustered on the coast. Evidence for habitation in Waialua for this period comes not only the inland valley sites of Anahulu but also for coastal areas such as at Haleiwa State Park, where Moore et al. (1993:70) found three fire pits at a site (Site 50-80-04-4590) along the coast with dates ranging from A.D. 1399-1672 (A.D. 1448-1672, 1420-1628, and 1399-1642). McDermott et al. (2001:60) found a cultural layer at Hale'iwa Ali'i Beach Park with one date ranging from A.D. 1440-1650 and a second date from A.D. 1440-1680 (87.4%). Nearer to the Dillingham Ranch project area, a cultural deposit (SIHP # 50-80-03-6638) was found at Mokulē'ia Beach Park (O'Hare et al. 2003), which was dated to A. D. 1280-1440. During this period, the coast may have also been used for human interments.

In the Proto-Historic Period (A.D. 1650-1795), habitations would be found along the coast and in the inland agricultural areas. In this and the following post-contact Conquest period (A.D. 1778-1812), the construction of wetland agricultural features, such as taro terraces and *'auwai* (irrigation ditches) would have intensified. The Conquest period also marks the introduction of the cultivation of new crops, which were traded to visiting ships in the Sandalwood and Whaling Periods (A.D. 1812-1830; 1830-1848). In the western portion of Waialua, the greatest effect of these periods was the decline in population, from falling birth rates, high death rates, and the out-migration of young people to find better lives for themselves in the urban areas of the island. The first missionary school was established in Kawaihāpai in 1839, and the area around this school seemed to be the focus of a continuation of Hawaiian farming practices until at least 1929. In the 1840s, there were cattle in Waialua, and this time period marks the beginning of the construction of large walls to keep the cattle contained (Sahlins 1992:148). Many of these walls were probably constructed by utilizing stones from existing pre-contact features. The entire coastal plain between the shoreline and the foothills was drastically modified during the sugar cane plantation era. Remnants of pre-contact and early post-contact habitation and agricultural features remain along the foothills and in gulch areas, as documented within the 861-acre Dillingham Ranch project area by Drolet and Schilz (1992). The construction of the Mokulē'ia Airfield in 1941, and the subsequent confiscation of surrounding land in 1946, likely ended the last vestiges of traditional Hawaiian lifestyle in the area.

It is anticipated that remnants of pre-contact/early post-contact traditional Hawaiian agricultural and associated habitation features may be located within the study area. The study area generally consists of moderate to steep sloping lands dissected by multiple seasonal drainage gullies. Vertical exposed basalt cliffs are also common along the *mauka* (southern) boundary of the study area. Based on the pattern of site clustering documented by Drolet and Schilz (1992) within the *mauka* (southern) portions of the 861-acre Dillingham Ranch project area, archaeological features are likely to be concentrated along the gulch areas, where breaks in slope allow for the development of agricultural complexes which utilize water from natural stream channels. In addition, agricultural features may be located along the hillside indicated by McAllister (1933) to be the location of the Site 194 "hidden waters" freshwater springs. According to traditional and historic accounts, the water from springs was very important to the local population and was likely heavily utilized. Finally, as exposed basalt cliff areas may be located within the *mauka* (southern) portion of the study area caves or overhang areas may exist. These caves or overhangs would have the potential for usage as temporary habitation features or interment sites for human remains.

It is also likely that remnants of historic, ranch-related infrastructure are located within the study area. The Dillingham Ranch property has a long history of horse and cattle ranching in the foothill areas. Stone walls and possibly irrigation infrastructure are anticipated.

Figure 14. General view of the eastern portion of the 75-acre inventory survey area, view to southwest

Figure 15. General view of the central portion of the 75-acre inventory survey area, view to northeast

Table 4. Historic Properties Identified within the 75-acre Inventory Survey Area.

SIHP # (50-80-03)	Site Type	Features	Age	Function	Significance Criteria	Mitigation Recommendations
6884	Stone Walls	4	Historic	Ranch-Related, Cattle Barrier	D	No Further Work
6885	3 Terraces, 1 Retaining Wall	4	Pre-Contact / Early Historic	Agricultural Complex	C, D	Preservation (Avoidance and Protection)

Table 5. Historic Properties Identified Outside of the 75-acre Inventory Survey Area

SIHP # 50-80-03-	Site Type	Features	Age	Function	Significance Criteria	Mitigation Recommendations
416	1 Mound, 2 Walls, and 3 Terraces within the Survey Area Site Complex Continues to the Northwest, Outside of the Survey Area	6 +	Pre-contact / Early Historic	Agricultural / Habitation Complex	C, D	Preservation (Avoidance and Protection)
6886	3 Terraces, 3 Mounds, and 1 Retaining Wall Associated w/ McAllister Site 192: Hidden Waters	7	Pre-contact / Early Historic	Agricultural Complex	D, E	Preservation (Avoidance and Protection)
6887	Modified Overhang Shelter	1	Historic, Possible Pre-contact Usage	Temporary Habitation	D	Preservation (Avoidance and Protection)
6888	6 Mounds Associated w/ McAllister Site 192: Hidden Waters	6	Pre-contact / Early Historic	Agricultural Complex	D, E	Preservation (Avoidance and Protection)

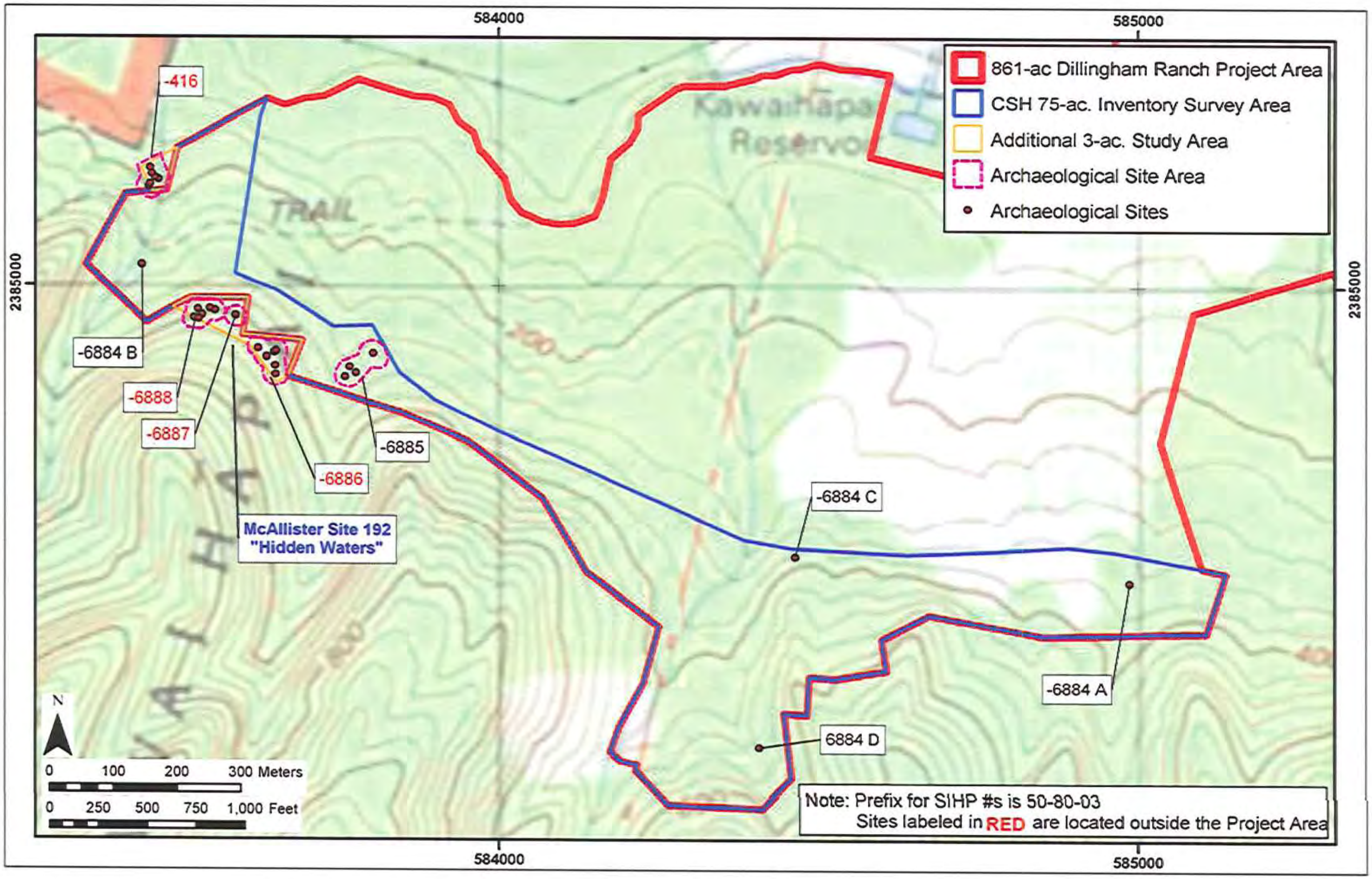


Figure 16. Portion of USGS 7.5 Minute Series Topographic Map, Ka'ena Quadrangle (1998), showing the locations of historic properties identified within the 75-acre inventory survey area and the additional 3-acre study area

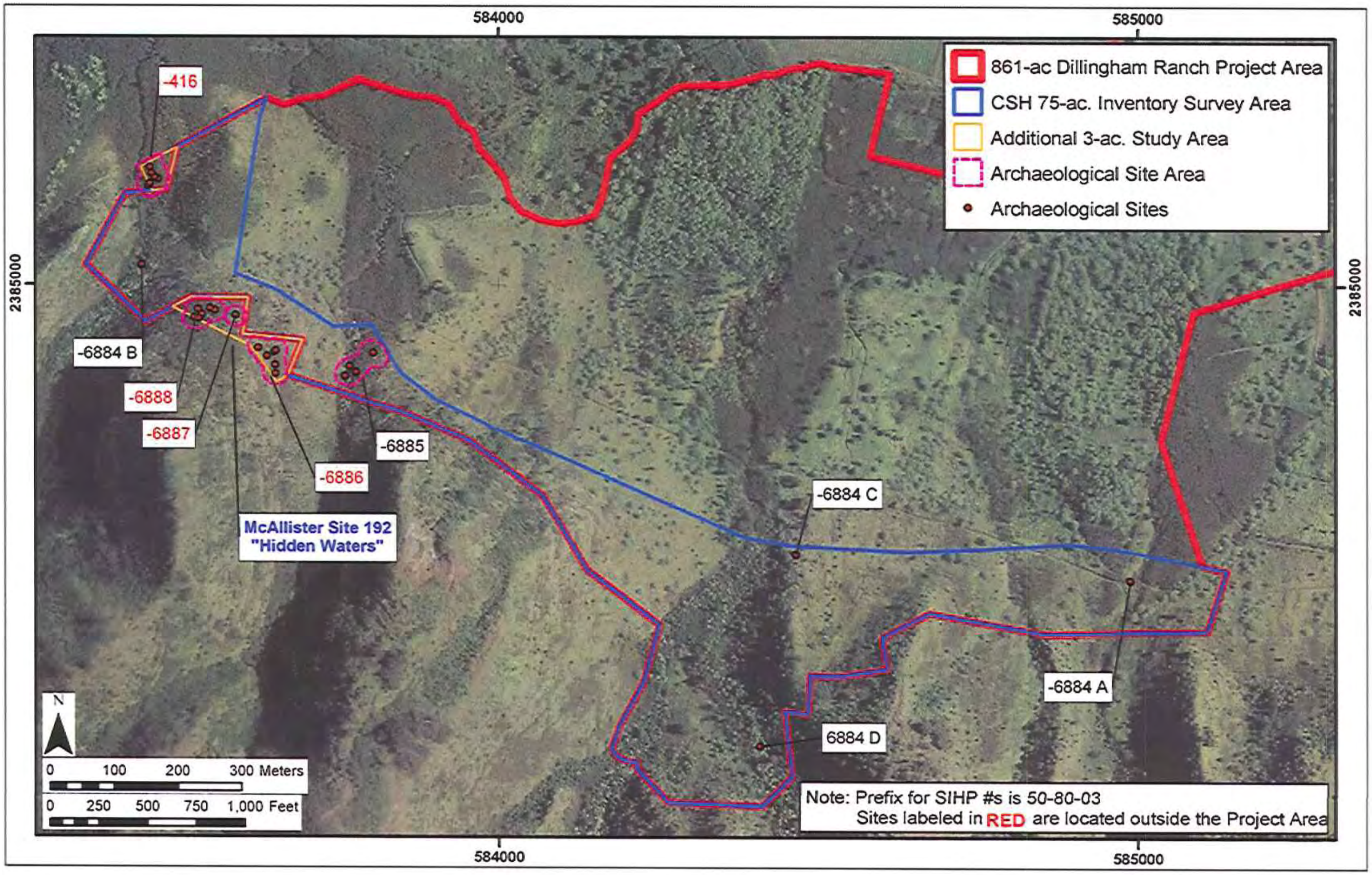


Figure 17. Aerial photograph, showing the locations of historic properties identified within the 75-acre inventory survey area and the additional 3-acre study area (source: USGS Orthoimagery 2005)

4.2 Site Descriptions

4.2.1 SIHP #: 50-80-03-416

SITE TYPE:	3 Terraces, 2 Walls, 1 Mound
FUNCTION:	Agricultural/Habitation
FEATURES:	6+
DIMENSIONS:	50 m N/S x 35 m E/W (within the current study area)
CONDITION:	Good
PROBABLE AGE:	Pre-Contact/Early Historic
TAX MAP KEY:	[1] 6-8-002:006

DESCRIPTION:

SIHP # 50-80-03-416 consists of numerous agricultural and habitation features located along the base of the coastal cliffs, extending west from Kawaihāpai Ahupua'a into Keālia Ahupua'a (see Figure 13). SIHP # 50-80-03-416 was originally described by Handy (1940):

> At the foot of the cliffs, watered by a stream the name of which was not learned, are several small terraces in which taro is grown by David Keaau...The large area of lowland terraces between the cliff and the elevated coral, though mostly in Kawaihapai, extends a short way into Kealia. (Handy 1940)

These terraces were given the designation of SIHP # 50-80-03-416 (also 50-0a-D2-4 in the Bishop Museum numbering system), and later listed as destroyed. However, portions of the site were relocated during a 1977 survey of the Dillingham Military Reservation by the Bishop Museum (Rosendahl 1977) and the remaining extent of the site area was mapped. The terraces are located 2,250-4,500 ft inland, on the *mauka* edge of the military reservation, at elevations of 80-140 ft AMSL. The site was described as an "extensive complex of agricultural and associated occupation features spread over virtually entire rocky sloping area between flat land of airfield and sheer cliffs" (Rosendahl 1977:1-25). An additional portion of SIHP # 50-80-03-416 was also identified in a later archaeological survey of the Dillingham Airfield (Moblo 1991).

An eastern extension of the SIHP # 50-80-03-416 complex was identified outside the northwestern corner of the 75-acre inventory survey area. Numerous additional archaeological features were observed continuing to the northeast, outside of the current study area, as indicated by previous archaeological studies. Six features, including three terraces, two walls, and one mound were located within the current study area, covering an area approximately 50 m N/S by 35 m E/W (Figure 18). No feature designations or inventory-level documentation has been conducted on SIHP # 50-80-03-416 to date. Therefore, the features identified in the current study have been designated Features A-F.

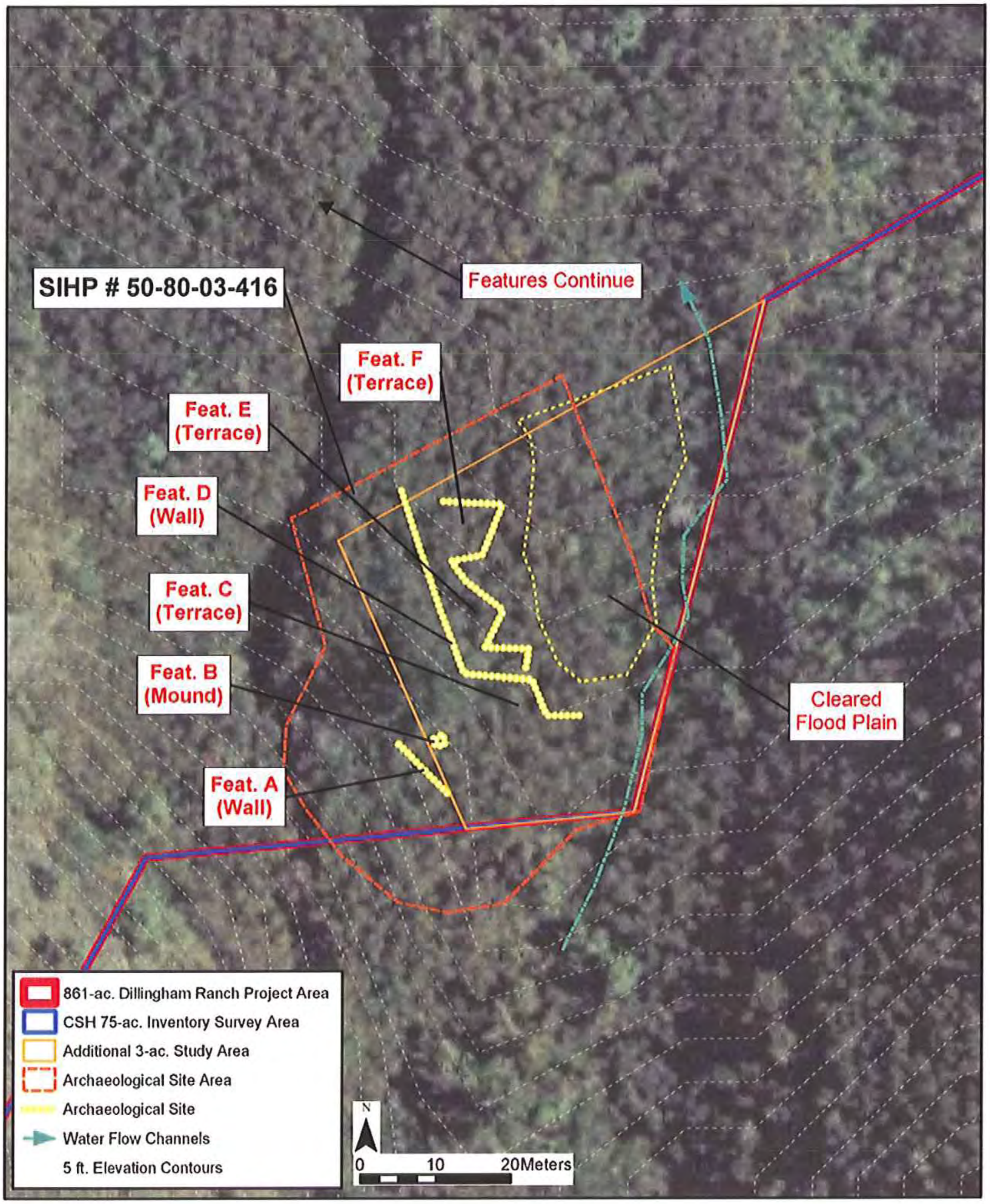


Figure 18. Aerial Photograph showing the SIHP # 50-80-03-416 agricultural complex area (source: USGS Orthoimagery 2005)

SIHP # 50-80-03-416 Features A-F are located along the western bank and slope of an unnamed stream channel (Figure 19). The complex is situated in an area where a deep, narrow gulch fans out to a wide area of gently sloping terrain to the north and west of the natural stream channel. The ridge to the east of the stream channel is very steep, serving as a natural boundary to the SIHP # 50-80-03-416 site area. The features identified within the current study area appear to be the easternmost extent of the site complex.

Feature A is a stacked-stone wall located at the southern end of the SIHP # 50-80-03-416 site complex. The wall is oriented roughly east-west, along the contour of the gently sloping terrain. The well-faced wall is constructed of loosely stacked basalt boulders and cobbles, 3 to 4 courses high, and incorporates several large, *in situ* basalt boulders into the wall construction (Figure 20). Stones comprising the wall construction average approximately 50 cm in diameter. The base of the wall is 2 to 3 courses wide, and tapers to 1 course wide at the top of the wall. Feature A measures approximately 1.0 m in height, 1.5 m wide, and 8.8 m in length within the current study area. The wall continues to the northwest outside of the study area. Feature A may have served as a boundary marker, delineating the *mauka* (southern) extent of the site complex.

Feature B is a mound located between the Feature A wall and Feature C terrace (Figure 19). The mound is constructed of crudely piled basalt boulders and cobbles, with large boulders around the perimeter and infilling with small boulders and cobbles (Figure 20). Feature B measures 2.7 m by 1.6 m wide, with a maximum height of 0.6 m. Feature B may have functioned as a clearing mound, associated with agricultural activities in the vicinity. An approximately 20 m by 13 m wide area relatively level and cleared of surface stones is located immediately northwest of the Feature B mound.

Feature C is a well-constructed terrace. The terrace retaining wall is situated along the edge of a low bluff, immediately upslope of a wide floodplain west of the unnamed stream channel (Figure 19). The well-faced retaining wall is constructed of stacked basalt boulders and cobbles, 3 to 7 courses high, and incorporates bedrock outcrops and large, *in situ* basalt boulders into the wall construction (Figure 21). Stones comprising the retaining wall construction range from approximately 0.2 m to 1.0 m in diameter. The Feature C terrace retaining wall measures approximately 11 m in length, 0.8 m wide, with a maximum height of 1.6 m. The wall retains a level soil terrace upslope, measuring 4.2 m by 3.3 m wide. Feature C is interpreted to function as an agricultural planting terrace.

Feature D is a stacked-stone wall located along the western edge of this portion of the SIHP # 50-80-03-416 site complex (Figure 19). The wall begins at the western edge of the Feature C terrace and runs roughly north-south and forms the western boundary of the Feature E and F terraces. The wall measures 1.2 m wide, 0.2 m to 0.8 m in height, and approximately 28 m in length within the current study area. The wall continues to the north outside of the study area. Feature D is constructed of loosely stacked basalt boulders and cobbles, with the southern portion of the wall 1 to 2 courses high, and the northern portion 3 to 4 courses high (Figure 22). Stones comprising the wall construction average approximately 30 cm in diameter. The wall is faced along the western edge and of a mounded-type construction along the eastern edge.

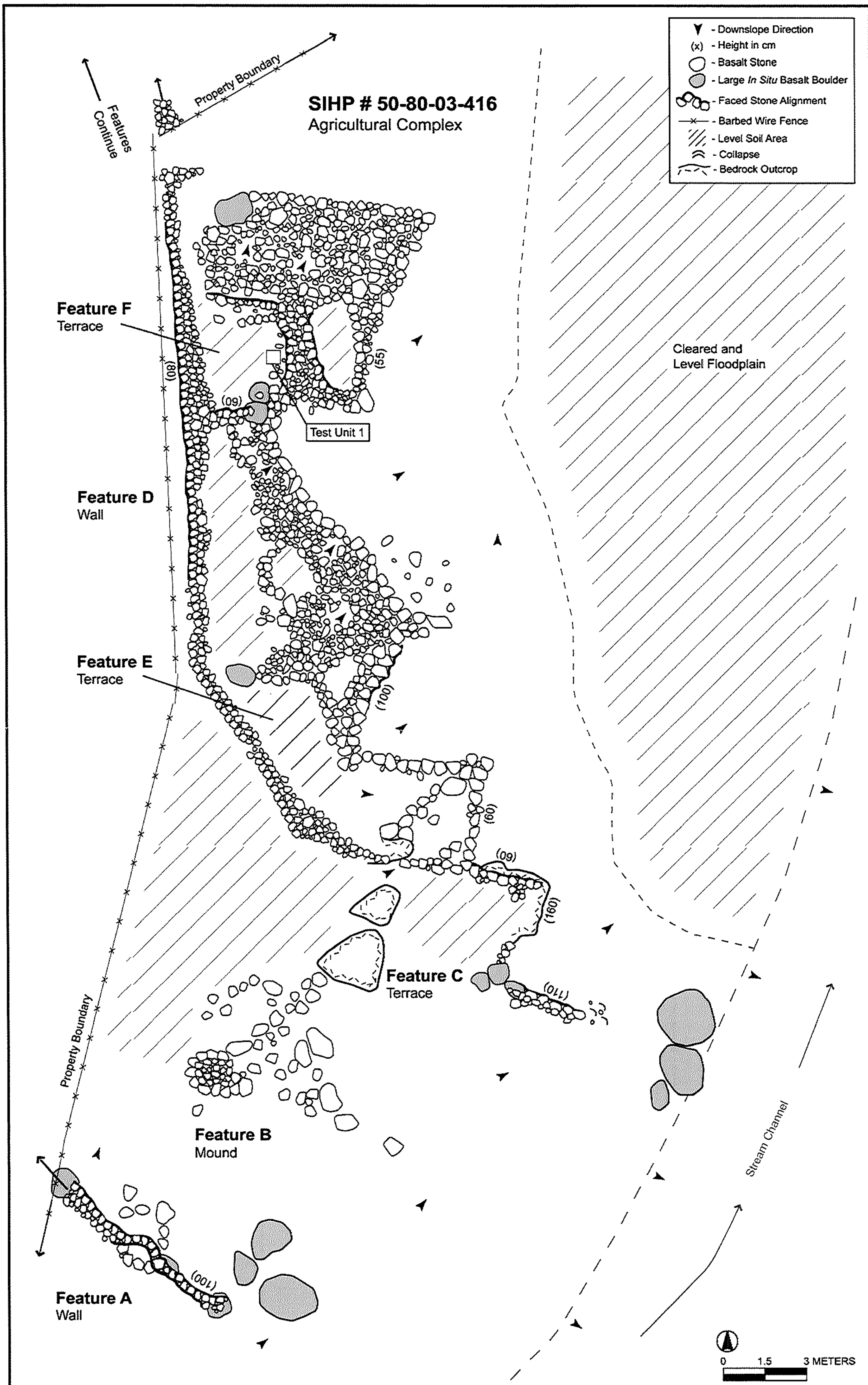


Figure 19. Plan view diagram of SIHP 50-80-03-416: agricultural/habitation complex

Figure 20. Photographs of SIHP # 50-80-03-416 Feature A wall (above, view to southwest) and Feature B mound (below, view to southwest)

Figure 21. Photographs of SIHP # 50-80-03-416 Feature C terrace retaining wall (above, view to south) and level soil area (below, view to northeast)

Figure 22. Photographs of SIHP # 50-80-03-416 Feature D wall (above, view to southeast) and Feature E terrace (below, view to northeast)

Features E and F consist of adjoining terraces located immediately northwest of the Feature C terrace (see Figure 19 above). The terraces are situated along the edge of a low bluff, immediately upslope of a wide floodplain west of the unnamed stream channel. The Feature E and F terraces are bounded along the upslope (western) edge by the Feature D wall. The retaining wall along the downslope edge of the Feature E and F terraces is of a mounded-type construction, consisting of basalt boulders and cobbles crudely piled against the edge of the natural bluff (Figure 23). The modified portion of the bluff measures approximately 23 m long, 2 to 4 m wide, and 2 to 3 m in height. The wall retains level soil areas upslope, between the retaining wall and the Feature D wall. The level soil terraces are divided by low, mounded walls, 1 to 2 courses high. Feature E includes two soil terraces, measuring 4.5 m by 2.3 m and 7.8 m by 1.8 m wide. Feature F also includes two soil terraces, one at the base of the bluff and one on the top surface. The terrace at the base of the bluff measures 3.3 m by 1.2 m wide, with intact facing along the western edge of the wall bounding the terrace. The upper terrace is circular in shape and measures 4.5 m by 3.2 m. The north, south, and eastern walls bounding the terrace have intact facing and are better constructed than the walls around the Feature E terraces (Figure 23). Features E and F are interpreted to function as agricultural planting terraces. However, the more careful construction of the Feature F terrace may indicate an associated habitation function.

In addition to the stacked stone constructions, a wide floodplain measuring approximately 20 m wide and over 40 m in length is located immediately east of the Feature C-F constructions, between the natural bluff and the unnamed stream channel. The floodplain is nearly level and appears to have been cleared of surface stones. The abundance of stones comprising the Feature E and F retaining wall may have been the result of clearing the adjacent floodplain. This floodplain would appear to be an ideal planting area, though no surface archaeological features exist to confirm cultivation of this area.

Features A-F are interpreted to be components of the previously described SIHP # 50-80-03-416 pre-contact/early historic agricultural and habitation complex. The site is constructed in an area of a natural break in slope, along a major stream channel. The archaeological features are in good condition with limited collapse observed. The surrounding area is largely undisturbed, with the exception of a ranch access roads and barbed-wire fences. Limited disturbance to the site was likely caused by roving cattle. Portions of SIHP # 50-80-03-416 were previously evaluated as significant for research and interpretive potential, and recommended for preservation (Rosendahl 1977; Yoshinaga 1977; Moblo 1991). SIHP # 50-80-03-416 maintains integrity of location, design, setting, materials, workmanship, feeling, and association. SIHP # 50-80-03-416 is assessed as significant under Criteria C (embodies the distinctive characteristics of a type, period, or method of construction) and D (have yielded, or may be likely to yield information important in prehistory or history) of the Hawai'i Register of Historic Places evaluation criteria.

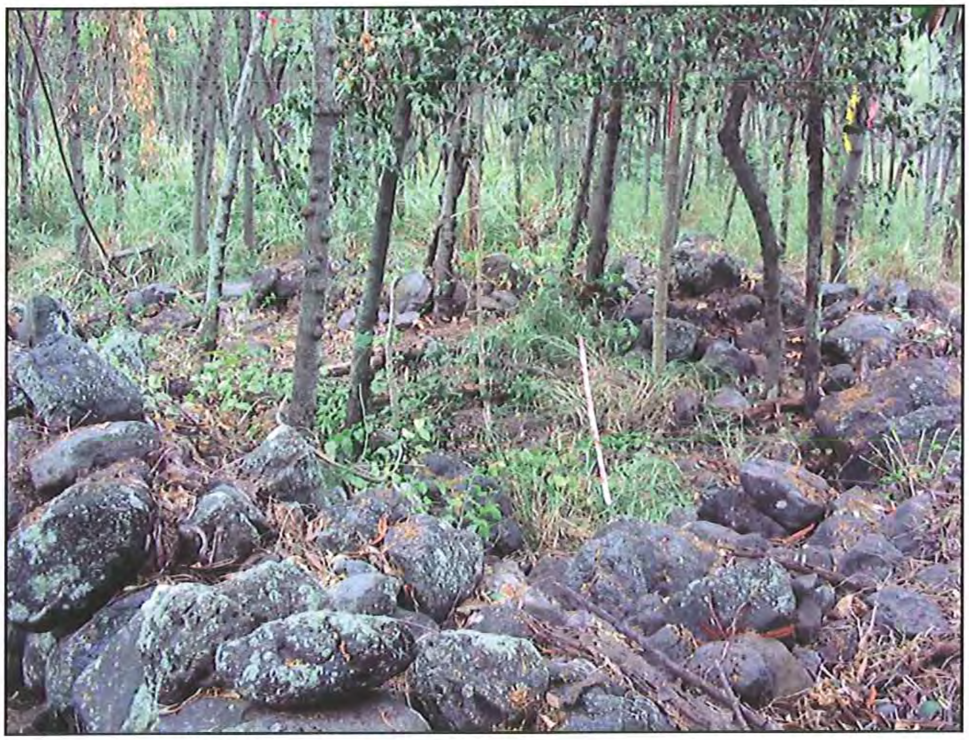


Figure 23. Photographs of SIHP # 50-80-03-416 Feature F terrace, (above, view to north) and sloping retaining wall along Features E and F (below, view to south)

4.2.2 SIHP #: 50-80-03-6884

SITE TYPE:	Walls
FUNCTION:	Ranch-Related, Cattle Barrier
FEATURES:	4
DIMENSIONS:	9.8 m NW/SE (Feature A), 5.8 m NW/SE (Feature B), 27.5 m NE/SW (Feature C), (Feature D)
CONDITION:	Good
PROBABLE AGE:	Historic
TAX MAP KEY:	[1] 6-8-003:006 (Features A and C), [1] 6-8-003:006 (Feature B)

DESCRIPTION:

SIHP # 50-80-03-6884 consists of four stone wall features located within gully areas in the eastern, central, and western portions of the 75-acre inventory survey area (see Figures 16 and 17 above). The wall features are each interpreted to be historic, ranch-related constructions that are of similar age, design, and function. Therefore, despite being spread throughout the 75-acre inventory survey area, the features were included under a single site designation.

SIHP # 50-80-03-6884 Feature A is a single, stacked-stone wall located within the eastern portion of the 75-acre inventory survey area (see Figures 16 and 17 above). The stone wall is situated across the sloping western bank of an unnamed stream channel and is oriented northwest-southeast, perpendicular to the direction of water flow (Figure 24). The wall is constructed from the top edge of the gully to the edge of the stream channel. SIHP # 50-80-03-6884 Feature A measures approximately 9.8 m in length, with a maximum height of 1.4 m and average width of 1.0 m. The well-faced wall is constructed of loosely stacked basalt boulders and cobbles, 3-6 courses high. The wall construction is comprised of stones averaging 50 cm in diameter. Large, *in-situ* basalt boulders are incorporated into the wall construction. Remnant barbed-wire fencing and a 1" diameter galvanized steel water pipe were observed along the length of the wall, and continuing in either direction beyond the wall construction. Outside of the gully, the barbed-wire fence is located immediately *makai* (north) of, and parallels an east-west oriented, unpaved ranch access road.

SIHP # 50-80-03-6884 Feature B is a single, stacked-stone wall located within the western portion of the 75-acre inventory survey area (see Figures 16 and 17 above). The stone wall is situated across the sloping eastern bank of an unnamed stream channel and is oriented northwest-southeast, perpendicular to the direction of water flow (Figure 25). SIHP # 50-80-03-6884 Feature B measures approximately 5.8 m in length, with a maximum height of 1.4 m and average width of 0.7 m. The well-faced wall is constructed of loosely stacked basalt boulders and cobbles, 2-4 courses high. The wall construction is comprised of stones averaging 40 cm in diameter. The wall is constructed between and incorporates large, *in-situ* basalt boulders and bedrock outcrops. Remnant barbed-wire fencing, as well as a portion of relatively new barbed-wire fencing, was observed along the length of the wall, and continuing in either direction beyond the wall construction. The southeast portion of the SIHP # 50-80-03-6884 Feature B wall has suffered damage from collapse.

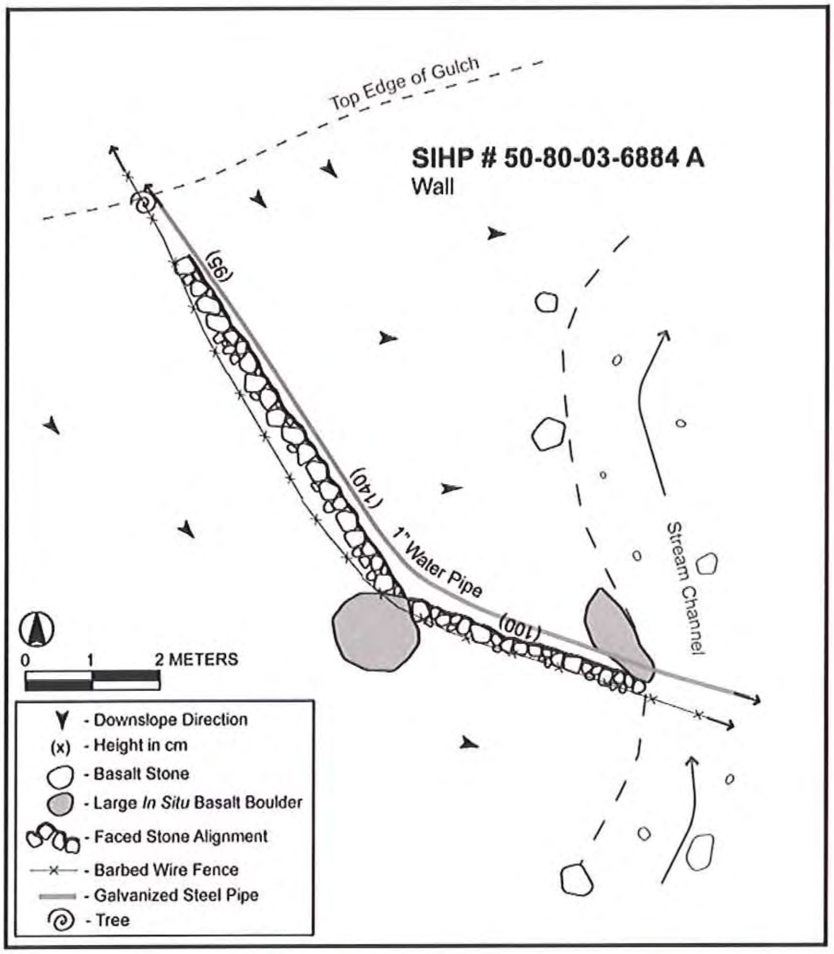


Figure 24. Plan view diagram (above) and photograph (below, view to west) of SIHP # 50-80-03-6884 Feature A: wall

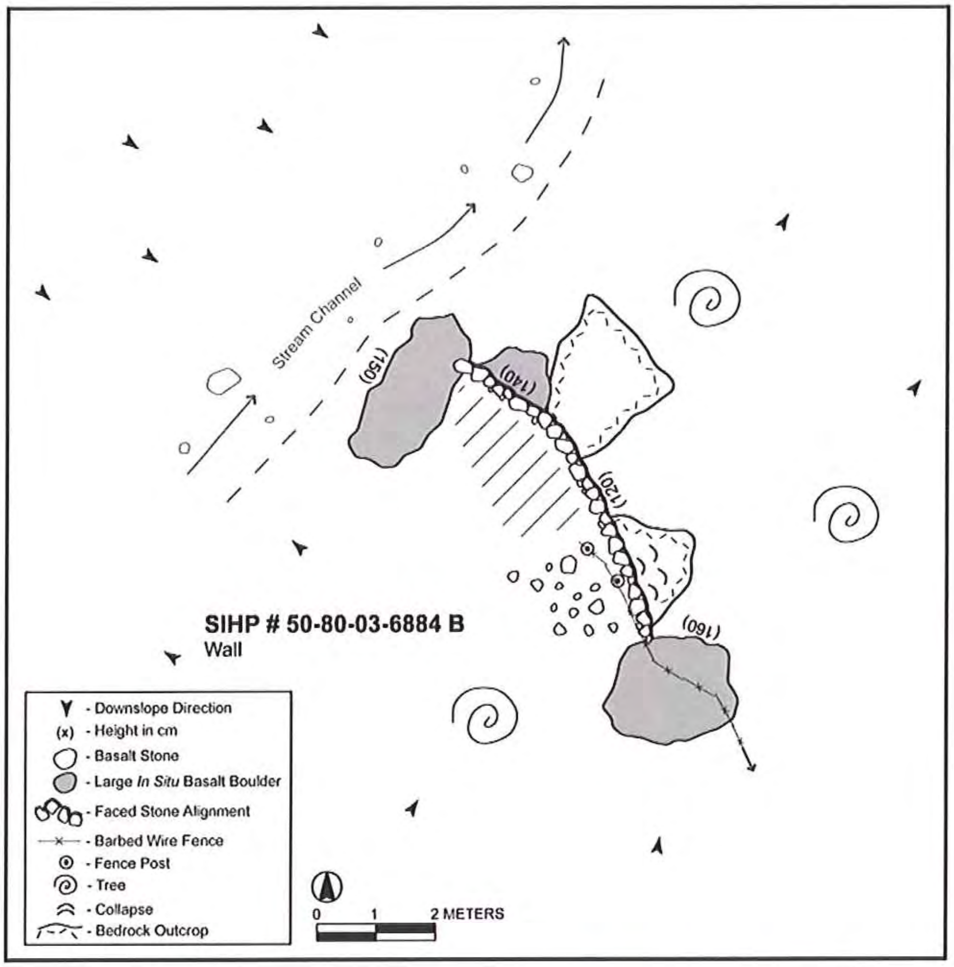


Figure 25. Plan view diagram (above) and photograph (below, view to west) of SIHP # 50-80-03-6884 Feature B: wall,

SIHP # 50-80-03-6884 Feature C is a single, stacked-stone wall located within the central portion of the 75-acre inventory survey area (see Figures 16 and 17 above). The stone wall is situated along the eastern slope of an unnamed gulch and is oriented northeast-southwest along the contour of the steep sloping hillside (Figure 26). SIHP # 50-80-03-6884 Feature C measures approximately 27.5 m in length, with a maximum height of 1.4 m on the downslope side and average width of 1.5 m. The wall is constructed of loosely stacked basalt boulders and cobbles, 5-7 courses high, in a core-filled manner. The wall construction is comprised of stones ranging from 10-80 cm in diameter, with larger boulders used for the base course and smaller stones in the upper courses. SIHP # 50-80-03-6884 Feature C is constructed along an exposed bedrock outcrop, with the northeastern end of the wall terminating at an approximately 1.5 m tall ledge, and the southwestern end of the wall ending flush against an approximately 1.8 m high bedrock outcrop. The wall is well-faced along the downslope edge, and nearly level with the sloping hillside along the upslope edge. A remnant barbed-wire fence is located immediately upslope of the wall, running roughly parallel to the wall and continuing northeast and southwest beyond the wall construction. Portions of the northeastern half of the wall have suffered damage from collapse.

SIHP # 50-80-03-6884 Feature D consists of two stacked-stone wall segments located within the central portion of the 75-acre inventory survey area (see Figures 16 and 17 above). The stone wall segments are constructed across a natural, seasonal drainage channel and alluvial terrace, within the same unnamed gulch as SIHP # 50-80-03-6884 Feature C. The stone wall segments are oriented roughly northeast-southwest, together measuring approximately 24 m in length (Figure 27). The wall segments are constructed of loosely stacked basalt boulders and cobbles, 2-5 courses high, with a maximum downslope height of 1.7 m on the northern segment and 1.4 m on the southern segment (Figure 28). The wall constructions are comprised of stones ranging from 20-80 cm in diameter, with larger boulders used for the base course and smaller stones in the upper courses. The wall segments are also constructed over and incorporate large, *in-situ* basalt boulders. The northern segment of the SIHP # 50-80-03-6884 Feature D wall is constructed across the base of a natural drainage channel, with the southern end of the northern wall segment terminating at the edge of an extremely large *in-situ* basalt boulder. A metal spike was observed to be supporting the base of a portion of the northern wall segment. The southern wall segment begins on top of the extremely large basalt boulder and continues southwest along the edge of a natural alluvial stream terrace within the gulch. The southern end of the southern wall segment terminates at the southern slope of the unnamed gulch, where water flow has washed out the end of the wall. The SIHP # 50-80-03-6884 Feature D wall is well-faced along the downslope edge, and nearly level with the sloping hillside along the upslope edge. A remnant barbed-wire fence is located immediately upslope of the wall, running roughly parallel to the wall and continuing north and southwest beyond the wall construction.

SIHP # 50-80-03-6884 Features A-D are interpreted to be historic, ranch-related cattle walls. The walls function in restricting the movement of cattle between pasture areas. SIHP # 50-80-03-6884 is in good condition as the walls are generally intact with little collapse observed. The features are relatively undisturbed, as are the surrounding areas which continue to be used as pasture for grazing livestock. SIHP # 50-80-03-6884 maintains integrity of location, design, setting, materials, workmanship, feeling, and association. SIHP # 50-80-03-6884 is assessed as significant under Criterion D (have yielded, or may be likely to yield information important in prehistory or history) of the Hawai'i Register of Historic Places evaluation criteria.

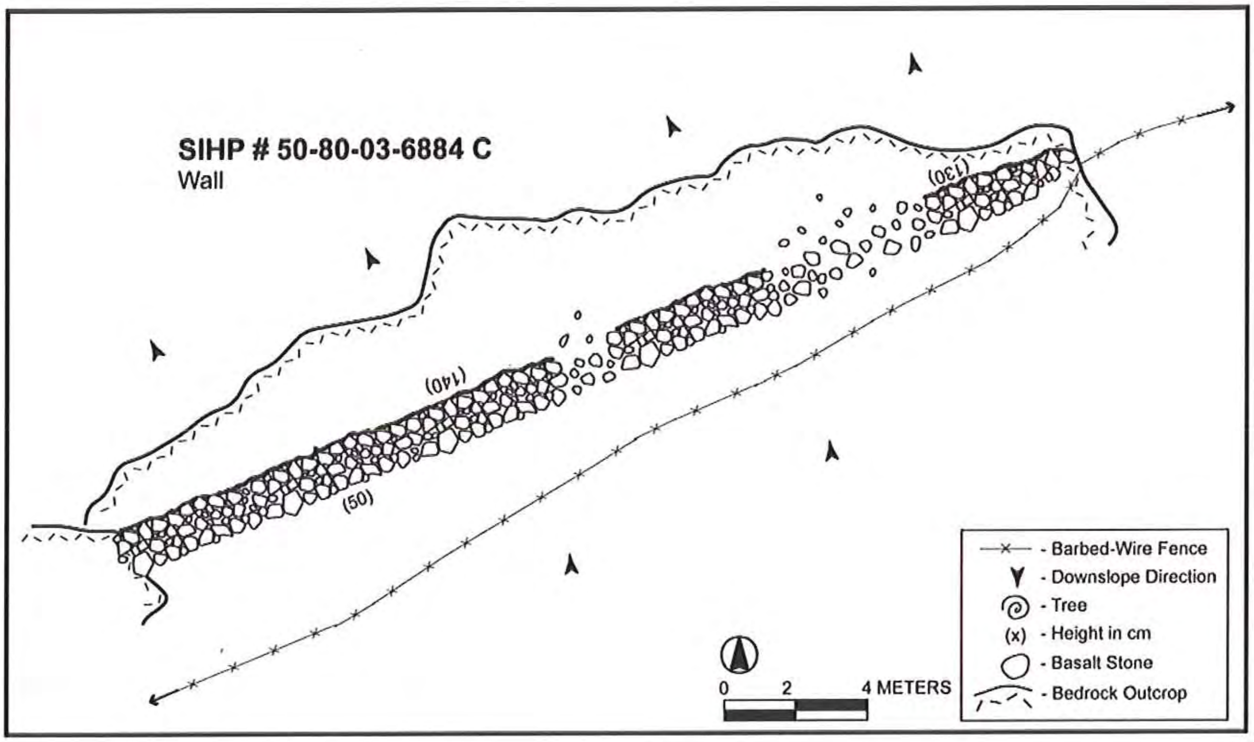


Figure 26. Plan view diagram (above) and photograph (below, view to south) of SIHP # 50-80-03-6884 Feature C: wall

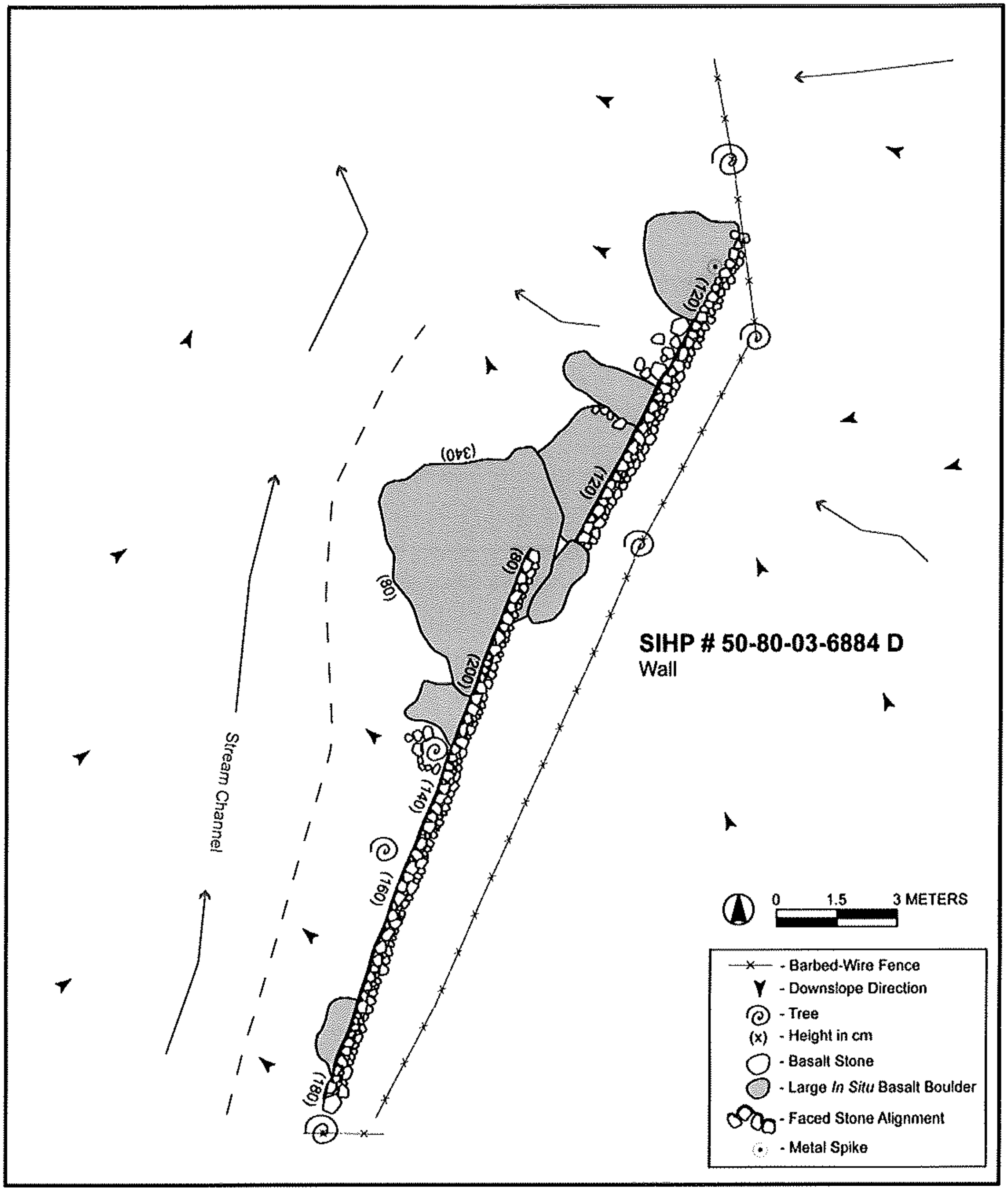


Figure 27. Plan view diagram of SIHP # 50-80-03-6884 Feature D: wall

Figure 28. Photographs of the northern (above, view to southeast) and southern (below, view to southeast) portions of SIHP # 50-80-03-6884 Feature D: wall

4.2.3 SIHP #: 50-80-03-6885

SITE TYPE: 3 Terraces, 1 Retaining Wall
FUNCTION: Agricultural Complex
FEATURES: 4
DIMENSIONS: 65 m NE/SW x 25 m NW/SE
CONDITION: Good
PROBABLE AGE: Pre-Contact / Early Historic
TAX MAP KEY: [1] 6-8-002:006

DESCRIPTION:

SIHP # 50-80-03-6885 is an agricultural complex located within a gully area in the western portion of the 75-acre inventory survey area (see Figures 16 and 17 above). The complex is comprised of four individual features covering an area approximately 65 m NE/SW by 25 m NW/SE (Figure 29). Features A-C are located within or along the banks of an unnamed stream channel, with Feature D located along a gently sloping flood plain approximately 40 m to the northeast. The SIHP # 50-80-03-6885 complex is constructed in an area which is naturally gently sloping, with steeper terrain both upslope and downslope of the site area.

SIHP # 50-80-03-6885 Feature A is a terrace constructed at the base of the gully. The terrace is composed of a retaining wall constructed roughly east-west across the eastern portion of the natural stream channel, perpendicular to the direction of water flow (Figure 30). The retaining wall measures a total of 6.8 m in length and 1.0 m in width, with a maximum height of 2.1 m. The well-faced retaining wall is composed of short, stacked-stone wall segments filling in gaps between large, *in-situ* basalt boulders strewn across the base of the gulch (Figure 31). The stacked-stone wall segments are constructed of loosely stacked basalt boulders and cobbles, 3 to 4 courses high. The base course of the retaining wall incorporates larger boulders averaging 70 cm in diameter, with progressively smaller boulders and cobbles in the upper courses. The retaining wall effectively creates a dam across the base of the gully and stream channel, and retains an approximately 6.5 x 9.5 m wide level-soil area immediately upslope (Figure 32). An approximately 1.5 m wide section at the western edge of the stream channel, is not walled-off, allowing flood waters to go around, rather than overtop the terrace, analogous to the spillway of a modern dam. Feature A is in good condition with no significant collapse observed. Feature A is interpreted to function as an agricultural terrace, utilizing the seasonal water flow from the natural stream channel for irrigation.

SIHP # 50-80-03-6885 Feature B is a retaining wall located immediately upslope of the Feature A level terrace area (Figure 30). The retaining wall begins at the eastern edge of the stream channel and continues approximately 24 m northeast along the base of a bluff, following the contour of the slope. The well-faced retaining wall is constructed of loosely stacked basalt boulders and cobbles, 2 to 3 courses high, with a maximum height of 1.1 m and average width of 0.8 m (Figure 33). The wall construction also incorporates several large, *in-situ* basalt boulders. Upslope of the Feature B retaining wall is a rocky, sloping hillside. Portions of the northern end of the retaining wall have suffered from collapse likely due to erosion and trampling by cattle. Feature B defines the southern boundary of the Feature A terrace and is interpreted to function in preventing erosion of sediment and rocks from the hillside upslope damaging the Feature A

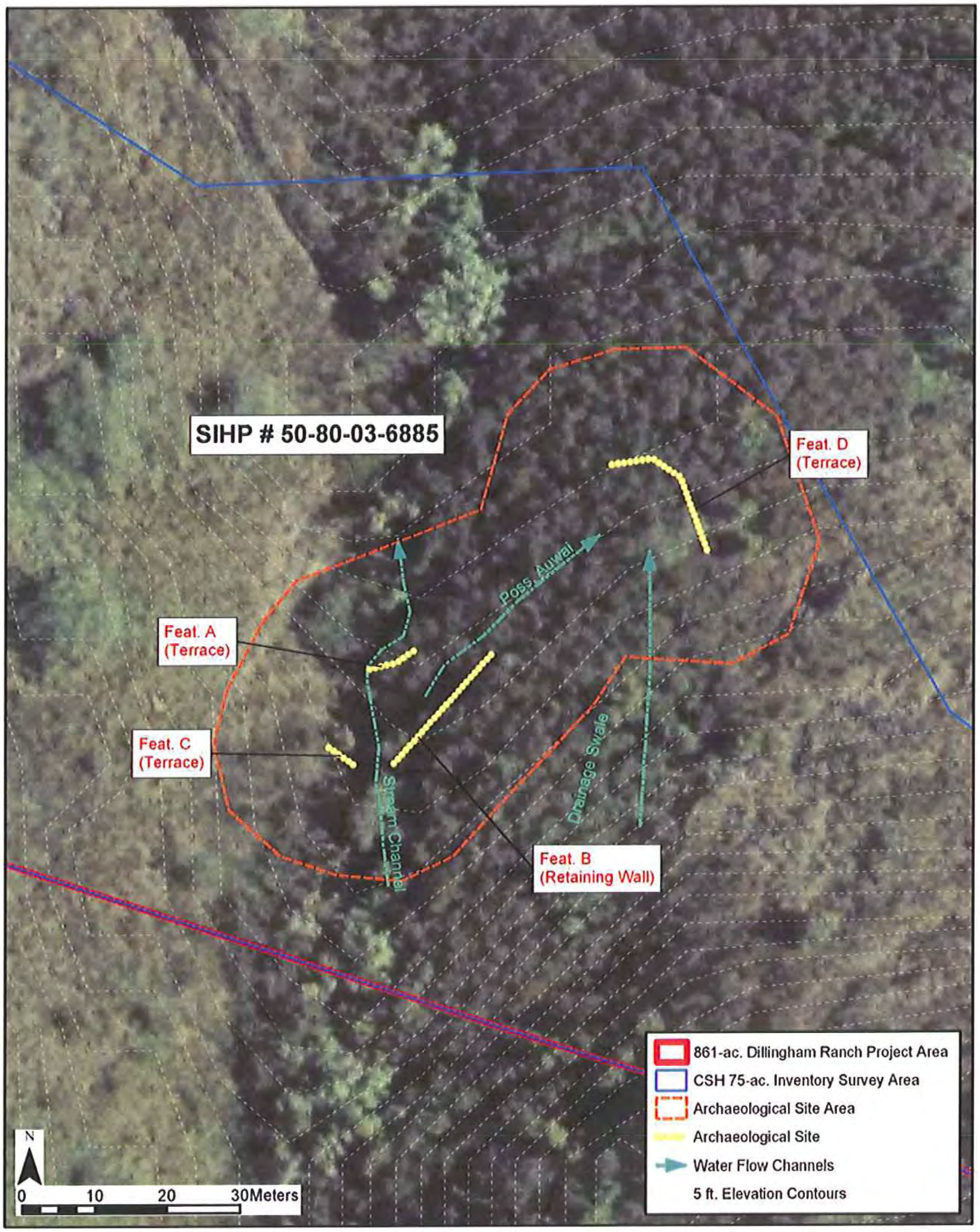


Figure 29. Aerial Photograph showing the SIHP # 50-80-03-6885 agricultural complex area (source: USGS Orthoimagery 2005)

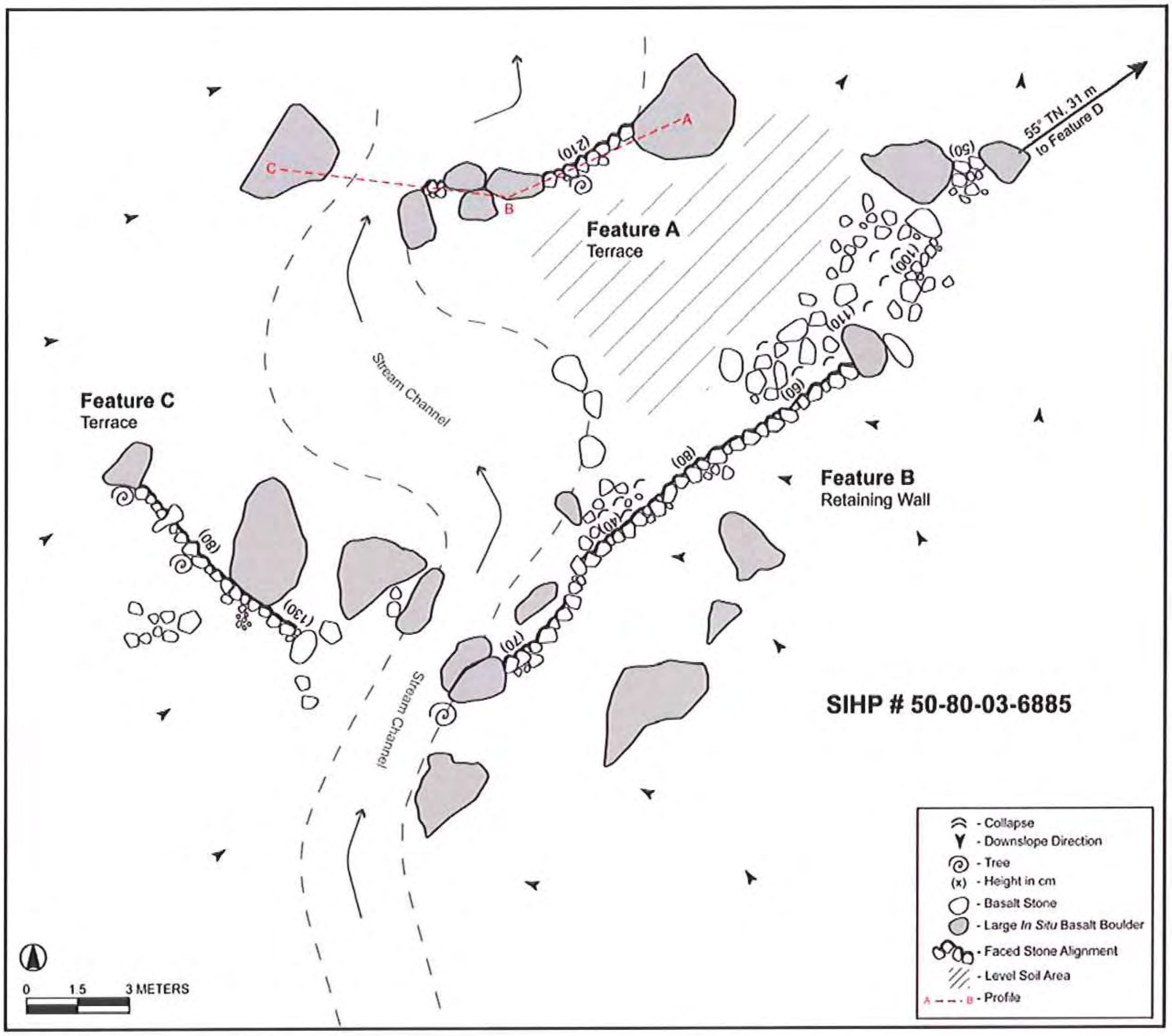


Figure 30. Plan view diagram of SIHP # 50-80-03-6885 Features A-C

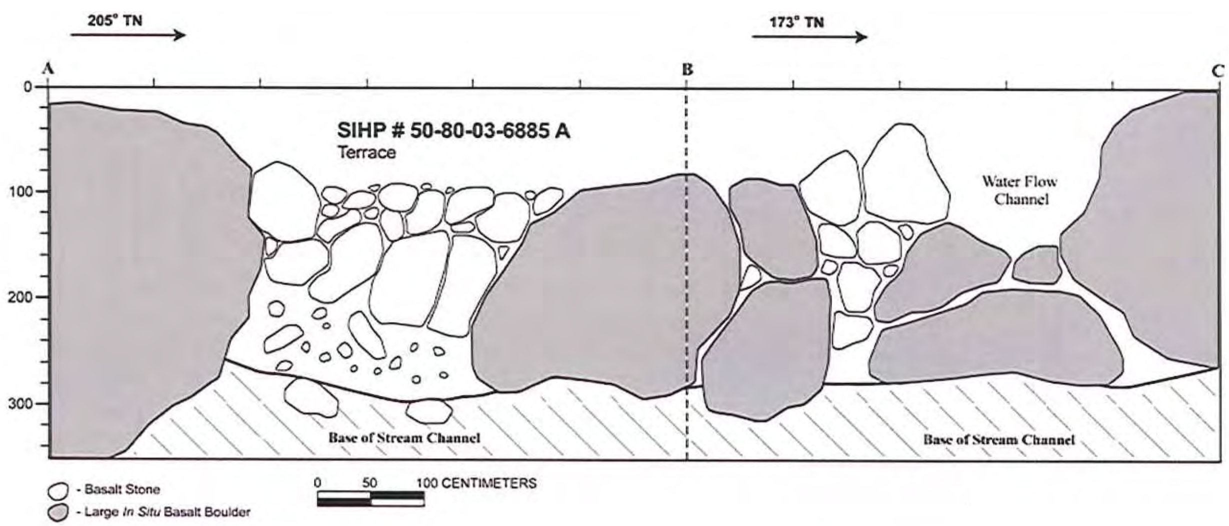


Figure 31. Profile diagram (above) and panorama photograph (below, view to south) of SIHP # 50-80-03-6885 Feature A: terrace

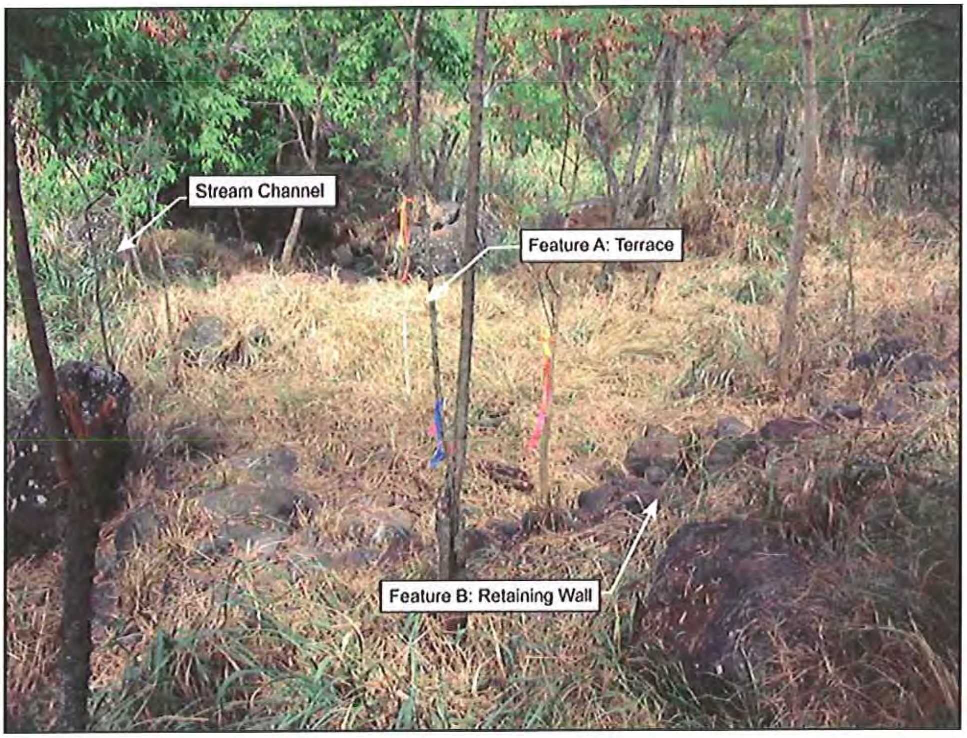


Figure 32. Photograph of SIHP # 50-80-03-6885 Features A and B, view to north

Figure 33. Photograph of SIHP # 50-80-03-6885 Feature B: retaining wall, view to east

terrace below. The Feature B retaining wall may also define the *mauka* (upslope) edge of a possible *'auwai* (irrigation ditch) leading from the stream channel to the Feature D terrace discussed below.

SIHP # 50-80-03-6885 Feature C is a small terrace constructed along the western edge of the natural stream channel (see Figure 30 above). The terrace is composed of an approximately 3 m long retaining wall that extends from the western edge of the stream channel to the base of the steep sloping western gulch face. The well-faced retaining wall is constructed of loosely stacked basalt boulders and cobbles, 2 to 3 courses high, and incorporates large *in-situ* basalt boulders (Figure 34). The retaining wall measures a maximum of 1.3 m in height and an average of 0.8 m in width. Feature C is interpreted to function as a water diversion feature. The constructed retaining wall allowed for sediment to build up behind the wall, thereby directing the water flow to the eastern portion of the stream channel, toward the Feature A terrace and a possible *'auwai* leading toward the Feature D terrace. Feature C may also have functioned as a small agricultural planting area.

SIHP # 50-80-03-6885 Feature D is a large terrace located along a gently sloping flood plain, approximately 40 m northeast of Features A-C (see Figure 29 above). The terrace is composed of an approximately 22 m long stacked-stone retaining wall, constructed along the contour of the slope, with a maximum height of 1.1 m and average width of 1.2 m (Figure 35). The wall generally retains an approximately 4 m wide level soil area upslope. The well-faced retaining wall is constructed of loosely stacked basalt boulders and cobbles, 3 to 4 courses high (Figure 36). The retaining wall construction is made up of 25 to 30 cm diameter stones and also incorporates several large *in-situ* basalt boulders. Portions of the retaining wall are constructed by filling in gaps between these large boulders with smaller boulders and cobbles. The northwestern portion of the retaining wall is the best-constructed, with the wall becoming lower and less well-defined along the southeastern portion. The southeastern end of the retaining wall consists of a single course alignment of boulders and cobbles. Feature D is interpreted to function as an agricultural planting terrace. The terrace is constructed to utilize water from a natural drainage swale along the sloping flood plain, as well as from a possible *'auwai* leading from the stream channel and Feature A terrace. No surface evidence of an *'auwai* was observed, possibly due to infilling by erosion, though the site configuration and topography suggest the possibility one may have existed. Feature D is in good condition with limited collapse of the retaining wall observed.

SIHP 50-80-03-6885 Features A-D are interpreted to represent pre-contact/early historic, integrated agricultural features. The site is constructed in an area of a natural break in slope and is situated to utilize natural drainages for irrigation. The archaeological features are in good condition and the surrounding area is largely undisturbed, with the exception of a ranch access road approximately 30 m north of Feature D. Limited disturbance to the site was likely caused by roving cattle. However, the dilapidated condition of fences in the area indicates cattle have not been grazing in this *mauka* (southern) portion of the project area for some time. The terraced area (i.e. Features A and B) and water diversion feature (i.e. Feature C) constructed at the base of a gully and within a natural stream channel appear to be unique within the 861-acre Dillingham Ranch project area, based on the results of previous archaeological research by Drolet and Schilz (1992). SIHP # 50-80-03-6885 maintains integrity of location, design, setting, materials, workmanship, feeling, and association. SIHP # 50-80-03-6885 is assessed as significant under

Criteria C (embodies the distinctive characteristics of a type, period, or method of construction) and D (have yielded, or may be likely to yield information important in prehistory or history) of the Hawai'i Register of Historic Places evaluation criteria.

Figure 34. Photograph of SIHP # 50-80-03-6885 Feature C: terrace, view to southwest

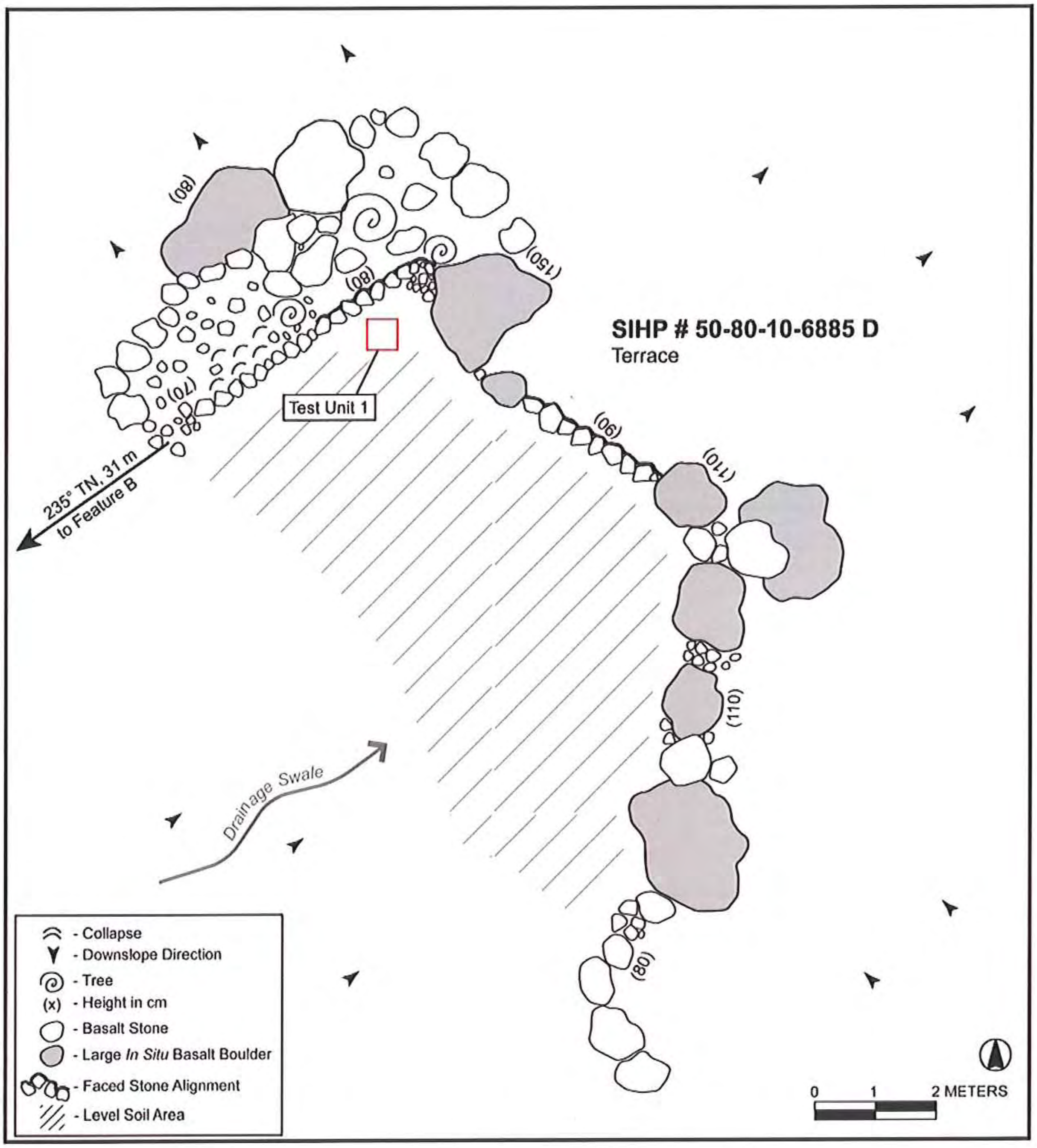


Figure 35. Plan view diagram of SIHP # 50-80-03-6885 Feature D: terrace

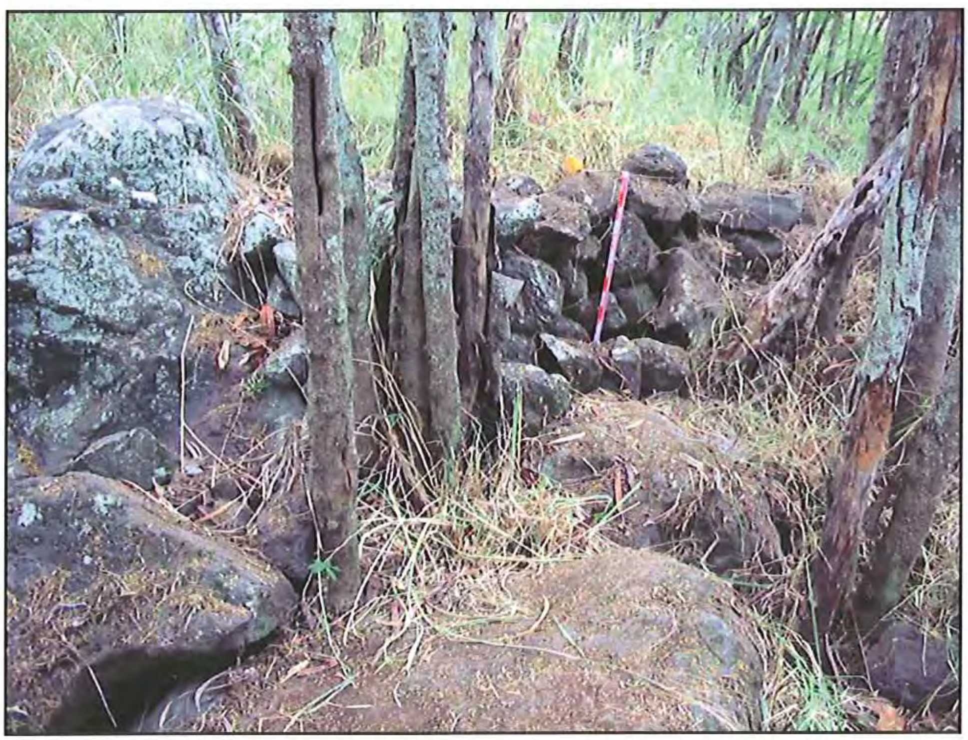


Figure 36. Photographs of the eastern (above, view to southeast) and western (below, view to southwest) portions of SIHP # 50-80-03-6885 Feature D: terrace

4.2.4 SIHP #: 50-80-03-6886

SITE TYPE: 3 terraces, 3 mounds, 1 retaining wall
FUNCTION: Agricultural Complex
FEATURES: 7
DIMENSIONS: 50 m N/S x 40 m E/W
CONDITION: Good
PROBABLE AGE: Pre-contact/Early Historic
TAX MAP KEY: [1] 6-8-002:006

DESCRIPTION:

SIHP # 50-80-03-6886 is an agricultural complex located outside the southwestern portion of the 75-acre inventory survey area, along the prominent hillside indicated by McAllister (1933) to be the location of the Site 192 "Hidden Waters" natural springs (see Figures 16 and 17 above). The complex is comprised of seven individual features covering an area approximately 50 m N/S by 40 m E/W (Figure 37). The complex includes a cluster of three rock mounds, three terraces, and one retaining wall. The three terraces (i.e. Features D, F, and G) are constructed along the top edge of exposed basalt cliffs. The mounds and retaining wall (i.e. Features A-C and E) are situated on steep sloping terrain immediately downslope of the exposed basalt cliffs. In addition to the seven identified features, additional small, crudely constructed mounds measuring less than 1 m in diameter were observed scattered throughout the SIHP # 50-80-03-6886 area. The features of SIHP # 50-80-03-6886 are also located adjacent to natural drainage channels that progress down the hillside to the gully below.

SIHP # 50-80-03-6886 Features A, B, and C consist of crudely constructed rock mounds. The mounds are composed of basalt boulders and cobbles piled against the steep sloping hillside. The mounds are not faced, and have sloping top surfaces. The constructions are generally elongated oval shapes, with the long axes oriented perpendicular to the prevailing slope direction. The mounds are also generally constructed on or against the upslope edges of large, *in situ* basalt boulders or bedrock outcrops. Narrow, relatively level soil areas are also retained upslope of the mound constructions

Feature A mound measures 5.0 m long, 1.6 m wide, with a maximum height of 1.0 m (Figure 38). The mound includes larger stones along the downslope edge and smaller stones on the upslope edge (Figure 39). Feature B mound measures 7.0 m long, 2.8 m wide, with a maximum height of 1.7 m (Figure 38). The mound is constructed primarily of boulders and large cobbles (Figure 39). Feature C mound measures 4.1 m long, 2.0 m wide, with a maximum height of 1.4 m (Figure 40). The mound is constructed against the upslope edge of a large, *in situ* basalt boulder, with basalt boulders and cobbles evenly distributed throughout the construction.

SIHP # 50-80-03-6886 Features D, F, and G consist of well-constructed terraces situated along the top edge of the exposed basalt cliffs upslope of Features A-C (Figure 37). The terraces are composed of stacked-stone retaining walls constructed across gaps in the cliff face, where natural drainage channels descend from upslope. The Feature D terrace retaining wall measures 5.6 m long, 0.4 m wide, with a maximum height of 1.4 m (Figure 41). The well-faced retaining wall is constructed of stacked basalt boulders and cobbles, 2 to 7 courses high, and incorporates natural bedrock outcrops into the construction (Figure 42). An approximately 5.4 m by 1.6 m

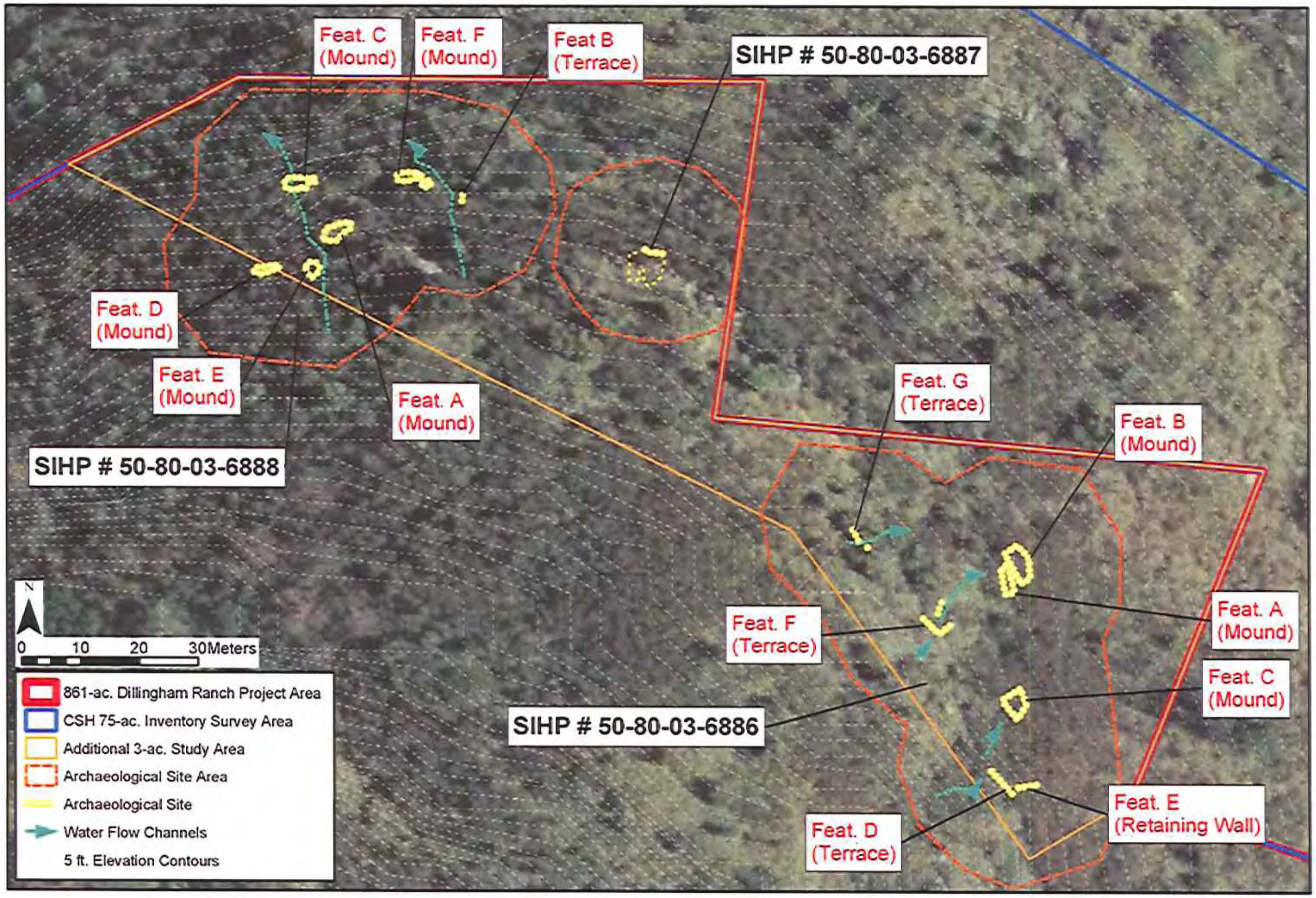


Figure 37. Aerial Photograph showing the SIHP # 50-80-03-6886 agricultural complex, 50-80-03-6887 overhang shelter, and 50-80-03-6888 agricultural complex along the hillside indicated by McAllister (1933) to be the location of the Site 192 "Hidden Waters" (source: USGS Orthoimagery 2005)

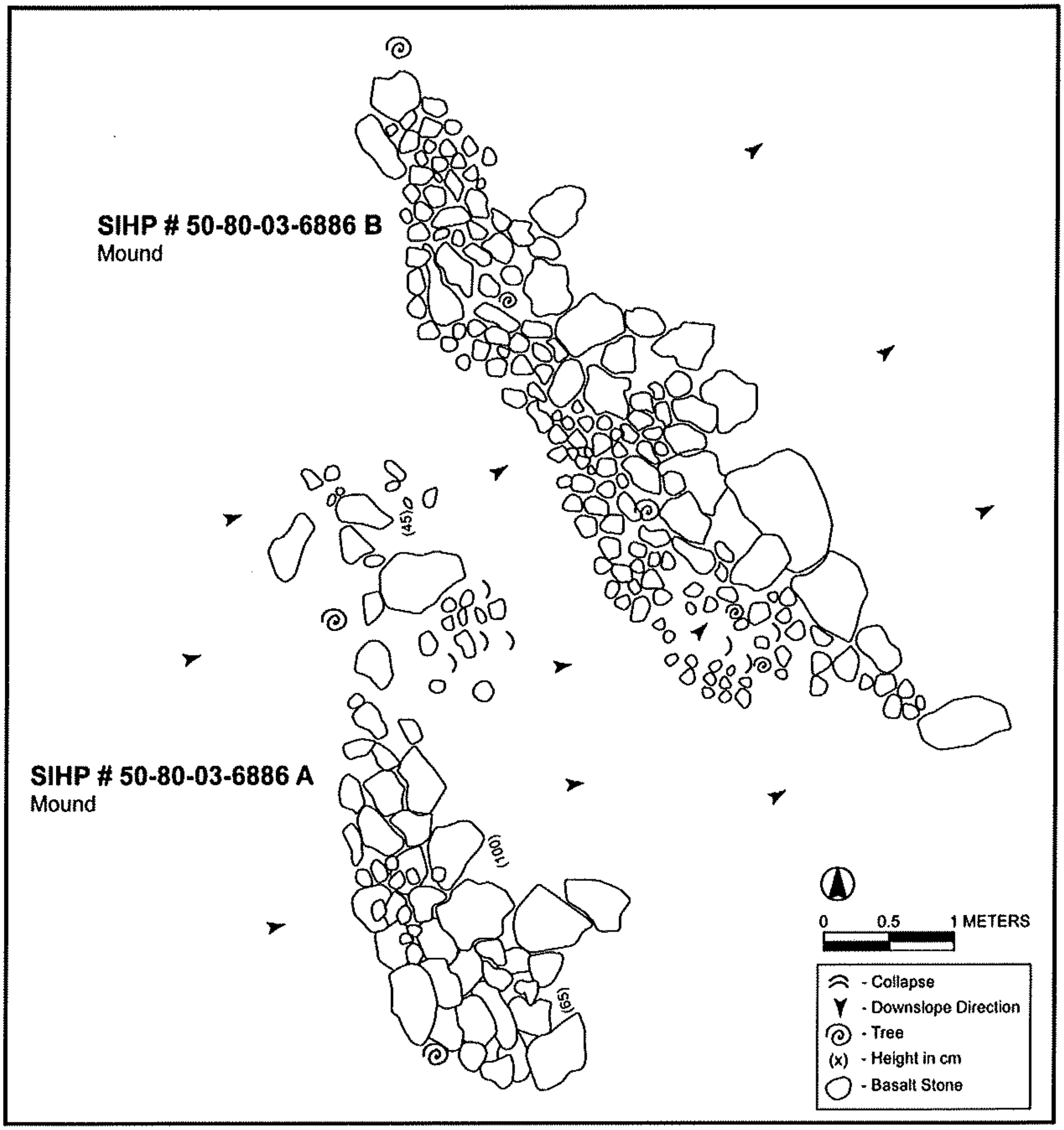


Figure 38. Plan view diagram of SIHP # 50-80-03-6886 Features A and B

Figure 39. Photographs of SIHP # 50-80-03-6886 Feature A mound (above, view to south) and Feature B mound (below, view to south)

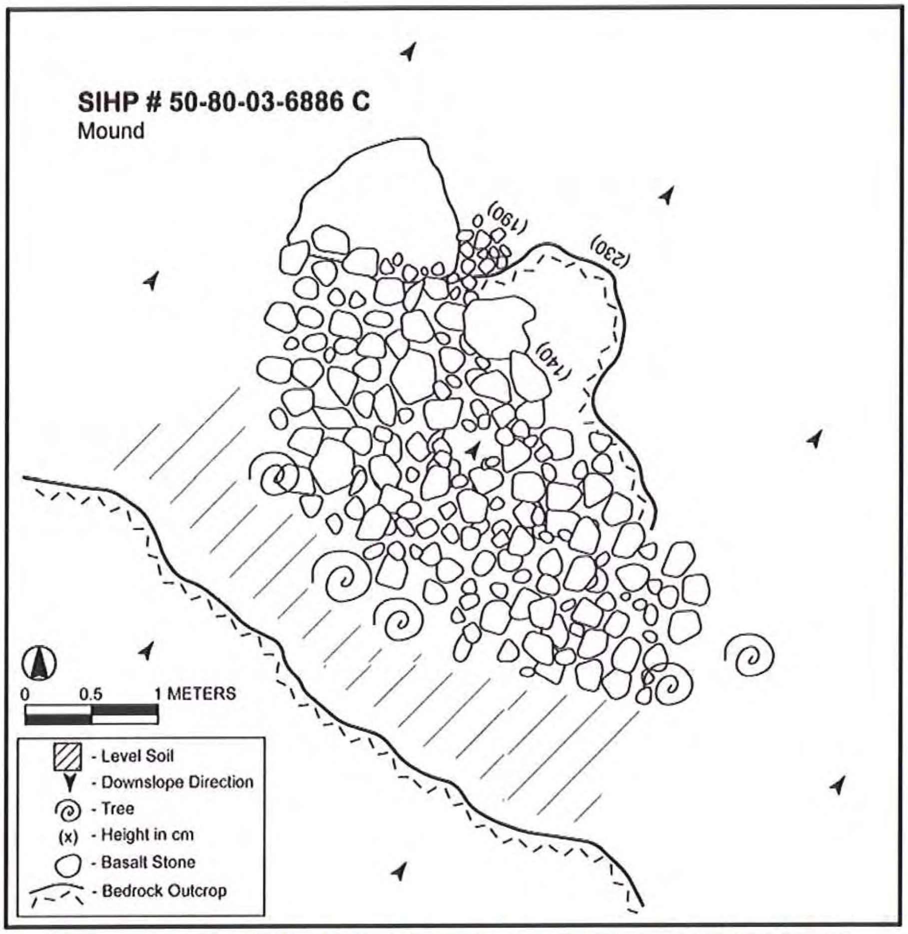


Figure 40. Plan view diagram (above) and photograph (below, view to south) of SIHP # 50-80-03-6886 Feature C: mound

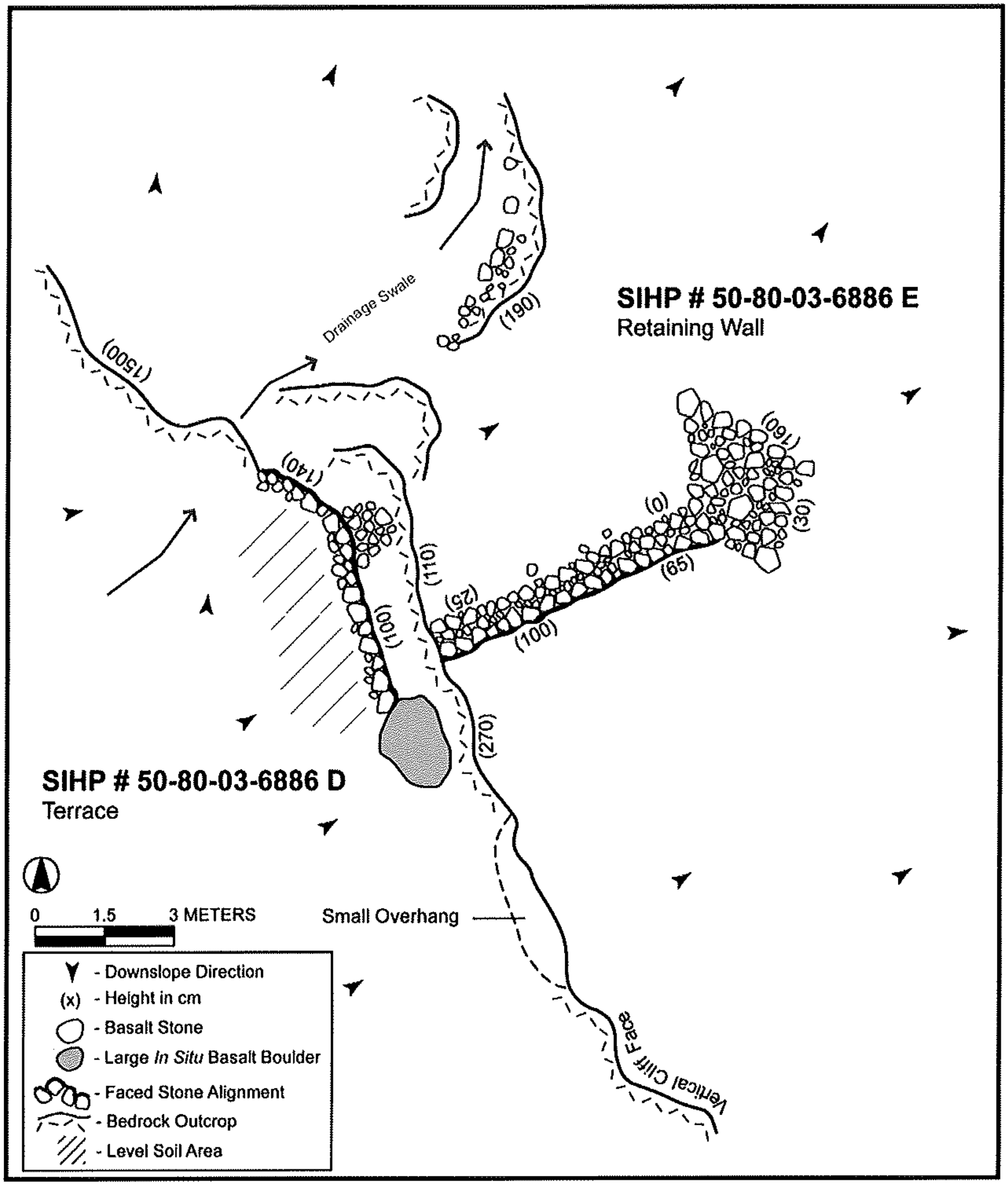


Figure 41. Plan view diagram of SIHP # 50-80-03-6886 Feature D terrace and Feature E retaining wall

Figure 42. Photographs of SIHP # 50-80-03-6886 Feature D terrace (above, view to southwest) and Feature E retaining wall (below, view to west)

wide rocky soil area is retained upslope of the retaining wall. The Feature F terrace retaining wall measures 3.6 m long, 0.6 m wide, with a maximum height of 1.4 m (Figure 43). The faced retaining wall is constructed of stacked basalt boulders and cobbles, 2 to 4 courses high. An approximately 1.8 m by 0.5 m wide rocky soil area is retained upslope of the retaining wall. Immediately downslope of the Feature F terrace is a single-course alignment of basalt boulders and cobbles measuring 2.2 m long, 0.2 m wide, and 0.6 m high. The alignment is oriented roughly parallel to the prevailing slope and is situated along the western edge of the natural drainage channel. The alignment appears to function in directing water flow toward the Feature A and B mounds downslope. The Feature G terrace retaining wall measures 2.0 m long, 0.3 m wide, with a maximum height of 0.6 m (Figure 44). The faced retaining wall is constructed of stacked basalt boulders and cobbles, 3 courses high. An approximately 1.3 m by 0.4 m wide rocky soil area is retained upslope of the retaining wall.

Feature E is a well-constructed retaining wall located immediately downslope of the Feature D terrace, oriented parallel to the prevailing slope. The retaining wall is constructed against the edge of an exposed basalt cliff face and extends approximately 9 m downslope. The wall is constructed of stacked basalt boulders and cobbles, 2 to 4 courses high, with a maximum height of 1.0 m and average width of 0.8 m. The wall is well-faced on the southern edge, and nearly flush with the ground surface on the northern edge. The wall fans out at the downslope end, resembling a crudely constructed mound similar to Features A-C.

SIHP # 50-80-03-6886 Features A-G are interpreted to represent pre-contact/early historic, agricultural planting mounds and terraces. The mound and terrace features are constructed along exposed cliffs and the steep sloping hillside immediately downslope, situated adjacent to natural drainage channels that run down the hillside. The features appear to be constructed to utilize naturally channeled water running down the hillside. The elongated shape and cross-slope orientation also help to trap water descending the slope. According to traditional and historic accounts (see Section 3.1: Traditional and Historical Background), the "hidden waters" indicated by McAllister (1933) to be located on this prominent hillside, consist of natural freshwater springs that originate at the base of cliffs. No flowing springs or seeps were observed during the current inventory survey investigation. However, the natural drainage channels utilized by the SIHP # 50-80-03-6886 agricultural features may have at one time been spring-fed. The SIHP # 50-80-03-6886 archaeological features are in good condition and the surrounding area is largely undisturbed. SIHP # 50-80-03-6886 maintains integrity of location, design, setting, materials, workmanship, feeling, and association. SIHP # 50-80-03-6886 is assessed as significant under Criterion D (have yielded, or may be likely to yield information important in prehistory or history) of the Hawai'i Register of Historic Places evaluation criteria. SIHP # 50-80-03-6886 is also assessed as significant under Criterion E (have an important value to the native Hawaiian people due to associations with traditional beliefs, events or oral history accounts) due to the possible association of the site with the legendary springs of Kawaihāpai.

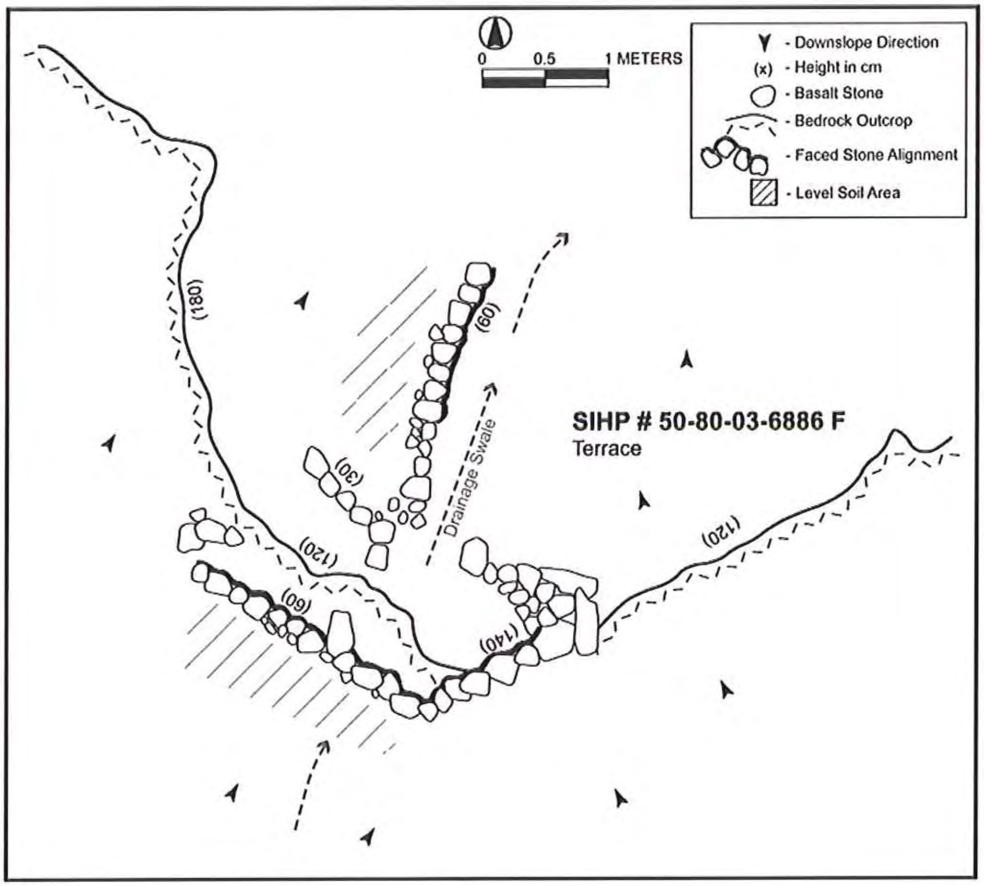


Figure 43. Plan view diagram (above) and photograph (below, view to southwest) of SIHP # 50-80-03-6886 Feature F: terrace

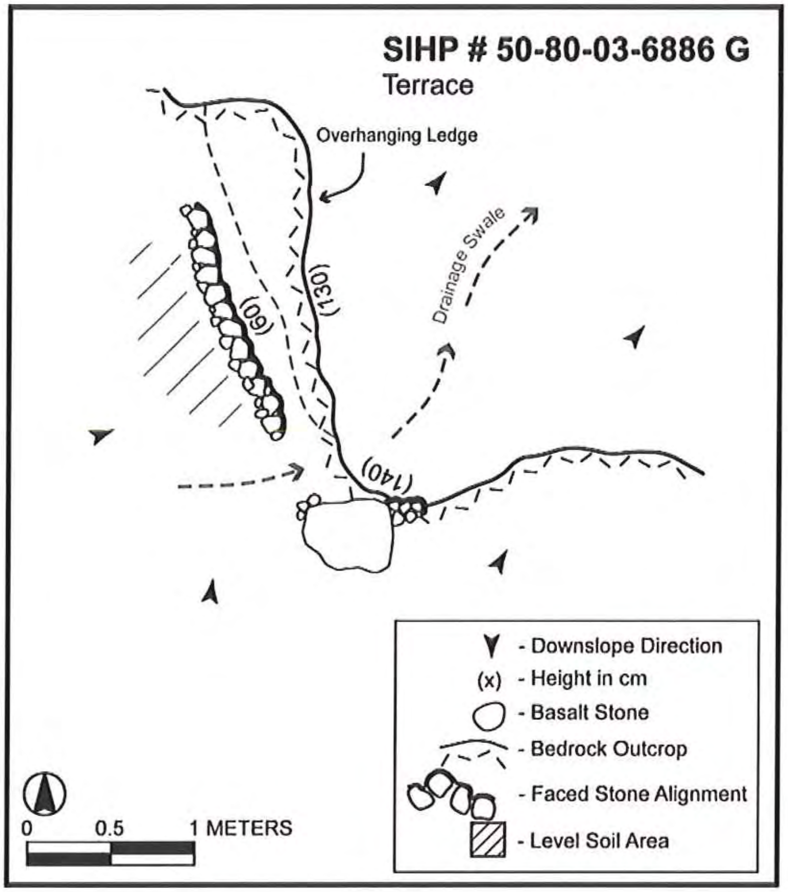


Figure 44. Plan view diagram (above) and photograph (below, view to west) of SIHP # 50-80-03-6886 Feature G: terrace

4.2.5 SIHP #: 50-80-03-6887

SITE TYPE: Overhang Shelter
FUNCTION: Temporary Habitation
FEATURES: 1
DIMENSIONS: 6.0 m N/S x 5.1 m E/W
CONDITION: Good
PROBABLE AGE: Historic
TAX MAP KEY: [1] 6-8-002:006

DESCRIPTION:

SIHP # 50-80-03-6887 is a modified overhang shelter located outside the southwestern portion of the 75-acre inventory survey area, along the prominent hillside indicated by McAllister (1933) to be the location of the Site 192 "Hidden Waters" natural springs (see Figures 16 and 17 above). The overhang is situated near the base of an approximately 6-8 m high exposed basalt cliff face. The terrain is generally steep sloping and rocky, both upslope and downslope of the vertical cliff area.

The entrance to the SIHP # 50-80-03-6887 overhang shelter is approximately 1.5 m above the exterior ground surface, and measures 6.0 wide and 1.5 to 3 m in height. A retaining wall is constructed across the eastern half of the overhang entrance (Figure 45). The retaining wall fills in a low gap in the naturally sloping entrance, to create a relatively level entry to the overhang (Figures 44 and 45). The retaining wall measures 2.8 m in length, 0.6 m wide, with a maximum height of 1.5 m on the downslope side and 0.7 m on the upslope side. The wall is constructed of loosely stacked basalt boulders and cobbles, 2-7 courses high, with intact facing on the downslope edge. A level soil terrace is retained immediately upslope of the wall, measuring approximately 2.0 by 2.2 m wide.

The interior of the overhang measures approximately 6.0 m wide and 5.1 m deep. The floor has three distinct levels, including the soil terrace (level 1) and two natural bedrock ledges (levels 2 and 3). The natural ledges are relatively level, with surfaces of exposed bedrock or shallow sediment. Ceiling heights within the overhang range from 2.9 m above the level 1 terrace, 3.0 m above the level 2 ledge, and 1.0 m above the level 3 ledge. Several modern and historic artifacts were observed throughout the surface of the overhang, including an aerosol can, tin cans, a metal pipe, historic and modern glass bottles, a metal storage box, a "1970" penny, melted candle wax, and a degraded foam sleeping mat. The interior of the cave was dry at the time of the current inventory survey investigation. However, evidence of water intrusion during heavy precipitation was observed.

SIHP # 50-80-03-6887 is interpreted to function as a historic, temporary habitation site. The overhang shelter may have been used for ranch-related activities dating from the mid-1800s to modern times. No evidence of pre-contact, traditional Hawaiian occupation was observed. However, as the SIHP # 50-80-03-6887 overhang is of adequate size for comfortable occupation, and is in close proximity to the SIHP # 50-80-03-6886 and 50-80-03-6888 pre-contact/early historic agricultural complexes, the overhang may have been utilized in the pre-contact period. SIHP # 50-80-03-6887 is in good condition. The interior of the overhang and the surrounding area are undisturbed. The constructed retaining wall and terrace are intact, with no collapse observed. SIHP # 50-80-03-6887 maintains integrity of location, design, setting, materials, workmanship, feeling, and association. SIHP # 50-80-03-6887 is assessed as significant under Criterion D (have yielded, or may be likely to yield information important in prehistory or history) of the Hawai'i Register of Historic Places evaluation criteria.

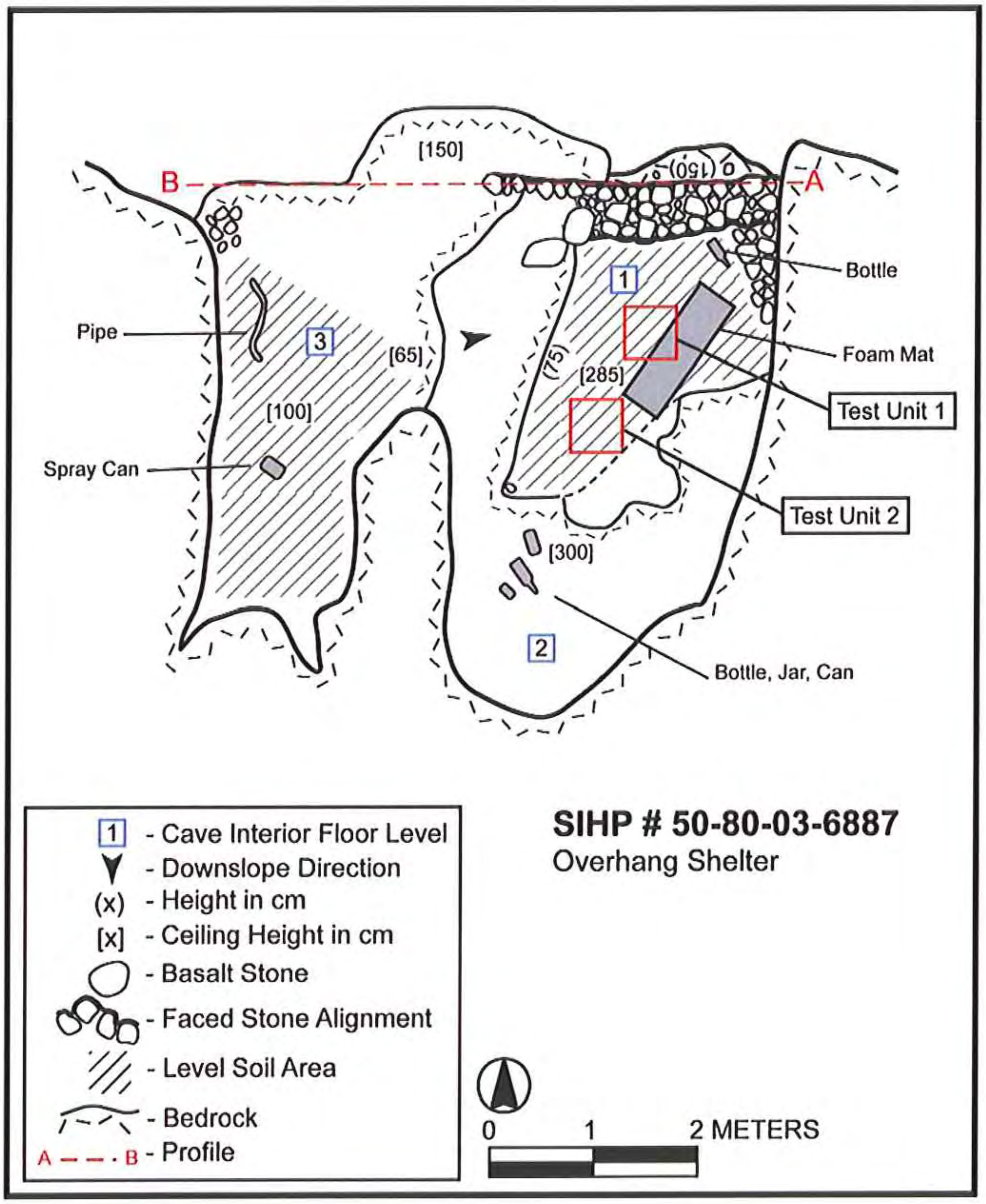


Figure 45. Plan view diagram of SIHP # 50-80-03-6887 overhang shelter

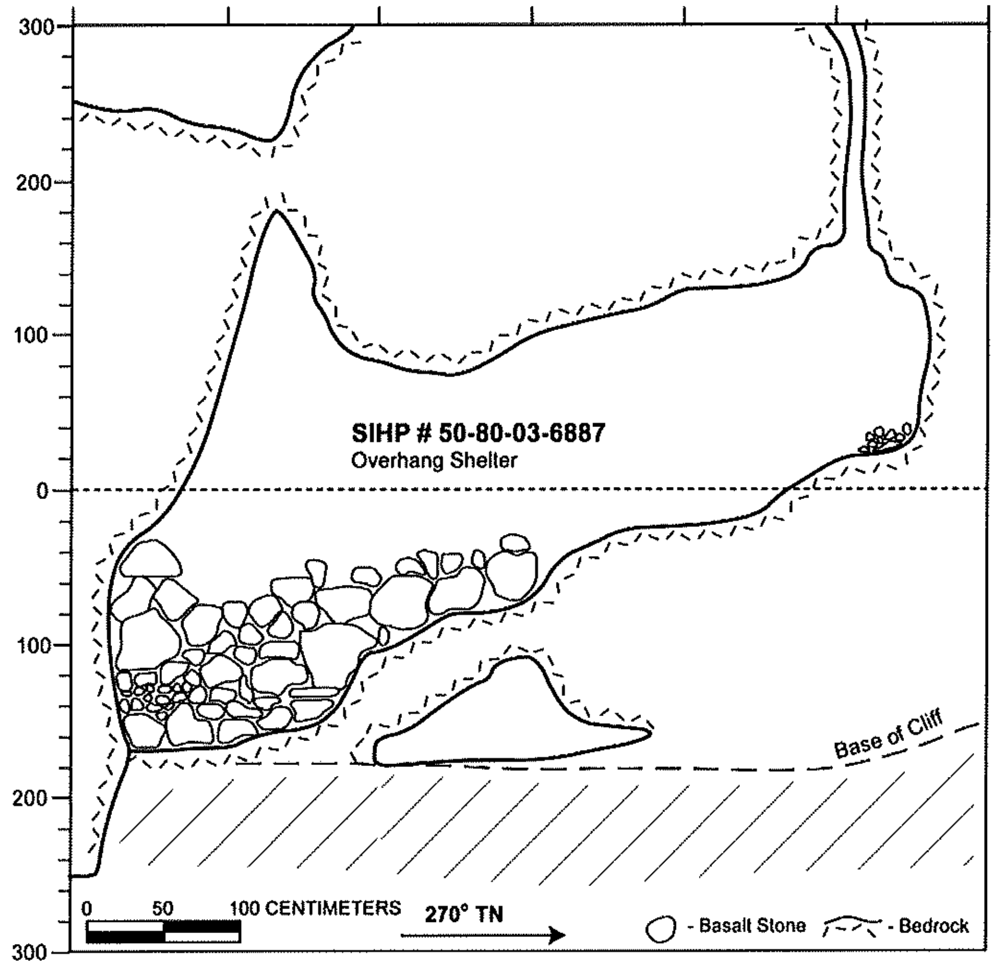


Figure 46. Profile diagram of the SIHP # 50-80-03-6887 overhang shelter entrance

Figure 47. Photograph of SIHP # 50-80-03-6887: modified overhang shelter, exterior, showing retaining wall across the overhang entrance, view to south

Figure 48. Photograph of SIHP # 50-80-03-6887: modified overhang shelter, interior, showing level terrace area within the overhang and foam mat, view to east.

4.2.6 SIHP #: 50-80-03-6888

SITE TYPE: 5 Mounds, 1 Terrace
FUNCTION: Agricultural Complex
FEATURES: 6
DIMENSIONS: 20 m N/S x 35 m E/W
CONDITION: Good
PROBABLE AGE: Pre-Contact/Early Historic
TAX MAP KEY: [1] 6-8-002:006

DESCRIPTION:

SIHP # 50-80-03-6888 is an agricultural complex located outside the southwestern portion of the 75-acre inventory survey area, along the prominent hillside indicated by McAllister (1933) to be the location of the Site 192 "Hidden Waters" natural springs (see Figures 16 and 17 above). The complex is comprised of six individual features covering an area approximately 20 m N/S by 35 m E/W (see Figure 37 above). The complex includes a cluster of five rock mounds and one terrace, situated on steep sloping terrain immediately downslope of exposed basalt cliffs. In addition to the six identified features, additional small, crudely constructed mounds measuring less than 1 m in diameter were observed scattered throughout the SIHP # 50-80-03-6888 area. The features of SIHP # 50-80-03-6888 are also located adjacent to natural drainage channels that progress down the hillside to the gully below.

SIHP # 50-80-03-6888 Features A, C, D, E, and F are crudely constructed rock mounds. The mounds are composed of basalt boulders and cobbles piled against the steep sloping hillside. The mounds are not faced, and have sloping top surfaces. The constructions are generally elongated oval shapes, with the long axes oriented perpendicular to the prevailing slope direction. The mounds are also generally constructed on or against the upslope edges of large, *in situ* basalt boulders or bedrock outcrops. Narrow, relatively level soil areas are also retained upslope of the mound constructions

Feature A mound measures 6.0 m long, 2.5 m wide, with a maximum height of 2.0 m (Figure 49). The mound is constructed immediately upslope of a bedrock outcrop and includes larger stones along the downslope edge and smaller stones on the upslope edge. Feature C mound measures 5.4 m long, 3.0 m wide, with a maximum height of 1.6 m (Figure 50). The mound is constructed across a natural drainage swale, with larger stones incorporated into the base of the mound and smaller stones piled on top. Feature D mound measures 4.5 m long, 1.5 m wide, with a maximum height of 1.1 m (Figure 51). The mound is constructed immediately upslope of a bedrock outcrop, primarily composed of basalt boulders, with few cobbles along the upslope edge. Feature E measures 3.5 m long, 2.2 m wide, with a maximum height of 1.7 m (Figure 52). The mound is constructed against the upslope edge of a large, *in situ* basalt boulder, with basalt boulders and cobbles evenly distributed throughout the construction. Feature F consists of two adjacent mounds, measuring 4.5 m long, 1.4 m wide, 1.6 m high and 2.1 m long, 1.5 m wide, 1.3 m high (Figure 53). The adjacent mounds are constructed with evenly distributed basalt cobbles and small boulders.

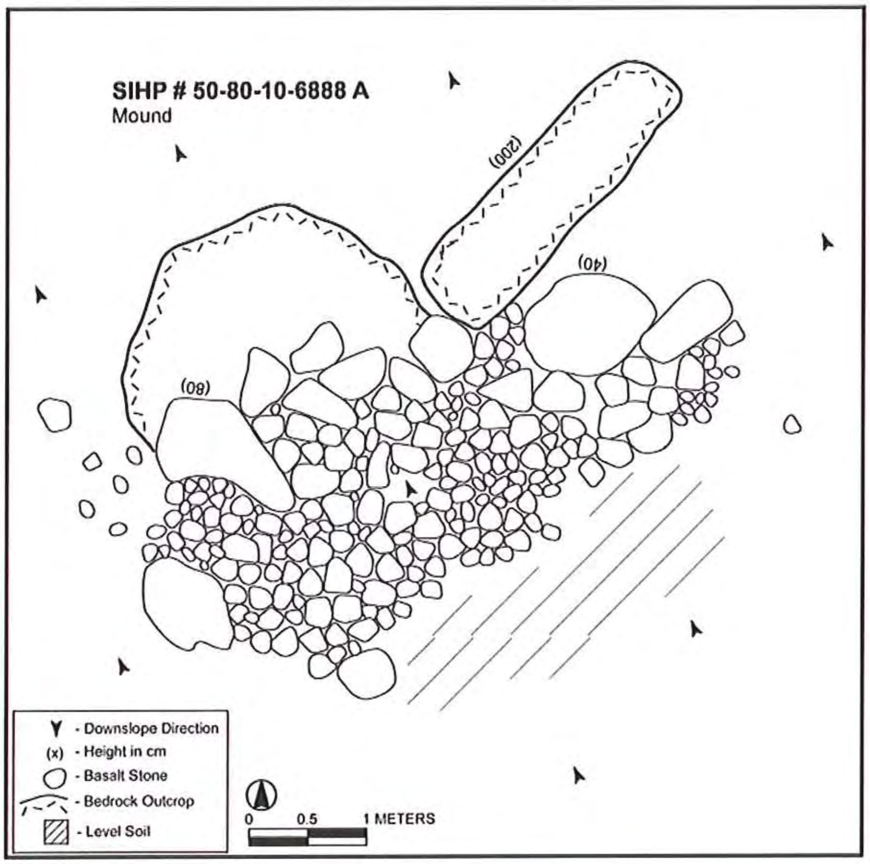


Figure 49. Plan view diagram (above) and photograph (below, view to southeast) of SIHP # 50-80-03-6888 Feature A: mound

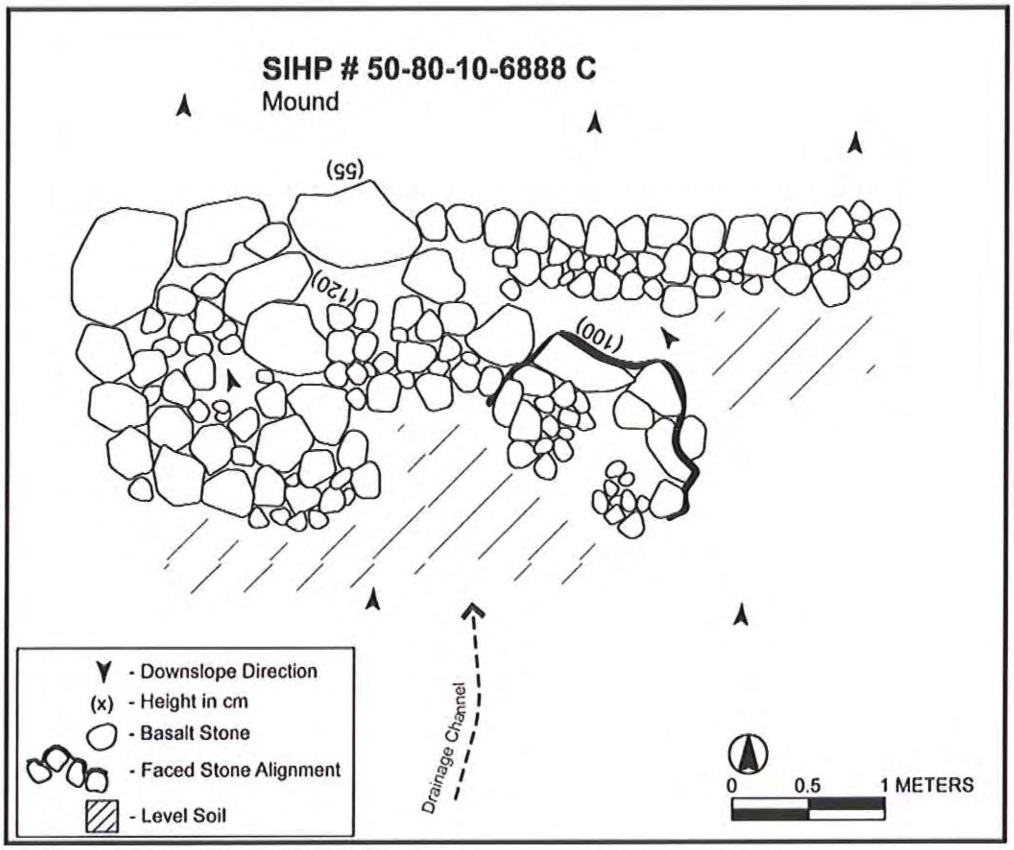


Figure 50. Plan view diagram (above) and photograph (below, view to southeast) of SIHP # 50-80-03-6888 Feature C: mound

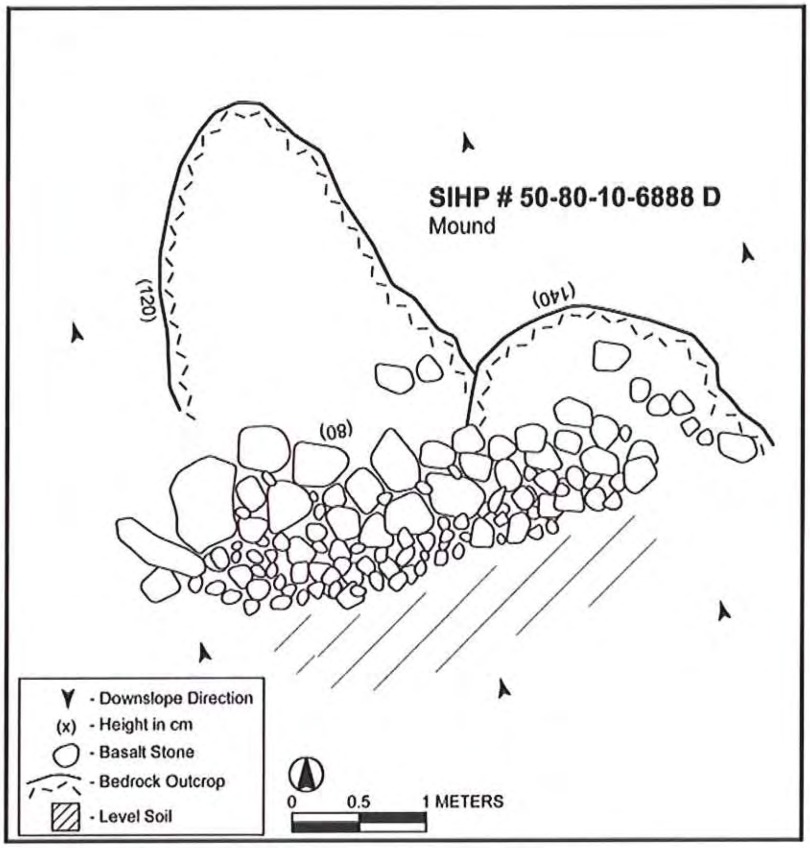


Figure 51. Plan view diagram (above) and photograph (below, view to southeast) of SIHP # 50-80-03-6888 Feature D: mound

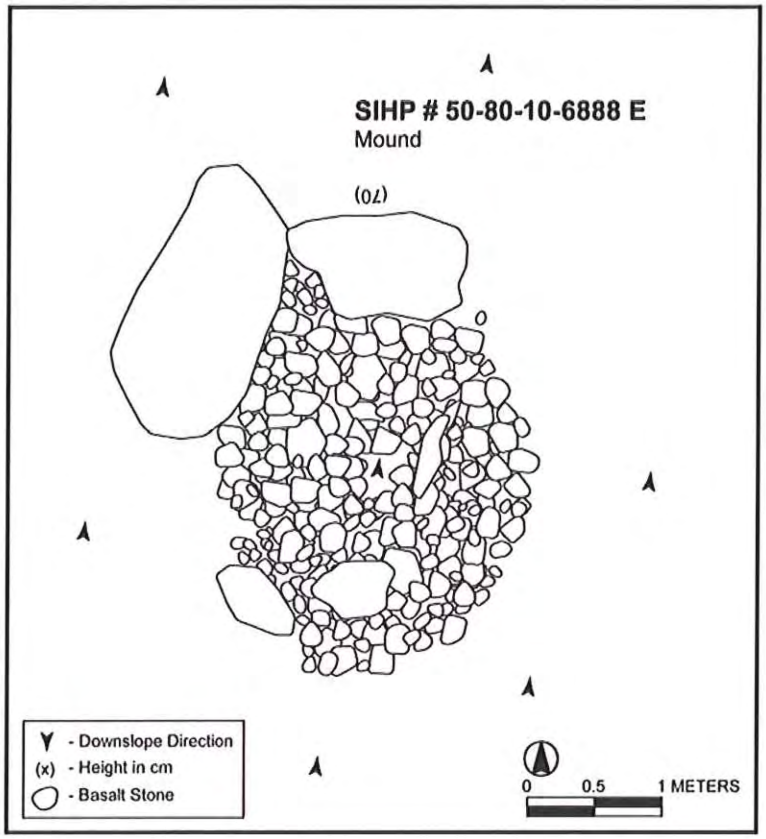


Figure 52. Plan view diagram (above) and photograph (below, view to southwest) of SIHP # 50-80-03-6888 Feature E: mound

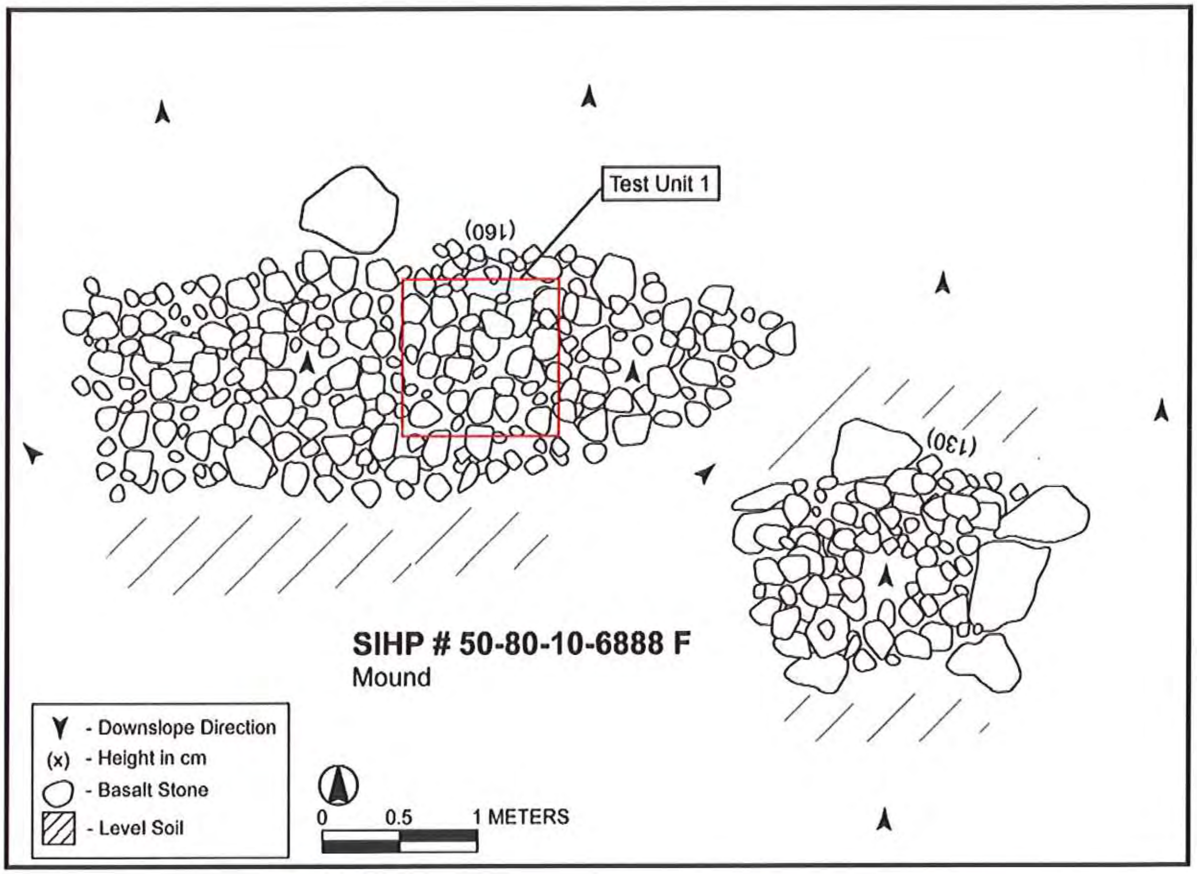


Figure 53. Plan view diagram (above) and photograph (below, view to southwest) of SIHP # 50-80-03-6888 Feature F: mound

Feature B is a small terrace feature within the SIHP # 50-80-03-6888 complex. The terrace is constructed with a small, loosely stacked basalt boulder and cobble retaining wall (Figure 54). The retaining wall is oriented parallel to the prevailing slope and is constructed between a large, *in situ* basalt boulder downslope and a bedrock outcrop upslope. The retaining wall measures 1.3 m long, 0.4 m wide, with a maximum height of 0.7 m along the downslope edge. The retaining wall is faced on the downslope side and retains a level soil terrace between the large boulder and bedrock outcrop, measuring 1.1 m by 1.0 m wide.

SIHP # 50-80-03-6888 Features A-F are interpreted to represent pre-contact/early historic, agricultural planting mounds and a planting terrace. The mound and terrace features are constructed along a steep sloping hillside downslope of exposed cliffs, situated adjacent to natural drainage channels that run down the hillside from the base of the cliffs. The features appear to be constructed to utilize naturally channeled water running down the hillside. The elongated shape and cross-slope orientation also help to trap water descending the slope. According to traditional and historic accounts (see Section 3.1: Traditional and Historical Background), the "hidden waters" indicated by McAllister (1933) to be located on this prominent hillside, consist of natural freshwater springs that originate at the base of cliffs. No flowing springs or seeps were observed during the current inventory survey investigation. However, the natural drainage channels utilized by the SIHP # 50-80-03-6888 agricultural features may have at one time been spring-fed. The SIHP # 50-80-03-6888 archaeological features are in good condition and the surrounding area is largely undisturbed. SIHP # 50-80-03-6888 maintains integrity of location, design, setting, materials, workmanship, feeling, and association. SIHP # 50-80-03-6888 is assessed as significant under Criterion D (have yielded, or may be likely to yield information important in prehistory or history) of the Hawai'i Register of Historic Places evaluation criteria. SIHP # 50-80-03-6888 is also assessed as significant under Criterion E (have an important value to the native Hawaiian people due to associations with traditional beliefs, events or oral history accounts) due to the possible association of the site with the legendary springs of Kawaihāpai.

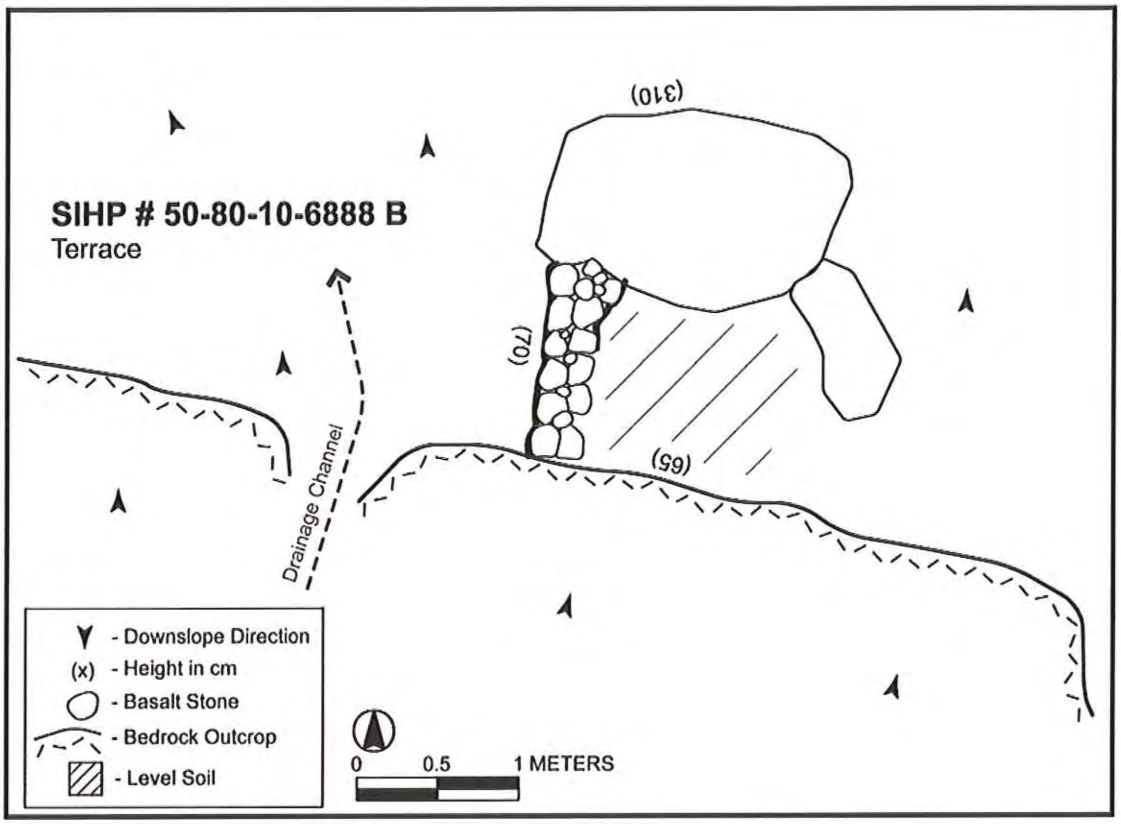


Figure 54. Plan view diagram (above) and photograph (below, view to east) of SIHP # 50-80-03-6888 Feature B: terrace

4.3 Test Excavation Findings

4.3.1 SIHP # 50-80-03-416 Feature F Test Unit 1

A 50 cm by 50 cm test excavation was made within the eastern portion of the SIHP# 50-80-03-416 Feature F terrace to better determine the age and function of the feature (see Figure 19). The test excavation was located in the best-constructed and minimally disturbed portion of the terrace. This area was thought to have the highest likelihood of containing intact cultural material.

The surface of the test excavation consisted of level soil, clear of surface stones, covered with a layer of leaf litter and humus (Figure 55). Two sediment strata were observed through the excavation of Test Unit 1 (Figure 56). Stratum I consisted of a loose, very dark brown silt loam sediment, representing developing top soil. Stratum II consisted of a dark grayish brown silt loam sediment, similar to Stratum I but more compact and containing approximately 30% basalt pebbles and cobbles incorporated into the sediment matrix. A light charcoal flecking was observed throughout the Stratum II sediment. 4.3 g of charcoal were recovered from the soil matrix and submitted for radiocarbon dating analysis. In addition, 3.0 g of marine shell midden were recovered from Stratum II. At approximately 35 cmbs, the test excavation was terminated at the surface of a layer of large basalt cobbles and small boulders. The terrace appears to have been built up with these stones and subsequently covered with the Stratum II soil.

Following the test excavation, the excavated area was reconstructed as closely as possible to its original state. Detailed sediment descriptions are as follows:

Strata	Depth (cmbs)	Description
Stratum I	0-5	10YR 2/2 very dark brown silt loam; weak, fine blocky structure; dry, loose consistency; non-plastic; no cementation; terrestrial origin; includes leaf litter and abundant roots and rootlets, no cultural material observed; Lower Boundary (LB) is clear, smooth.
Stratum II	5-BOE	10YR 3/2 very dark grayish brown silt loam; moderate, fine blocky structure; dry, slightly hard consistency; non-plastic; no cementation; terrestrial origin; includes 30% basalt pebbles and cobbles, abundant roots and rootlets, contains light charcoal flecking and a small amount of marine shell midden; Lower Boundary (LB) below base of excavation.

Figure 55. Pre-excavation (above) and post-excavation (below) photographs of SIHP # 50-80-03-416 Feature F Test Unit 1

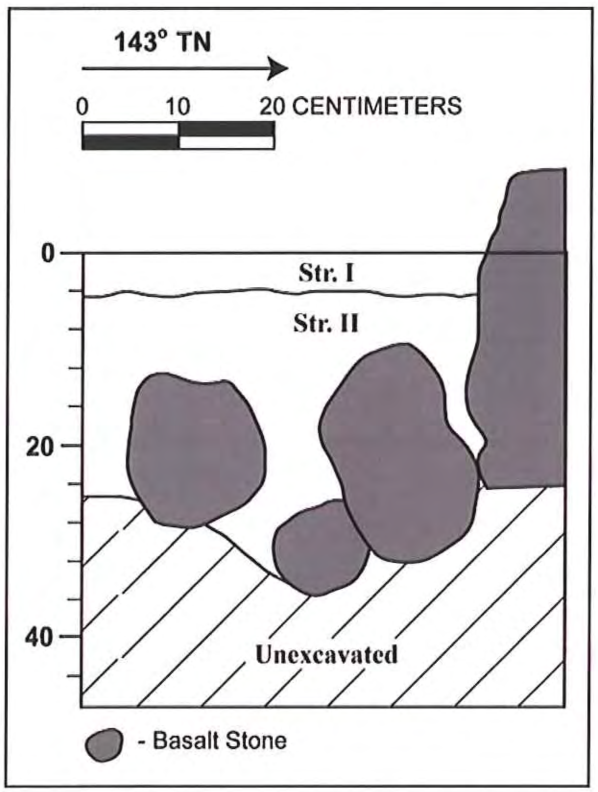


Figure 56. Photograph (above) and stratigraphic profile (below) of the northeast wall of SIHP # 50-80-03-416 Feature F Test Unit 1

4.3.2 SIHP # 50-80-03-6885 Feature D Test Unit 1

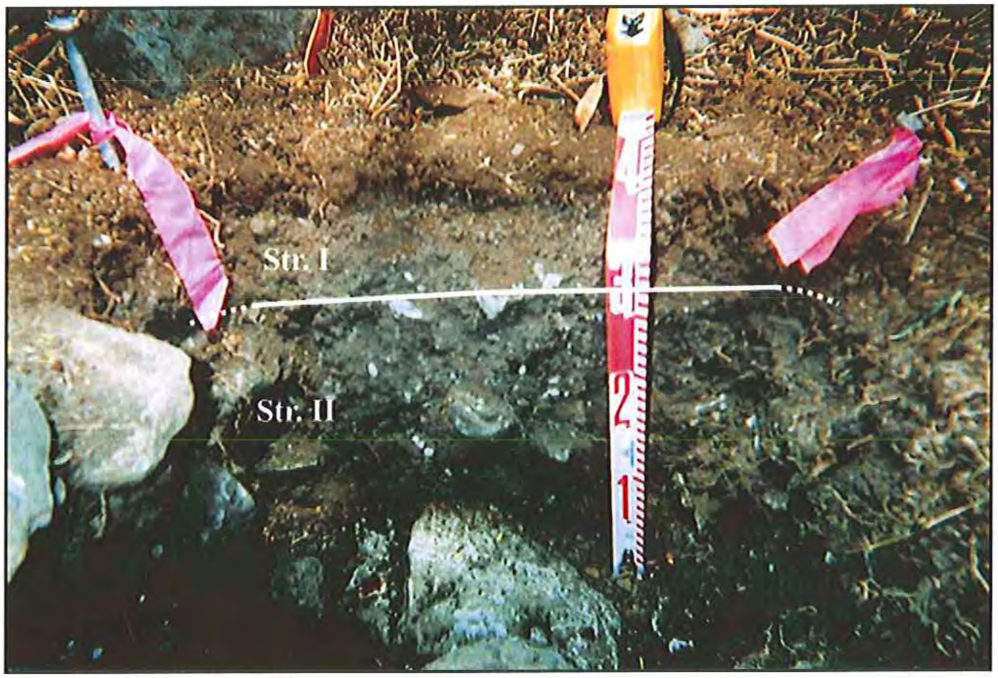
A 50 cm by 50 cm test excavation was made within the northeastern portion of the SIHP# 50-80-03-6885 Feature D terrace to better determine the age and function of the feature (see Figure 35 above). The test excavation was located in the best-constructed and minimally disturbed portion of the terrace. This area was thought to have the highest likelihood of containing intact cultural material.

The surface of the test excavation consisted of level soil, clear of surface stones, covered with a layer of leaf litter and humus (Figure 57). Two sediment strata were observed through the excavation of Test Unit 1 (Figure 58). Stratum I consisted of a loose, very dark grayish brown silt loam sediment, representing developing top soil. Stratum II consisted of a dark brown silt loam sediment, similar to Stratum I but slightly more compact. Stratum II included plentiful angular basalt pebbles and cobbles incorporated into the sediment matrix. A small pocket of charcoal flecking was encountered along the east wall of the test excavation at 23 cmbs. Approximately 2.5 g of charcoal were recovered. However, because the charcoal did not originate from an identifiable feature, such as a hearth or cultural layer, and due to the small amount of charcoal recovered, a charcoal sample was not submitted for radiocarbon dating analysis. At approximately 35 cmbs, the test excavation was terminated at the surface of a layer of large basalt cobbles and small boulders. The stones were likely the upslope portion of the terrace retaining wall. Stratum II represents soil accumulation behind the constructed terrace wall.

Following the test excavation, the excavated area was reconstructed as closely as possible to its original state. Detailed sediment descriptions are as follows:

Strata	Depth (cmbs)	Description
Stratum I	0-10	10YR 3/2 very dark grayish brown silt loam; weak, medium crumb structure; dry, loose consistency; slightly plastic; no cementation; terrestrial origin; includes plentiful roots and rootlets, few angular basalt pebbles; no cultural material observed; Lower Boundary (LB) is clear, smooth.
Stratum II	10-BOE	10YR 3/3 dark brown silt loam; weak, fine granular structure; dry, loose consistency; slightly plastic; no cementation; terrestrial origin; includes a small pocket of charcoal, abundant roots and rootlets, and plentiful angular basalt pebbles and cobbles; LB is below base of excavation.

Figure 57. Pre-excavation (above) and post-excavation (below) photographs of SIHP # 50-80-03-6885 Feature D Test Unit 1



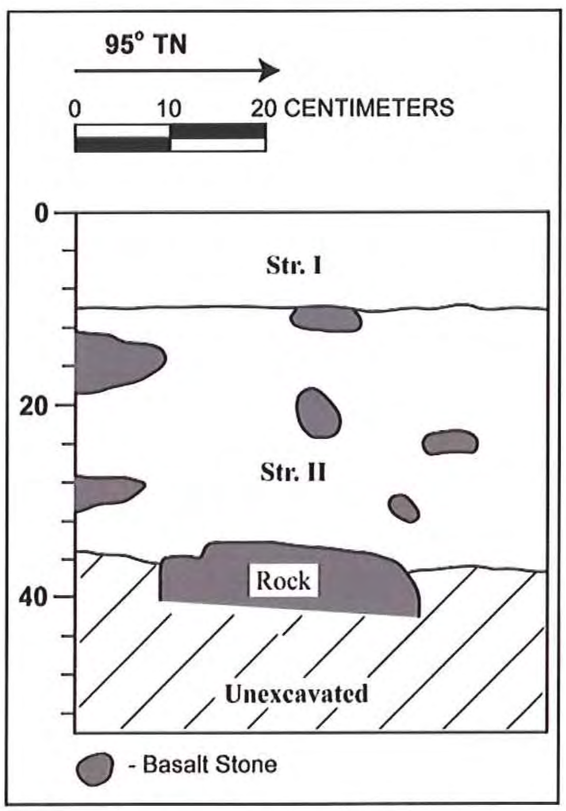


Figure 58. Photograph (above) and stratigraphic profile (below) of the north wall of SIHP # 50-80-03-6885 Feature D Test Unit 1

4.3.3 SIHP # 50-80-03-6887 Test Unit 1

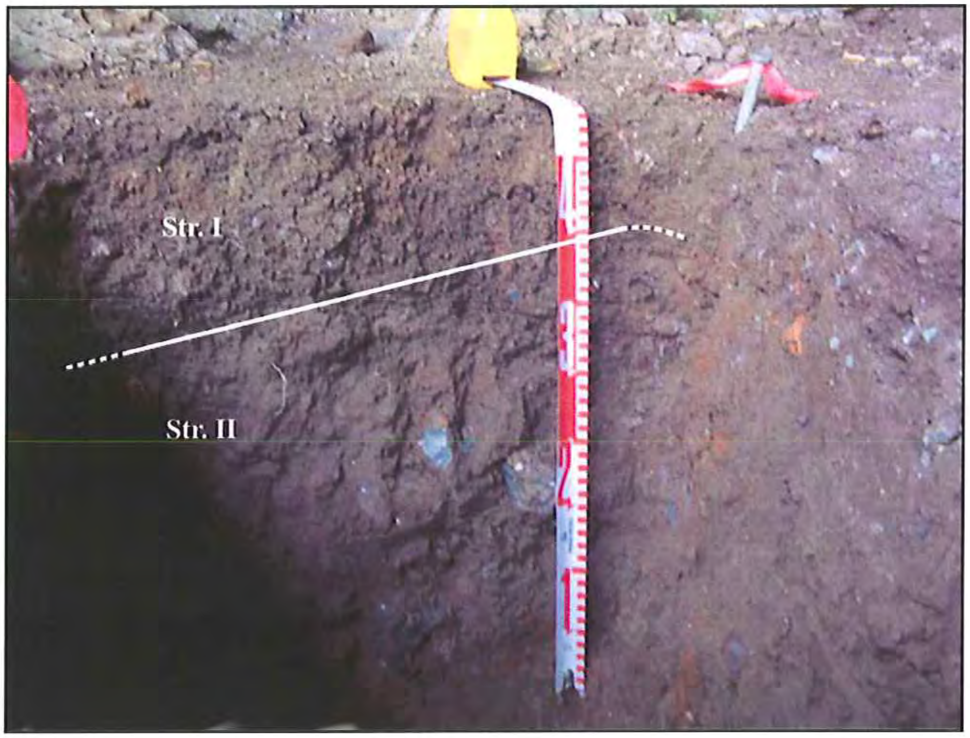
A 50 cm by 50 cm test excavation was made within the central portion of the interior terrace in the SIHP# 50-80-03-6887 overhang shelter to better determine the age of the feature (see Figure 45). The test excavation was located in the modified portion of the overhang shelter, which was thought to have the highest likelihood of containing intact cultural material.

The surface of the test excavation consisted of level soil, clear of surface stones, with historic and modern garbage, including a foam sleeping mat (Figure 59). Two sediment strata were observed through the excavation of Test Unit 1 (Figure 60). Stratum I consisted of a slightly hard, dark brown clay loam sediment, representing continued sediment buildup within the overhang. Stratum II consisted of a very hard, dark brown clay sediment. Stratum II included plentiful decomposing basalt pebbles and cobbles incorporated into the sediment matrix. Stratum II represents sterile sediment accumulation behind the constructed terrace wall. The test excavation was terminated at bedrock, at a depth of 46 cmbs. No cultural material was observed through the excavation of Test Unit 1.

Following the test excavation, the excavated area was reconstructed as closely as possible to its original state. Detailed sediment descriptions are as follows:

Strata	Depth (cmbs)	Description
Stratum I	0-15	7.5YR 3/2 dark brown clay loam; moderate, medium crumb structure; dry, slightly hard consistency; slightly plastic; no cementation; terrestrial origin; no cultural material observed; Lower Boundary (LB) is abrupt, smooth.
Stratum II	15-BOE	7.5YR 3/2 dark brown clay; structureless; dry, very hard consistency; plastic; no cementation; terrestrial origin; no cultural material observed; Lower Boundary (LB) is at bedrock.

Figure 59. Pre-excavation (above) and post-excavation (below) photographs of SIHP # 50-80-03-6887 Test Unit 1



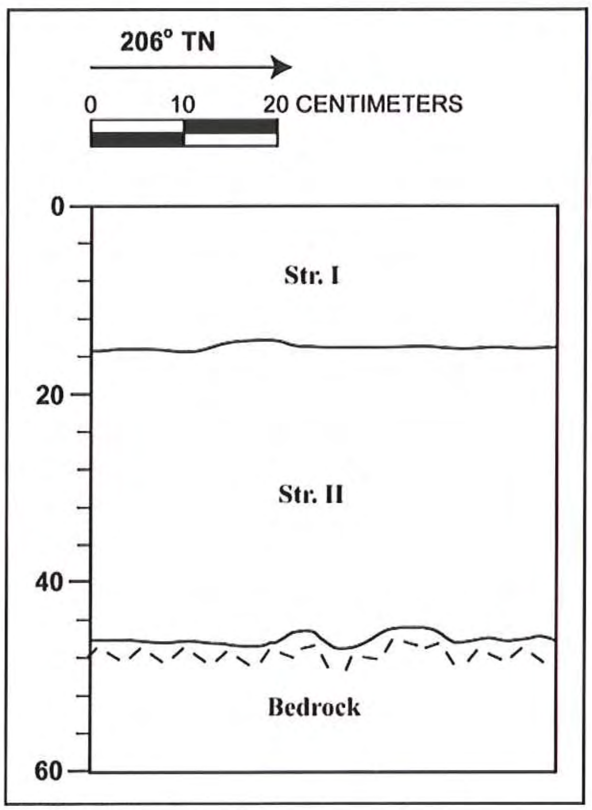


Figure 60. Photograph (above) and stratigraphic profile (below) of the east wall of SIHP # 50-80-03-6887 Test Unit 1

4.3.4 SIHP # 50-80-03-6887 Test Unit 2

A second 50 cm by 50 cm test excavation was made within the northern portion of the interior terrace in the SIHP # 50-80-03-6887 overhang shelter to better determine the age of the feature (see Figure 45). The test excavation was located in the modified portion of the overhang shelter, which was thought to have the highest likelihood of containing intact cultural material.

The surface of the test excavation consisted of level soil, clear of surface stones, with historic and modern garbage, including a foam sleeping map (Figure 61). Two sediment strata were observed through the excavation of Test Unit 2 (Figure 62). Stratum I consisted of a slightly hard, dark brown clay loam sediment, representing continued sediment buildup within the overhang. Stratum II consisted of a very hard, dark brown clay sediment. Stratum II included plentiful decomposing basalt pebbles and cobbles incorporated into the sediment matrix. Stratum II represents sterile sediment accumulation behind the constructed terrace wall. A portion of a hearth, or fire pit, was encountered in the northeastern portion of the test excavation. The Feature A hearth was observed to have been excavated into the Stratum II sediment and was capped by the undisturbed Stratum I sediment, indicating a period of sediment buildup within the overhang shelter following the disuse of the hearth. The Feature A hearth contained abundant charcoal, including large chunks, burnt fish bones, and fire-cracked basalt cobbles. 81.1 g of charcoal and 0.4 g of marine vertebrate midden were recovered from Test Unit 2. A 40.1 g charcoal sample was submitted for radiocarbon dating analysis. The test excavation was terminated at a depth of 30 cmbs, within clearly sterile Stratum II sediments.

Following the test excavation, the excavated area was reconstructed as closely as possible to its original state. Detailed sediment descriptions are as follows:

Strata	Depth (cmbs)	Description
Stratum I	0-10	7.5YR 3/2 dark brown clay loam; moderate, medium crumb structure; dry, slightly hard consistency; slightly plastic; no cementation; terrestrial origin; includes few basalt pebbles and small cobbles; no cultural material observed; Lower Boundary (LB) is abrupt, smooth.
Stratum II	15-BOE	7.5YR 3/2 dark brown clay; structureless; dry, very hard consistency; plastic; no cementation; terrestrial origin; includes a hearth (Feature A) excavated into Str. II sediment, containing abundant charcoal, burnt rocks, burnt bone midden; LB is below base of excavation.

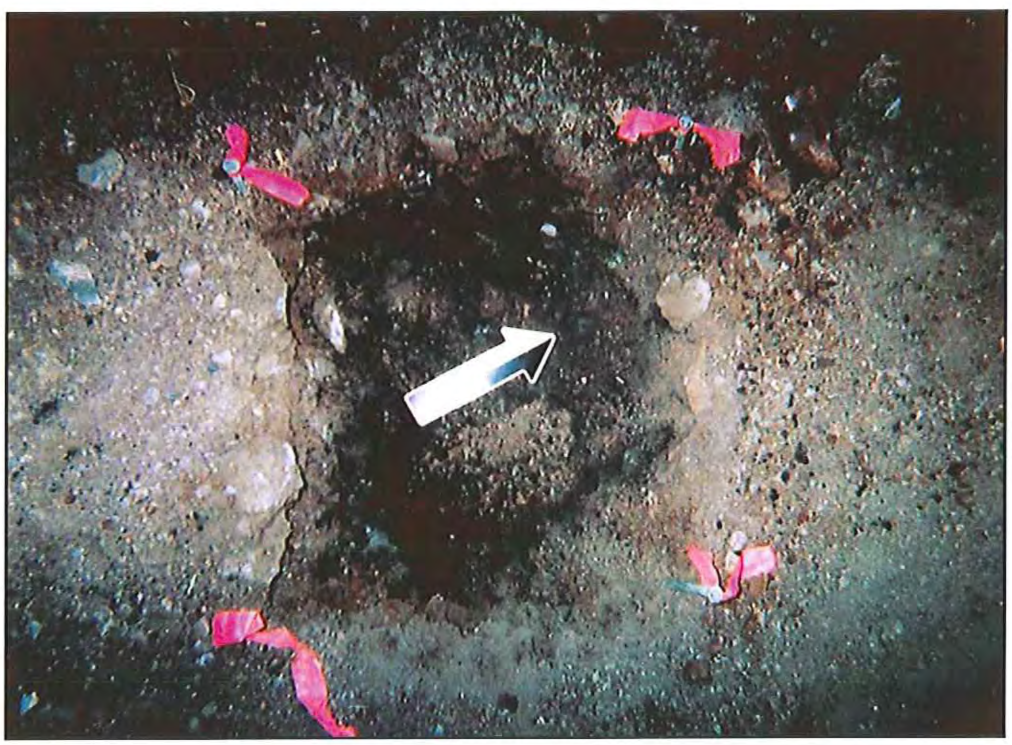
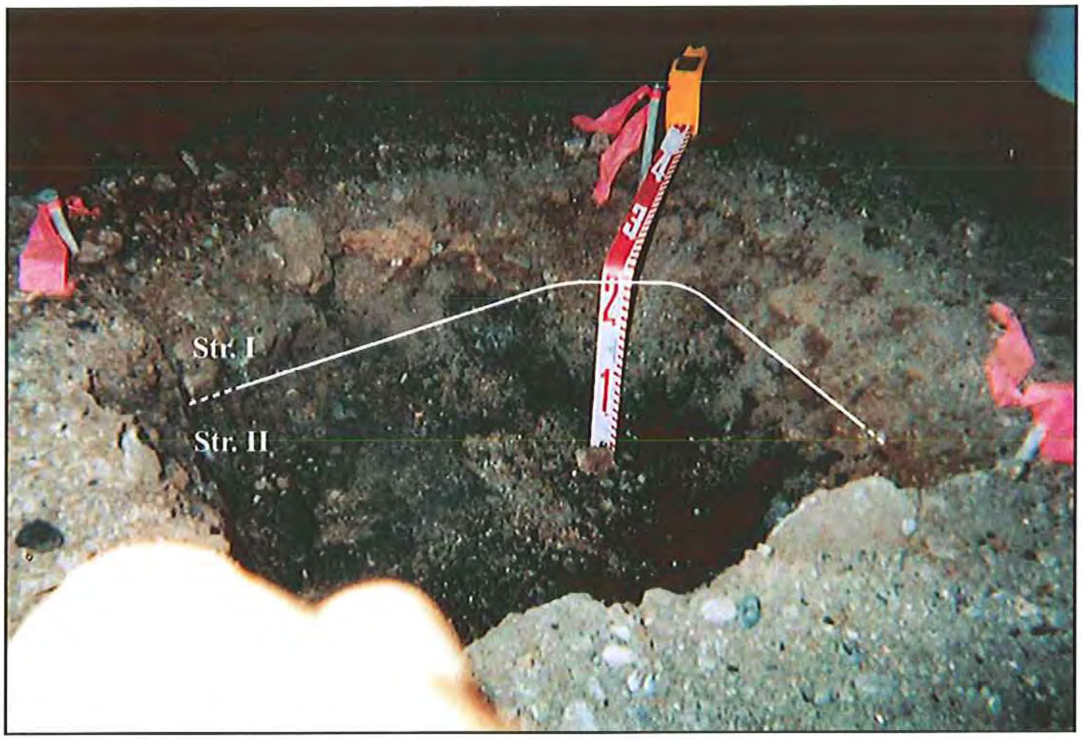


Figure 61. Pre-excavation (above) and post-excavation (below) photographs of SIHP # 50-80-03-6887 Test Unit 2



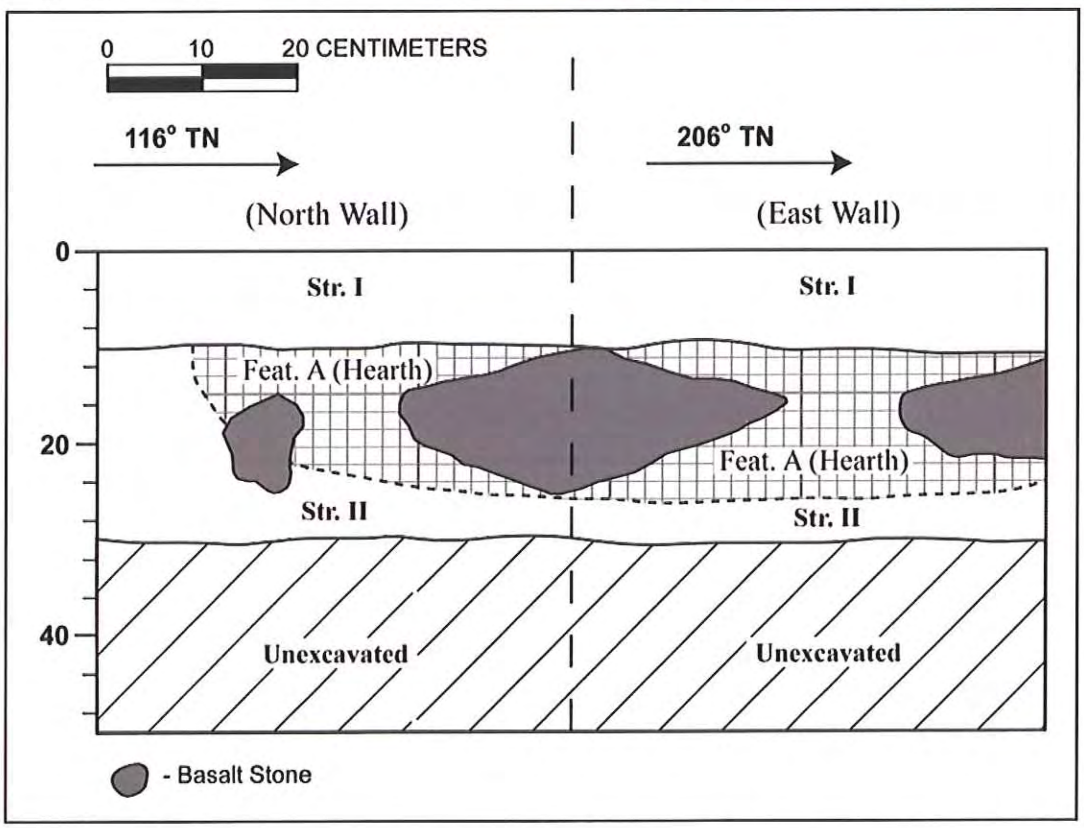


Figure 62. Photograph (above) and stratigraphic profile (below) of the north and east walls of SIHP # 50-80-03-6887 Test Unit 2

4.3.5 SIHP # 50-80-03-6888 Feature F Test Unit 1

A 1 m by 1 m test excavation was made within the central portion of the SIHP# 50-80-03-6888 Feature F mound to better determine the function and method of construction of the feature (see Figure 53). The test excavation was located in a well-constructed and minimally disturbed portion of the mound.

The sloping surface of the test excavation consisted of piled basalt boulders and cobbles, covered with a layer of leaf litter and humus (Figure 63). Deconstruction of the mound feature revealed the stones were loosely piled approximately 20-30 cm above the current soil surface, with a mixed soil and stone matrix extending to the base of excavation. This soil buildup in the lower portion of the rock matrix indicates the lower courses of the mound structure function in retaining soil. The stones comprising the mound structure were unsorted, with boulders, cobbles, and pebbles distributed throughout the construction. Several flat, plate-like stones were also incorporated into the mound construction. These stones were unlikely to have rolled down the hillside, and therefore provide further evidence the mounds are man-made constructions, rather than natural rockfall accumulations.

Two sediment strata were observed through the excavation of Test Unit 1 (Figure 64). Stratum I consisted of a brown silt loam sediment, representing developing top soil. Stratum II consisted of a brown silt loam sediment, similar to Stratum I but more compact. Stratum II includes the lower portion of the mound structure, with basalt pebbles, cobbles, and boulders incorporated into the sediment matrix. Stratum II represents soil accumulation at the base of the mound construction. The test excavation was terminated at a point of heavy rock density and a lack of sediment to excavate.

Following the test excavation, the excavated area was reconstructed as closely as possible to its original state. Detailed sediment descriptions are as follows:

Strata	Depth (cmbs)	Description
Stratum I	0-5	7.5YR 4/3 brown silt loam; moderate, fine blocky structure; dry, weakly coherent consistency; non-plastic; no cementation; terrestrial origin; includes leaf litter and abundant roots and rootlets, no cultural material observed; Lower Boundary (LB) is clear, wavy.
Stratum II	5-BOE	7.5YR 4/4 brown silt loam; moderate, fine blocky structure; dry, hard consistency; non-plastic; no cementation; terrestrial origin; includes abundant roots and rootlets; Lower Boundary (LB) is below base of excavation.

Figure 63. Pre-excavation (above) and post-excavation (below) photographs of SIHP # 50-80-03-6888 Feature F Test Unit 1

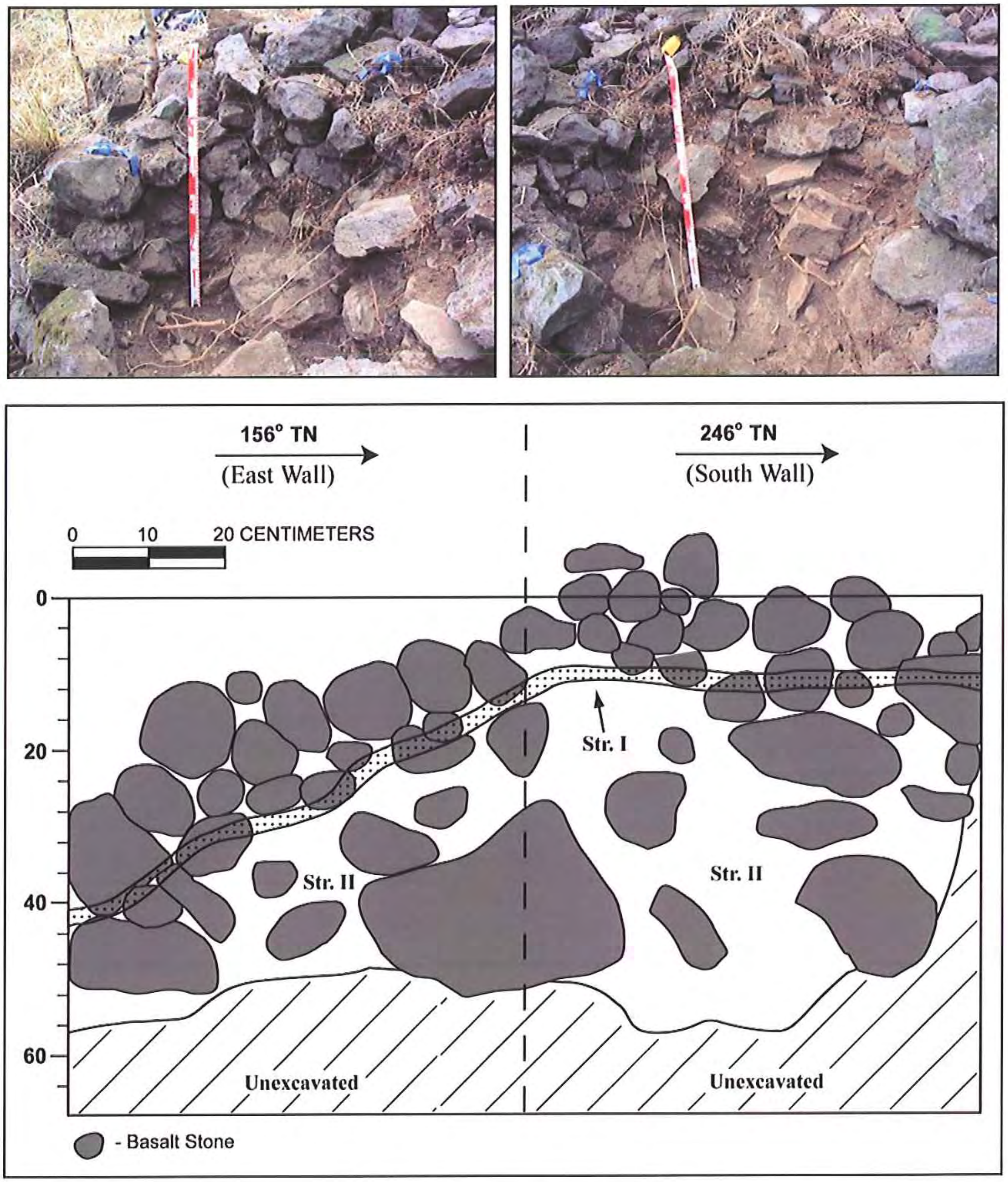


Figure 64. Photographs (above) and stratigraphic profile (below) of the east and south walls of SIHP # 50-80-03-6888 Test Unit 1

Section 5 Results of Laboratory Analyses

Test Unit 1 at SIHP# 50-80-03-416 Feature F contained a total of 3.0 g of midden and 4.3 g of charcoal. The midden collection (Table 6) contained 3.0 g of marine midden, consisting of unidentified gastropod shell remains. The limited amount of marine shell midden was distributed throughout the Stratum II sediment. 4.3 g of charcoal was recovered from Stratum II (Table 7) and consisted of light flecking distributed throughout the Stratum II sediment. The recovered charcoal was submitted to Beta Analytic, Inc. for radiocarbon dating analysis (MOKUL 4-2; Beta -221342) (see Radiocarbon Dating Analysis below). Radiocarbon dating analysis yielded three possible date ranges, with calibrated 2-sigma date ranges of A.D. 1670-1780 (43.7% probability) and A.D. 1790-1890 (35.7% probability) being the most probable. Analyses also yielded multiple radiocarbon calibration curve intercepts of A.D. 1680, 1730, 1810, 1930, and 1950. The relatively broad calibrated date ranges and multiple intercepts span the late pre-contact period to the historic period, and therefore do not provide conclusive evidence for dating the occupation of the SIHP# 50-80-03-416 Feature F terrace.

Test Unit 2 at SIHP # 50-80-03-6887 contained a total of 0.4 g of midden and 81.1 g of charcoal. The midden collection (Table 6) contained 0.4 g of burnt, unidentified fish bone. The limited amount of marine vertebrate midden was located with the Feature A hearth charcoal matrix. 81.1 g of charcoal, including large chunks, were recovered from the Feature A hearth. A 41.1 g charcoal sample was submitted to Beta Analytic, Inc. for radiocarbon dating analysis (MOKUL 4-1; Beta -220909) (see Radiocarbon Dating Analysis below). Radiocarbon dating analysis yielded two possible date ranges, with a calibrated 2-sigma date range of A.D. 1660-1890 (79.3% probability) being the most probable. Analyses also yielded multiple radiocarbon calibration curve intercepts of A.D. 1680, 1740, 1800, 1930, and 1950. The relatively broad calibrated date range and multiple intercepts span the late pre-contact period to the historic period, and therefore do not provide conclusive evidence for dating the occupation of the SIHP# 50-80-03-6887 overhang shelter.

Table 6. Catalog of Marine Midden Recovered from SIHP# 50-80-03-416 Feature F, Test Unit 1 and SIHP # 50-80-03-6887, Test Unit 2.

	Weight (g)	
SIHP # 50-80-03	**416 F**	**6887**
Test Unit/Stratum	**1/II**	**2/Feature A**
Depth (cmbs)	**5-35**	**10-21**
Class Gastropoda		
Unidentifed/Other	3.0	0.0
TOTAL MOLLUSCA	**3.0**	**0.0**
Class Osteichthyes		
Unidentified/Other	0.0	0.4
TOTAL CHORDATA	**0.0**	**0.4**
TOTAL MARINE MIDDEN	**3.0**	**0.4**

Table 7. Catalog of Charcoal Recovered from SIHP# 50-80-03-416 Feature F, Test Unit 1, SIHP # 50-80-03-6885 Feature D, Test Unit 1, and SIHP # 50-80-03-6887, Test Unit 2.

Acc. #	SIHP # (50-80-03)	Test Unit	Stratum	Depth (cmbd)	Weight (g)	Comments
C-1	6887	2	(Feature A)	10-21	81.1	40.1 g sample for analysis (MOKUL 4-1; Beta -220909)
C-2	416 F	1	II	5-35	4.3	4.3 g sample for analysis (MOKUL 4-2; Beta -221342)
C-3	6885 D	1	II	23	2.5	

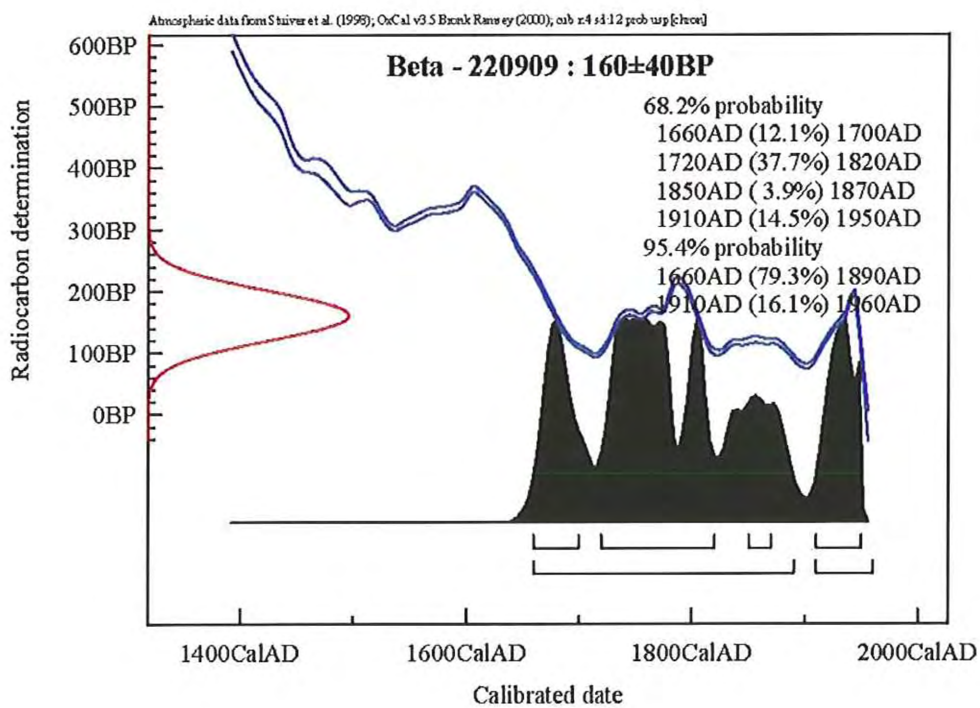
Radiocarbon Dating Analysis

Dr. Hallett H. Hammatt **Report Date: 10/4/2006**

Cultural Surveys Hawaii **Material Received: 9/11/2006**

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 220909	170 +/- 40 BP	-25.4 o/oo	160 +/- 40 BP

SAMPLE : MOKUL4-1
ANALYSIS : Radiometric-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 1660 to 1950 (Cal BP 290 to 0)

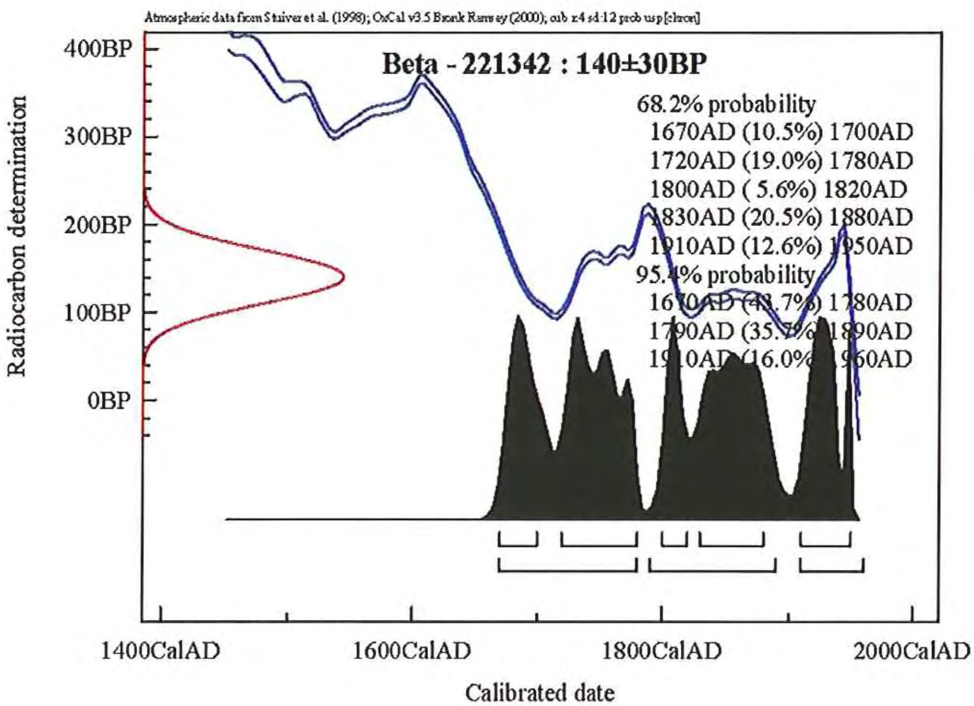


Dr. Hallett H. Hammatt Report Date: 10/24/2006

Cultural Surveys Hawaii Material Received: 9/21/2006

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 221342	100 +/- 30 BP	-22.6 o/oo	140 +/- 30 BP

SAMPLE : MOKUL4-2
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 1670 to 1950 (Cal BP 280 to 0)



Section 6 Summary and Interpretation

The current study identified six historic properties, representing two distinct periods of land-use within the Dillingham Ranch property. SIHP #s 50-80-03-416, 50-80-03-6885, 50-80-03-6886, and 50-80-03-6888 represent late pre-contact to early historic traditional Hawaiian agricultural complexes. The SIHP # 50-80-03-416 and 50-80-03-6885 site complexes, primarily consisting of well-constructed agricultural terraces, are situated within gully areas with a sufficient break in slope and suitable arable land. In addition to channeling precipitation and runoff, the gully areas provide shelter from the sun and wind, which helps to retain moisture. The location, feature types, and pattern of relatively dense site clustering are similar to the "settlement clusters" identified by Drolet and Schilz (1992). SIHP #s 50-80-03-6886 and 50-80-03-6888 site complexes consist of agricultural mounds and terraces located along the prominent hillside indicated by McAllister (1933) to be the location of "hidden waters," described as freshwater springs that originate from the base of cliffs. The mound and terrace features are located along or immediately downslope of exposed cliff faces, and appear to be situated to utilize water from natural water flow channels, which may have been spring-fed. No springs or seeps were observed at the time of the inventory survey. However, the lack of water flow may be seasonal, or due to drawdown of the water table by the many artesian wells in the area.

Each of the identified traditional Hawaiian agricultural complexes are situated to maximize utilization of limited water resources. Historic accounts as well as recent observations indicate the foothills of the Mokulē'ia / Kawaihāpai area to generally be a fairly arid environment. However, the agricultural complexes identified within the Dillingham Ranch project area demonstrate that these upland areas were successfully cultivated, likely to support a growing population centered along the coast. No conclusive radiocarbon dates were obtained during the current inventory survey investigation or the Drolet and Schilz (1992) study to date the site complexes. However, the planned preservation of nearly all of the traditional Hawaiian archaeological features within the 861-acre Dillingham Ranch project area leaves great potential for future archaeological research to develop a better chronology for settlement of the Mokulē'ia / Kawaihāpai area.

SIHP # 50-80-03-6884 consists of four historic ranch-related stone walls. The stone wall segments function in restricting the movement of cattle from designated pasture areas. These features represent the ranching period which has a long history in the Waialua District, with large ranches developing *circa* the mid to late 1800s.

Section 7 Significance Assessments

Each historic property identified by the current study was evaluated for significance according to the broad criteria established for the Hawai'i Register of Historic Places. The five criteria are:

- A Associated with events that have made an important contribution to the broad patterns of our history;
- B Associated with the lives of persons important in our past;
- C Embodies the distinctive characteristics of a type, period, or method of construction, represents the work of a master, or possesses high artistic value;
- D Have yielded, or is likely to yield information important for research on prehistory or history;
- E 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 history accounts – these associations being important to the group's history and cultural identity.

An eastern extension of the SIHP # 50-80-03-416 pre-contact/early historic agricultural and habitation complex was identified outside the northwestern corner of the 75-acre inventory survey area. Numerous additional archaeological features were observed continuing to the northeast, outside of the study area, as indicated by previous archaeological studies. Six features, including three terraces, two walls, and one mound were located within the current study area. Portions of SIHP # 50-80-03-416 were previously evaluated as significant for research and interpretive potential, and recommended for preservation (Rosendahl 1977; Yoshinaga 1977; Moblo 1991). SIHP # 50-80-03-416 is assessed as significant under Criteria C and D of the Hawai'i Register of Historic Places evaluation criteria.

SIHP # 50-80-03-6884 consisted of four stone walls located within the eastern, central, and western portions of the 75-acre inventory survey area. The walls were interpreted to be historic, ranch-related cattle walls. SIHP # 50-80-03-6884 is evaluated as significant under Criterion D of the Hawai'i Register of Historic Places evaluation criteria.

SIHP # 50-80-03-6885 consisted of three terraces and one retaining wall located within a gully area in the central portion of the 75-acre inventory survey area. The four features were interpreted to represent a pre-contact/early historic, integrated agricultural complex. SIHP # 50-80-03-6885 is assessed as significant under Criteria C and D of the Hawai'i Register of Historic Places evaluation criteria.

SIHP # 50-80-03-6886 consisted of three terraces, three mounds, and one retaining wall located outside the southwestern portion of the 75-acre inventory survey area, along the prominent hillside indicated by McAllister (1933) to be the location of the Site 192 "Hidden Waters" natural springs. The seven features are interpreted to represent a pre-contact/early historic agricultural complex. SIHP # 50-80-03-6886 is assessed as significant under Criterion D of the Hawai'i Register of Historic Places evaluation criteria. SIHP # 50-80-03-6886 is also assessed as significant under Criterion E due to the possible association of the site with the legendary springs of Kawaihāpai.

SIHP # 50-80-03-6887 is a modified overhang shelter located outside the southwestern portion of the 75-acre inventory survey area, along the prominent hillside indicated by McAllister (1933) to be the location of the Site 192 "Hidden Waters" natural springs. SIHP # 50-80-03-6887 is interpreted to function as a historic, temporary habitation site. The overhang shelter may have been used for ranch-related activities dating from the mid-1800s to modern times. No evidence of pre-contact, traditional Hawaiian occupation was observed. However, as the SIHP # 50-80-03-6887 overhang is of adequate size for comfortable human occupation, and is in close proximity to the SIHP # 50-80-03-6886 and 50-80-03-6888 pre-contact/early historic agricultural complexes, the overhang may have been utilized in the pre-contact period. SIHP # 50-80-03-6887 is assessed as significant under Criterion D of the Hawai'i Register of Historic Places evaluation criteria.

SIHP # 50-80-03-6888 consisted of five mounds and one terrace located outside the southwestern portion of the 75-acre inventory survey area, along the prominent hillside indicated by McAllister (1933) to be the location of the Site 192 "Hidden Waters" natural springs. The six features were interpreted to represent a pre-contact/early historic agricultural complex. SIHP # 50-80-03-6888 is assessed as significant under Criterion D of the Hawai'i Register of Historic Places evaluation criteria. SIHP # 50-80-03-6888 is also assessed as significant under Criterion E due to the possible association of the site with the legendary springs of Kawaihāpai.

Section 8 Project Effect and Mitigation Recommendations

The following project effect discussion and cultural resource management recommendations are intended to facilitate project planning and support the project's required historic preservation consultation. This discussion is based on the results of this archaeological inventory survey investigation and CSH's communication with agents for the project proponents regarding the project's potential impacts to the historic properties described in the Results of Fieldwork section, above.

8.1 Project Effect

The initial study area for the current archaeological inventory survey consisted of approximately 78 acres. Following the pedestrian inspection of the 78-acre study area, the boundaries of the 861-acre Dillingham Ranch project area were adjusted to exclude historic properties identified along the periphery of the project area. As a result, the archaeological inventory survey area for this report is defined as approximately 75 acres.

Proposed development within the 861-acre Dillingham Ranch project area may include subdivision of the *mauka* (southern) portion of the project area into 80 agricultural lots, ranging from approximately 5 to 9-acres in size. Associated infrastructure, such as roads, utilities, and water tanks, are also included in the development plan. Minimally, land disturbing activities would include grubbing and grading, excavations for subsurface utilities, and dwelling construction. The area of potential effect (APE) is defined as the entire approximately 861-acre project area, including the approximately 75-acre inventory survey area. The approximately 3-acre portion of the study area excluded from the 861-acre Dillingham Ranch project area will not be affected by the current development project.

The 75-acre archaeological inventory survey investigation identified the following historic properties within the 861-acre Dillingham Ranch project area. These features will likely, or potentially, be affected by the proposed project:

1. SIHP # 50-80-03-6884: 4 historic, ranch-related stone walls, evaluated as significant under Criterion D of the Hawai'i Register of Historic Places evaluation criteria. The proposed project may have an adverse effect on the entire length or portions of each of the wall features.
2. SIHP # 50-80-03-6885: Pre-contact/early historic agricultural complex, comprised of three terraces and one retaining wall, assessed as significant under Criteria C and D of the Hawai'i Register of Historic Places evaluation criteria. The SIHP # 50-80-03-6885 archaeological features are in good condition and appear to be unique constructions within the project area, based on the results of previous archaeological research within the 861-acre Dillingham Ranch project area by Drolet and Schilz (1992). Land owner/developer interests have indicated they are agreeable to preserving these features with an appropriate buffer.

CSH's project-specific effect recommendation is "effect, with proposed mitigation commitments." The recommended mitigation measures will reduce the project's potential adverse effect to these significant historic properties.

As previously discussed, SIHP #s 50-80-03-416, 50-80-03-6886, 50-80-03-6887, and 50-80-03-6888 are located outside of the 861-acre Dillingham Ranch project area. These historic properties are beyond the APE and will not be affected by the proposed development project.

8.2 Mitigation Recommendations

To reduce the proposed project's potential adverse effect on significant historic properties, the following mitigation measures are recommended. The mitigation measures should be completed prior to any land disturbing activities within the 861-acre Dillingham Ranch project area.

SIHP# 50-80-03-6884 historic, ranch-related stone walls were documented with written descriptions, photographs, scale drawings, and accurately located with GPS survey equipment. No further work is recommended for SIHP# 50-80-03-6884. Sufficient information regarding the location, function, age, and construction methods of the SIHP# 50-80-03-6884 stone walls has been generated by the current inventory survey investigation to mitigate any adverse effect caused by proposed development activities.

SIHP # 50-80-03-6885 agricultural complex was documented with written descriptions, photographs, scale drawings, and accurately located with GPS survey equipment. Limited subsurface testing was also conducted within the Feature D terrace. The SIHP # 50-80-03-6885 features are distinctive remnants of Mokulē'ia and Kawaihāpai's pre-contact/early historic land use and potential resources for future archaeological research. Preservation, in the form of avoidance and protection, is recommended for the SIHP # 50-80-03-6885 agricultural complex.

Due to the close proximity of SIHP #s 50-80-03-416, 50-80-03-6886, 50-80-03-6887, and 50-80-03-6888 to the project area boundaries, mitigation recommendations are provided to prevent potential inadvertent damage to these significant historic properties during future development activities.

SIHP # 50-80-03-416 agricultural complex was documented with written descriptions, photographs, scale drawings, and accurately located with GPS survey equipment. Limited subsurface testing was also conducted within the Feature F terrace. The SIHP # 50-80-03-416 features are distinctive remnants of Mokulē'ia and Kawaihāpai's pre-contact/early historic land use and are potential resources for future archaeological research. Preservation, in the form of avoidance and protection, is recommended for the agricultural complex.

SIHP # 50-80-03-6886 agricultural complex was documented with written descriptions, photographs, scale drawings, and accurately located with GPS survey equipment. SIHP # 50-80-03-6886 has high cultural significance due to possible association of the site with the legendary springs of Kawaihāpai. Preservation, in the form of avoidance and protection, is recommended for the agricultural complex.

SIHP # 50-80-03-6887 modified overhang shelter was documented with written descriptions, photographs, scale drawings, and accurately located with GPS survey equipment. Limited subsurface testing was also conducted within the overhang shelter. SIHP # 50-80-03-6887 is a potential resource for future archaeological research due to possible association with agricultural sites in the vicinity of McAllister Site 192 "Hidden Waters." Preservation, in the form of avoidance and protection, is recommended for the overhang shelter.

SIHP # 50-80-03-6888 agricultural complex was documented with written descriptions, photographs, scale drawings, and accurately located with GPS survey equipment. Limited subsurface testing was also conducted within the Feature F mound. SIHP # 50-80-03-6888 has high cultural significance due to possible association of the site with the legendary springs of Kawaihāpai. Preservation, in the form of avoidance and protection, is recommended for the agricultural complex.

It is also recommended that a cultural resource preservation plan be prepared for the proposed 861-acre Dillingham Ranch development project, in accordance with Hawai'i Administrative Rules (HAR) 13-277-3, to address buffer zones and protective measures for all historic properties recommended for preservation. This preservation plan should detail the short and long term preservation measures that will safeguard the historic property during project construction and subsequent use of the project area.

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Appendix A SHPD Review of ERCE Inventory Survey

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

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JOHN P. KEPPELER, II
DONA L. HANAIKE

AQUACULTURE DEVELOPMENT PROGRAM

AQUATIC RESOURCES
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CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION DIVISION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

April 24, 1992

Mr. Allan J. Schilz
Ogden Environmental & Energy Services
680 Iwilei Rd., Suite 660
Honolulu, HI 96817

LOG NO. 5155
DOC NO. 0682t

Dear Mr. Schilz:

SUBJECT: Chapter 6E Review -- Archaeological Inventory Survey and Evaluation Prepared for Mokuleia Land Company (February 1992)
Mokule'ia and Kawaihapai, Waialua, O'ahu
TMK: 6-8-02 and -03 various

Thank you for the copy of this report which adequately addresses concerns with an earlier draft noted in our letter of October 7, 1991 and in a subsequent meeting and telephone conversations. We now believe that this is an acceptable inventory survey report.

A total of 840 acres was inventoried through a combination of pedestrian survey and backhoe test excavation. These survey techniques were adequate to locate all extant historic sites. Fifteen historic sites (comprising 40 features) were found and have been assigned state numbers 50-80-03-4424 through -4438. Table 2 on p.41 offers a preliminary significance assessment for each of the 40 features; technically, the site is the unit of analysis for significance determinations. Abstracting from this table, three sites (-4424, -4428, and -4438) are assessed as significant for their information content (criterion D) and for their historical value to the Hawaiian ethnic group (criterion E); eight sites (-4425, -4426, -4427, -4429, -4430, -4431, -4432, and -4434) for criterion D alone; and four sites (-4433, -4435, -4436, and -4437) are no longer significant because their location and description exhaust the information about Hawaiian history and pre-history that they contain. Based on the information presented in this report we disagree with the significance assessments for the six sites (-4424, -4425, -4426, -4427, -4428, and -4429) comprising Settlement Cluster 1. Given these sites' excellent integrity, the fact that they represent a related group of sites characteristic of the type that was built on the coastal terrace of Mokule'ia during prehistoric times, and because other site groups of this type in the region might have less

Mr. Allan Schilz
April 24, 1992
Page 2

integrity, we believe that these sites are also significant because they embody the distinctive characteristics of a type (criterion C). Our disagreement on this point does not affect the acceptability of the inventory survey report. It does require that consultation to resolve the differences take place; this could be a letter from Mokuleia Land Company, or you as their agent, agreeing to our assessment. If you do not agree, then we will need to schedule a meeting.

Once concurrence on significance assessments is reached, the next step will be to determine the effect of Mokuleia Land Company's proposed development on significant historic sites, and once these effects have been agreed upon, to develop a mitigation plan. It is at this stage that recommendations for excavation and/or preservation are appropriate.

If you have any questions please call Tom Dye at 587-0014.

Sincerely,

DON HIBBARD, Administrator
State Historic Preservation Division

TD:amk

APR 28 1992

Appendix B OHA Consultation Letter

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

Providing Excellence in Cultural Resource Management

O'ahu P.O. Box 1114
Kailua, HI 96734
Ph.: (808) 262-9972
Fax.: (808) 262-4950

Maui 16 S. Market St., #2N
Wailuku, HI 96793
Ph.: (808) 242-9882
Fax.: (808) 244-1994

Kaua'i P.O. Box 498
Lawai, HI 96765
Ph.: (808) 245-4883

13 December 2006

Clyde W. Nāmu'o
Administrator
State of Hawai'i Office of Hawaiian Affairs (OHA)
711 Kapi'olani Boulevard, Suite 500
Honolulu, Hawai'i 96813

Subject: CSH's request for cultural consultation and/or comment regarding the fieldwork results, significance evaluations, and preservation recommendations for the Dillingham Ranch development project -- archaeological inventory survey and preservation plan, Mokulē'ia and Kawaihāpai, Oahu.

CSH Job Code: MOKUL 4

Dear Mr. Nāmu'o:

Dillingham Ranch Aina, LLC intends to develop an approximately 840-acre portion of the 2,800-acre Dillingham Ranch property, Mokulē'ia 2, Auku'u, Kikahi, and Kawaihāpai Ahupua'a, Waialua District, Island of O'ahu (TMK: [1] 6-8-002:006 por.; 6-8-003:006 por., 015, 019, 021, 030, 031, 033-035, 040). The Dillingham Ranch project area is located immediately *mauka* (south) of Farrington Highway, roughly between the Mokulē'ia residential community to the east and the Dillingham Airfield to the west (see included figures). The project area extends *mauka* to approximately 180 m (600 ft.) elevation and includes the foothills of the Wai'anae Mountain Range, up to the base of the coastal cliffs. The proposed Dillingham Ranch development plan includes subdivision of the *mauka* (southern) portion of the project area into agricultural lots and construction of associated infrastructure, including roads, utilities, and water tanks. Minimally, land disturbing activities would include grubbing and grading for the subdivision roads and excavations for the installation of subsurface utilities.

Approximately 783-acres of the roughly 840-acre Dillingham Ranch project area were covered by a previous archaeological inventory survey associated with prior plans to develop portions of the Dillingham Ranch property (Drolet and Schilz 1992). The inventory survey report was reviewed and accepted by the State Historic Preservation Division (SHPD) in 1992 (Log No. 5155, Doc No. 0682t). In 2006, Cultural Surveys Hawai'i (CSH) conducted an archaeological inventory survey investigation on adjacent *mauka* lands that were not covered by the Drolet and Schilz (1992) inventory survey, but are included as part of the current Dillingham Ranch development plan.

In compliance with applicable Hawai'i state historic preservation legislation, Cultural Surveys Hawai'i, Inc. (CSH) conducted fieldwork for the project-related archaeological inventory survey on August 15-30, 2006, with additional fieldwork completed on October 11, 2006 and November 15, 2006. Per the Hawai'i

www.culturalsurveys.com info@culturalsurveys.com

state requirements for archaeological inventory surveys [Hawai'i Administrative Rules (HAR) Chapter 13-276-5, 13-284-6, and 13-284-8], CSH is providing OHA with a brief summary of the fieldwork findings and the initial significance assessments for the six historic properties located within the CSH 2006 survey area. Also, as part of the project's preservation plan, CSH is providing OHA with a summary of all historic properties recommended for preservation within the entire 840-acre Dillingham Ranch project area, per HAR 13-277-3.

As part of its 2006 inventory survey field effort, CSH conducted a systematic pedestrian inspection of an approximately 57-acre portion of the Dillingham Ranch property that was not covered by the previous archaeological inventory survey by Drolet and Schilz (1992) (see the attached project area map). Of the 57-acre survey area, approximately 53-acres are included in the current 840-acre Dillingham Ranch development project. Approximately 4-acres of the CSH 2006 survey area are excluded from the 840-acre project area.

Six historic properties, comprised of 27 individual features, were documented within the CSH 2006 survey area. The historic properties are located on the attached USGS map and aerial photograph, and summarized in Tables 2 and 3. Of the six historic properties identified, two are located within the current 840-acre project area, and four are located outside of the 840-acre project area. Preliminary significance assessments are provided for each of the historic properties, and project-specific mitigation recommendations are provided for historic properties located within the project area.

Of particular interest are the State Inventory of Historic Properties (SIHP) # 50-80-03-6886 agricultural complex and the SIHP # 50-80-03-6888 agricultural complex. These complexes are located below natural cliff faces along a prominent hillside. This hillside was indicated by McAllister (1933) to be the location of Site 192 "Hidden Waters." The site is described as four "hidden waters," or natural springs, with legendary associations. The agricultural features also appear to be situated to take advantage of water from natural seeps and springs. Therefore, due to the probable association of sites SIHP # 50-80-03-6886 and SIHP # 50-80-03-6888 with the "hidden waters," these sites are preliminarily assessed as significant under Criterion E of the Hawai'i Register of Historic Places evaluation criteria, for having an important value to native Hawaiian people due to associations with traditional beliefs. The SIHP # 50-80-03-6886 agricultural complex and the SIHP # 50-80-03-6888 agricultural complex are located outside of the current 840-acre project area and will not be affected by the proposed development.

In addition to the comments on the newly identified historic properties, CSH is also requesting OHA's input and comments on historic properties within the 840-acre Dillingham Ranch project area that are recommended for preservation. The project's preservation plan will include discussion of all historic properties recommended for preservation, including both the newly identified historic properties and historic properties documented in the previous archaeological inventory survey by Drolet and Schilz (1992). Avoidance and protection is recommended for each of the historic properties designated for preservation.

A total of 15 historic properties, comprised of 40 individual features were identified within the Dillingham Ranch project area by Drolet and Schilz (1992). Of these 15 historic properties, 11 were recommended for preservation. The historic properties recommended for preservation are located on the attached USGS map and aerial photograph, and summarized in Table 1. In general, the historic properties were located in the foothills above the coastal plain and were concentrated in three "settlement clusters." Three of the historic properties were interpreted to function as religious or ceremonial structures and were evaluated as significant under Criterion E for their traditional cultural significance to native Hawaiians. SIHP # 50-80-03-4772 consists of a well constructed enclosure interpreted to be McAllister's Site 194: Poloaiae Heiau. SIHP # 50-80-03-4776 consists of a raised mound with branch coral incorporated in the construction, interpreted to be a shrine. SIHP # 50-80-03-4786 consists of a large, well-constructed platform interpreted to be a religious or ceremonial structure.

Proposed preservation measures are to include the establishment and demarcation of long term buffer zones around each of the sites or site areas designated for preservation. With the exception of the SIHP # 50-80-03-6885 site complex, each of the archaeological preserve areas will be isolated within designated subdivision lots that will not be subject to sale or development. The SIHP # 50-80-03-6885 site complex is proposed to be preserved as an easement within a subdivision development lot.

I hope this summary provides the information you require to comment on the inventory survey findings, proposed historic property significance assessments, and preservation recommendations. Per the requirements of HAR Chapter 13-284-6 and 13-284-8, CSH is particularly interested in OHA's input and comment regarding the significance and treatment of the historic properties evaluated as significant under Criterion E.

Thank you very much for your assistance with this matter. OHA's response to this request will become part of the project's historic preservation administrative record and will help assist the project proponent, with their compliance with Hawai'i state historic preservation legislation. OHA's response will also help ensure that the proposed project's cultural resource management review and mitigation decisions are based on the most accurate cultural information. Please contact me with any questions.

Sincerely,

Todd Tulchin
Cultural Surveys Hawai'i, Inc.
ttulchin@culturalsurveys.com

Appendix C OHA Consultation Reply

PHONE (808) 594-1888 FAX (808) 594-1865

STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

HRD06/2846

December 26, 2006

Todd Tulchin
Cultural Surveys of Hawai'i, Inc.
P.O. Box 1114
Kailua, HI 96734

RE: Consultation Request for Dillingham Ranch Development Project, Mokulē'ia and Kawaihāpai, O'ahu, TMK: 6-8-002:006 (por.) & 6-8-003: various parcels

Dear Todd Tulchin,

The Office of Hawaiian Affairs (OHA) is in receipt of your December 13, 2006, request for comments on the above-referenced project, which would include subdivision of the project area into agricultural lots and construction of associated infrastructure. OHA offers the following comments on the results of fieldwork, significance evaluations, and preservation plans; and we commend the developer for proposing to preserve the vast majority of sites in the project area.

OHA has several comments. First, we strongly urge the developer of this project to formally preserve and protect the sites located near the "Hidden Waters" (Site 192) traditional cultural property (TCP). You indicate that, because Sites 6886, 6887, and 6888 are located outside of the 840-acre Dillingham Ranch project area, no mitigation will be recommended. However, as shown in your figures, these sites are very close to the project area boundaries. Our experience has been that sites located this close to proposed boundaries may be at risk of inadvertent damage and/or destruction by future construction projects that may take years to complete, and may involve construction crews that are unaware of the presence of these sites.

Second, before commenting on your preservation plans, we request additional information, including specific details of the size of buffer zones, methods of demarcating the buffer zones, and plan-view depictions of preservation areas for each site. As provided, the figures are at too large of a scale to be useful for assessing the adequacy of the preservation areas.

Finally, we strongly urge community consultation during the preparation of the preservation plans, particularly for sites assessed as eligible under significance criterion E.

Todd Tulchin
Cultural Surveys of Hawai'i, Inc.
December 26, 2006
Page 2

OHA further requests your assurances that if this project goes forward, should iwi kūpuna or Native Hawaiian cultural or traditional deposits be found during ground disturbance, work will cease, and the appropriate agencies will be contacted pursuant to applicable law.

Thank you for the opportunity to comment. If you have further questions, please contact Kai Markell, Director – Native Rights, Land, and Culture, at (808) 594-1945 or kaim@oha.org.

Sincerely,

for **Clyde W. Nāmu'o**
Administrator

Appendix D UTM Coordinates of Identified Historic Properties

Coordinate System: UTM

Zone: 4 North

Datum: NAD 83

SIHP	Easting	Northing
50-80-03-416	583459	2385170
50-80-03-6884 A	584987	2384532
50-80-03-6884 B	583441	2385032
50-80-03-6884 C	584464	2384573
50-80-03-6884 D	584408	2384271
50-80-03-6885	583785	2384875
50-80-03-6886	583644	2384885
50-80-03-6887	583588	2384952
50-80-03-6888	583539	2384957

Appendix E

Traffic Assessment of Proposed
Subdivision of Dillingham Ranch Property
Mokūle‘ia, O‘ahu, Hawai‘i

Julian Ng, Incorporated
Transportation Engineering Consultant

P. O. Box 816
Kaneohe, Hawaii 96744-0816

phone: (808) 236-4325
fax: (808) 235-8869
email: jnghi@hawaii.rr.com

January 4, 2008

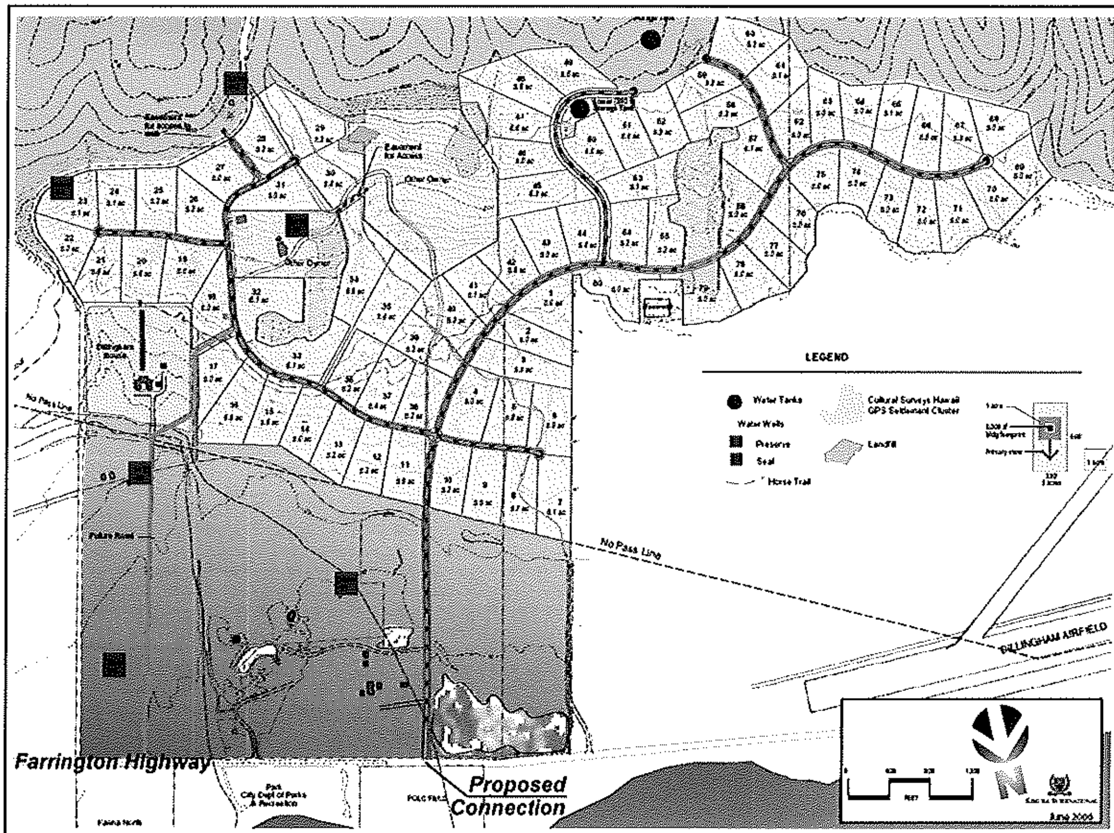
Mr. Clifford R. Smith
Senior Vice President
Kennedy Wilson
9601 Wilshire Boulevard, Suite 220
Beverly Hills, CA 90210

Subject: Update of Traffic Assessment of Proposed Subdivision of Dillingham Ranch property Mokuleia, Oahu, Hawaii

Dear Mr. Smith:

This letter updates the letter traffic assessment we had prepared on June 20, 2006 for the proposed subdivision of the Dillingham Ranch property in Mokuleia. The property, adjacent to and east of Dillingham Airfield and south (mauka) of Farrington Highway, has a total area of approximately 900 acres and will be subdivided to create approximately 80 agricultural lots.

The earlier assessment's finding that the project will have minor impacts to traffic in the area is still valid. The existing roadway system will be able to accommodate the increase in traffic that could result from the proposed project. Figure 1 shows a conceptual plan of the project.



Source: Kimura International, Inc., (June 16, 2006)

Figure 1 – Project Master Plan

While the subdivision plan has changed slightly from the master plan, vehicular access is the same, with access provided by a dedicated project roadway that intersects Farrington Highway as the stem of a "T"-intersection. Traffic on the project roadway's northbound approach to the intersection will be controlled by a "STOP" sign. The project roadway, a two-lane roadway carrying traffic in both the northbound and southbound directions, will have a single lane on the northbound approach that will be shared by traffic making left turns and right turns onto the highway.

Existing Traffic Conditions

Traffic volumes on Farrington Highway are based on the latest published count data from a 48-hour traffic count taken by the State Highways Division on Farrington Highway at Kapalaau Bridge near the project site in March 2005; the daily totals and peak hour volumes from this count are shown in Table 1.

Table 1 – Existing Traffic on Farrington Highway

	24-hour total		AM Peak Hour		PM Peak Hour	
	March 21-22, 2005	March 22-23, 2005	March 21-22, 2005	March 22-23, 2005	March 21-22, 2005	March 22-23, 2005
Westbound	1,297	1,305	78	88	92	97
Eastbound	1,281	1,287	55	61	123	112
Total	2,578	2,592	133	149	215	167
Peak Hour			8:00-9:00	8:00-9:00	3:00-4:00	3:30-4:30

Source: State of Hawaii, Department of Transportation, Highways Division. Count data for station on Farrington Highway at Kapalaau Bridge.

Project Impact

The traffic impact of the proposed subdivision was evaluated for 80 new agricultural lots. These lots will typically generate only small volumes of traffic during peak hours; however, in order to determine the potential traffic impact, peak hour traffic volumes generated by these lots were estimated using trip rates for suburban detached (single-family) dwellings from the Institute of Transportation Engineers, which assume that residents commute regularly. Table 2 shows the estimates of peak hour traffic generation (shown to nearest 5 vehicles).

Table 2 – Traffic Generation

	Trip Rates * detached dwellings		Traffic Generated 80 dwelling units	
	Trips per dwelling	% entering	Entering site	Exiting site
Average weekday	9.57	50%	380	380
AM Peak Hour	0.75	25%	15	45
PM Peak Hour	1.01	63%	50	30

* Source: Institute of Transportation Engineers, *Trip Generation, 7th Edition.*

The traffic generated by the project is well below the 100 vehicles per hour in the peak direction that has been suggested by the Institute of Transportation Engineers[1] as the threshold for conducting a traffic impact or site access study.

With Farrington Highway terminating approximately three miles to the west near Kaena Point and no significant destinations for peak hour residential traffic located in that direction, all of the project traffic is expected to use Farrington Highway to the east.

Future Conditions at Proposed Access Intersection

Peak hour conditions at the proposed intersection of the project access road and Farrington Highway would determine if additional improvements will be needed. Future conditions at the intersection, therefore, were analyzed.

The most recent available estimates of the Average Daily Traffic (ADT) volumes on the segment of Farrington Highway between Dillingham Airfield and Puuiki Street, located in Waialua approximately 3 miles to the east of the project, are shown in Table 3.

Table 3 – Historic Trend in Highway Traffic Volumes

Year	Average Daily Traffic
1999	3,794
2000	3,953
2001	3,743
2002	4,053
2003	4,074
Source: State of Hawaii Department of Transportation Highways Division, *Traffic Summary – Island of Oahu, 2003.*	

The average rate of increase in traffic volumes from 1999 to 2003 was 1.8% per year. At this average rate of increase, traffic volumes in the future year 2030 would be 56% higher than in 2005. Average Daily Traffic at this rate of growth would be 4,450 vehicles per day in 2008 and 6,600 vehicles per day in 2030. As a comparison, the traffic generated by the project (760 vehicles on an average weekday, from Table 2) would be approximately 17% of the existing traffic on the highway.

Figure 2 shows estimates of future (year 2030) peak hour traffic volumes at the intersection of the project access road with Farrington Highway. The through volumes on the highway are based on the average peak hour volumes counted at the nearby station in 2005 and the annual rate of increase discussed above. The turning volumes assumed that all of the project traffic would turn to or from the east (Waialua direction). The traffic assignments include additional turning movements to and from the east (an additional 10 vehicles per hour in each direction) to account for other traffic that may use the project access road. Additional traffic movements of 5 vehicles per hour were also added for turning movements to and from the west (Kaena Point direction).

1 Institute of Transportation Engineers, *Traffic Access and Impact Studies for Site Development, A Recommended Practice, 1991*

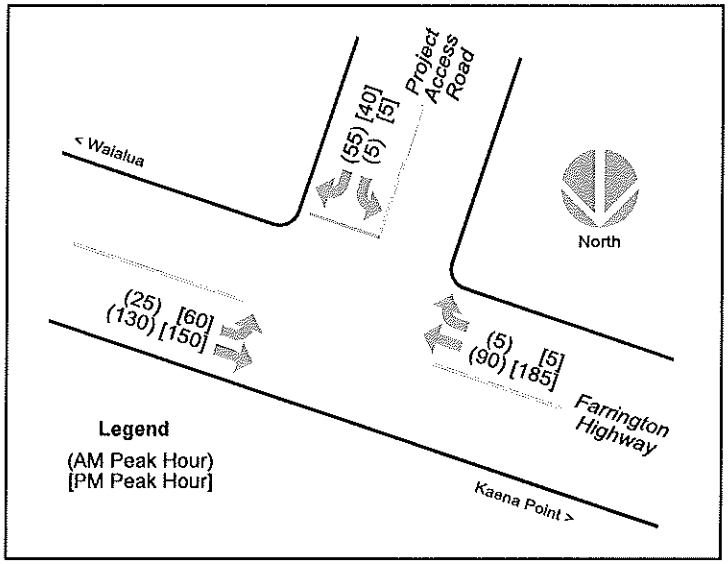


Figure 2 – Traffic Assignments (2030)

The procedure described in the *Highway Capacity Manual*[2] *(HCM)* was used to analyze the intersection and acceptable conditions at the intersection were found, as summarized in Table 4. The analysis estimates average delays based on traffic volumes, these delays are described by "Levels of Service" for the controlled movements at the intersection; the *HCM* defines the Level of Service (LOS) for unsignalized intersections as follows (Level of Service C or better is considered acceptable):

LOS	General Description of Delay	Average Delay (seconds per vehicle)
A	Little or no delay	≤ 10
B	Short traffic delays	> 10 and ≤ 15
C	Average traffic delays	> 15 and ≤ 25
D	Long traffic delays	> 25 and ≤ 35
E	Very long traffic delays	> 35 and ≤ 50
F	Very long traffic delays	>50

Table 4 – Intersection Levels of Service (2030)

	Westbound left turns from highway		Northbound approach (shared lane, stop sign)	
	Delay	LOS	Delay	LOS
AM Peak Hour	7.5 seconds	A	9.3 seconds	A
PM Peak Hour	7.8 seconds	A	10.0 seconds	B

2 Transportation Research Board, National Research Council, *Highway Capacity Manual,* Washington, D.C., 2000.

While left turns from the highway can be made with minimal delays, the need for a separate left turn lane on the highway was also evaluated. The "green book" design manual published by the American Association of State Highway and Transportation Officials (AASHTO) provides a table showing conditions under which a separate left turn lane should be considered on two-lane highways. The AASHTO table is used to determine the advancing volume at which a separate turning lane should be considered. As shown in Table 5, the estimates of the advancing volume (from Figure 2) are less than the volumes at which a separate left turn lane should be considered.

Table 5 – Traffic Characteristics for Consideration of a Separate Left Turn Lane

	AM Peak Hour	PM Peak Hour
Proportion left turns (from Figure 2)	16%	29%
Opposing volume (from Figure 2)	95	190
Advancing volume (from Figure 2)	155	210
Advancing volume at which separate turn lane should be considered, for an operating speed of 50 miles per hour (interpolated) *	380	275
Consider separate left turn lane?	not necessary	not necessary

* based on Exhibit 9-75 of *A Policy on Geometric Design of Highways and Streets,* from American Association of State Highways and Transportation Officials, Washington, D.C.

A simple connection to the highway with a stop sign controlling the side street will adequately serve future traffic volumes at the intersection. A separate left turn lane on the highway is not warranted and will not be needed.

Conclusions and Recommendations

The proposed subdivision is not expected to have a significant impact to traffic conditions on Farrington Highway. The estimated peak hour volumes at the intersection of the project access road and the highway do not meet the guidelines for consideration of adding a separate left turn lane.

The intersection should be designed with adequate sight distance for drivers at the stop sign on the side street. The intersection should be clearly visible for drivers on the highway; if necessary, warning signs should be considered to improve driver awareness of the new intersection. Should you have any questions, please contact me.

Sincerely,

JULIAN NG, INCORPORATED

Julian Ng, P.E., P.T.O.E.
President

P.T.O.E. refers to the Professional Traffic Operations Engineer™ certification from Transportation Professional Certification Board, Inc.
For more information, please see http://www.tpcb.org/ptoe/default.asp

Appendix F

Agriculture Feasibility Report
(Expanded Supplement on the Working Ranch)
Dillingham Ranch

Agriculture Feasibility Report

(Expanded Supplement on the Working Ranch)

Dillingham Ranch

Prepared for

Dillingham Ranch Aina, LLC
c/o Kennedy Wilson International
9601 Wilshire Boulevard, Suite 220
Beverly Hills, California 90210

Prepared by:

Development Strategies, LLC
3465 Waialae Avenue, Suite 260
Honolulu, Hawaii 96816

Agronomics by:

Tropical Crops Services
94-350 Punono Street
Mililani, Hawaii 96789

November 2007

Introduction

In June 2007, an Agricultural Feasibility Report for Dillingham Ranch was submitted as part of an application for the consolidation and resubdivision of the parcels comprising the property. The Agricultural Feasibility Report focused on the creation of "80 Five Acre Lots" within an agricultural community, while providing limited information on the large bulk parcels that would comprise the majority of the property devoted to the agricultural activities of the "working ranch."

This expanded report addresses the agricultural activities of the working ranch and the plan for its sustainable future. As an expansion of the original Agricultural Feasibility Report, this "Supplemental Report" will limit repetition of the information presented previously in favor of expanding the focus on the working ranch. To the extent new or more definitive information has been generated since the prior Agricultural Feasibility Report, it has been incorporated herein

Background

Dillingham Ranch Aina, LLC (hereinafter referred to as "DRA"), is the current owner of Dillingham Ranch (the "Ranch"). DRA acquired the 2,722 acre property out of receivership in 2006. Kennedy Wilson International and Cargill, the two major partners in DRA, intend to restore the existing infrastructure and make other improvements to maintain the Ranch in active cattle production and other agricultural pursuits that are harmonious with the character and ambiance of the Mokuleia-Waialua area.

A major part of DRA's effort will also involve restoration of the Dillingham House, a historically significant structure located on the premises. The Dillingham House and the surrounding grounds reflect the ambiance of the gracious lifestyle that characterized the plantation era of Hawaii in the early 1900s. Unfortunately, the Dillingham House has suffered a gradual deterioration over the years and is in need of attention. DRA plans to completely refurbish the structure and the grounds for use as a community amenity and as a location for special events.

It should also be noted that the North Shore Water Company, which operates the two active wells on the site, is wholly owned by DRA. The North Shore Water Company delivers potable and non-potable water to sustain the day-to-day operation of the Ranch. In addition, as a quasi-public utility, the North Shore Water Company also provides domestic water to 120 customers in the adjacent community of Mokuleia located to the west of the Ranch. The provision of domestic water service is essential, as the Board of Water Supply system terminates about a half mile in the Waialua direction (east) of the bulk water meter that provides domestic water to the Mokuleia community and the North Shore Water Company anticipates that it will continue to provide domestic water service for the foreseeable future.

The Property

Located in Mokuleia, Oahu, Dillingham Ranch stretches from its frontage along the mauka (mountain) side of Farrington Highway to the boundary with the State of Hawaii forest reserve in the upper elevations of the Waianae Mountains. A total of thirteen Regular and Land Court parcels totaling 2,722 acres comprise the property.

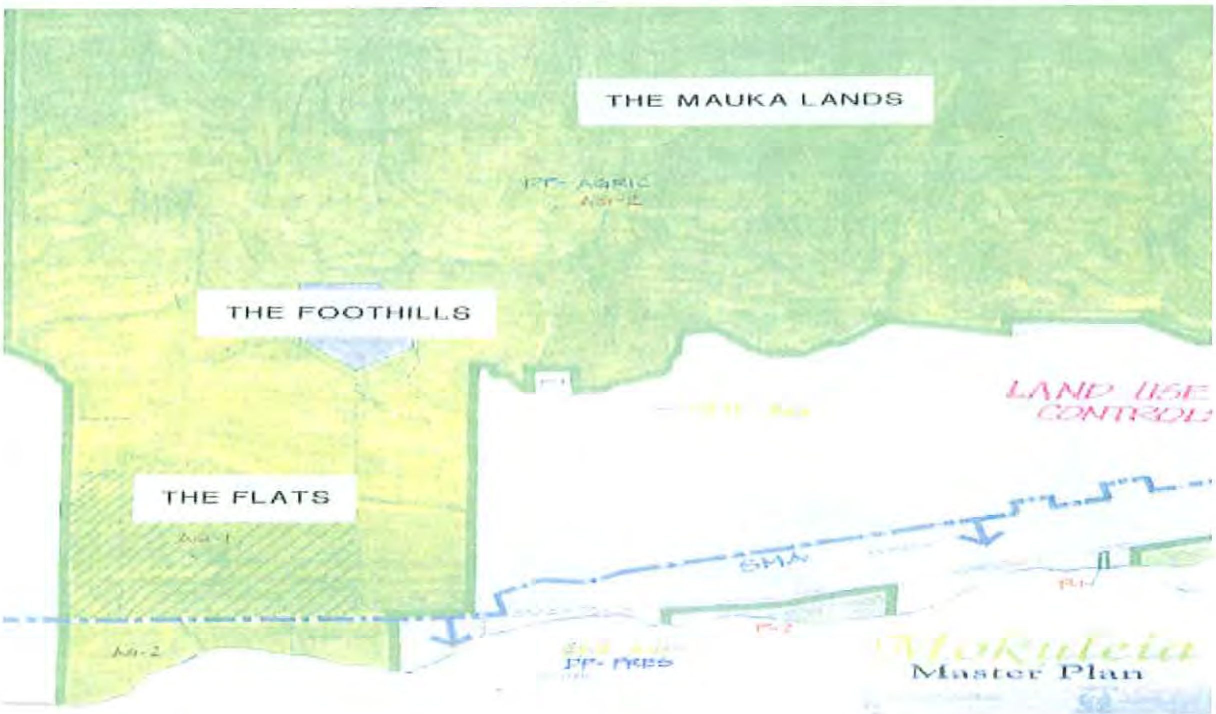


Figure 1: Zones

Putting the existing parcel boundaries aside, the Ranch is naturally segregated into three distinct zones by the topography of the land (Figure 1):

- The Flats – This zone encompasses the area that starts at Farrington Highway and extends inland for a distance of approximately ¾ of a mile. The terrain in this area is relatively flat, with grades of less than 1% by the highway and increasing to 5% at the transition into The Foothills at an elevation of about 80'.

  This low, level portion of the property encompassing approximately 380 acres is prone to intermittent flooding due to storm water flows from Makaleha Stream. This condition restricted the ability to use The Flats for the cultivation of sugarcane and other dense crops. The coconut tree farm, horse paddocks and equestrian center occupy the nominally higher areas of The Flats.

A large pond located to the right of the main access into the Ranch is a distinctive feature of the property. The pond, a former sand mining pit, was created by gradual filling by runoff and artesian water over the years and is now a nesting site for several species of water fowl.

- The Foothills – This is the transitional portion of the property ranging in elevation from roughly 80' to 400'. Although the terrain is undulating, slopes steadily increase from about 5% to 25% with the rise in elevation. The Foothills, an area of roughly 450 acres, is presently used for the grazing of cattle and will be the location of the contemplated agricultural community.

- The Mauka Lands – Above The Foothills, the property continues to rise up to the boundary with the State forest reserve, which starts at about 1,100 feet. Slopes in this area vary considerably, but typically in exceed 15% to 20% along the mauka-makai axis. A network of trails meanders through this portion of the property. The Mauka Lands comprise the remaining 1,892 acres of the property.

  The Mauka Lands were historically used to graze cattle, but this activity has been curtailed by the inability to provide water to the higher elevations of the property. This is primarily due to deterioration of the lines feeding the watering troughs.

Figure 2: Adjacent Land Uses (Prior to 1990)

The Working Ranch

Unlike lands to the east and west of the Ranch that were in active sugarcane cultivation up until the demise of the Waialua Sugar Plantation in the late 1980s (Figure 2), Dillingham Ranch has always been engaged in cattle production. The current commercial agricultural activities that comprise the working ranch include cattle, the "tree farm" (field stock coconut and royal palms), boarding of horses and the equestrian center. Over the years the Ranch has evolved into a location filming and photo shoots, and the Dillingham House as also been used for special events under the provisions of a Special Use Permit.

Cattle: A herd of 130 cows and 7 bulls is presently grazed in The Foothills on about 500 to 600 acres of land. The propagation of livestock produces 70 to 80 calves per year. The wean-outs, which are three to four months old, are sold to other ranches in the State on a quarterly basis. The calves weigh in at about 250 pounds and fetch an average of $200 a head. Revenue for the 12 months from October 1, 2006 to September 30, 2007 amounted to $30,100.

Tree Farm: The Ranch is the largest supplier of coconut trees in the State, providing trees for a variety of landscape projects on Oahu and the Neighbor Islands. The tree farm encompasses about 70 acres of The Flats on the Waialua (east) side of the Ranch, along both sides of the road leading up to the Dillingham House (Figure 3). Landscape contractors excavate and transport the trees from the Ranch, which limits disputes over damage to the purchased plant material.

The unit prices set for the field stock trees as of August 2007 are:

Coconut:	Up to 25'	$400/tree
	25' to 30'	$475/tree
	Over 30'	$600/tree
Royal Palm:	Up to 15'	$600/tree
	Over 15'	$700tree

Sales have been steady, amounting to $327,992 for the 12 month period ending September 30, 2007. The remaining inventory consists of about 6,500 field stock trees.

Boarding and Equestrian: The paddocks and fenced pasture occupy approximately 125 acres of The Flats. Fencing divides the area into private paddocks for boarding of a single horse, semi-private paddocks for boarding three or more horses and a large mixed pasture area for animals that are not segregated. The present paddocks are not of a uniform size, a condition that will be addressed in the near future when the old fencing is replaced.

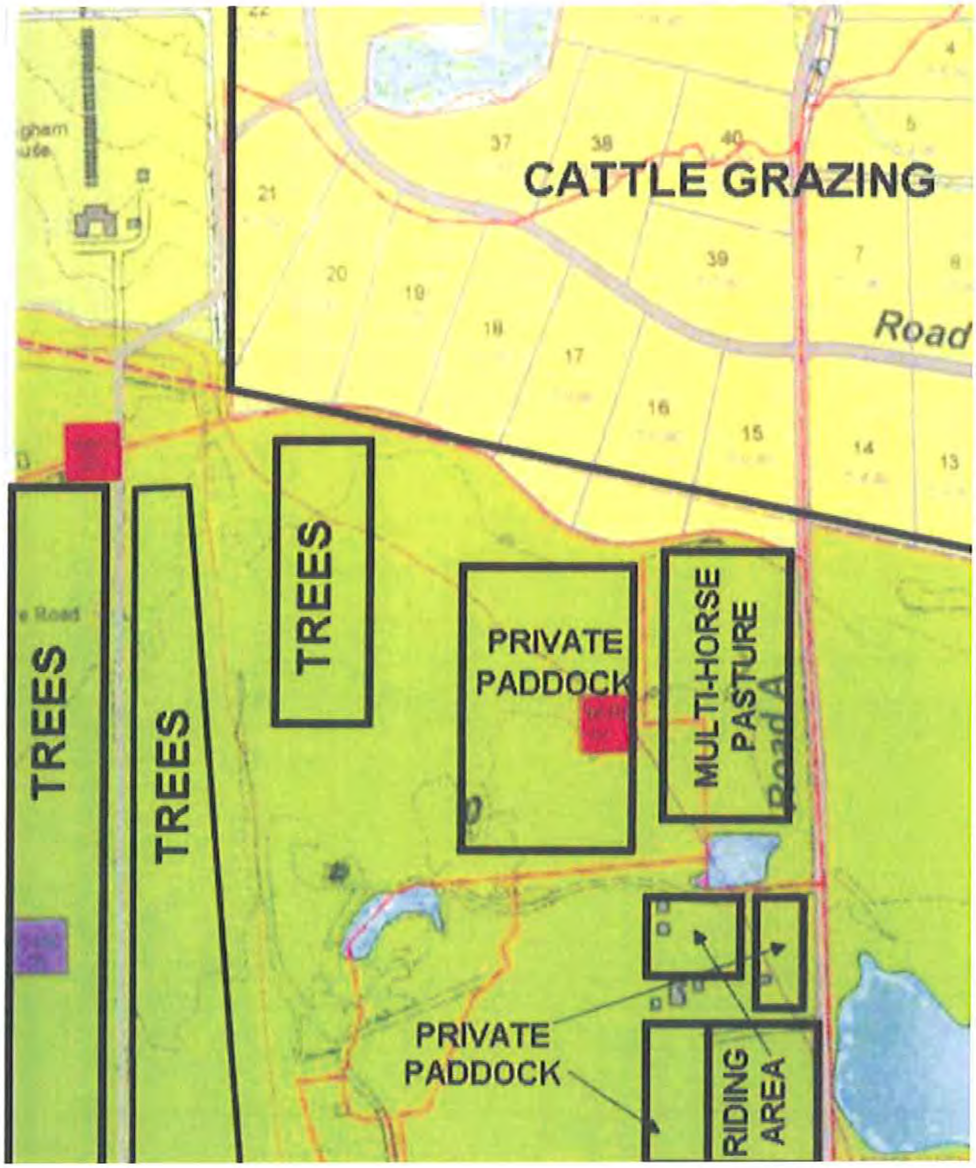


Figure 3 – Existing Uses (Illustrative Only -Not to Scale)

Approximately 100 to 110 horses are boarded at the Ranch during any given month. The cost for boarding varies based on the selection made in terms of paddocks or fenced pasture. Monthly boarding rates as of September 2007 are:

Private Paddock	$185/horse
Semi-Private Paddock	$165/horse
Mixed pasture	$145/horse

In addition, arrangements can be made with the Ranch for feeding service at a charge of $50/horse extra a month ($30/pony for Pony Club members). Most owners take the feeding service and provide the feed and any supplements at their cost. Revenue from boarding and feeding service amounted to $226,829 for the 12 month period ending September 30, 2007.

Revenue from the Equestrian Center is primarily related to two horse shows and two "Pony Club" events per year and is reported under "Other Activities." For the 12 month period ending May 31, 2007 revenue totaled $2,076. There is no charge for use of the equestrian training areas during other times for horses boarded at the Ranch.

Other Activities: Additional revenue is generated from rental of the property or the Dillingham House for commercial filming and photo shoots. The sale of coconuts is also included in this category. In addition, the provisions of the Special Use Permit allows for rental of the Dillingham House for functions having up to 300 guests twice a month. Activity at the Dillingham House will be curtailed for about 11 months by the restoration activities which started on May 15, 2007. Income from Other Activities (including horse shows and Pony Club events) amounted to $31,871 from January 1, 2007 to May 7, 2007.

Subdivision Concept

As covered in the previous Agricultural Feasibility Report, the subdivision concept for the Ranch contemplates the consolidation and resubdivision of 12 of the 13 existing parcels to create 77 five acre lots, 6 bulk lots ranging in size from 32 acres to 116 acres in The Flats, with an additional large bulk parcel comprising 1,484 acres of The Mauka Lands (collectively the "Ranch Lots"). An updated Preliminary Map (Figure 4) has been modified to address comments received during the Agency Review Process conducted by the Department of Planning & Permitting ("DPP").

Figure 4 – Revised Preliminary Map

The large Ranch Lots will be utilized for the various activities of the working ranch described above. Although not included in the consolidation and resubdivision action, the 433 acre bulk parcel identified as TMK: 6-8-003:005 will also be part the working ranch, used primarily for the grazing of cattle (the "Grazing Lot"). The combined area of the Ranch Lots and the Grazing Lot totals to 2,241 acres, with roughly 1,917 acres comprising The Mauka Lands. Table 1 below summarized the lots created through resubdivision of the consolidated parcels:

Table 1

Lot Numbers	Lot Type	Land Area
1 to 77	Agricultural Lots (Subdivided Lots)	443
1001 to 1006	Makai Ranch Lots	314
1007	Mauka Ranch Lot	1,484
R-1 to R-6	Roadway Lots	21
Misc.	Utility and Archaeological Lots	27
	TOTAL	2,722

The subdivision action will also create 77 smaller agricultural lots (the "Subdivided Lots") as part of an agricultural community encompassing 443 acres. Located roughly a mile back from Farrington Highway, the agricultural community will blend into the terrain due to the mix of managed pasture, orchards and other agricultural activities on the Subdivided Lots. A limitation on the area that can be used for the construction of a farm dwelling (see the DPP Interpretation of Building Polygon - Appendix A) will ensure that the agricultural community will not be visually intrusive.

Master Association/Sub-Association

Structurally, the relationship between the Ranch Lots, the Grazing Lot and the Subdivided Lots comprising the agricultural community is contemplated to be as follows:

- DRA will conduct the operations of the working ranch on the Ranch Lots and the Grazing Lot. Whether the working ranch will function as DRA or through an affiliate entity via a lease of the land has not been determined at this time.
- As the owner of the Ranch Lots and the Grazing Lot, DRA will be a member of the Master Association for Dillingham Ranch with the number of votes for each parcel to be determined as the Association documents are drafted.
- A Homeowners Association will be established as a Sub-Association to handle the affairs for the agricultural community. The Homeowners Association will be a member of the Master Association holding one or more collective votes.
- DRA is sensitive to the long-term viability of the working ranch and the intent is to ensure that the interests of the individual owners of the Subdivided Lots will be represented without dominating the Master Association.

- The Master Association will be responsible for maintenance of the common areas of the Ranch outside of the agricultural community, such as the ranch roads, drainage easements and landscaped areas.

- The Homeowners Associations will be responsible for the maintenance of the common areas within the agricultural community, such as the internal roadways, subdivision infrastructure and drainage easements, and external infrastructure such as the common leach field.

- It is anticipated that certain improvements, such as the main access road and utility systems, may require some allocation of responsibility between the Master Association and the Homeowners Association.

- The Homeowners Association and/or individual lot owners within the agricultural community will have the option to contract with the working ranch for the grazing of cattle on their lots, as an alternative to fencing the Subdivided Lot and pasturing their own livestock or cultivating crops.

- Homeowners will also have the ability to have the working ranch provide pasture management services through the Homeowners Association as part of their monthly assessment or directly with DRA (format to be determined).

- To facilitate operations of the working ranch, easements will be provided through the agricultural community to permit ranch personnel and equipment to access portions of the working ranch.

- Easements will be provided for lot owners to access portions of the Ranch Lots and the Grazing Lot, such as the Dillingham House for special events and The Mauka Lands for riding trails.

These and other structural details will be refined as the legal documents for the property are drafted.

Agriculture Plan

The Agriculture Plan for the working ranch is intended to restore the Ranch to an efficient, self-sustaining operation. In this regard, the Plan focuses on improvements to the existing core activities of the Ranch, making more productive use of the property and enhancing the quality of the products and services provided to the various market segments, rather than attempting to launch new and unfamiliar ventures. This strategy capitalizes on the existing expertise of the Ranch personnel, but redirects the focus to maximizing efficiency and accessing new, untapped markets for existing goods and services:

Cattle: Revenue from the propagation of cattle is marginal and needs to be improved. A modest increase in the size of the herd, along with an upgrade of the stock for the natural food market, is contemplated over the next 3 to 4 years, given the strong demand for range fed beef.

Part of the strategy also calls for calves to be kept until they are 8 months old and weigh about 400 pounds. Heifers and steers of this size appeal to both local ranches and mainland operations that service natural food retailers like Whole Foods. For the West Coast market, livestock of this size can be packed 68 to a shipping container and their low height permits the containers to be stacked double-decked. At $1.00 per pound, the revenue would amount to $400 per calf.

The quality of an open pasture is highly dependent on soil conditions, amount and seasonality of rainfall, micro-climate of the area, type of pasture grass and the topography. An average, non-irrigated pasture is capable of supporting a fully grown cow (an "Animal Unit") on 5 to 7 acres. Less optimal pasture conditions (soils, rainfall, topography, etc.) would require 8 to 10 acres to support an Animal Unit. Difficult conditions (steep topography, lack of rainfall) would require over 10 acres per Animal Unit.

Future grazing activities would utilize the mauka Ranch Lot and the Grazing Lot, which would provide a gross area of about 1,900 acres. The projected size of the expanded herd would be approximately 220 cows and 15 bulls. In addition to making productive use of The Mauka Lands, the grazing of cattle in this area would also reduce the unchecked growth of vegetation, mitigating the potential for wild fires like those the plagued the Waialua-Mokuleia area in 2007.

Relocation of the cattle to The Mauka Lands will take place incrementally over the next several years as The Foothills are developed into the contemplated agricultural community. Coordination of the move in tandem with development of the infrastructure to service the Subdivided Lots will be essential, as the source of drinking water for the cattle will be provided from common water lines. Extension of water lines beyond the perimeter of the agricultural community will be handled by the ranch crew, with backflow prevention devices installed to ensure that the domestic water system is not contaminated.

In addition to the water lines, approximately 30,000 linear feet of cattle fencing will be installed to replace dilapidated fencing and create three grazing areas in The Mauka Lands. The fencing would be installed incrementally, as the size of the herd is increased. The preliminary cost of the water line extensions and the fencing is estimated at $125,000. More refined figures will be obtained from contractors as the construction plans for the subdivision improvements evolve.

In order to implement the Agriculture Plan, DRA also recognizes that the current breeding stock is aging and the quality of the herd must be upgraded over the next two to three years to achieve the quality of heifers and steers required by buyers for range fed beef stock. While some of the expansion can be done through holding back a small portion (10% to 15%) of the heifers that would otherwise be marketed, this will also require the acquisition of about a 100 head of quality breeding stock (a year and a half old) over the period. Heifers of this age will command a price of $700 to $800 a head, an investment or $70,000 to $80,000 over time. A potential local source would be Parker Ranch in Kamuela, which markets breeding stock once a year. The other option would be to ship heifers in from the West Coast, which might provide a broader selection of breeding stock and lower pricing. However, this alternative would involve the additional cost for shipping.

Assuming a herd of 220 cows, a 70% to 75% birth rate would produce about 160 calves for the market annually or potential revenue of $64,000. While the dollar return is nominal, the grazing of cattle will retain The Mauka Lands in open space, preserve scenic vistas of the Waianae Mountains, reduce the potential for wild fires and maintain the area in valuable watershed. ***Attached is a Whitepaper by the Hawaii Cattlemen's Council that discusses these issues, including the returns to the landowner, the cattle rancher and the general public, in greater detail (Appendix B).***

A knowledgeable resource for the cattle operations would be Mark S. Thorne, PhD, State Range Specialist for the College of Tropical Agriculture & Human Resources:

Kamuela Extension Office
67-5189 Kamamalu Road,
Kamuela, Hawaii 96743 8439
Phone: (808) 887-6163

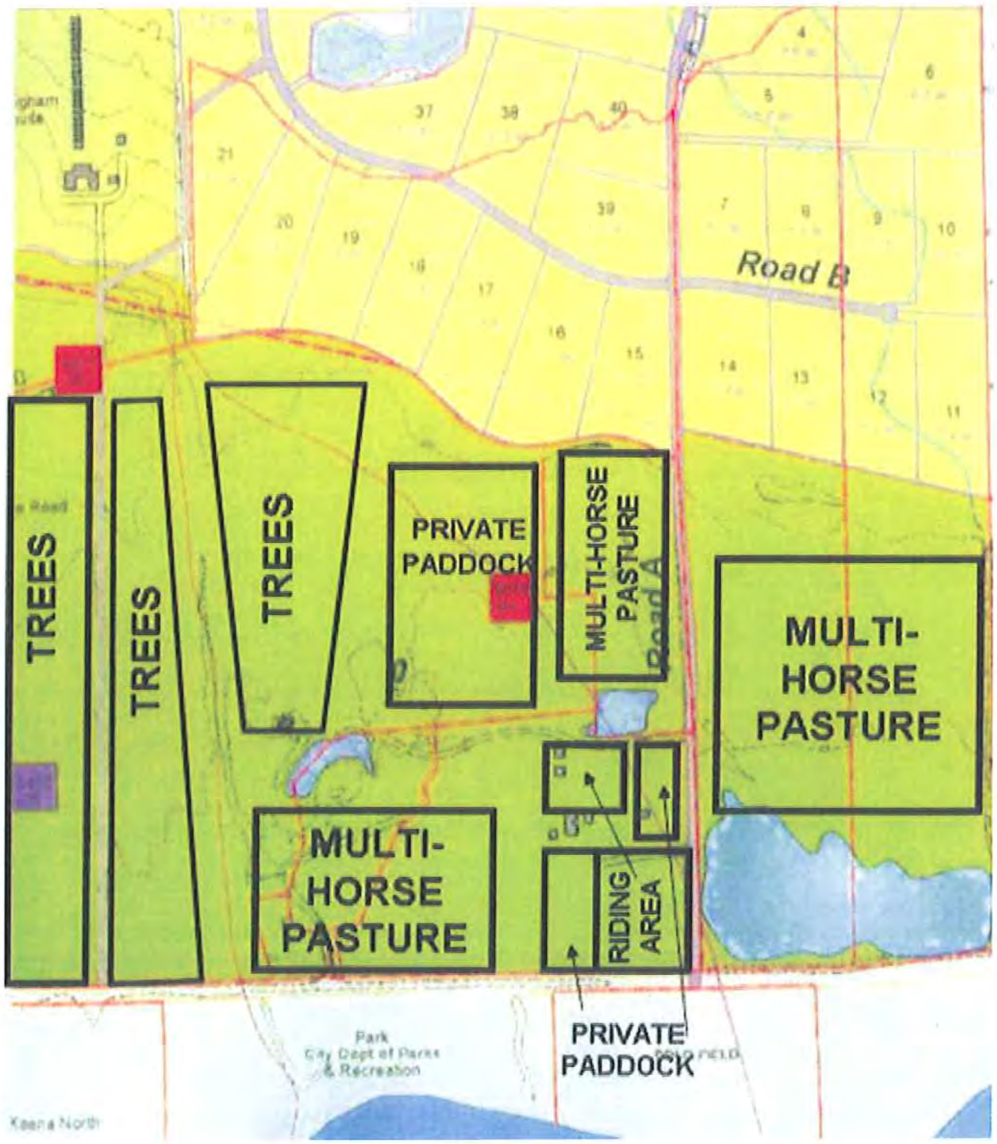


Figure 5 – Future Uses (Illustrative Only – Not to Scale)

Tree Farm: The propagation of new coconut trees to replace sold field stock and to meet grow contracts is anticipated to expand the tree farm by roughly 25%. Expansion of the tree farm by 15 to 20 acres would be into the adjacent underutilized portion of The Flats which are presently subject to occasional flooding by storm water from Makaleha Stream (Figure 5). However, the expansion area is located in the flood fringe, where the back-up of storm water comes from the parcel across the highway that was conveyed to the City & County of Honolulu ("City") for a future park site in 2000.

To mitigate these occasional impacts, DRA has taken the lead and is presently clearing overgrown vegetation in the site of the future park. In addition to the vegetation, accumulated silt and debris from an area that is supposed to function as a retention basin is also being removed. This work is being done in conjunction with the City's Department of Parks & Recreation and Department of Facilities Maintenance which have issued the necessary permits to DRA. With this clean-up completed, storm water will be able to flow freely under the bridges on Farrington Highway, into the retention basin and eventually out to the ocean. This will minimize the times that the expansion area for the tree farm is subject to inundation.

With the initial expansion of the tree farm, seedlings will be planted with 15' to 20' spacing between the trees, which will allow for the full spread of the fronds for optimal growth and to facilitate removal of the mature trees. The future inventory from the expansion area will enable the stock in the existing tree farm to be depleted so that seedlings can eventually be plated with the required on center spacing.

The ability to remove mature field stock trees without damaging the adjacent landscape material is critical to position the tree farm for the long-term. The existing material in the tree farm provides a gross inventory count of 6,500 trees. However, damage inflicted during each removal from the closely packed trees reduces the value of the remaining stock, as the damaged trees are unmarketable and must eventually be written-off. Nicks and gauges to the trunks of trees eventually form holes which results in the demise of the tree. Landscape contractors do not touch damaged trees due to the potential liability of eventually having to replace the transplanted tree at their cost.

In addition to adequate spacing, drip irrigation will be utilized to improve the growth rate of the seedlings. This is essential during the initial two years to accelerate the growth of the trees before the root ball is firmly established. The objective is to quickly grow the trees to the 15' to 25' height that is highly marketable. Properly spaced, trees can be efficiently watered by drip irrigation for an average of 400 to 500 gallons per acre/day.

Drip irrigation significantly lowers water loss during application, minimizes labor costs and has the advantage of limiting the growth of weeds as water is delivered directly to the root ball. The installation of a drip irrigation system in the expansion area would involve nominal expense, as a water distribution line presently runs across area. Flexible drip irrigation lines are easy to handle and relatively inexpensive. The cost for additional extension of distribution lines and drip irrigation tubing is estimated to be $35,000.

In terms of revenue, the price structure for the sale of the field stock trees was recently increased based upon a survey of the market, including large contractors like Green Thumb, Inc and Takano Nakamura. The result of the mid-year survey indicates that demand for field stock trees will remain strong, with the two contractors estimating that about 500 trees combined would be purchased in the second half of 2007. This is anticipated to generate annual revenues in the $350,000+ range for the current fiscal year.

Additional access to the landscape community would be provided through membership in the Landscape Industry Council of Hawaii ("LICH"). Boyd Ready, a landscape contractor (Akahi Services – Phone: 455-5995) is the current President. Another good resource is the Hawaii Chapter of the American Society of Landscape Architects. Bradley Tanimura (Belt Collins Hawaii – Phone: 521-5361) is the President. Both of these organizations provide access to an effective network to landscape contractors and landscape design professionals on Oahu.

Boarding and Equestrian:

DRA will shortly initiate a program to completely replace the fencing for the existing paddocks and pasture area. While this is not anticipated to increase the aggregate area of the combined paddocks and pasture from the present 125 acres, the reconfiguration will create more paddocks with a uniform 70' by 120' size, which is an industry standard.

Up to date pasture management practices will be employed to increase the growth of pasture grass and Giant Bermuda will be introduced incrementally to achieve a better yield per acre of forage. The combination of the foregoing activities is anticipated to enable the Ranch to maintain the equivalent number of horses stabled within the reconfigured and upgraded paddocks and fenced pasture areas with increased efficiency.

A new fenced, multi-horse pasture will be created on the Kaena (west) side of the main entry road into Dillingham Ranch. The new pasture area will be implemented once the combined leach field for the agricultural community has been installed (underground piping). The pasture will not be irrigated and is intended to only be used as part of a systematic rotation designed to provide a chance for the smaller paddocks to regenerate. At this time, there are no plans for this to become an expansion area for the boarding of horses.

At some point in the future, a polo field may be constructed on a portion of the new fenced pasture area. At most, the polo field would be a seasonal use of the pasture area, possibly on a concession or licensed basis to an independent operator. The grassed pasture/polo field will not affect the leach filed or alter the intermittent flow of runoff from the areas inland.

As the clean-up of the future City park area is completed to mitigate the occasional inundation of The Flats, an additional fenced, multi-horse pasture may be an option for the most flood prone area of the Ranch, just inland of the frontage along Farrington Highway. The additional multi-horse pasture will be used for the rotation of horses to enhance regeneration of the individual paddocks and as an alternate pasture site during the polo season. This area is not intended to become a permanent pasture for the boarding of horses and will not be irrigated.

As part of the upgrades to the Ranch, the office and related buildings at the Equestrian Center will be renovated. The existing training facilities will also be upgraded to provide more areas for simultaneous multi-horse activities. To facilitate the foregoing, new fencing will be erected to create separate areas for specialized training, such as dressage.

Two new improvements planned for the area of the Equestrian Center are a feed barn, to replace the present use of a tent, and a horspital to permit certain treatments to be performed on-site. The horspital will enable sick or injured animals to be isolated while they are being treated. The horspital will also contain a small office for use by veterinarians and a separate room where minor procedures can be done on site. These facilities will significantly improve the services offered as part of the boarding operation to further differentiate Dillingham Ranch from other stables.

In total, improvements to the paddocks, pasture areas and the Equestrian Center will amount to about $1,897,500, with all of the upgrades to be in place in 2008. Additional improvements to the on-site water system are anticipated to cost $575,000, with other upgrades and improvements to be done to the makai area at a cost of $617,000.

Once the foregoing improvements have been completed, the upgraded facilities will enable DRA to command higher rental rates, averaging about $330/horse per month, including the feeding service. Approximately 75% of the owners currently take the feeding program and this is anticipated to continue. Revenue is projected to reach $400,000 annually for the upgraded boarding operation.

Other Activities: Income from the sale of coconuts, horse shows and Pony Club events is anticipated to remain steady. Annual revenues from various events are projected to be as follows: Pony Club - $2,000, polo and horse shows - $5,000 and vending operations - $2,000.

With the development of the agricultural community, an additional source of revenue for the working ranch will come from the provision of pasture management services to the individual owners of the Subdivided Lots. While still in an embryonic stage, pasture management is contemplated to encompass monitoring the health of the pasture grass, maintenance of the irrigation system, cycling of the areas to be irrigated and tending to the livestock (including a feeding program), particularly when the owner is out-of-state. The fees for these services have not been established at this stage, but the method of payment could either be structured as part of the monthly assessment by the Homeowners Association or through a direct payment to DRA.

Revenue from commercial filming, photo shoots and special events at the Dillingham House will drop in the near term while the facility is being restored. Prior to the start of restoration work on May 15th, DRA had successfully leased the Dillingham House and the grounds for movie production, photo shoots, special events and receptions. These activities will be reactivated as of April 2008 and revenues are anticipated to average $75,000 per year.

In addition, restoration of the Dillingham House and the grounds will enable DRA to actively market the Ranch to the Japanese wedding market, solely for wedding ceremonies. Due to the high cost of weddings in Japan, Hawaii has become an attractive destination for young couples to come for their exchange vows. The major reason for this alternative to a wedding at home is that the obligatory guest list is pared down to a limited group of friends willing to travel to Hawaii with the bride and groom. The younger generation is constantly looking for unique sites for their Hawaiian wedding, which typically only involves only a short-term rental of the location for the ceremony. The revenue potential for this untapped market has not been included in the foregoing figure, which contemplates larger, more formal wedding events followed by a reception at the Dillingham House.

The restoration work required to the historically significant Dillingham House will be extensive, with costs anticipated to reach $2,119,000. Renovations necessary for the kitchen to be reconfigured to handle special events, such as receptions, is projected to cost an additional $778,000. Earlier in 2007, the old cesspool was upgraded to a state-of-the-art aerobic treatment system and leach field meeting the requirements of the State Department of Health at a cost of $250,000. The new treatment system has been sized to accommodate the larger special events planned to be held at the restored Dillingham House.

<u>The Agricultural Community</u>

The agricultural community is an integral part of the Agriculture Plan, as the capital infusion required to refurbish and upgrade existing infrastructure systems and fund other improvements for the working ranch will be recovered from the sale of the Subdivided Lots. The in place income received by a landowner for the long-term commitment of land to agricultural activities is modest and alone does not support the up-front commitment of the funds necessary to restructure the working ranch.

The creation of an agricultural community, the "80 Five Acre Lots" noted in the prior Agricultural Feasibility Study, is a critical component of the Agriculture Plan contained herein (Note: the updated Preliminary Map has a total of 77 Subdivided Lots). The sale of the Subdivided Lots is the mechanism by which DRA will recover its significant, up-front expenditure of capital for the improvements necessary to reposition the working ranch and in turn contribute to increased future revenues from all current income sources (as well as association dues for those amenities shared by the individual members of the agricultural community).

The Subdivided Lots that comprise the agricultural community will be ranching oriented. This is in keeping with the long history of Dillingham Ranch in the Mokuleia community, which has always been in cattle and horses, not in the cultivation of sugarcane or other farming activities. Ranching, the grazing of cattle, pasturing of horses and livestock propagation, is a bone fide agricultural activity. Pursuant to the provisions of Chapter 205, Hawaii Revised Statutes ("HRS"), the property will be subject to recorded covenants requiring that the Subdivided Lots be used for agricultural activities (see Appendix C).

Development of the agricultural community will be a huge undertaking. The costs associated with the provision of roadway access and related off-site and on-site infrastructure improvements to support the Subdivided Lots are high due to the distance from the highway, the topography of The Foothills is and the limited utility service available in this rural area. In compliance with the Subdivision Rules & Regulations, all infrastructure improvements will be designed and constructed to City standards.

Potable and Non-Potable Water

The previous Agricultural Feasibility Report for the "80 Five Acre Lots" contemplates the creation of managed pasture, orchards and other agricultural activities on each of the lots (referred to herein as the "Subdivided Lots"). For purposes of assessing the water resources at the Ranch, the Supplemental Report assumes that the primary activity on the Subdivided Lots will involve the cultivation of Giant Bermuda or other pasture grasses. Due to the arid climate of the Mokuleia area, it is anticipated that irrigation will be employed to supplement rainfall to ensure optimal growth of the pasture grass.

Sources of Water

The provision of sufficient water to support the contemplated agricultural activities is an essential component of the Agriculture Plan. The following is an overview of the water sources available to the Ranch:

Well Sources - Water for the existing domestic and agricultural activities at the Ranch is provided by two active sources located on The Flats (Figure 6) – Wells Nos. 3410-01 and 03 (the "Makai Wells"). Potable water from Well No. 3410-01 also services the domestic water requirement for the Mokuleia community to the west of the Ranch. Two additional water sources – Well Nos. 3310-01 and 02 - are located in the lower fringes of The Mauka Lands (the "Mauka Wells"). Both of the Mauka Wells have been cased, grouted and pump tested. However, the wells have not been outfitted for production.

All four wells have Water Use Permits and water allocations from the State Commission on Water Resource Management ("CWRM"). The aggregate Allocation in gallons per day ("GPD") for the four wels amounts to 4,100,000 GPD. The two active Makai Wells account for 2,000,000 GPD. Copies of the Water Use Permits are provided for reference in Appendix D. Table 2 below summarizes the foregoing information:

Table 2 – Well Capacity

Well Number	Well Owner	Water Use Permit	Allocation
3410-01	Dillingham Ranch Aina	WUP No. 813	500,000
3410-03	Dillingham Ranch Aina	WUP No. 779	1,500,000
3310-01	Dillingham Ranch Aina	WUP No. 776	1,200,000
3310-02	Dillingham Ranch Aina	WUP No. 777	850,000

Data on water for existing operations was obtained from the monthly pumpage records for Well No. 3410-01, which covers a 2-1/2 year period from January 2005 to July 2007. This data provides an accurate confirmation as to an average daily pumpage of 160,634 GPD. For Well No. 3410-03, pumpage of the non-potable well was not recorded prior to December 2006. In addition, readings for the first four months of 2007 are unreliable. Accordingly, only readings from May through August are usable and these have been increased by 50% to obtain a conservative estimate of the average daily pumpage of 161,904 GPD.

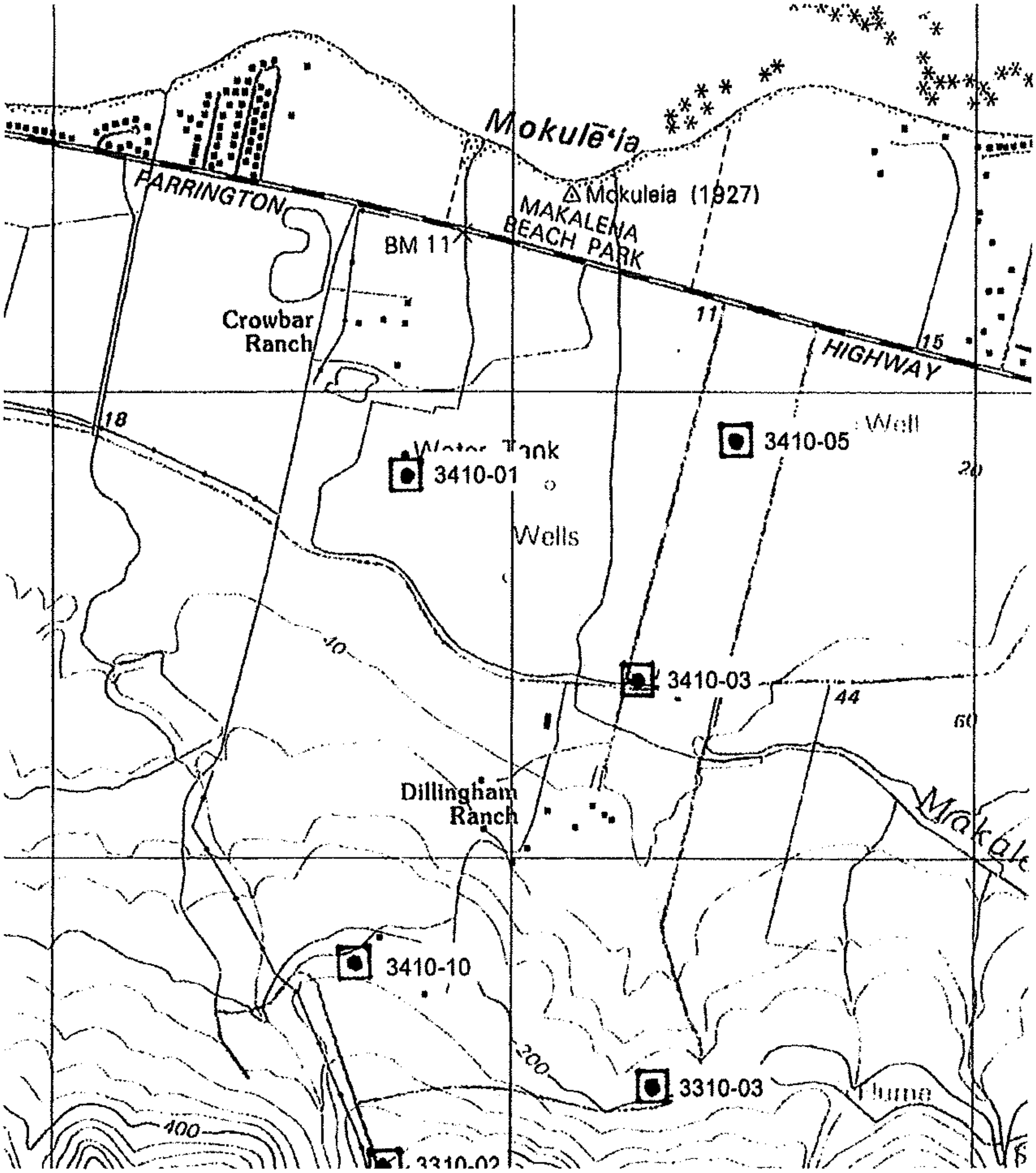


Figure 6 – Wells on Dillingham Ranch

Additional Water Demand for Working Ranch - Future water requirements for the working ranch have been estimated as follows:

- At a consumption of 12 to 15 GPD/head, the increase of about 100 cows and 80 calves would produce a nominal additional water requirement for the cattle operation of 2,700 GPD. Water consumption by the existing herd is included in the present pumpage from the two makai wells.

- With improvements to the water distribution and irrigation system, the present pumpage for Well No. 3410-03 is anticipated to be adequate to cover both the existing field stock trees and the expansion of the tree farm. Drip irrigation will be employed to significantly increase irrigation efficiency and conserve water.

- The boarding of horses in the reconfigured paddocks and fenced pasture area is anticipated to remain steady at about 100 horses, which will not generate a requirement for additional water. Refurbishing of the existing distribution and irrigation systems plus improved water management practices will reduce system losses and over-watering. The two future multi-horse pasture areas will not be irrigated.

Future Water Demand for Managed Pasture - For the Subdivided Lots, an estimate as to the additional water required for managed pasture was generated based on monthly rainfall data collected over 46 years at Kawaihepai Station 841 in Waialua. Review of the mean monthly rainfall figures indicated a strong seasonal variation in the pattern of precipitation between the winter and summer months.

The deficit between annualized monthly rainfall amounts and the requirement for pasture grass (65 inches/year) was used to generate an average daily water shortfall to be provided by irrigation. The analysis is summarized in Figure 7, which indicates an average water requirement on 2,940 gallons per acre/day. Assuming that four acres of each of the 77 five acre lots is irrigated pasture, the total requirement for water amounts to 905,520 GPD.

Based on the projected average requirement of 2,940 gallons per acre/day, the availability of water to support the Agriculture Plan is summarized below in Table 3:

Table 3

Well No.	Location	WUP No.	Allocation (GPD)	Current Use (GPD)	Capacity (GPD)
3410-01	Makai		500,000	160,634	339,366
3410-03	Makai		1,500,000	161,904	1,338,096
3310-01	Mauka		1,250,000	0	1,250,000
3310.02	Mauka		850,000	0	850,000
			Available	**Capacity**	**3,777,462**
			Expanded	Cattle Herd	(2,700)
			Managed	Pasture	(905,520)
			Remaining	**Allocation**	**2,869,242**

[illegible]

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.8	0.9	0.8	1.7	2.6	3.7	25.5 (Total)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.6	10.8	9.6	20.4	31.2	44.4	25.5 (Weighted Av)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	65.0	65.0	65.0	65.0	65.0	65.0	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	55.4	54.2	55.4	44.6	33.8	20.6	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.6	4.5	4.6	3.7	2.8	1.7	
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	31	31	30	31	30	31	365
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.148925	0.145699	0.153889	0.119892	0.093889	0.0553763	
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4,045	3,958	4,180	3,257	2,550	1,504	
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	125,407	122,691	125,407	100,960	76,512	46,632	1,072,978

Weighted Average gallons/ac/day: 2,940

[illegible]

Figure 7 – Rainfall/Irrigation

The foregoing indicates that the additional water demands for the expanded operations of the working ranch and managed pasture will not deplete the Allocations available to DRA. Pasture grass is a relatively high consumer of water and the mix of crops that is ultimately cultivated on the Subdivided Lots will influence the amount of irrigation required per acre/day, as will the method of application – spray/micro-sprinkler/drip. It should also be noted that during extended drought conditions, water for irrigation can also be conserved through the import of feed to supplement grazing.

Note: A detailed Water Master Plan will be prepared as part of the preliminary engineering of the infrastructure required for the contemplated agricultural community. Data from the Water Master Plan will supersede the preliminary analysis provided above at such time as it is available.

North Shore Water Company

The North Shore Water Company is presently operating under the oversight of the Public Utilities Commission (the "PUC") pursuant to PUC Decision & Order 23471 for Docket No. 2006-0137 (May 31, 2007). Condition 1(C) of he Decision & Order stipulates: "The rates to be charged customers shall be no more than the BWS rates that were effective as of October 1, 2006."

North Shore Water Company was given to September 15, 2008 to either form a community association [made up of water users] or file for a Certificate of Public Convenience and Necessity ("CPCN"). In the forth Quarterly Report filed on September 15, 2007, North Shore Water Company notified the PUC as to its failure to form a community association and willingness to apply for a CPCN.

North Shore Water Company intends to make application for a CPCN, consistent with all conditions of Chapter 269, HRS, and Chapter 6-61 of the Administrative Rules of the PUC. As a regulated quasi-public utility, North Shore Water Company can only charge the rates and fees approved by the PUC. It is anticipated that the rates and fees, including those for agricultural uses, will be competitive with the BWS rate schedule.

Summary and Conclusion

Dillingham Ranch has suffered a prolonged period of decline since the height of the plantation era of the early 1900s. The lack of reinvestment in the Ranch by a series of owners has left the working ranch operating on seriously deteriorated infrastructure. This situation extended to the once gracious Dillingham House, where years of neglect are evident.

Kennedy Wilson International and Cargill, the two major partners in Dillingham Ranch Aina, LLC acquired the property out of receivership, recognizing the unique opportunity presented to reposition the Ranch as the heart of the Mokuleia community. While part of their effort deals with the repair and upgrade of the physical infrastructure and other facilities, the larger task involves the restructuring of the "working ranch" to ensure its long-term viability.

In addition to a significant investment in the facilities at the Ranch, the Agriculture Plan detailed herein is premised on a revamping of the core activities of the working ranch, rather than attempting to launch new and unfamiliar ventures. The focus maximizes the value of the existing expertise and is directed at achieving more efficient day-to-day operations, enhancing the quality of the goods and services offered by the Ranch and tapping into new and expanded markets for the existing products.

Implementation of the Agriculture Plan will require a significant up-front expenditure of capital on the part of DRA. Such outlays cannot be recovered by the existing operations of the working ranch – cattle, trees, boarding and special events. This is the reason the subdivision and sale of five acre ag lots within an agricultural community on the Ranch is an integral component of the Agriculture Plan. This is the critical element that will generate the capital infusion required to make implementation of the Plan a reality.

The core activities of the working ranch are in compliance with the provisions of Section 2054.5, HRS, and the City's Land Use Ordinance, both of which regulate uses and activities on agricultural land. The creation of managed pasture, orchards or other crops on the five acre Subdivided Lots has been covered in the previous Agricultural Feasibility Report. In addition, the important role of the Subdivided Lots to funding the provisions of the Agriculture Plan is covered herein.

Based on the foregoing, the proposed consolidation/resubdivision action to create the Ranch Lots and the Grazing Lot for the working ranch and the 77 Subdivided Lots in the agricultural community forms the foundation for generating the capital infusion necessary to reposition the Dillingham Ranch for the future.

Appendix G

Rockfall Potential and Hillside Slope Evaluation
Dillingham Ranch Mokūle‘ia Development
Mokūle‘ia, O‘ahu, Hawai‘i

February 15, 2008
W.O. 5721-20(Rev.[5])

Mr. Clifford Smith
Dillingham Ranch Aina, LLC
9601 Wilshire Boulevard, Suite 220
Beverly Hills, CA 90210

GEOTECHNICAL ENGINEERING CONSULTATION SERVICES
ROCKFALL POTENTIAL AND HILLSIDE SLOPE EVALUATION
DILLINGHAM RANCH MOKULEIA DEVELOPMENT
TMK: 6-8-002: 006, 6-8-003: 006, 015, 019, 030, 031, 033, 035, AND 040
MOKULEIA, OAHU, HAWAII

Dear **Mr. Smith:**

In accordance with our fee proposals dated August 8, 2006 and September 18, 2007 we conducted an evaluation of the hillsides and potential rockfall hazard conditions at the project site. This report summarizes the findings based on our field reconnaissance of the existing site conditions and our engineering and statistical analyses of the potential rockfall processes anticipated at the project site.

The findings and recommendations presented herein are based on a revised subdivision layout and our performance of additional field reconnaissance and engineering analyses. The revised subdivision layout was performed in part to reduce the effect of potential rockfall hazards from adjacent mountain slopes at some portions of the project site.

Therefore, the findings and recommendations presented herein rescind and supersede our August 13, 2007 Rockfall Potential and Hillside Slope Evaluation Dillingham Ranch Mokuleia report in its entirety. The findings and recommendations are subject to the limitations noted at the end of this report.

PROJECT CONSIDERATIONS

The proposed project is in the Kawaihapai area of Mokuleia at the northwestern portion of the Island of Oahu, Hawaii. Based on the preliminary information provided, the project consists of developing about 77 agricultural lots encompassing about 4.16 to 10.83 acres each. We understand the initial site development will include construction of roads and pavements, installation of utilities, construction of rockfall protection improvements, and construction of drainage improvements associated with the roadways and control of off-site runoff through the lots.

The project site resides along the foot of the northerly facing Waianae Mountain Range as shown on the Project Location Map, Plate 1. Of the proposed 77 agricultural lots, 9 lots appear to have a moderate to high risk for potential rockfall encroachment from adjacent mountain slopes. The 9 lots are along the upslope side of the western and central portion of the development adjacent to undeveloped ridge and valley terrain. Furthermore, 5 other lots at the southern boundary of the eastern portion of the development appear to have a low risk for potential rockfall encroachment from adjacent mountain slopes.

In accordance with the City and County of Honolulu Subdivision Rules and Regulations, Sections 2-201(c)(7) and 2-201(d), we conducted a geological and geotechnical engineering evaluation of the existing hillsides, natural hazards, and potential rockfall hazard conditions, which could affect the proposed subdivision development in the future.

This report presents the results of our Phase I Rockfall Potential and Hillside Slope Evaluation and includes our preliminary recommendations for rockfall mitigation to reduce the hazard associated with potential rockfall conditions. Following the owner's and/or client's review and acceptance of the conceptual rockfall hazard mitigation scheme, a second phase of detailed study will be performed to refine the selected mitigation scheme and develop a basis of design and construction documents package, which would include appropriate construction plans and technical specifications to perform the rockfall hazard mitigation work. Refinements to the conceptual rockfall mitigation scheme may include modification of the design rockfall energy capacity and height of the rockfall impact barrier. In addition, some adjustments to the location and length of rockfall barriers may be needed as a result of our additional detailed analyses performed for the project design.

PURPOSE AND SCOPE

The purpose of our work was to conduct geological reconnaissance and evaluation of the existing hillslope conditions to develop a generalized data set to analyze and formulate a preliminary rockfall hazard assessment with probable rockfall hazard mitigation measures. In order to accomplish the objective, a program generally consisting of the following tasks and work efforts was performed:

1. Research and review of available development plans and in-house soils and geological information, including aerial photographs from the project site and vicinity.

2. Performance of geological reconnaissance (visual observations) of the project site to evaluate the existing hillslope conditions and surface exposures of rock outcroppings and boulders by our geologists.

3. Engineering analyses of the field data, including the performance of preliminary potential rockfall simulation modeling using the computer-based Colorado Rockfall Simulation Program (CRSP) to develop a statistical basis for the rockfall hazard assessment.

4. Preparation of this letter report presenting our preliminary findings and recommendations.

5. Coordination of our work on the project by our project geologist.

6. Quality assurance of our overall work on the project and client/design team consultation by our principal engineer.

7. Miscellaneous work efforts such as drafting, word processing, clerical support, and reproductions.

REGIONAL GEOLOGY

The Island of Oahu was built by the extrusion of basaltic lava from the Waianae and Koolau shield volcanoes. The older Waianae Volcano is estimated to be middle to late Pliocene in age (2.7 – 3.4 million years ago), and Koolau Volcano is estimated to be late Pliocene to early Pleistocene (Ice Age) in age (2.2 – 2.5 million years ago). After a long period of volcanic inactivity, during which time erosion incised deep valleys into the Waianae and Koolau shields, volcanic activity returned with a series of lava flows followed by cinder and tuff cone formations located mainly at the southeastern portion of the Island of Oahu.

The project site is situated on the foothill pediment along the northerly facing slopes of the Waianae Range, as indicated on the Project Location Map, Plate 1. The gently to moderately sloping pediment was formed by the long-term accumulation of a relatively thick wedge of eroded and transported alluvium and colluvium (Quaternary Alluvium). The deposits are believed to have accumulated in relatively stable settings during the deposition of extensive alluvial/colluvial fans, which emanate from the primary Waianae Range drainages. The alluvial/colluvial fans are generally composed of eroded and transported clayey soils with embedded rock fragments ranging from cobbles to very large boulders. The deposits are believed to be very old as evidenced by local near-surface exposures of boulder conglomerate (semi-consolidated colluvial rock deposits) and alluvial soils that have consolidated with a residual and saprolitic soil appearance.

The steeper slopes upslope from the southern development boundary are composed of layered basaltic rock, which erupted from the Waianae Volcano. The basaltic rock exposed on the hillsides generally consists of interbedded dense (massive) lava rock layers and thinner seams of medium hard clinker, which represent sequential lava flows. Natural long-term erosion of the rock materials has produced some loose fractured surface rock outcroppings capable of producing individual boulders. As a result of the weathering and erosion processes, boulder materials may separate from the parent rock outcrop and roll or bounce from the steeper hillside terrain. The boulder movement could produce hazardous rockfall encroachment on down slope development. Based on our field reconnaissance, the primary source region for potential rockfall activity encompasses the steeper slopes composed of layered basaltic rock upslope from the southern boundary of the development.

GENERAL SITE CONDITIONS

The project site is along the northerly facing slopes of the Waianae Range in the Mokuleia area of the Island of Oahu, Hawaii. The site generally encompasses an open range vegetated with scattered trees and heavy dry land brush and grasses. A number of existing ranch trails traverses the project site. Ground surface elevations generally range between about +30 feet Mean Sea Level (MSL) at the northern lowland portion of the proposed development to a maximum elevation of about +450 feet MSL along portions of the upslope development boundary. The proposed development plan including the lot and roadway layout used for our analyses is shown on the Site Plan, Plate 2.

The project site resides where annual precipitation ranges between about 35 to 40 inches per year, with most of the precipitation falling in the winter months. Based on our observations, stream flow appears to be intermittent and generally in response to widespread storm conditions or higher elevation rainfall and runoff. Existing vegetation type indicates that the site conditions are typically dry with limited periods of stream flow, surface runoff, and wet ground conditions. Therefore, it is anticipated that the general rate of rock weathering and erosion may be slower than other wetter climatic regions on the Island of Oahu.

Based on our review of available geological and soils maps, most of the project site is underlain by rocky Quaternary Alluvium (Qa) deposits, which comprise the gentle to moderate foothill pediment slopes. The Quaternary Alluvium generally consists of mixed soils and a high volume of embedded basaltic boulders. Surface basaltic rock formation including rock outcroppings and other in-situ derived residual and saprolitic soils [referred to collectively as Tertiary Waianae Basalt (Twb)] are mainly encountered further upslope of the project site.

SITE RECONNAISSANCE

A surface field reconnaissance was performed along the southern development boundary and at selected interior hill slopes to obtain an overview of the existing site conditions with respect to potential natural hazards such as rockfall, slope instability, and debris flow. The primary purpose of our field reconnaissance was to obtain an overview of the general location and character of existing surface boulders and rock outcroppings residing on sloping terrain.

In addition, field reconnaissance was performed to evaluate probable boulder rolling paths that could affect the proposed down slope development. The field information was used to support our computer simulation and statistical evaluation of potential rockfall behavior using the CRSP engineering analytical tool.

Existing Potential Rockfall Conditions

Based on our site reconnaissance and evaluation for potential rockfall hazards with respect to the Dillingham Ranch Mokuleia Development Plan, 9 proposed lots (identified as Lot Nos. 47 and 58 through 65) appear to have a moderate to high risk for potential rockfall encroachment from adjacent high mountain slopes outside of the development boundary. These higher risk lots are along and adjacent to the southern development boundary at the western and central portions of the site as shown on the Site Plan, Plate 2. The 9 lots reside along alternating ridge and valley topography associated with the Waianae Range. In general, the areas of potential rockfall hazard are fronting the ridgeline nose and side slopes of the mountain ridges.

Furthermore, 5 lots (identified as Lot Nos. 30, 31, 32, 34, and 35) appear to have a low risk for potential rockfall encroachment from adjacent mountain slopes outside of the development boundary. The 5 lots reside along the flatter terrain of the lower elevation flanking mountain slopes. These lower risk lots are along the southern development boundary at the eastern end of the project site downslope and adjacent to the existing Department of Land and Natural Resources (DLNR) access road, as shown on the Site Plan, Plate 2.

Based on our site reconnaissance and analyses, it is our opinion that other proposed lots below the adjacent mountain slopes (including Lot Nos. 46, 48 through 50, and 57) should not be affected by rockfall encroachment. Rockfall encroachment is not anticipated at these lots because of the following observed conditions:

1. A limited source of upslope boulders and rock outcroppings was observed;
2. The lots are at a greater distance from the observed potential rockfall source areas;
3. Gentle hill slopes provide natural buffering terrain; and,
4. Some existing natural topographic barriers such as ravines were observed.

Based on our site reconnaissance, a large volume of widely scattered boulders in generally stable ground surface settings were observed throughout the project site interior. The boulders represent old alluvial and colluvial deposits from the early erosion and geological evolution of the Waianae Range. We believe the old boulder deposits within the subdivision development have a low potential for producing hazardous rockfall conditions due to the gently sloping and generally stable depositional terrain. It is anticipated that boulders will be encountered during the grading and development of the individual lots. The individual lot owners should be advised to obtain the services of a competent geotechnical engineer to evaluate existing boulder deposits within their lots for potential instability and possible rockfall hazard mitigation.

Based on our observations, some broad trends in the rockfall hazard potential and level of rockfall hazard risk with respect to the lots along the southern development boundary were identified. In general, the potential for rockfall activity to encroach upon the development increases from east to west across the southern development boundary. This is based on the following general observations:

1. Upslope mountain ridges (rockfall source region) gradually steepen toward the west.

2. Foothill pediment slopes (probable rockfall run-out region encompassed by the lots) gradually steepen towards the west.

3. The distribution and relief of source rock outcrops increases toward the west.

4. The distribution of existing non-embedded surface boulders increases toward the west.

Based on our site reconnaissance, the existing ground surfaces within the lots along the upslope development boundary are composed of mixed soils containing an appreciable volume of basaltic cobbles and boulders. Surface boulders ranging between 3 and 12 feet in dimension were observed in generally stable ground settings within the lots. The larger surface boulders were generally encountered at the upper elevations of the western end of the project site. Most of the surface boulders encountered are partly embedded and are believed to be erosional remnants of old regional colluvial fan deposits that had accumulated a very long time ago. However, the distribution of non-embedded surface boulders (potentially more recent fallen rock) appears to increase toward the southwestern corner of the project site, in the vicinity of Lot Nos. 58 through 63. The greater distribution of existing surface boulders towards the southwestern corner of the development (vicinity of Lot Nos. 58 through 63) appears to correlate with the observed increased occurrence of upslope rock outcroppings consisting of higher relief, fractured rock.

Existing Slope and Drainage Conditions

Based on our reconnaissance, a number of existing well-established drainage ravines emanate from the large inland valleys. These substantial drainage ravines transect from south to north through the proposed development. The incised ravines provide near-surface exposures of the colluvial/alluvial fan deposits including scoured exposure of localized basalt rock formation in some upslope locations. The normally dry drainage ravines are believed to transmit appreciable runoff derived from the interior mountains during periods of high rainfall. As a result, the ravines should be considered as potential flash-flood conduits and future building sites should be set back at appropriate distances from the established channels. Hydrologic study should be performed as a basis for the designation of the infrastructure set backs from the drainage ravines.

Based on our site reconnaissance and a review of aerial photographs, overt visible signs of active, large-scale ground instability were not revealed within the project site. Because the drainage ravines incise the colluvial/alluvial fan deposits composed of unconsolidated and semi-consolidated hard cobbles and boulders, the existing ravine slopes appear to be naturally armored by the rocky and semi-consolidated deposits. However, some erosion and raveling of the natural stream banks composed of soils and rocky deposits should be anticipated; therefore, appropriate setback restrictions for future structures, roadways, and other improvements should be established by the project geotechnical engineer.

Based on our site reconnaissance, geological evidence related to the occurrence of other natural hazards such as recent debris flow and landslide activity was not encountered. Historic documentation or records of past occurrences of these natural hazards at the project site was not revealed.

DISCUSSIONS AND RECOMMENDATIONS

Site reconnaissance and literature review was performed to assist in the evaluation of the existing project site conditions with respect to natural hazards such as rockfall potential, hill slope stability, and debris flow/flash flood potential. In addition to our reconnaissance and literature review, we performed computer simulation and statistical analysis of potential rockfall activity using the Colorado Rockfall Simulation Program Version 4 (CRSP).

Based on our evaluation of the existing project site conditions with respect to potential natural hazards such as rockfall, slope instability, and debris flow, it is our opinion that the site is suitable for residential subdivision development and is feasible from a geotechnical point-of-view provided that the recommendations provided herein are implemented. Once the final grading plans for the project are available and have been reviewed, Geolabs will render an opinion addressing the stability of slopes in the post-development condition.

Rockfall Simulation Analysis (CRSP)

As previously discussed, site reconnaissance was performed to visually identify potential rockfall hazards such as loose surface boulders and unstable rock outcroppings residing within the project site and the adjacent slopes above. The site reconnaissance also permitted us to evaluate probable rolling trajectories in relation to the existing topography and development boundaries. Following the site reconnaissance, selected information recorded in the field was input to the CRSP to validate the field observations.

The CRSP is a computer program that is a widely accepted engineering tool used to estimate potential rockfall behavior by simulating probable rockfall activity based on input parameters that are assigned on a site-specific basis. The input parameters for this project were assigned based on the observations and measurements collected in the field. The program provides a statistical evaluation of potential rockfall behavior based on hill slope topographic profiles and other specific input information such as rock size, shape, and parameters used to quantify the typical ground surface conditions. Information obtained from the CRSP analysis includes the predicted falling rock velocity, bouncing height, kinetic energy, and roll-out distance. The output information is useful to assist in the site-specific design of various rockfall mitigation schemes such as rockfall impact barriers or other rockfall containment systems.

Topographic information input to the CRSP was obtained from United States Geological Survey (USGS) topographic quadrangle map. The map contours are generally at 40-foot intervals. As a result, the model hill slope profiles developed from the available topographic map provide a generalized representation of the existing ground surface topography.

Six selected hill slope model profiles identified as Slope Profiles 1 through 6 were developed to support our CRSP analysis. The approximate locations of the six slope profiles used in our analysis are shown on the Site Plan, Plate 2. The graphic representation of the model slope profiles produced from the available topographic information is shown on the Slope Profiles, Plates 3.1 through 3.3.

Our CRSP analysis was performed using spherical shaped boulders (conservative rolling scenario) ranging in size from 2 to 8 feet in dimension rolling from the source area(s) identified during the field reconnaissance. For each simulation run, 1,000 source rocks were utilized to develop a statistical distribution of the results. Numerical input coefficients were selected to approximate the typical condition of the existing ground surfaces.

Our rockfall protection criterion is defined as the probable interception and catchment of 90 percent of possible rockfall hazards assessed by the computer rockfall simulation analysis (CRSP). The 90 percent catchment criteria is a target that is commonly used in engineering practice for evaluation criteria that can be quantified by a statistical and probability analysis using model data for natural occurrences such as rockfall activity. Since the analyses are based on statistics and probability, a 100 percent criteria is impractical to achieve.

Based on our reconnaissance and preliminary rockfall simulation analysis, rockfall encroachment at Lot Nos. 30 through 35 is anticipated to be limited and of low risk due to the existing gently sloping terrain adjacent to the development and the presence of the existing DLNR access road between the observed potential rockfall source area and the subdivision lots. Based on our CRSP analysis of these slopes, less than 2 percent of simulated rockfall could encroach beyond the DLNR roadway corridor upslope of the development.

Based on our reconnaissance and preliminary rockfall simulation analysis, no rockfall encroachment at Lot Nos. 46, 48 through 50, and 57 is anticipated due to conditions previously described in the Site Reconnaissance section herein.

Based on our reconnaissance and preliminary rockfall simulation analysis for Lot No. 47, the western half of the lot is exposed to potential rockfall hazards from the north and east facing slopes of the hillside bordering the lot. Based on our CRSP analysis of these slopes, about 50 to 85 percent of simulated rockfall could encroach into the western side of Lot No. 47.

Based on our reconnaissance and preliminary rockfall simulation analysis for Lot Nos. 58 through 65, the lots are exposed to potential rockfall hazards from the adjacent northerly facing mountain slopes. Based on our CRSP analysis, about 25 to 100 percent of simulated rockfall could encroach upon the lots, depending on the location along the mountain slopes.

Conceptual Rockfall Mitigation System

Based on our site reconnaissance and review of the CRSP results, 9 lots are believed to be exposed to potential rockfall hazards from steep slopes outside of the subdivision boundary. The 9 lots include Lot Nos. 47, and 58 through 65. Based on our assessment, we believe the lots may be exposed to relatively moderate to high levels of risk for potential rockfall encroachment. For these 9 lots, we recommend constructing an appropriate rockfall containment system such as a rockfall impact barrier fence on the hillside above the affected lots to reduce the potential for rockfall encroachment.

Furthermore, 5 lots are believed to have some limited exposure to potential rockfall hazards from the hill slopes outside of the subdivision boundary. The 5 low risk lots include Lot Nos. 30, 31, 32, 34, and 35. Based on our assessment, we believe these lots may be exposed to a limited potential for rockfall encroachment. For these 5 lots, we recommend constructing an appropriate rockfall containment system such as a low capacity rockfall impact barrier fence or chain link fencing adjacent to and above the existing DLNR roadway corridor to minimize the potential for rockfall encroachment.

Based on our assessment of the site conditions and discussions with the project owner, we believe that an appropriate rockfall containment system could consist of the construction of specialized rockfall impact barrier fences and associated graded access trails within land owned by Dillingham Ranch Aina, LLC above the subdivision lots. We recommend the construction of graded access trails along the higher capacity rockfall impact barrier alignments to facilitate the heavy barrier construction and the future maintenance of the barriers, which will traverse rough and irregular terrain containing many existing large boulders. At the eastern end of the development above Lot Nos. 30 through 35, we recommend the construction of a low capacity rockfall impact barrier fence (or chain link fencing where appropriate) on the upslope side of the existing DLNR access road. Because of the existing access provided by the DLNR roadway, a graded access trail along the fence alignment may not be necessary if construction access to the site could be granted via the existing paved DLNR roadway.

Rockfall Impact Barrier

Rockfall impact barriers are used worldwide as an effective rockfall mitigation and protection system. Rockfall impact barriers are commonly constructed on hillsides where the protection of down slope areas from varied and widespread sources of falling rock is necessary. Rockfall impact barriers are considered to be a viable rockfall protection measure where a specific and limited source of potential rockfall cannot be readily identified and stabilized, or where the source area may encompass disturbance-sensitive land that makes other mitigation measures impractical to implement.

Rockfall impact barriers are specially designed fences consisting of steel support beams linked by wire rope (cable) or steel wire ring nets, which are designed to flex and absorb rockfall impact energy. The nets and beams are supported by drilled and grouted ground anchors at specified intervals. The barrier height is typically constructed 8 to 12 feet above ground level and black in coloration. Rockfall barrier fences require periodic inspection and possible future maintenance to remove accumulated boulder debris and replace worn components. Portions of the barrier may require repair or replacement following a very large impact where severe deformation of the system is experienced. Ultimately, the rockfall barrier will require replacement of components affected by natural environmental degradation such as corrosion.

We roughly estimate the effective life of the steel barrier system in the near coastal setting such as Mokuleia as being about 30 to 40 years, at which time replacement of components such as nets, ground anchors and support beams may be required to maintain the desired level of protection. Stainless steel components and special surface coatings are available to increase resistance to corrosion but at a significant extra cost. A schematic of a typical medium-high capacity rockfall impact barrier is presented on Plate 5.

Rockfall Protection at Lot No. 47

Based on our evaluation of the existing site conditions in the vicinity of Lot No. 47 and the adjacent subdivision roadway, we believe that a rockfall impact barrier is needed to protect the western side of Lot No. 47 and a short segment of the subdivision Road "D" fronting the nose of a mountain ridge. The southern and western lot lines at Lot No. 47 are proposed based on a recent visual assessment of the area to allow for the provision of a rockfall impact barrier on suitable terrain upslope of the lot boundary. A ground topographic survey will be conducted in the project design phase to verify the constructability of a rockfall barrier at the desired location above Lot No. 47 and the subdivision roadway.

If suitable terrain for an effective rockfall barrier cannot be identified by the topographic survey along the western side of Lot No. 47, the lot may be further reduced in size to accommodate an appropriate rockfall barrier to protect Lot No. 47 and the adjacent subdivision roadway. In the unlikely event that Lot No. 47 is eliminated from the development plan, the portion of the proposed rockfall impact barrier for Lot No. 47 could be reduced in length and replaced with a section of rockfall impact barrier along a limited segment of the proposed Road "D". Based on our preliminary CRSP analysis using the available topographic information, we anticipate that the 8 to 10-foot high rockfall impact barrier may be approximately 550 lineal feet in length with a capacity of about 100 to 150 foot-tons. The approximate location of Rockfall Impact Barrier "A" at Lot No. 47 and the adjacent subdivision roadway is shown on the Conceptual Rockfall Mitigation Plan 1, Plate 4.1.

To facilitate the construction and future maintenance of the rockfall impact barrier fence, a graded access trail should be constructed along the barrier alignment. A conceptual typical section for the rockfall barrier and access trail construction is presented on Plate 6.

Rockfall Protection at Lot Nos. 58 through 65

Based on our evaluation of the existing site conditions in the vicinity of Lot Nos. 58 through 65, we believe that a rockfall impact barrier is needed to protect the lots from potential rockfall encroachment from the adjacent high mountain slopes. The approximate and preliminary location of the rockfall barrier was identified by field reconnaissance. A ground topographic survey will be conducted along the barrier alignment in the project design phase to assist in the design of the improvements. The rockfall impact barrier above Lot Nos. 58 through 65 could consist of two segments of barrier fencing with a break provided for the existing drainage gulch in the vicinity of Lot Nos. 62 and 63. The approximate location of Rockfall Impact Barriers "B" and "C" for Lot Nos. 58 through 65 is shown on the Conceptual Rockfall Mitigation Plan 1, Plate 4.1.

Based on the results of our preliminary CRSP analyses, we anticipate that the 8 to 10-foot high Rockfall Impact Barrier "B" and "C" may be approximately 3,490 lineal feet in length with a capacity of about 200 to 250 foot-tons.

To facilitate the construction and future maintenance of the rockfall impact barrier fence, a graded access trail should be constructed along the barrier alignment. A conceptual typical section for the rockfall barrier and access trail construction is presented on Plate 6.

Rockfall Protection at Lot Nos. 30, 31, 32, 34, and 35

Previously, we recommended "Dwelling Location Restrictions" for these lots due to the relatively low risk and large lot sizes. However, the current development concept does not include "Dwelling Location Restrictions".

Based on our evaluation of the existing site conditions in the vicinity of Lot Nos. 30 through 35 and the existing DLNR roadway, we believe that a low capacity rockfall impact barrier (or chain link fencing at appropriate non-critical locations) could be constructed to reduce the risk for potential rockfall encroachment at the lots. Based on our preliminary design concept, the fence could be constructed approximately 10 to 20 feet upslope from the existing DLNR road Right-of-Way within land owned by Dillingham Ranch Aina, LLC. A ground topographic survey should be conducted in the project design phase to verify the constructability of the fencing at the desired location. Some clearing of existing boulders along the fence alignment may be necessary to facilitate the construction of the barrier structure.

Based on our preliminary CRSP analysis using the available topographic information, we anticipate that the 6 to 8-foot high rockfall impact barrier may be approximately 2,400 lineal feet in length with a capacity of about 30 foot-tons or less. The approximate location of Rockfall Impact Barrier "D" for Lot Nos. 30 through 35 and the adjacent DLNR roadway is shown on the Conceptual Rockfall Mitigation Plan 2, Plate 4.2.

Based on our evaluation and analyses, our professional opinion is that the recommended rockfall hazard mitigation scheme should significantly reduce the potential for dangerous rockfall activity to affect downslope development at the proposed Dillingham Ranch Mokuleia project site. However, it must be stated that there are no guarantees in the professional engineering and architectural design fields with respect to potential rockfall hazards. The construction of rockfall impact barriers as described in the conceptual-level context of this report should provide a high level of safety against rockfall hazard based on past applications of similar mitigation methods.

Potential Drainage and Debris Flow Hazards

Based on our site reconnaissance, a number of large natural drainage ravines emanating from the upland valleys transect the proposed development. We believe the ravines are capable of transmitting appreciable runoff through the development, especially during widespread storm runoff conditions. A rapid increase in stream flow during storm conditions (flash-flood conditions) should be anticipated in the normally dry drainage channels. The stream flow hydrology should be assessed by a qualified engineering consultant to address possible safety setback requirements for development adjacent to the stream channels.

No record or documentation of previous debris flow activity at the project site is known; however, the potential for transmission of debris flow materials within the larger valley draining stream channels is considered to be a possibility due to the well-developed character of the primary drainage ravines and extensive area of the upslope off-site drainage basins. Field evidence of past debris flow activity resulting from slope instability occurring within the project limits and adjacent to the upslope development boundary were not encountered.

Phase II Rockfall Mitigation Design

Our professional opinion is that the recommended rockfall mitigation plan offers a comprehensive and cost effective mitigation scheme to provide a high level of rockfall protection for development downslope of the rockfall protection improvements shown on the Conceptual Rockfall Mitigation Plans 1 and 2, Plates 4.1 and 4.2.

Following the acceptance of the conceptual rockfall mitigation plan by the owner, design of the rockfall mitigation improvements may proceed. A topographic ground survey should be performed at the locations surrounding the probable barrier construction sites to obtain detailed topographic information necessary for design and construction. Additional rockfall simulation using the CRSP should be performed to obtain more detailed information for the design of the rockfall impact barriers. Design of the grading for the rockfall impact barrier access trails along the barrier alignments should be performed by the project civil engineer with input provided by Geolabs, Inc. We anticipate that homeowner or community association maintenance easements surrounding the rockfall impact barrier and access trail will be established. We envision that the easements may be designated during the design phase of the project, when the final location and alignment of the barriers is defined.

Rockfall Impact Barriers "B" and "C" and the associated access trails will be designed to terminate and not cross the existing large drainage gully in the vicinity of Lot Nos. 62 and 63. We believe that the existing deep drainage gulch provides substantial ground relief and buffer to serve as an effective topographic rockfall barrier.

We understand that Rockfall Impact Barriers "A", "B", "C", and "D" will be dedicated to a community or homeowners association for future maintenance responsibility. Based on the preliminary conceptual layout of the rockfall impact barriers, we anticipate that additional easements between the barrier/access trail alignment and the subdivision roadways will need to be established.

LIMITATIONS

The findings and recommendations submitted herein are based, in part, upon information obtained from visual site observations and computer simulation and statistical analysis of potential rockfall behavior only. Variation in the surface and subsurface conditions between our observations and analysis points may occur, and the nature and extent of these variations may not become evident until additional field exploration or construction is underway. If variations then appear evident, it will be necessary to re-evaluate the findings and recommendations provided herein.

It should be noted that slopes composed of rock materials (rock slopes) deteriorate with the passage of time due to natural weathering processes, wet-dry and hot-cold cycles, and erosion conditions. Due to the inherent deterioration of rock slopes resulting from natural processes (weathering, wet-dry and hot-cold cycles, and erosion conditions), the potential for rockfall hazard at any site changes with the passage of time. Therefore, the findings and recommendations contained herein may be used only within a reasonable time from the date of issuance of this letter report. Land use, site conditions, and/or other factors may change with the passage of time. Therefore, additional work to evaluate the applicability of the findings and preliminary recommendations contained in this letter report due to changes with the passage of time will be required. Finally, there are no guarantees in the professional engineering and architectural design fields with respect to potential rockfall hazards due in large part to the unpredictable nature of rockfall activity, which is affected by many external variables including natural and man-induced causes.

This report has been prepared for the exclusive use of Dillingham Ranch Aina, LLC and their consultants for specific application to the Potential Rockfall Hazard and Slope Evaluation Study in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied. Any party other than the client who wishes to use this report shall notify Geolabs, Inc. in writing of their intended use.

This report has been prepared solely for the purpose of evaluating and assisting the client/owner in the understanding of potential rockfall hazards located within the project study area. Therefore, this report may not contain sufficient data, or the proper information, to serve as the basis for construction cost estimates. A contractor wishing to bid on this project is urged to retain a competent geotechnical engineer to assist in the interpretation of this report and/or in the performance of additional site-specific exploration for bid estimating purposes.

The owner/client should be aware that unanticipated surface and subsurface conditions are commonly encountered. Unforeseen conditions, such as surface rock outcroppings, archeological features, terrain irregularities, perched groundwater, soft deposits, hard layers or loose fills, may occur in localized areas and may require additional exploration or corrections in the field (which may result in construction delays) to attain a properly constructed project. Therefore, a sufficient contingency fund is recommended to accommodate these possible extra costs.

CLOSURE

We appreciate the opportunity to provide our services to you on this project. If you have questions or need additional information, please contact our office.

Respectfully submitted,

GEOLABS, INC.

By
Steven F. Carr, R.G.
Project Geologist

CLAYTON S. MIMURA
LICENSED PROFESSIONAL ENGINEER
No. 4176-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

By
Clayton S. Mimura, P.E.
President

SIGNATURE
4-30-08
EXPIRATION DATE OF THE LICENSE

CSM:SC:mj/as

Attachments: Project Location Map, Plate 1
Site Plan, Plate 2
Slope Profiles, Plates 3.1 thru 3.3
Conceptual Rockfall Mitigation Plans 1 and 2, Plates 4.1 and 4.2
Schematic Detail for Typical Rockfall Impact Barrier Fence, Plate 5
Typical Section Rockfall Impact Barrier & Access Trail, Plate 6
Site Condition Photographs, Plates 7 thru 14
Photograph Key Map, Plate 15

(1 Copy to Addressee)

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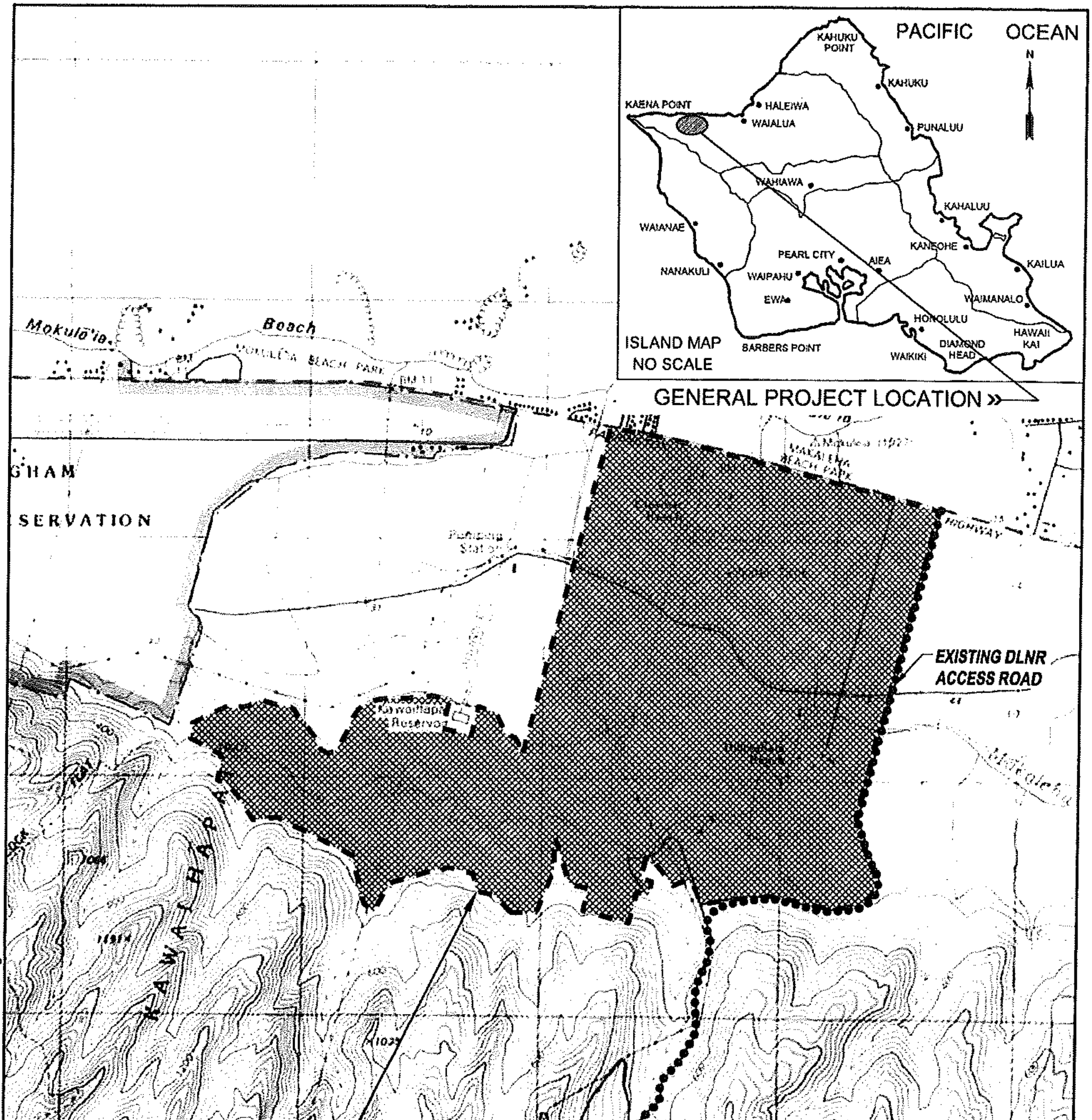

PROJECT LOCATION MAP

ROCKFALL POTENTIAL AND HILLSIDE SLOPE EVALUATION
DILLINGHAM RANCH MOKULEIA DEVELOPMENT
TMK: 6-8-002: 006, 6-8-003: 006, 015, 019, 030, 031, 033, 035, AND 040
MOKULEIA, OAHU, HAWAII

2000 1000 0 2000 FT.
GRAPHIC SCALE

N

REFERENCE: MAP CREATED WITH TOPO!® ©2001 NATIONAL GEOGRAPHIC (WWW.NATIONALGEOGRAPHIC.COM/TOPO).

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DATE	DRAWN BY	PLATE
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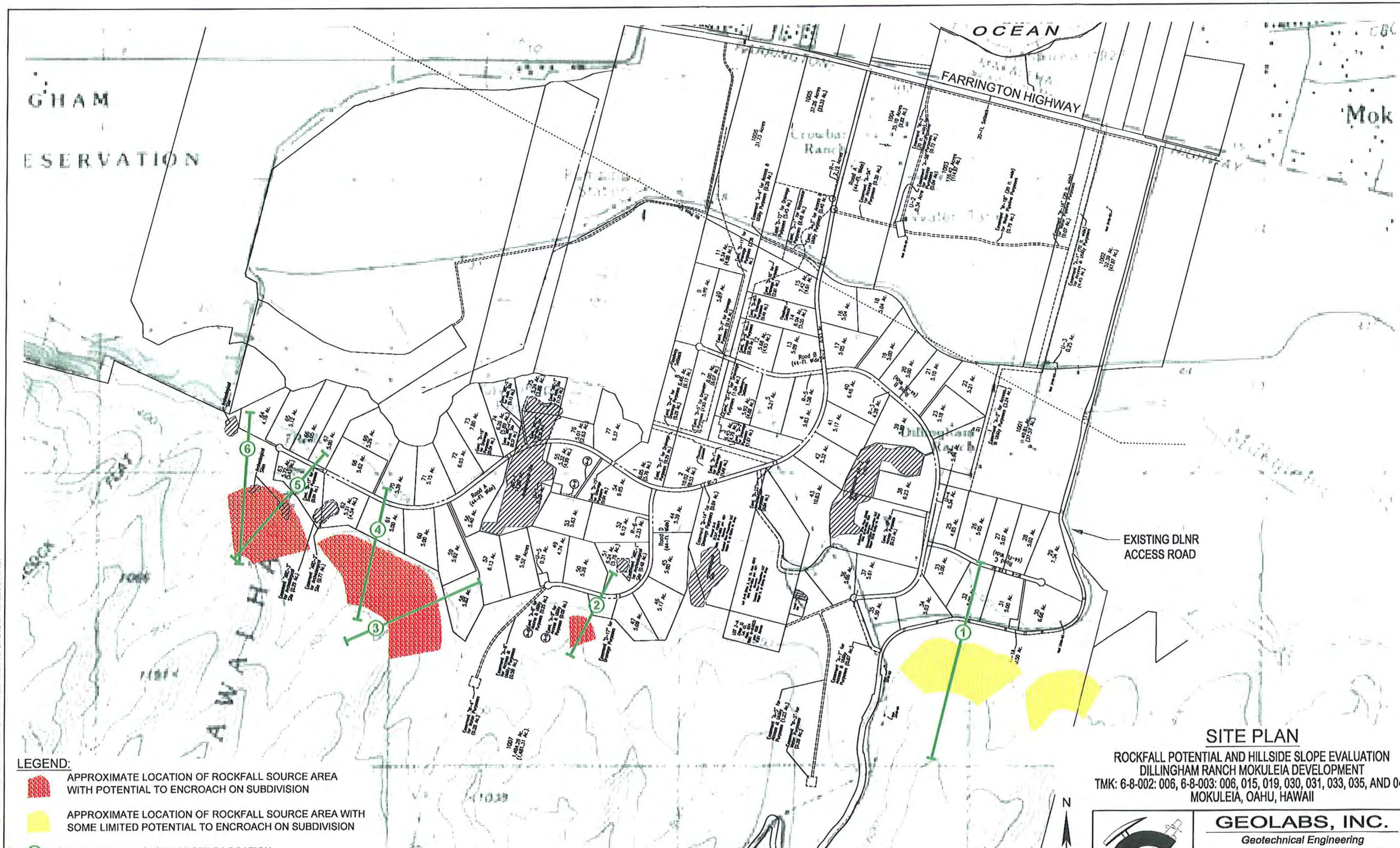

LEGEND:

- APPROXIMATE LOCATION OF ROCKFALL SOURCE AREA WITH POTENTIAL TO ENCROACH ON SUBDIVISION
- APPROXIMATE LOCATION OF ROCKFALL SOURCE AREA WITH SOME LIMITED POTENTIAL TO ENCROACH ON SUBDIVISION
- ② APPROXIMATE SLOPE PROFILE LOCATION

REFERENCE: PLOT PLAN TRANSMITTED BY CONTROLPOINT SURVEYING, INC. ON OCTOBER 30, 2007 OVERLAYED ON MAP CREATED WITH TOPO!®

0 500 1000 2000 3000 FT.
GRAPHIC SCALE

SITE PLAN

ROCKFALL POTENTIAL AND HILLSIDE SLOPE EVALUATION
DILLINGHAM RANCH MOKULEIA DEVELOPMENT
TMK: 6-8-002: 006, 6-8-003: 006, 015, 019, 030, 031, 033, 035, AND 040
MOKULEIA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
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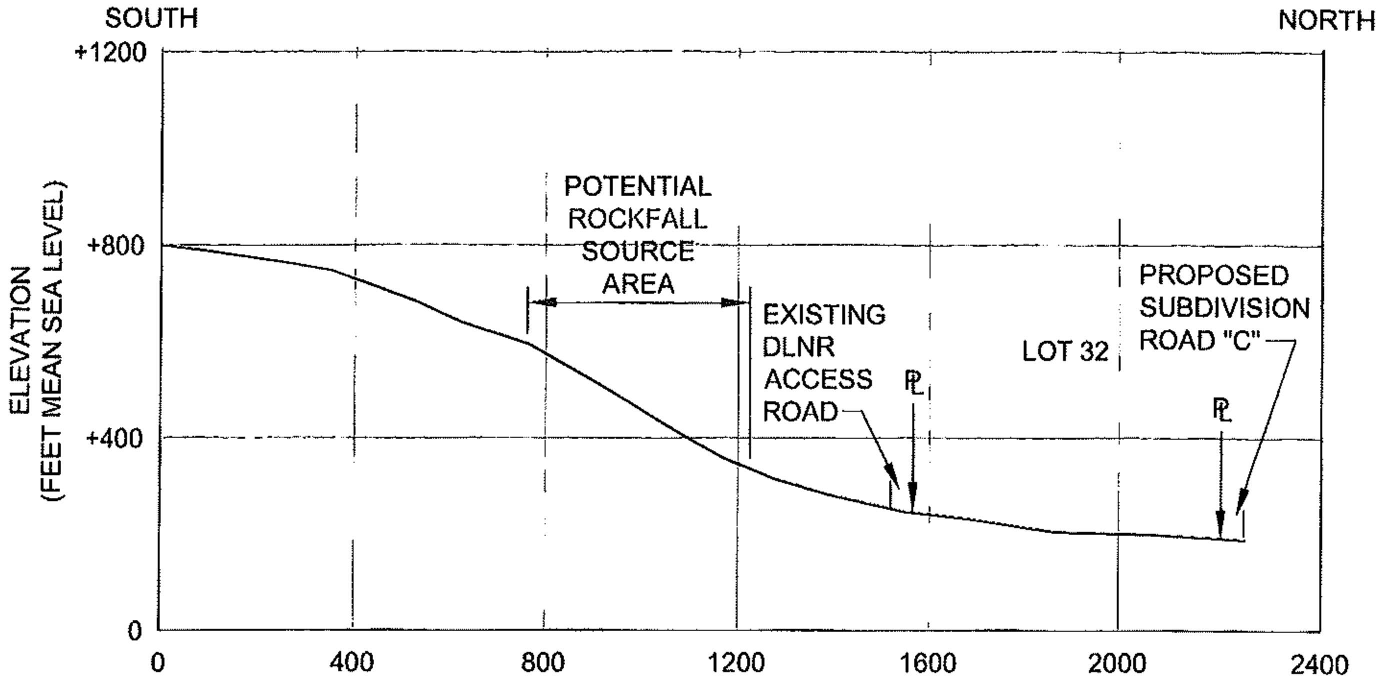
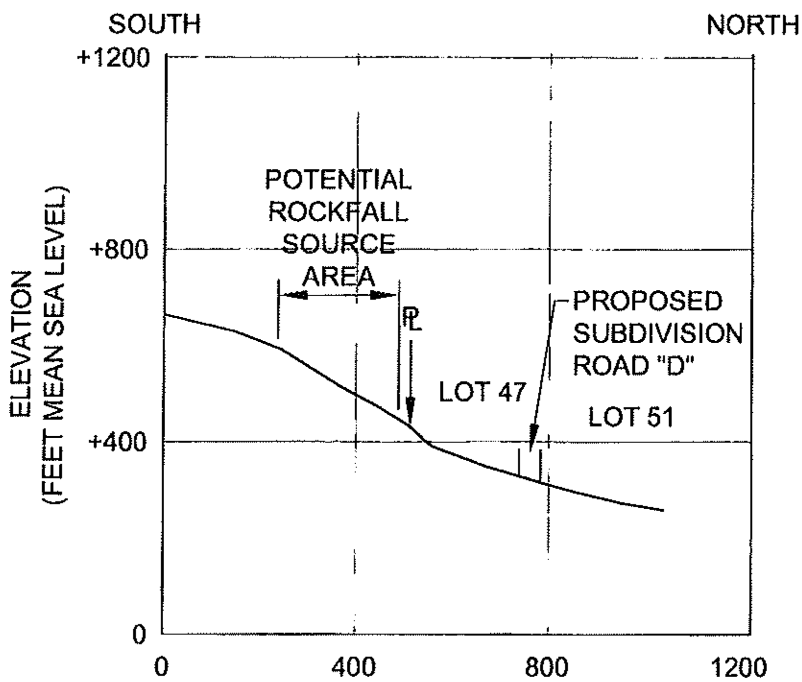


SLOPE PROFILE 1



SLOPE PROFILE 2

SLOPE PROFILES

ROCKFALL POTENTIAL AND HILLSIDE SLOPE EVALUATION
DILLINGHAM RANCH MOKULEIA DEVELOPMENT
MOKULEIA, OAHU, HAWAII

REFERENCE: TOPOGRAPHIC INFORMATION FROM U.S.G.S. QUADRANGLE MAP WITH 40-FOOT CONTOUR INTERVAL.

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
NOVEMBER 2007	KHN	
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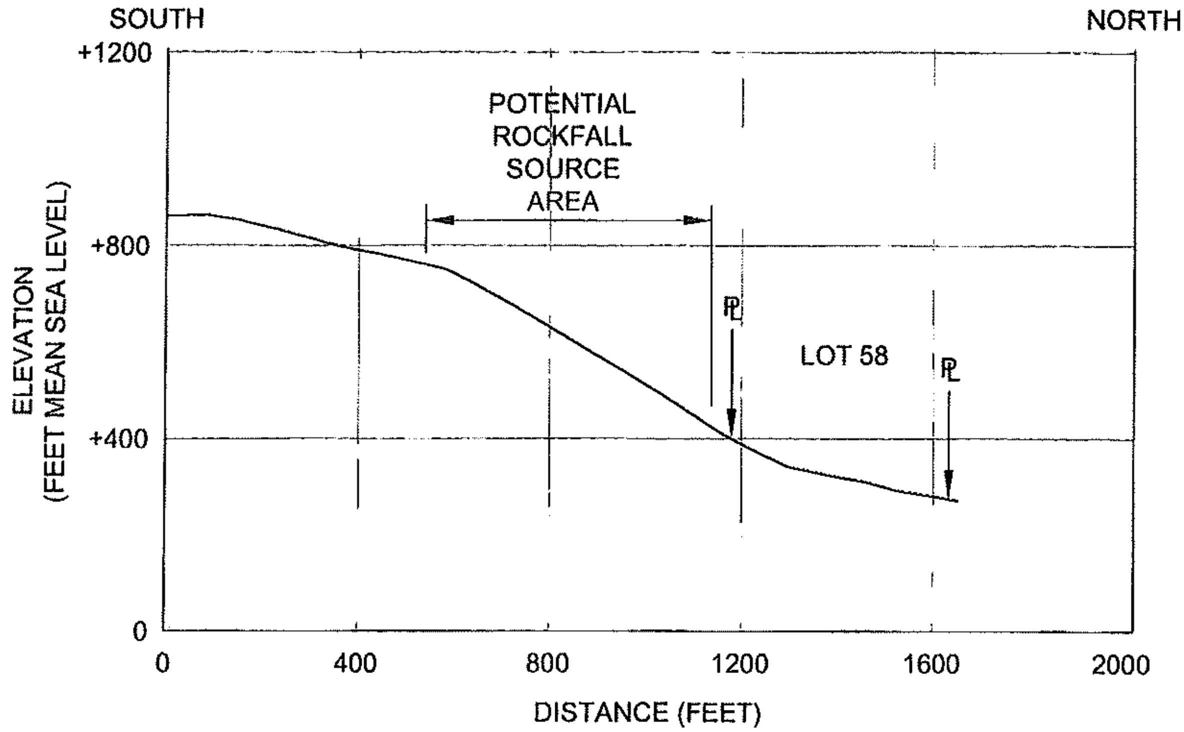

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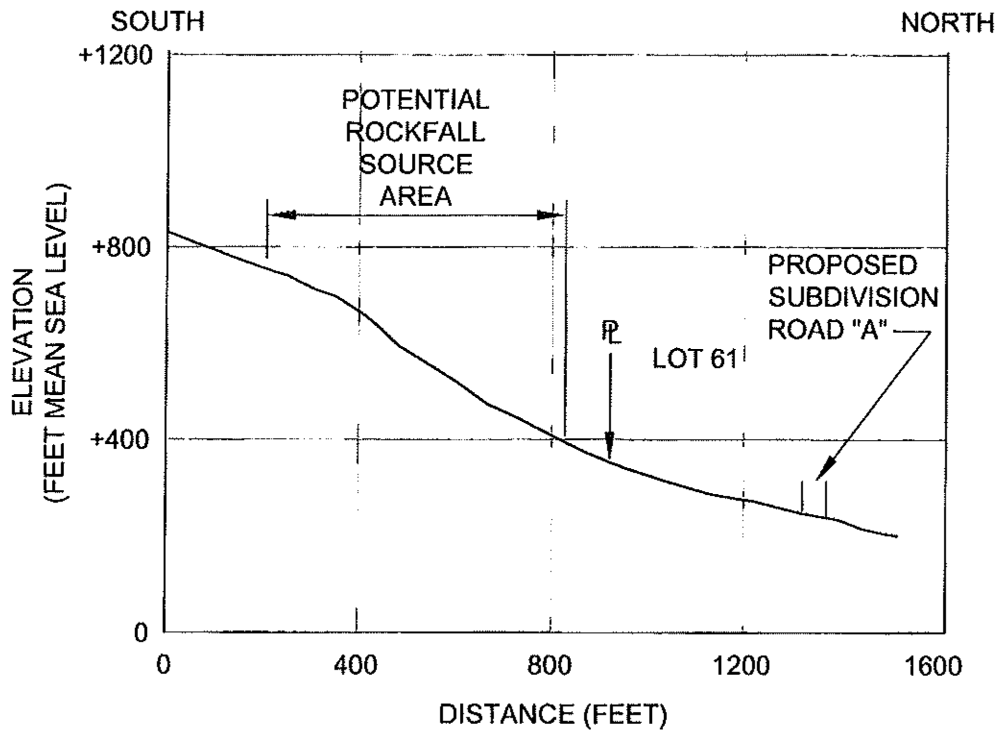

SLOPE PROFILE 4

SLOPE PROFILES

ROCKFALL POTENTIAL AND HILLSIDE SLOPE EVALUATION
DILLINGHAM RANCH MOKULEIA DEVELOPMENT
MOKULEIA, OAHU, HAWAII

REFERENCE: TOPOGRAPHIC INFORMATION FROM U.S.G.S. QUADRANGLE MAP WITH 40-FOOT CONTOUR INTERVAL.

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
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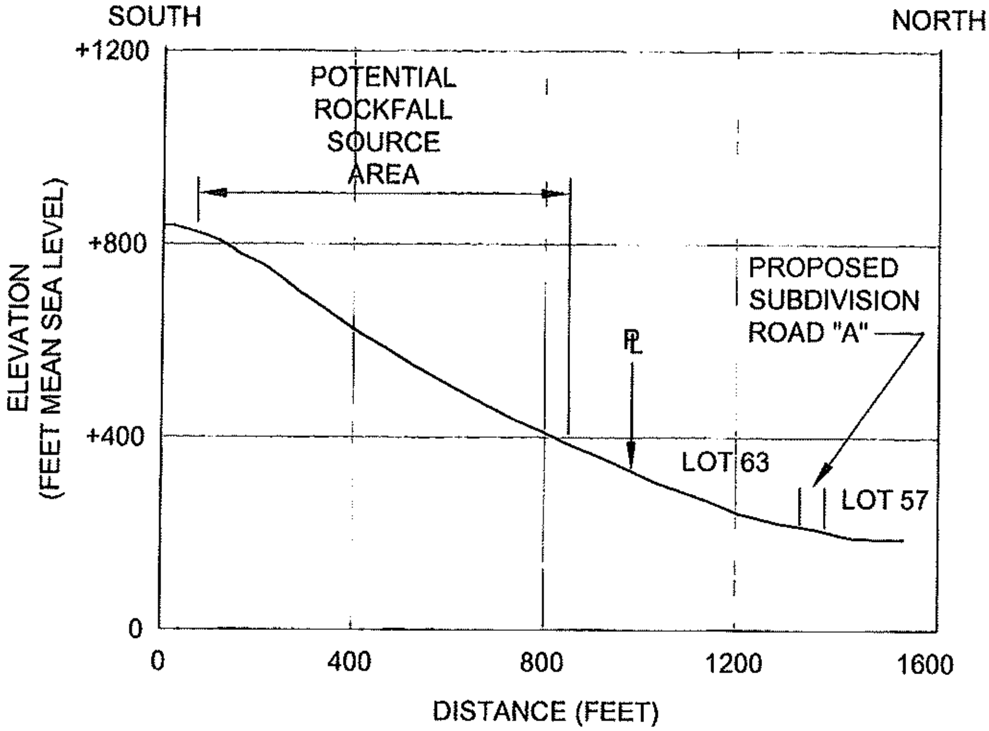
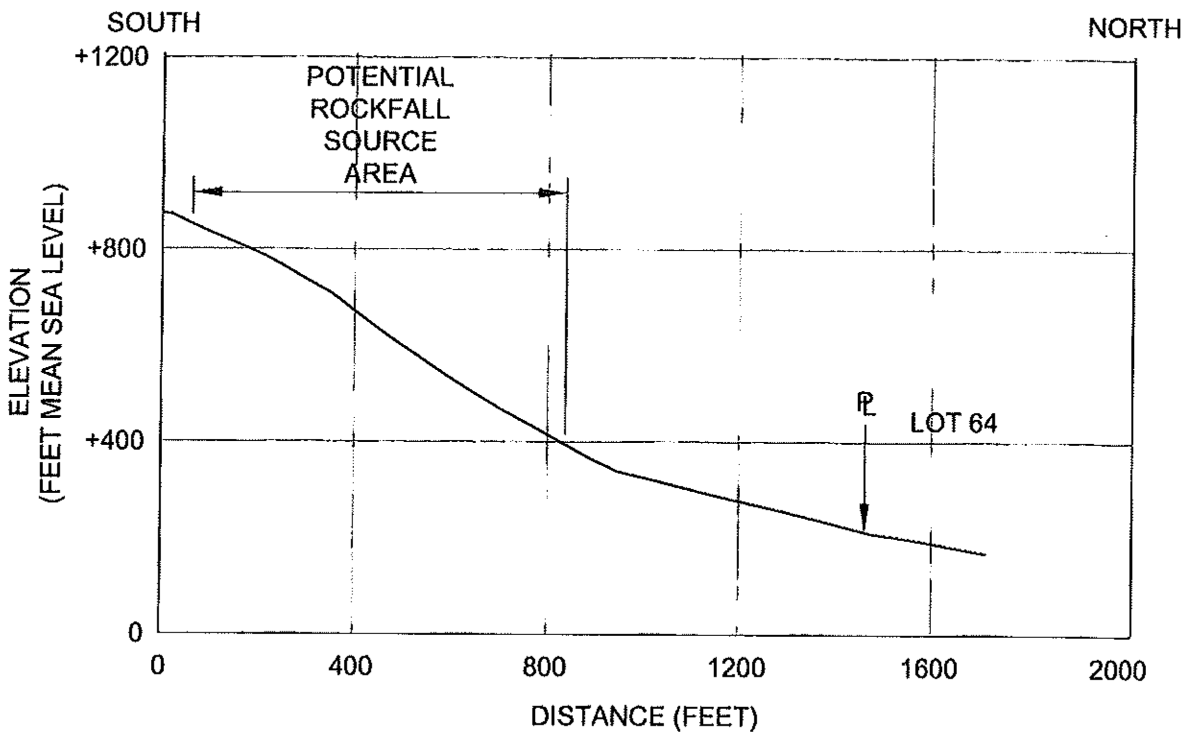


SLOPE PROFILE 5



SLOPE PROFILE 6

SLOPE PROFILES

ROCKFALL POTENTIAL AND HILLSIDE SLOPE EVALUATION
DILLINGHAM RANCH MOKULEIA DEVELOPMENT
MOKULEIA, OAHU, HAWAII

REFERENCE: TOPOGRAPHIC INFORMATION FROM U.S.G.S. QUADRANGLE MAP WITH 40-FOOT CONTOUR INTERVAL.

GEOLABS, INC.
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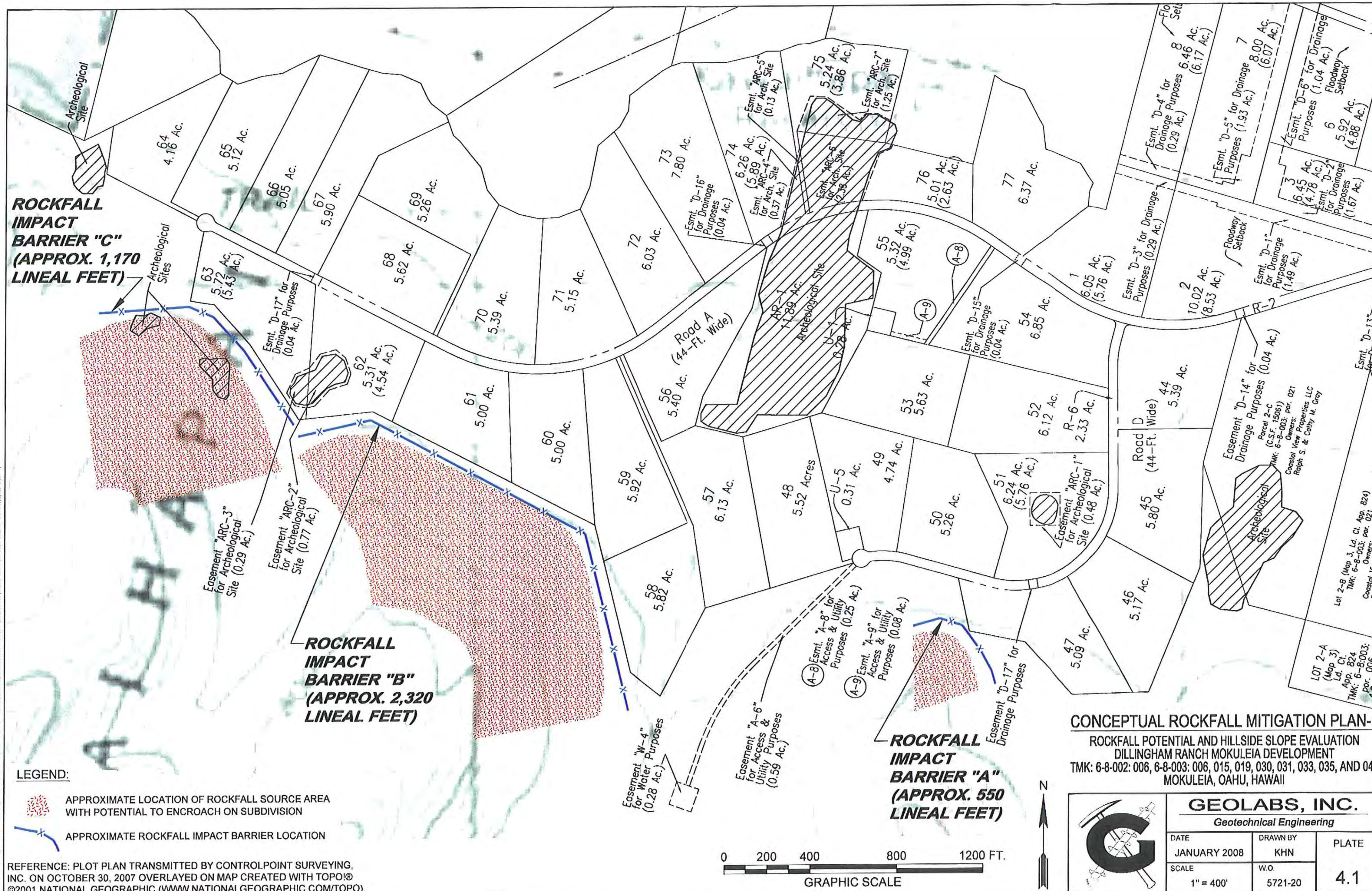
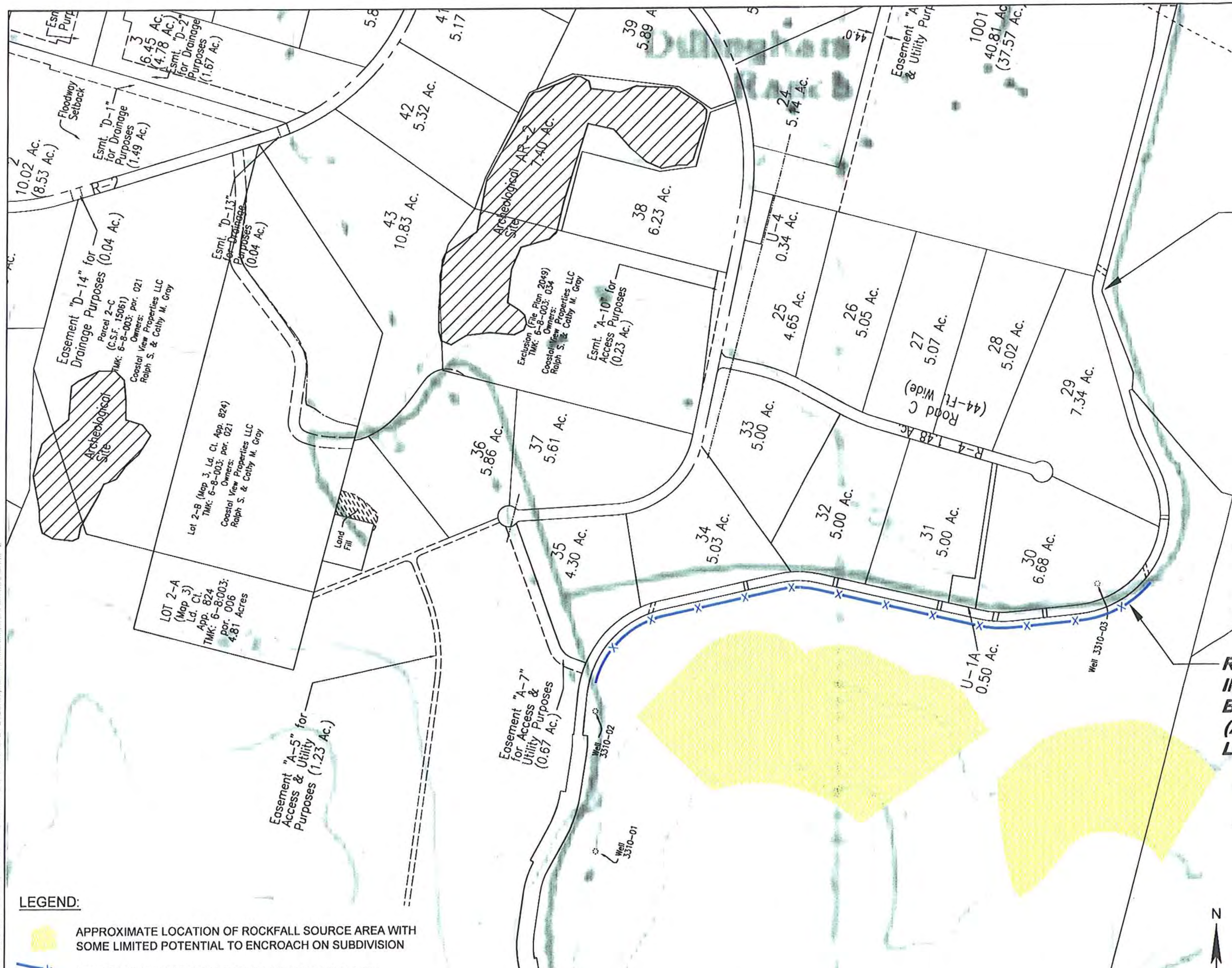

ROCKFALL IMPACT BARRIER "C" (APPROX. 1,170 LINEAL FEET)
ROCKFALL IMPACT BARRIER "B" (APPROX. 2,320 LINEAL FEET)
ROCKFALL IMPACT BARRIER "A" (APPROX. 550 LINEAL FEET)
Archeological Site
Archeological Sites
Easement "ARC-3" for Archeological Site (0.29 Ac.)
Easement "ARC-2" for Archeological Site (0.77 Ac.)
Esmt. "D-17" for Drainage Purposes (0.04 Ac.)
Road A (44-Ft. Wide)
Road D (44-Ft. Wide)
AR-1 11.09 Ac.
U-1 0.28 Ac.
U-5 0.31 Ac.
R-6 2.33 Ac.
R-7
64 4.16 Ac.
65 5.12 Ac.
66 5.05 Ac.
67 5.90 Ac.
68 5.62 Ac.
69 5.26 Ac.
70 5.39 Ac.
71 5.15 Ac.
72 6.03 Ac.
73 7.80 Ac.
74 6.26 Ac. (5.89 Ac.)
75 5.24 Ac. (3.86 Ac.)
76 5.01 Ac. (2.63 Ac.)
77 6.37 Ac.
63 5.72 Ac. (5.43 Ac.)
62 5.31 Ac. (4.54 Ac.)
61 5.00 Ac.
60 5.00 Ac.
59 5.92 Ac.
58 5.82 Ac.
57 6.13 Ac.
56 5.40 Ac.
55 5.32 Ac. (4.99 Ac.)
54 6.85 Ac.
53 5.63 Ac.
52 6.12 Ac.
51 6.24 Ac. (5.76 Ac.)
50 5.26 Ac.
49 4.74 Ac.
48 5.52 Acres
47 5.09 Ac.
46 5.17 Ac.
45 5.80 Ac.
44 5.39 Ac.
1 6.05 Ac. (5.76 Ac.)
2 10.02 Ac. (8.53 Ac.)
3 6.45 Ac. (4.78 Ac.)
6 5.92 Ac. (4.88 Ac.)
7 8.00 Ac. (6.07 Ac.)
8 6.46 Ac. (6.17 Ac.)
Easement "W-4" for Water Purposes (0.28 Ac.)
Easement "A-6" for Access & Utility Purposes (0.59 Ac.)
Esmt. "A-8" for Access & Utility Purposes (0.25 Ac.)
Esmt. "A-9" for Access & Utility Purposes (0.08 Ac.)
Easement "D-17" for Drainage Purposes
Easement "ARC-1" for Archeological Site (0.48 Ac.)
Easement "D-14" for Drainage Purposes (0.04 Ac.)
LEGEND:
APPROXIMATE LOCATION OF ROCKFALL SOURCE AREA WITH POTENTIAL TO ENCROACH ON SUBDIVISION
APPROXIMATE ROCKFALL IMPACT BARRIER LOCATION
REFERENCE: PLOT PLAN TRANSMITTED BY CONTROLPOINT SURVEYING, INC. ON OCTOBER 30, 2007 OVERLAYED ON MAP CREATED WITH TOPO!® ©2001 NATIONAL GEOGRAPHIC (WWW.NATIONALGEOGRAPHIC.COM/TOPO).
0 200 400 800 1200 FT.
GRAPHIC SCALE
N
CONCEPTUAL ROCKFALL MITIGATION PLAN-1
ROCKFALL POTENTIAL AND HILLSIDE SLOPE EVALUATION
DILLINGHAM RANCH MOKULEIA DEVELOPMENT
TMK: 6-8-002: 006, 6-8-003: 006, 015, 019, 030, 031, 033, 035, AND 040
MOKULEIA, OAHU, HAWAII
GEOLABS, INC.
Geotechnical Engineering
DATE JANUARY 2008
DRAWN BY KHN
PLATE 4.1
SCALE 1" = 400'
W.O. 5721-20



LEGEND:

APPROXIMATE LOCATION OF ROCKFALL SOURCE AREA WITH SOME LIMITED POTENTIAL TO ENCROACH ON SUBDIVISION

APPROXIMATE ROCKFALL IMPACT BARRIER LOCATION

REFERENCE: PLOT PLAN TRANSMITTED BY CONTROLPOINT SURVEYING, INC. ON OCTOBER 30, 2007 OVERLAYED ON MAP CREATED WITH TOPO!® ©2001 NATIONAL GEOGRAPHIC (WWW.NATIONALGEOGRAPHIC.COM/TOPO).

CONCEPTUAL ROCKFALL MITIGATION PLAN-2

ROCKFALL POTENTIAL AND HILLSIDE SLOPE EVALUATION
DILLINGHAM RANCH MOKULEIA DEVELOPMENT
TMK: 6-8-002: 006, 6-8-003: 006, 015, 019, 030, 031, 033, 035, AND 040
MOKULEIA, OAHU, HAWAII

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DATE	DRAWN BY	PLATE
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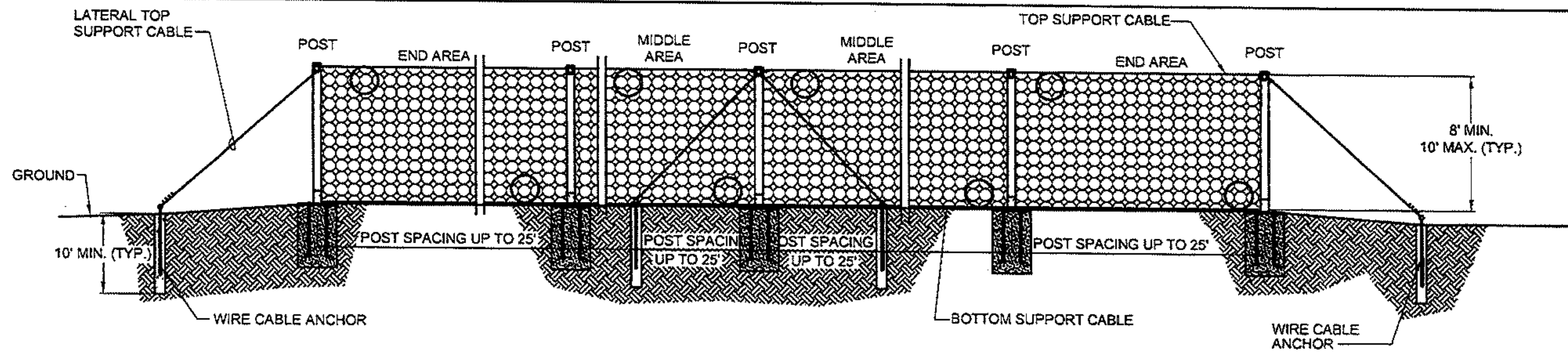
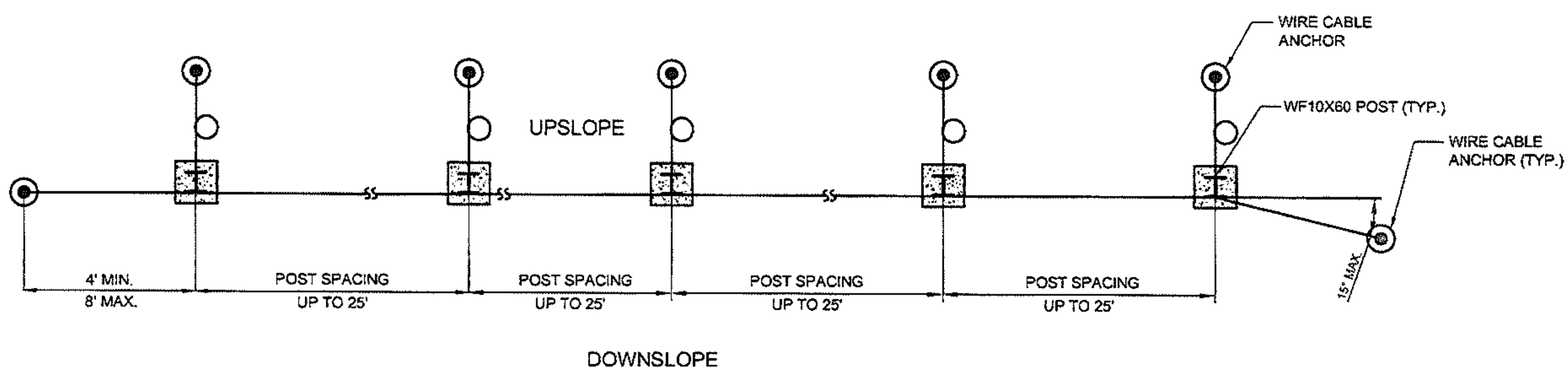


TYPICAL MEDIUM - HIGH CAPACITY
ROCKFALL IMPACT BARRIER
NOT TO SCALE



TYPICAL LAYOUT OF POSTS AND WIRE CABLE ANCHOR
NOT TO SCALE

SCHEMATIC DETAIL FOR TYPICAL ROCKFALL IMPACT BARRIER FENCE

ROCKFALL POTENTIAL AND HILLSIDE SLOPE EVALUATION
DILLINGHAM RANCH MOKULEIA DEVELOPMENT
TMK: 6-8-002: 006, 6-8-003: 006, 015, 019, 030, 031, 033, 035, AND 040
MOKULEIA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
NOVEMBER 2007	KHN	
SCALE	W.O.	
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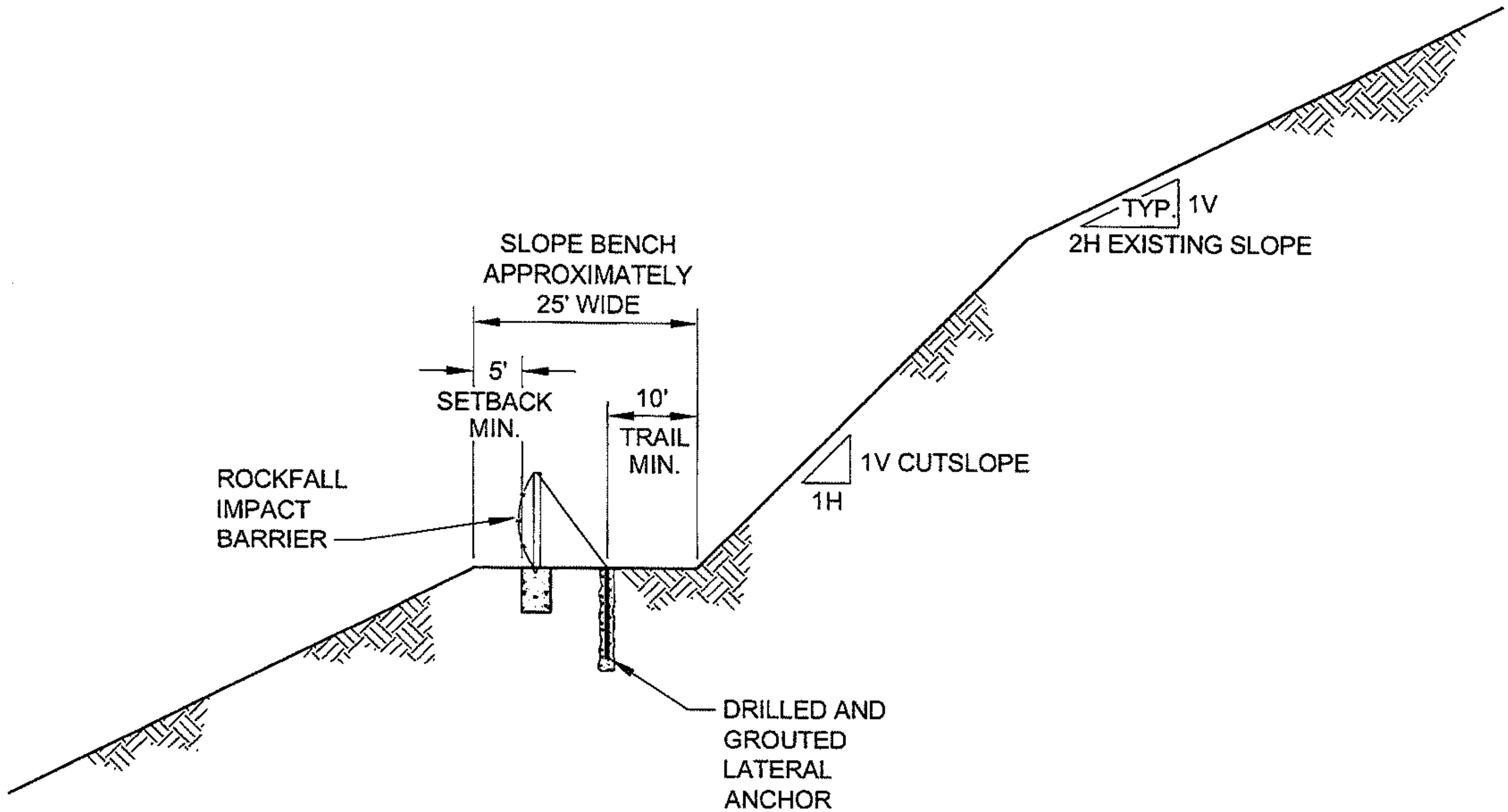

TYPICAL SECTION
ROCKFALL IMPACT BARRIER AND ACCESS TRAIL

ROCKFALL POTENTIAL AND HILLSIDE SLOPE EVALUATION
DILLINGHAM RANCH MOKULEIA DEVELOPMENT
TMK: 6-8-002: 006, 6-8-003: 006, 015, 019, 030, 031, 033, 035, AND 040
MOKULEIA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
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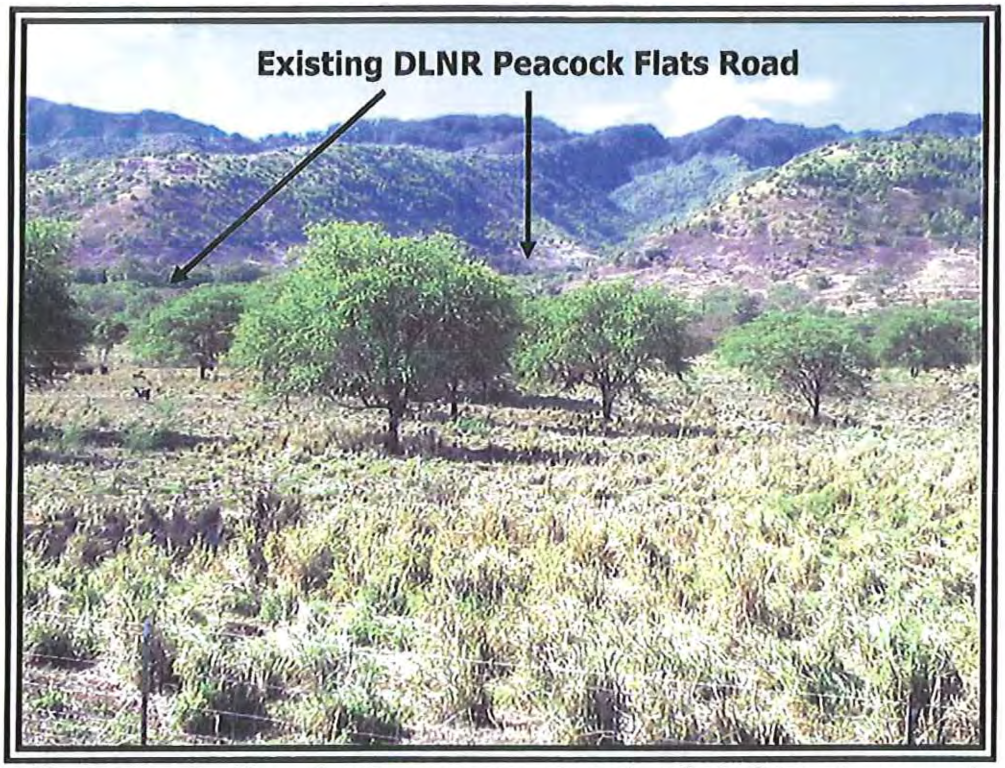
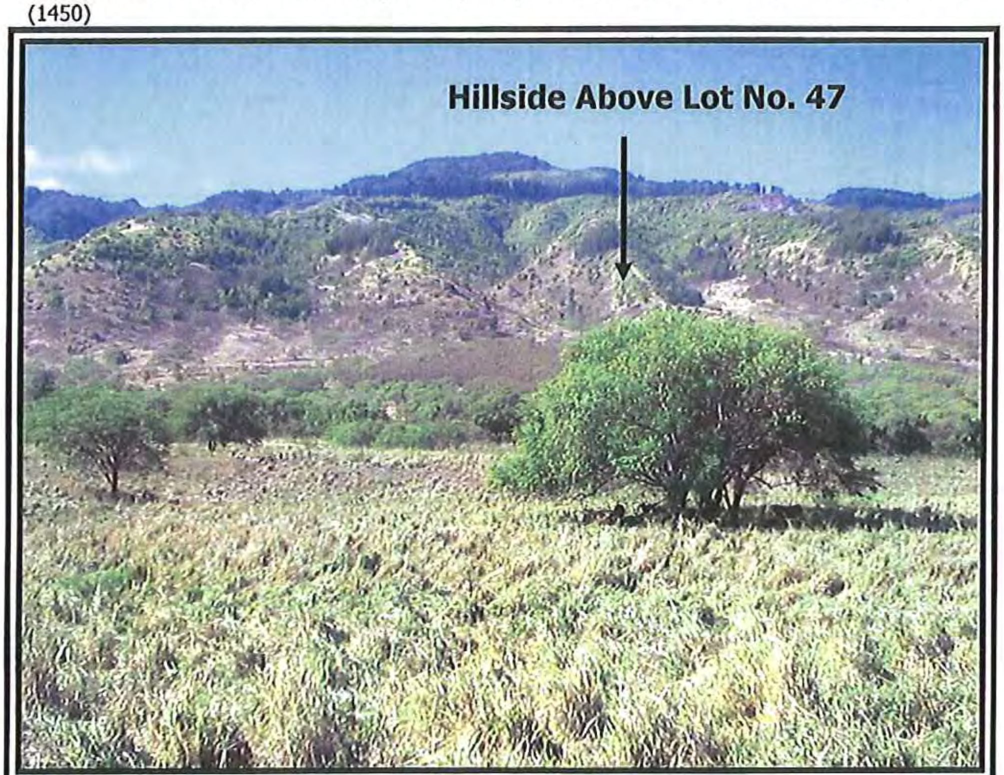
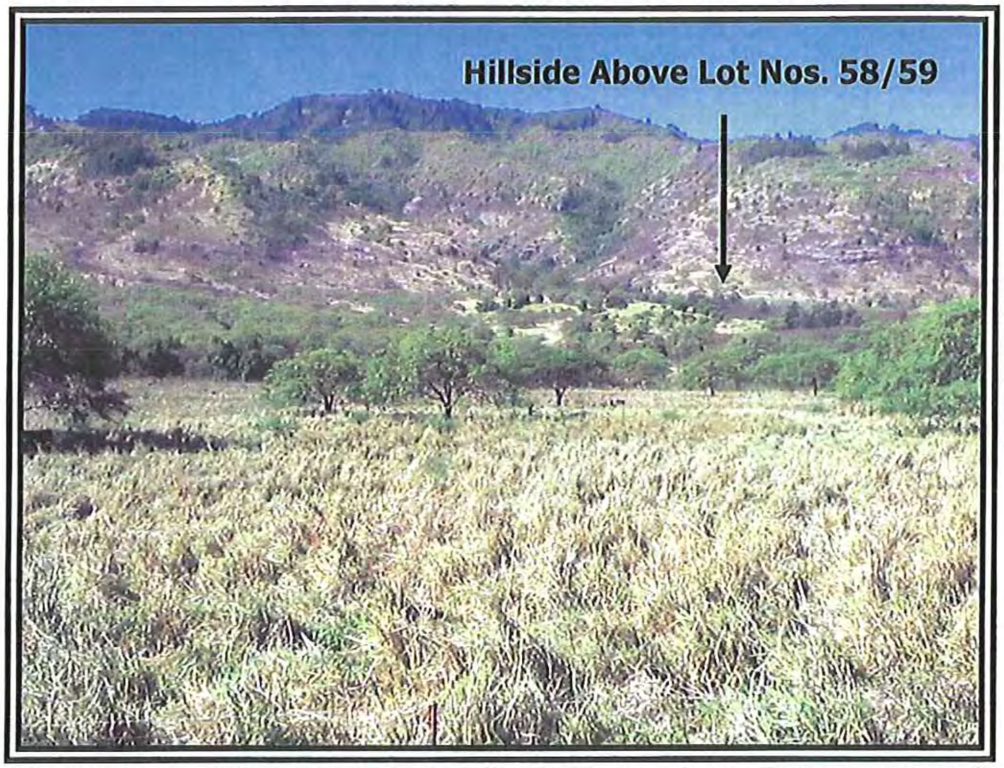


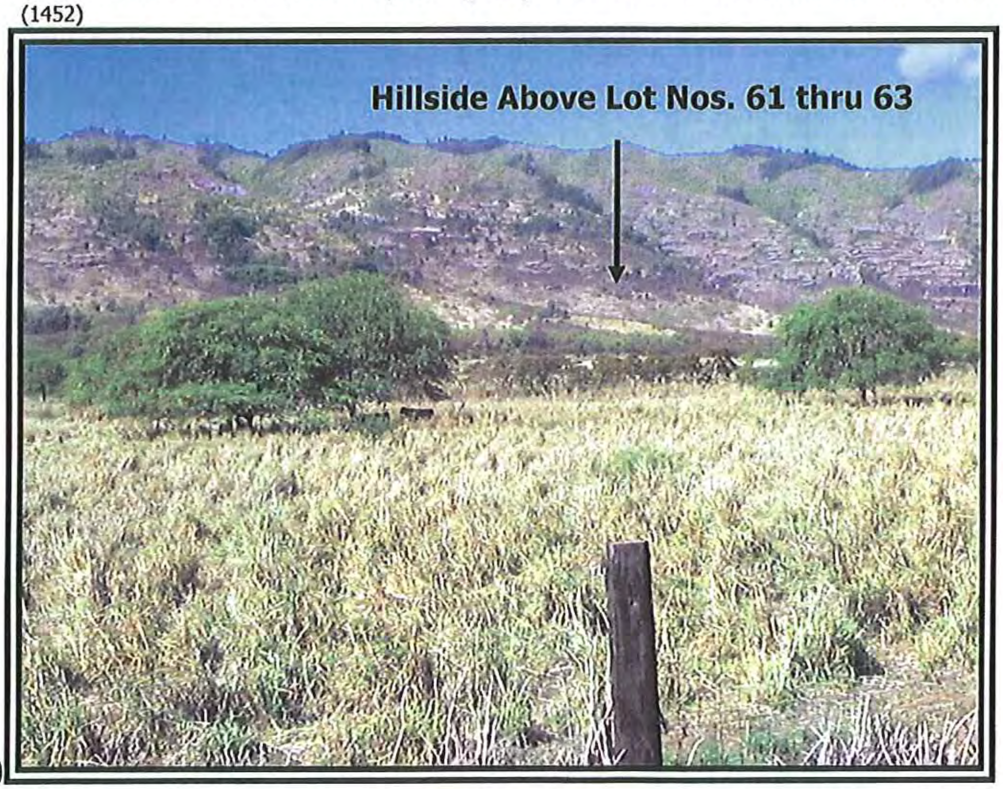
<u>Photograph No. 1</u>: *Panoramic view 1 of 4.* Distant general overview of mountain slopes upslope of about Lot Nos. 30 thru 35. (1450)



<u>Photograph No. 2:</u> *Panoramic view 2 of 4.* Distant general overview of mountain slopes upslope of about Lot No. 47. (1451)



Photograph No. 3: *Panoramic view 3 of 4.* Distant general overview of mountain slopes upslope of about Lot Nos. 57 thru 60. (1452)



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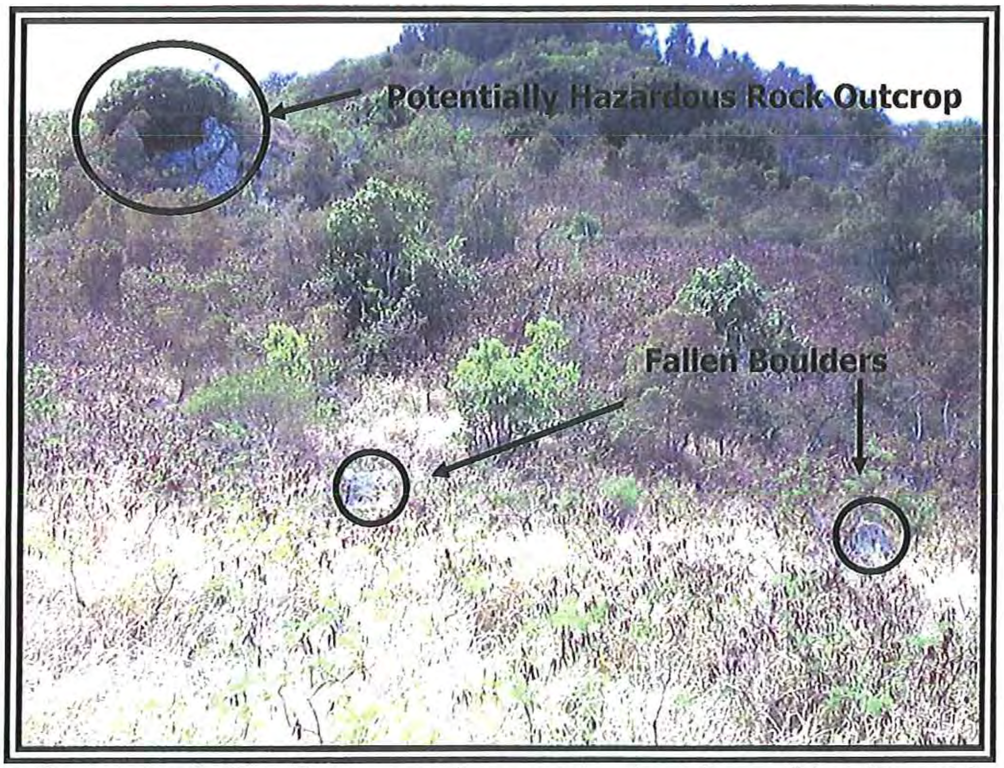
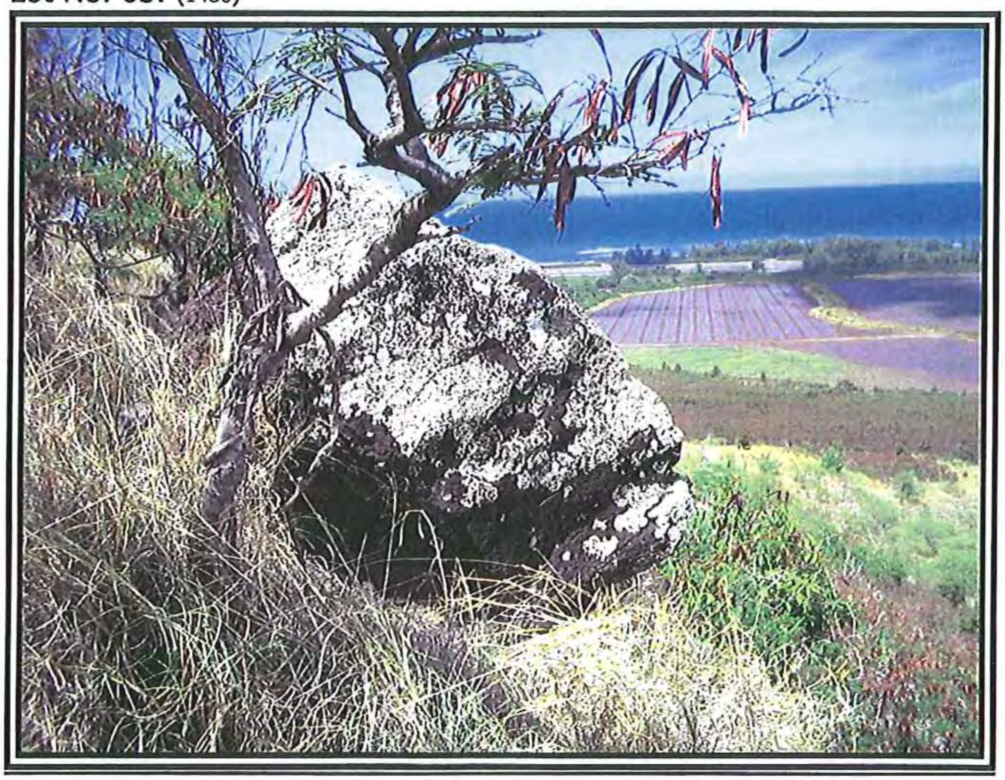
Photograph No. 4: *Panoramic view 4 of 4.* Distant general overview of mountain slopes upslope of about Lot Nos. 61 thru 64. (1453)



<u>Photograph No. 5:</u> Proposed vacant land upslope of Lot Nos. 64 and 65, and westerly of Lot No. 63. Large potentially hazardous rock outcrop located well above the development boundary. (1459)

<u>Photograph No. 6:</u> View down slope of Lot No. 63 from existing rock ledge outcropping above the development boundary. Note vehicle located on existing access trail at about the lot midpoint elevation. Also note fallen boulder at right edge of photo. (1474)

Photograph No. 7: Existing boulder cluster above about Lot No. 63. (1480)



Photograph No. 8: Existing surface boulder above about Lot No. 63. (1481)

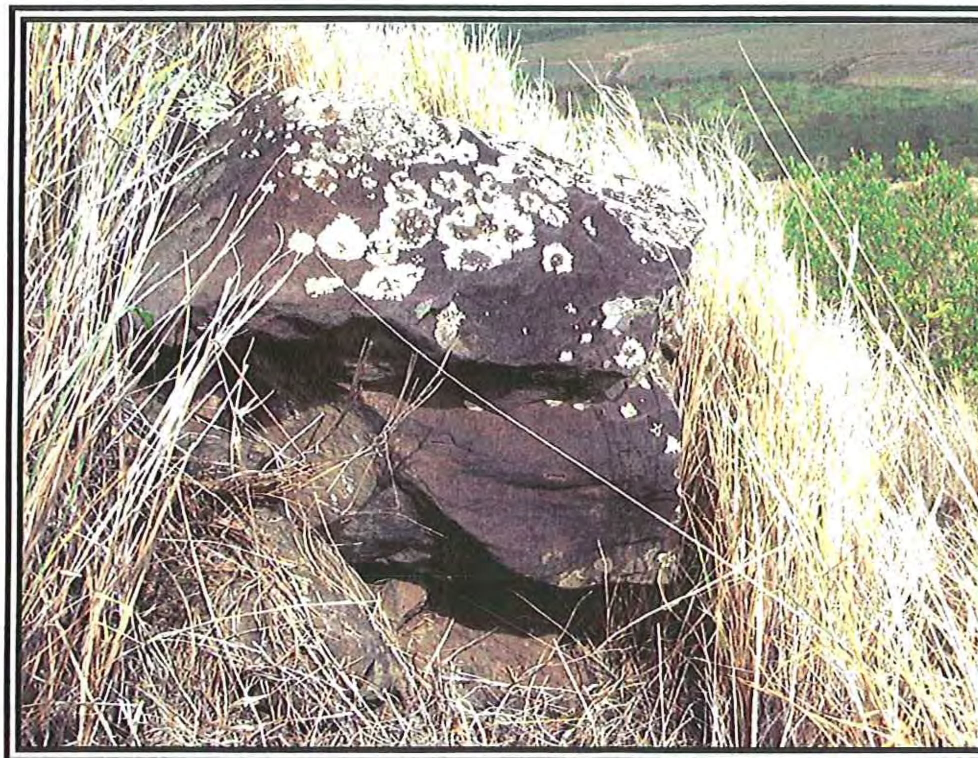
Photograph No. 9: Typical conditions with view down slope toward ravine and Lot No. 62 from existing rock outcroppings above about Lot No. 63. (1483)

Photograph No. 10: Existing boulders on slope above about Lot No. 61. (1485)

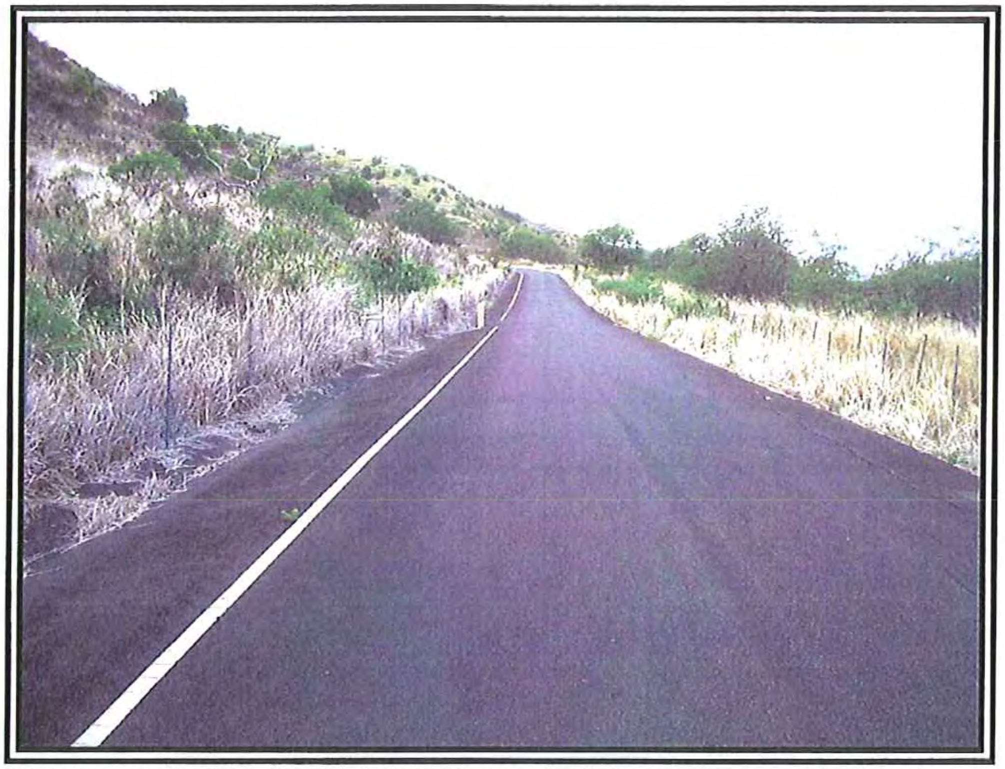
Photograph No. 11: View from Lot No. 58 of rock outcroppings on hillside above about Lot Nos. 58 and 59. (1490)

Photograph No. 12: View down slope toward about Lot Nos. 49 and 50 showing typical conditions with generally few rockfall hazards. (1511)

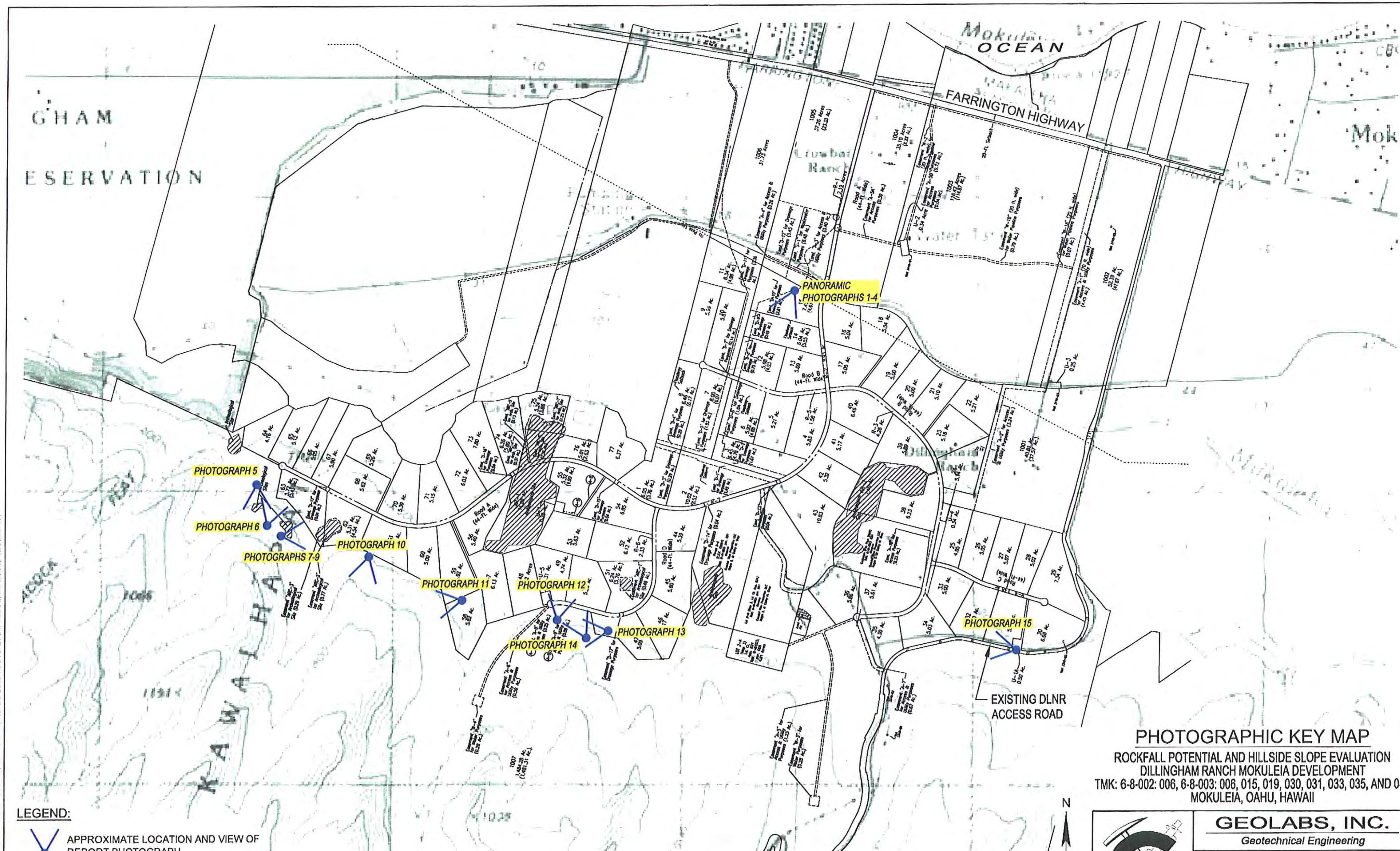
Photograph No. 13: View upslope from Lot No. 47 showing the east facing hillside containing widely scattered boulders and rock outcroppings above the western side of Lot No. 47. (0606)



Photograph No. 14: Typical condition of existing widely scattered boulders on steep hillside above Subdivision Road "D". (0603)



Photograph No. 15: Existing Peacock Flats access road traversing above Lot Nos. 30 thru 35. (1533)



REFERENCE: PLOT PLAN TRANSMITTED BY CONTROLPOINT SURVEYING, INC. ON OCTOBER 30, 2007 OVERLAYED ON MAP CREATED WITH TOPO!® ©2001 NATIONAL GEOGRAPHIC (WWW.NATIONALGEOGRAPHIC.COM/TOPO).

PHOTOGRAPHIC KEY MAP

ROCKFALL POTENTIAL AND HILLSIDE SLOPE EVALUATION
DILLINGHAM RANCH MOKULEIA DEVELOPMENT
TMK: 6-8-002: 006, 6-8-003: 006, 015, 019, 030, 031, 033, 035, AND 040
MOKULEIA, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
NOVEMBER 2007	KHN	
SCALE	W.O.	
1" = 1,000'	5721-20	15

Appendix H

Application for Individual Wastewater System (IWS)
Dillingham Ranch ʻĀina, LLC
Mokūleʻia, Oʻahu, Hawaiʻi

DEPARTMENT OF HEALTH - WASTEWATER BRANCH
INDIVIDUAL WASTEWATER SYSTEM (IWS)
APPLICATION INFORMATION SHEET
Please Print or Type

Engineer: Ross Tanimoto Ph# 596-2378 Fax 596-2046

Owner: Dillingham Ranch Aina, LLC

Owner's Mailing Address: 9601 Wilshire Blvd, Suite 220
(required)
Beverly Hills, CA 90210

Project Location: Mokuleia, Oahu
(Street Address, Subdivision Name and General Area):
N/A

Project Tax Map Key (TMK) Number: (1) 6 - 8 - 003 : 6 & 40

Lot Size: Total Area = 433.9 Acres, (80) Lots 5.0 Acres - 8.9 Acres

Projected Flow (gallons per day) or Number of Bedrooms: 5 Bedroom

Proposed Treatment Unit (Manufacturer, Model, Design Capacity):
EWMS, ESIS 1700, 1000 gpd

Proposed Disposal System: Absorption Bed

Design Percolation Rate: 12 (Hirata & Associates) min/in

Existing IWS on lot: NO YES Type:

Existing potable drinking water well within 1,000 ft of the proposed disposal system? NO YES

Existing structure on lot: NO YES Type:

LCC upgrade? NO YES

FOR DEPARTMENT USE ONLY:

Date Received: ______ Project Engineer: ______ File No. ______

Filing Fee ($100 ______ $25 ______) Check Date: ______ Check No. ______

Notes: ______

IWS Application Information Sheet.wpd EC] as of April 11, 2005

A

BEST INDUSTRIES **USA**
535 Ward Avenue, Suite 210; Honolulu, Hawaii 96814
P. O. Box 25577; Honolulu, Hawaii 96825
Phone: (808) 596-BEST Fax: (808) 596-2063
E-mail: bestindus001@hawaii.rr.com
www.bestindustriesusa.com

Date: March 9, 2007

Department of Health
Wastewater Branch
919 Ala Moana Blvd. Room 309
Honolulu, HI 96814

Attention: Mr. Harold Yee

Project: Dillingham Ranch

Subject: Individual Wastewater System for Dillingham Ranch TMK: (1) 6-8-003:006&040

Dear Harold,

Enclosed is the IWS design for the Dillingham Ranch subdivision, at Mokuleia, Oahu, for your review. The proposed 80-lot subdivision configuration will conform to the Agriculture District farm dwelling provisions in the City & County of Honolulu Land Use Ordinance. One (1) ESIS 1700 aerobic IWS unit has the capability and capacity to treat the daily wastewater flows up to 1,000 gallons per day generated by a 5-bedroom farm dwelling. The aerobically treated effluent will be discharged into an absorption bed below the No Pass Line.

If you have any question, please feel free to call our engineer, Ross Tanimoto, or me at 596-2378. Thank you.

Sincerely,

Harold K. Nagato
BEST INDUSTRIES **USA**

Enclosure

B

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

BEST INDUSTRIES USA, INC.

535 Ward Avenue, Suite 210
Honolulu, Hawaii 96814
Phone: (808) 596-2378
Fax: (808) 596-2063

INDIVIDUAL WASTEWATER SYSTEM

FOR

DILLINGHAM RANCH
MOKULEIA

MOKULEIA, OAHU, HAWAII
TMK: (1) 6 - 8 - 003 : 006 & 040

ROSS TANIMOTO
LICENSED PROFESSIONAL ENGINEER
No. 10087-M
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION (OBSERVATION AS DEFINED IN CHAPTER 16-115 OF THE HAWAII ADMINISTRATIVE RULES, DEPARTMENT OF COMMERCE AND CONSUMER AFFAIRS ENTITLED PROFESSIONAL ENGINEERS, ARCHITECTS, SURVEYORS, AND LANDSCAPE ARCHITECTS).

LICENSE EXPIRES ON: 30 April 2008

Dillingham Ranch

SIZE	FSCM NO.	DWG NO.	REV

DATE: 09 MAR 2007 | SCALE NONE | SHEET C

SITE EVALUATION/PERCOLATION TEST

Date/Time:	June 19, 2006
Test performed by:	Hirata & Associates, Inc.
Owner:	Dillingham Ranch House
Tax Map Key:	6-8-3: Portion of 6 and 40
Test Number:	P1

Elevation: ~29.5± ft.
Depth to Groundwater Table: >15 ft. below grade (based on nearby probe B1)
Depth to Bedrock (if observed): >15 ft. below grade
Diameter of Hole: 4 in.
Depth to Hole Bottom: 5.5 ft. below grade

Depth (inches)	**Soil Profile** (Color, texture, other)
0 - 66	Brown to dark brown clayey silt.

PERCOLATION READINGS

Time 12 inches of water to seep away: >30 min.
Time 12 inches of water to seep away: >30 min.

___ For percolation tests in sandy soils, record time intervals and water drops every 10 minutes for at least 1 hour.

√ For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record time intervals and water drops at least every 30 minutes for 4 hours or until 2 successive drops do not vary by more than 1/16 inch.

Time Interval	Drop in Inches	Time Interval	Drop in Inches
10 min	4-7/8"	30 min	2-1/2"
10 min	2-5/8"	30 min	2-1/2"
10 min	1-3/4"	30 min	2-1/2"
10 min	1-1/8"		
30 min	3-1/8"		

Percolation Rate (time/final water level drop): 12 min/in

As the engineer responsible for gathering and providing site information and percolation test results, I attest to the fact that above site information is accurate and that the site evaluation was conducted in accordance with the provisions of Chapter 11-62, "Wastewater Systems" and the results were acceptable.

Rick I.K. Yoshida

Engineer's Signature/Stamp

RICK I.K. YOSHIDA
LICENSED PROFESSIONAL ENGINEER
No. 11118-C
HAWAII, U.S.A.

Plate A1

SITE EVALUATION/PERCOLATION TEST

Date/Time: June 19, 2006

Test performed by: Hirata & Associates, Inc.

Owner: Dillingham Ranch House

Tax Map Key: 6-8-3: Portion of 6 and 40

Test Number: P2

Elevation: ~30± ft.

Depth to Groundwater Table: >15 ft. below grade (based on nearby probe B1)

Depth to Bedrock (if observed): >15 ft. below grade

Diameter of Hole: 4 in.

Depth to Hole Bottom: 5.5 ft. below grade

Depth (inches)	Soil Profile (Color, texture, other)
0 - 66	Brown to dark brown clayey silt.

PERCOLATION READINGS

Time 12 inches of water to seep away: >30 min.

Time 12 inches of water to seep away: >30 min.

___ For percolation tests in sandy soils, record time intervals and water drops every 10 minutes for at least 1 hour.

√ For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record time intervals and water drops at least every 30 minutes for 4 hours or until 2 successive drops do not vary by more than 1/16 inch.

Time interval	Drop in inches	Time interval	Drop in inches
10 min	1-3/8"	30 min	2-9/16"
10 min	1-3/4"	30 min	2-3/4"
10 min	1-7/16"	30 min	2-11/16"
30 min	3-13/16"	30 min	2-5/8"
30 min	2-7/16"		

Percolation Rate (time/final water level drop): 11.4 min/in

As the engineer responsible for gathering and providing site information and percolation test results, I attest to the fact that above site information is accurate and that the site evaluation was conducted in accordance with the provisions of Chapter 11-62, "Wastewater Systems" and the results were acceptable.

Rick I.K. Yoshida

Engineer's Signature/Stamp

RICK I.K. YOSHIDA
LICENSED PROFESSIONAL ENGINEER
No. 11118-C
HAWAII, U.S.A.

Plate A2

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

GENERAL NOTES

1. All work shall conform to the Building Codes, Stands of Industry, Department of Health, Uniform Plumbing Codes, and other related items.

2. The installation indicates the overall Scope of Work and Intent, Contractor to provide verification at the job site for adjustment and to inform the engineer of change.

3. Gravel shall be #3 Coarse, no bigger than 3/4" in size with no fines or washed rock.

4. Engineer's drawings herewith does not indicate underground lines, and as such, Contractor shall inspect or tone the area for said underground lines.

5. All work shall be guaranteed for one (1) year after completion by Contractor.

6. No trees or shrubs shall be planted within 5 feet of the Sewage Treatment Unit or Disposal Unit.

7. The Sewage Treatment Unit and Disposal System shall be located in a Non-vehicular Traffic Area.

8. Depths of pipe inverts of the Sewage Treatment Unit and Disposal System are controlled by Topographic Features. The existing pipe invert may impact the depths shown on the drawings.

9. The Sewage Treatment Unit shall be at least 5 feet from the Disposal System.

10. The Sewage Treatment Unit and Disposal System shall be at least 5 feet from any wall line or any structure.

11. The Sewage Treatment Unit and Disposal System shall be at least 5 feet from the property line.
    a. Absorption System shall be at least 5 feet from the property line.
    b. Seepage Pit shall be at least 9 feet from the property line.

12. Seepage Pits shall be at least 12 feet from another Seepage Pit.

13. The Sewage Treatment Unit and Disposal System shall be at least 50 feet from streams, the ocean at the vegetation line,ponds, lakes, or other surface water body.

ROSS TANIMOTO
LICENSED PROFESSIONAL ENGINEER
No. 10087-M
HAWAII, U.S.A.

[illegible]

[illegible]

Dillingham Ranch

SIZE	FSCM NO.	DWG NO.	REV

DATE: 09 MAR 2007

SCALE NONE

SHEET 2

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

DESIGN CRITERIA

1. Owner: Dillingham Ranch Aina, LLC
   Project Name: Dillingham Ranch
   TMK: (1) 6-8-003:006 & 040
   Description: Proposed 80-lot subdivision configuration will conform to the Agriculture District farm dwelling provisions in the City & County of Honolulu Land Use Ordinance.

2. Sewage Treatment Unit Flow:
   5-bedroom dwelling = 1000 gallons per day (gpd)

3. IWS Selection:
   Eighty (80) ESIS 1700 total.
   One (1) ESIS 1700 per 5-bedroom dwelling.
   Max IWS Flow = 1000 gpd per unit
   Max IWS Volume = 1700 gallons per unit

4. Disposal System Design: Centralized Absorption Bed located below "No Pass" line.
   Percolation Rate = 12 min./in.
   Required Absorption Area per Unit =
   (175 sq.ft.)/(200 gpd) x (1000 gpd/unit) = 875 sq. ft./unit
   Required Absorption Area of Centralized Disposal System =
   (875 sq. ft./unit) x (80 units) = 70,000 sq. ft. = 1.61 acres
   Absorption Bed Dimensions = 250' x 400'
   Available Absorption Area = 250' x 400' = 100,000 sq. ft. = 2.30 acres

5. Required Land Area for Subdivision =
   (10,000 sq. ft./IWS unit) x (80 IWS units) = 800,000 sq. ft.
   Available Land Area of Subdivision = 433.9 acres = 18,900,684 sq. ft.

ROSS TANIMOTO
LICENSED PROFESSIONAL ENGINEER
No. 10087-M
HAWAII, U.S.A.

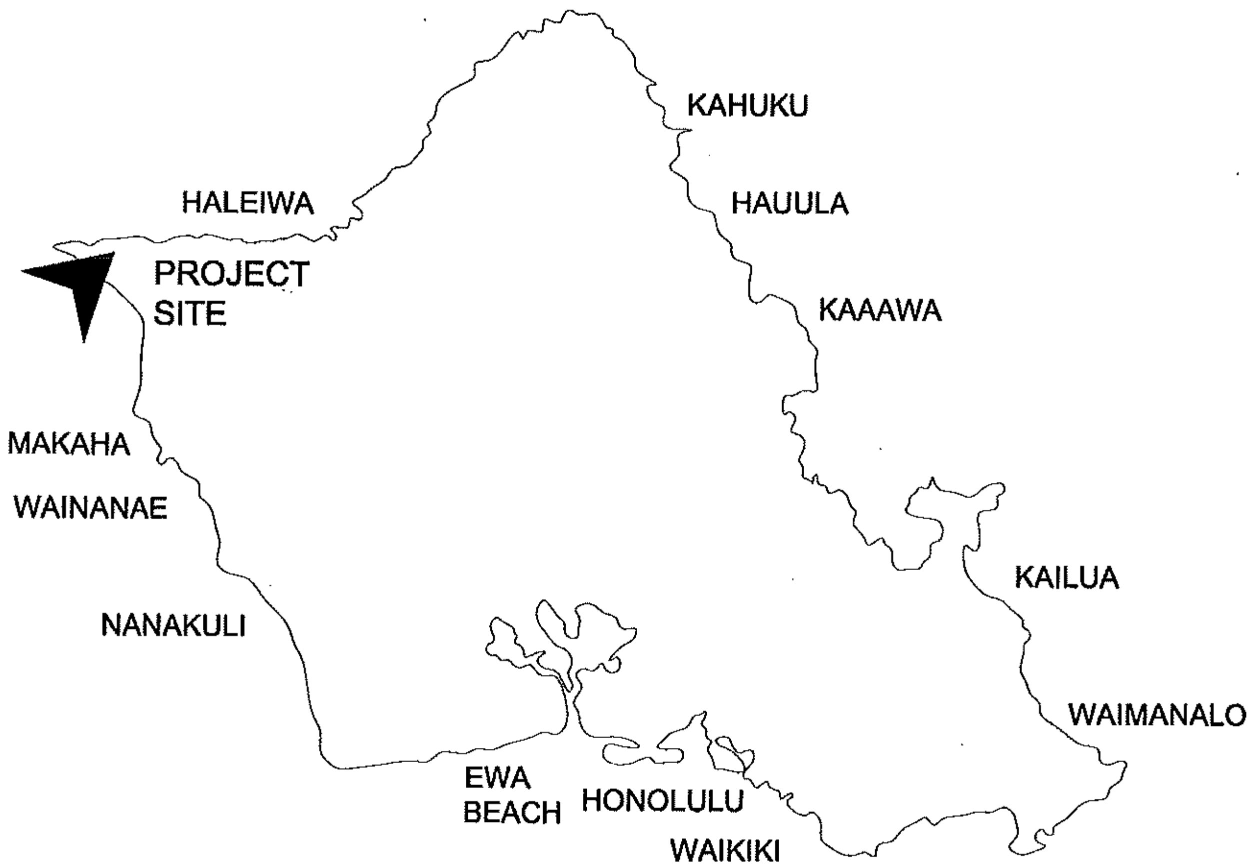
LICENSE EXPIRES ON: 30 April 2008

Dillingham Ranch

SIZE	FSCM NO.	DWG NO.	REV

DATE: 09 MAR 2007 | SCALE NONE | SHEET 3

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



ISLAND OF OAHU

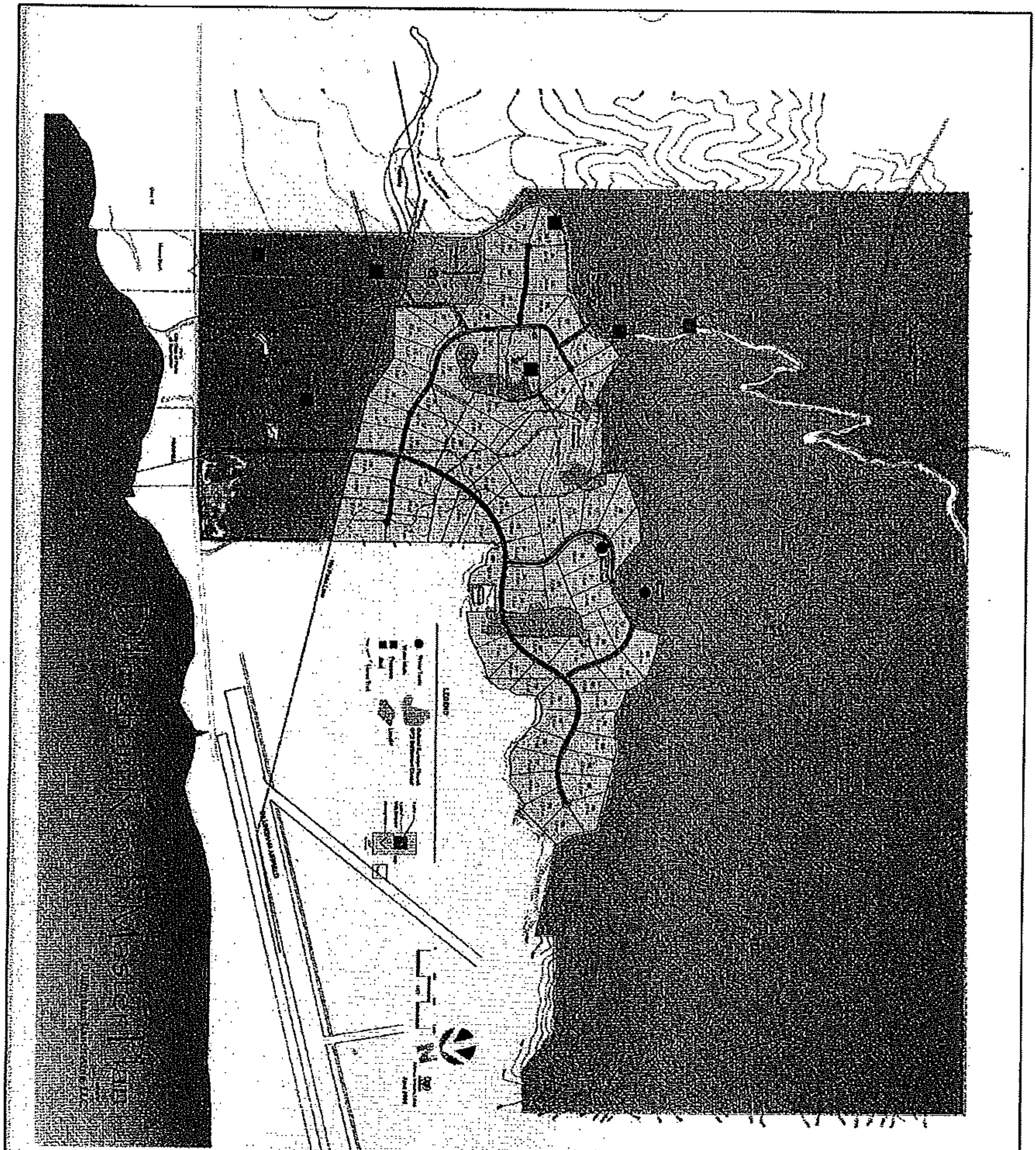
LICENSE EXPIRES ON: 30 April 2008

Dillingham Ranch

SIZE	FSCM NO.	DWG NO.	REV

DATE: 09 MAR 2007 | SCALE NONE | SHEET 4

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



ROSS TANIMOTO
LICENSED PROFESSIONAL ENGINEER
No. 10087-M
HAWAII, U.S.A.

DATE: 09 MAR 2007

LICENSE EXPIRES ON: 30 April 2008

Dillingham Ranch

SIZE	FSCM NO.	DWG NO.	REV

SCALE NONE		SHEET 5

Appendix I

Preliminary Water System Report
Dillingham Ranch Agricultural Subdivision
Mokūle‘ia, O‘ahu, Hawai‘i

Preliminary Water System Report

Dillingham Ranch Agricultural Subdivision
Mokuleia, Oahu, Hawaii

JANUARY 17, 2008

HAROLD T. TAKEMOTO
LICENSED PROFESSIONAL ENGINEER
No. 8210-C
HAWAII, U.S.A.

EXP. DATE 4-30-08

Prepared For:

Dillingham Ranch Aina, LLC

R. M. TOWILL CORPORATION
SINCE 1930

2024 North King St., Suite 200
Honolulu, Hawaii 96819
(808) 842-1133 • Fax: (808) 842-1937
(RMTC Ref: 1-20853-0E)

PRELIMINARY WATER SYSTEM REPORT

PROJECT NAME:	DILLINGHAM RANCH AGRICULTURAL SUBDIVISION
LOCATION:	Waialua, Oahu, Hawaii
TAX MAP KEY:	(1) 6-8-02:6 & (1) 6-8-03:5, 6, 15, 19, 30, 31, 33, 35, and 40
ZONING:	AG-1 and AG-2
OWNER:	Dillingham Ranch Aina, LLC
ENGINEERING CONSULTANT:	R. M. Towill Corporation 2024 North King Street, Suite 200 Honolulu, Hawaii 96819 Phone: (808) 842-1133 Fax: (808) 842-1937
DATE:	January 17, 2008

REFERENCES:

1. Water System Standards (for Oahu), State of Hawaii 2002. (WSS)
2. Preliminary Hydrogeological Evaluation of Dillingham Ranch Wells, Water Resource Associates 2003.
3. Memorandum - Description of Well 3410-03 for the Water Master Plan, Tom Nance Water Resource Engineering, January 3, 2008.

1. INTRODUCTION

This report will discuss the proposed expansion of the existing Public Water System (PWS) No. 326, owned by the North Shore Water Company, and includes: (1) the sizing of private water system water mains, (2) reservoirs, and (3) water sources to support the Dillingham Ranch Subdivision. The proposed subdivision consists of seventy-seven (77) 5-acre agricultural lots located between 22-ft and 450-ft elevation. For location and vicinity see Figures 1 and 2.

Two service zones will be created within the proposed water distribution system. The upper service zone will be supplied by a proposed reservoir with a spillway elevation of 500 ft. The lower service zone will be supplied by a proposed reservoir with a spillway elevation of 310 ft.

The sizing of the water mains, reservoirs, and well pumps are based on design criteria (see Table 1).

2. EXISTING INFRASTRUCTURE

Well No. 3410-01

Well No. 3410-01 is an existing source that will be part of the expansion of PWS No. 326. This well was drilled sometime prior to 1911 and is located 1800 feet mauka of Farrington Highway. Records state the well has a 6-inch casing which extends to a depth of 388 feet below sea level, with 25 feet of open hole to a depth of 417 feet below sea level. The well has a reported head of 18.2 feet when first developed.

This well has 4 pumps; two 3 HP, one 7.5 HP, and one 15 HP pump. Pump testing resulted in normal operation at 400 GPM at 50 psi. The existing piping is a current limitation. The well pumps and piping will need to be upgraded to increase pumping capacity.

The water use permit for this well allows 0.5 MGD for domestic, livestock, and irrigation use (approved 9/11/81 and transferred to Metropolitan Mortgage and Securities Co., Inc. on 2/10/03).

Well No. 3410-03

Well No. 3410-03 will be an additional source of supply for the expansion of PWS No. 326. The construction of the well occurred sometime after Well 3410-01, although the exact date is unknown. The well has 398 feet of 10-inch casing and 105 feet of open hole below the casing. The depth of the well is 498 feet, with its bottom at 468 feet below sea level.

The semi-confined groundwater tapped by this well has a piezometric head of about 17 feet above sea level and very low salinity. Pump testing in August 2007 resulted in less than three feet of drawdown at 800 GPM. Authorized use of the well by the Commission on Water Resource Management is 1.5 MG (WUP No. 779 issued in September 1981). The well pump was installed in August 2007. It is a 2-stage, Grundfos Model 800S500 and it is driven by a 50 HP, 460-volt, 3450 RPM Franklin motor. The pump's nominal design point is 800 GPM against a TDH of 194 feet.

3. DESIGN CRITERIA

The design criteria used for the water system analysis is listed in Table 1 and is based on the WSS. The design criteria follows the WSS with the following deviation:

1. For pipeline sizing: The average daily demand of 500 gallons per unit (Residential) in addition to 1,145 gallons per acre for irrigation is applied to each lot. See Table 2 for irrigation rate calculations. The average daily demand of 5,080 gallons per lot, instead of 4,000 gallons per acre (Agricultural zoning), is assumed to irrigate a 4-acre lot and provide residential usage.

2. For pipeline sizing: The maximum daily demand of 750 gallons per unit (Residential multiplied by max demand factor of 1.5) in addition to 2,085 gallons per acre for maximum irrigation rate is applied to each lot. See Table 2 for maximum irrigation rate calculations. The maximum daily demand of 9,090 gallons per lot, is assumed to irrigate a 4-acre lot and provide residential usage. The maximum irrigation rate of 2,085 gallons per acre is also applied to peak hour demand scenarios.

3. The well pump capacity has an operating time of 24 hours instead of 16 hours.

Table 1. Water System Facilities Sizing Criteria

<u>Demand Factors</u>

- Average Day Demand = 1,145 Gallons Per Acre Per Day (for 4 acres)
  Plus 500 GPD Per Lot (Residential, Single Family)
- Maximum Day Demand = 2,085 Gallons Per Acre Per Day (for 4 acres)
  Plus 1.5 * (Residential) Average Day Demand
- Peak Hour Demand = 2,085 Gallons Per Acre Per Day (for 4 acres)
  Plus 3.0 * (Residential) Average Day Demand

<u>Fire Flow</u>

- Agriculture: 1,000 gallons per minute (GPM) for 0.5 hour
- Single Family: 1,000 GPM for 1 hour
- Neighborhood Business: 2,000 GPM for 2 hours

<u>Service Pressures</u>

- Minimum of 40 psi (except during fire flow)
- Maximum of 125 psi
- 20 psi at critical fire hydrant for fire flow with coincident maximum daily demand

<u>Pipeline Sizes</u>

- Allow maximum velocity of 6.0 feet per second (fps) (without fire flow)
- Meet minimum fire hydrant pressure criterion for fire flow plus maximum daily flowrate with no velocity restriction
- Compute pipeline pressure losses using Hazen-Williams formula with:
  C = 150 for all HDPE pipelines

<u>Pump</u>

Future Wells

- Meet maximum day demand (which includes maximum irrigation rate) for an operating time of 24 hours with the largest well pump out of service.

Interim Wells

- Meet maximum day demand (potable only) in 24 hour pumping with the largest pump out of service.
- Meet maximum day demand (which includes maximum irrigation rate) for an operating time of 24 hours for both wells. No backup for irrigation.

<u>Reservoir</u>

- Meet maximum day domestic consumption. Reservoir full at the beginning of the 24-hour period with no source input to the reservoir.
- Meet fire flow and coincident maximum daily demand for the duration of the fire with the reservoir 3/4 full at the start and credit for well inflow with the largest pump out of service.

Table 2. Water System Facilities Sizing Criteria

Month	Adjusted Mean Rain @ Sta. 843	Mean Pan Evaporation		Potential ET Deficit	Irrigation Requirement	
		Sta. 847	Sta. 861		In/Mo	GPD/Ac
January	6.06	4.17	3.78	0	0	0
February	4.29	4.59	4.22	1.19	0.83	402
March	4.25	5.54	5.01	2.09	1.46	639
April	3.27	5.88	5.23	3.10	2.17	982
May	1.77	7.22	6.23	5.40	3.78	1,655
June	1.02	7.76	6.39	6.31	4.42	2,000
July	1.10	8.33	6.92	6.80	4.76	2,085
August	1.26	8.27	7.05	6.72	4.70	2,058
September	1.02	7.24	6.24	5.98	4.18	1,896
October	2.76	5.91	5.29	3.53	2.47	1,082
November	3.62	4.54	4.13	1.62	1.13	511
December	4.80	3.90	3.84	0.27	0.19	394
Annual Average Irrigation Rate (For WUP Limits)						1,145
Maximum Irrigation Rate (Month of July, For Infrastructure Sizing)						2,085

Notes:
(1) Rainfall from "Rainfall Atlas of Hawaii," DLNR Report R76.
(2) Pan Evaporation from "Pan Evaporation: State of Hawaii, 1894-1983," DLNR Report R74.
(3) Potential ET deficit is the average Pan Evap. at Sta. 847 and 861 minus "effective" rainfall, defined as 0.75 times rainfall at Sta. 843.
(4) Irrigation requirement in inches per month is 0.70 times potential ET deficit (Allan Schildknecht, Irrigation Hawaii, recommends 0.65).
(5) GPD/Acre converts inches per month assuming 50% crop rotation (assumption...generous according to A. Schildkencht).
- See Appendix D for original calculations.

4. DESIGN ANALYSIS

PWS No. 326, served by existing Well No. 3410-01, will be upgraded to create two service zones within the subdivision site. Currently, the existing water system serves 56 existing users along Farrington Highway. These users include the Mokuleia Beach Colony's 52 condominium units, served by 2 meters and Camp Mokuleia, also served by 2 meters.

During the interim period Well No. 3410-01 and Well No. 3410-03, see Figure 3, will initially serve the proposed subdivision, the Ranch House, and the users along Farrington Highway. An application to convert Well No. 3410-03 to a potable well is being filed with the State Department of Health.

The existing users of PWS No. 326 and 52 lots of the proposed subdivision will be receive water from the lower zone served by the reservoir with a 310-ft elevation spillway. The upper zone will be served by the reservoir with a 500-ft elevation spillway. This zone serves 25 proposed (upper portion) lots in the subdivision. For the interim, a booster pump will transport the upper zone maximum daily demand water from the lower service zone reservoir to the upper service zone reservoir. In Table 3, the sizing of both reservoirs is summarized.

Table 3. Water System Demands for Reservoir Sizing

Upper Zone: 500-Feet Reservoir Demands	Flowrates for Design		
	Average Day (GPD)	Maximum Day (GPD)	Fire Flow (GPM)
New Users	12,500	18,750	1,000
Upper Zone Totals ==>	12,500	18,750	

New Users, 25 lots at 500 GPD

Lower Zone: 310-Feet Reservoir Demands	Flowrates for Design		
	Average Day (GPD)	Maximum Day (GPD)	Fire Flow (GPM)
Existing Users	90,000	135,000	1,000
New Users	26,000	39,000	1,000
Ranch House	2,000	3,000	2,000 *
Lower Zone Totals ==>	118,000	177,000	

New Users, 52 lots at 500 GPD.
*Existing Users: Single Family Fire Flow = 1,000 GPM For 0.5 hour omitted, Small Business Fire Flow = 2,000 GPM For 2 hours used for design purposes.

Ultimately, the subdivision will be served by future potable Well No. 3311-01 and Well No. 3311-02 located next to the 500-ft spillway elevation reservoir shown in Figure 3. Until this occurs, existing Well Nos. 3410-01 and 3410-03 (with upgraded pumps) will meet the required demand. Together these wells will need to meet the max day domestic demand along with the max irrigation requirement in 24 hours with the largest pump out of service. In Table 4, the maximum daily demand and max irrigation requirements have been included.

Future potable Well No. 3311-01 and Well No. 3311-02 will each be outfitted with pumps capable of providing max day demand in 16 hours. Combined, these wells will provide max day demand along with max irrigation requirements in 24 hours.

Analysis and design of the water system for this report were completed using a water distribution modeling software system, WaterCAD by Haestad Methods Incorporated. This program allows the designer to develop a hydraulic model of a pressurized pipe system and was used for this report to perform the following analyses:

1. Steady-state analysis of the water system, including pipes and reservoirs
2. Extended period simulation to analyze the system under varying supply and demand conditions
3. Fire flow analysis

The proposed distribution system shown in Figure 3, is comprised of nodes or pressure junctions that connect or end multiple pipe segments. Demands were assigned to the nodes based on the number of lots that are being served at that particular node. The distribution of demands is located in Appendix B.

Table 4. Water System Demands for Well Pump and Pipeline Sizing

Upper Zone: 500-Feet Reservoir Demands	Flowrates for Design				
	Gallons Per Day (GPD)			Gallons Per Minute (GPM)	
	Average Day	Max Day	Peak Hour	Peak Hour	Max Day
New Users*	12,500	18,750	37,500	26	13
- Ag. Irrigation	114,500	208,500	208,500	145	145
Upper Zone Totals ==>	127,000	227,250	246,000	171	158

*New Users, 25 lots at 500 GPD

Lower Zone: 310-Feet Reservoir Demands	Flowrates for Design				
	Gallons Per Day (GPD)			Gallons Per Minute (GPM)	
	Average Day	Max Day	Peak Hour	Peak Hour	Max Day
Existing Users	90,000	135,000	270,000	188	94
New Users**	26,000	39,000	78,000	54	27
- Ag. Irrigation	238,160	433,680	433,680	301	301
Ranch House	2,000	3,000	6,000	4	2
Lower Zone Totals ==>	356,160	610,680	787,680	547	424

**New Users, 52 lots at 500 GPD

<u>WaterCAD Simulation Analysis Method</u>:

Fixed Pattern:
Analysis shows that under the average daily demand the water system satisfies the WSS requirements. Velocities were below 6 feet per second. Pressure junctions were also below the maximum allowable pressure.

Maximum Day Plus Fire Flow Pattern:
According to WSS, the fire flow condition the pressure at each junction should be at least 20 psi. Fire flow conditions were simulated by applying the fire flow demand to various pressure junctions and the maximum daily demand to all junctions. Each of the service zones was tested with a single fire flow for each run. The proposed water distribution system is sufficient to handle fire flow during the maximum daily demand.

Peak Hour Flow:
Under this condition, all the pressure junctions are required to meet the minimum pressure requirement of 40 psi. The analysis proved this to be the case except for a couple of junctions following the reservoir.

See Appendix C for results produced by WaterCAD.

5. RESULTS

The proposed distribution system in Figure 3 consists of two main pipelines connecting the reservoirs to the water system branches. Distribution waterlines sizes used are 8 inch and 12 inch. See Figures 4 & 5 for additional schematics of the water distribution system. These figures identify junction and pipe line locations which corresponds to Appendix B and the WaterCAD analyses results found in Appendix B.

The sizes for the two domestic water reservoirs (310-ft and 500-ft) are 0.1 MG and 0.25 MG, respectively. Together the 0.1 MG and 0.25 MG reservoirs are sized to serve existing users (PWS No. 326 and Ranch House) and subdivision potable demand plus fire flow. Assuming the future wells will be drilled next to the 500' spillway reservoir, the 0.25 MG volume will provide proper well pump cycles. The excess volume in the 0.25 MG reservoir can be applied to the lower reservoir to meet the overall potable demand.

The startup of the water system will use existing Well No. 3410-01 and Well No. 3410-03 (to be upgraded). Existing Wells No. 3310-01, No. 3310-02, No. 3310-03, and No. 3410-05 will not be used for the subdivision. After Well No. 3311-01 and Well No. 3311-02 are drilled/cased/certified, existing Well No. 3410-01 and Well No. 3410-03 will be taken off line.

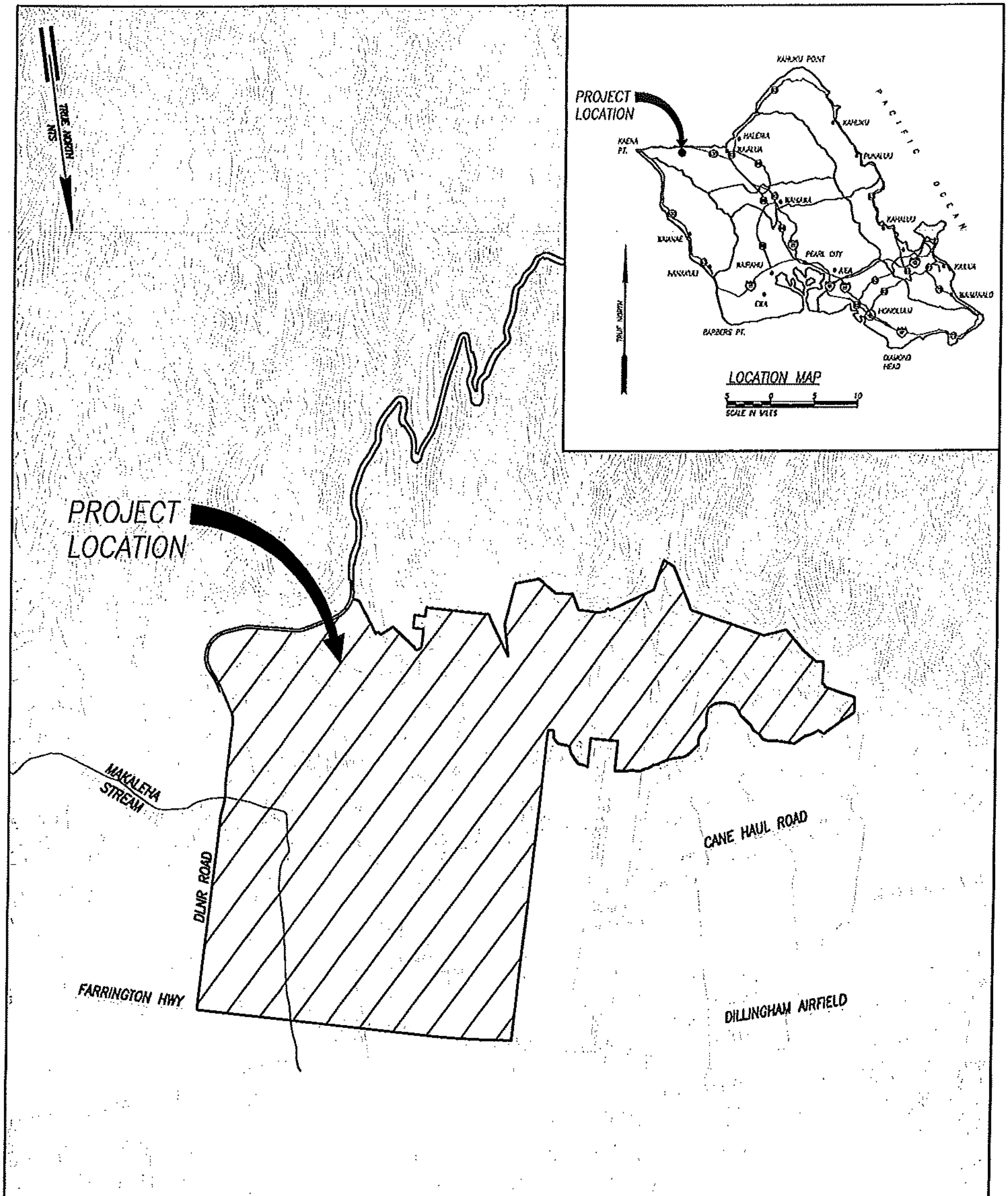


FIGURE 1: PROJECT LOCATION MAP

SCALE: NTS

Planning - Engineering - Environmental Services - Photogrammetry - Surveying - Construction Management R. M. TOWILL CORPORATION 808 842 1133 2024 North King Street Suite 200 Honolulu Hawaii 96819-3470	Dillingham Ranch Agricultural Subdivision TMK: (1)6-8-02:6 & (1)6-8-03:5,6,15,19,20,30,31,33,35, & 40	Figure 1

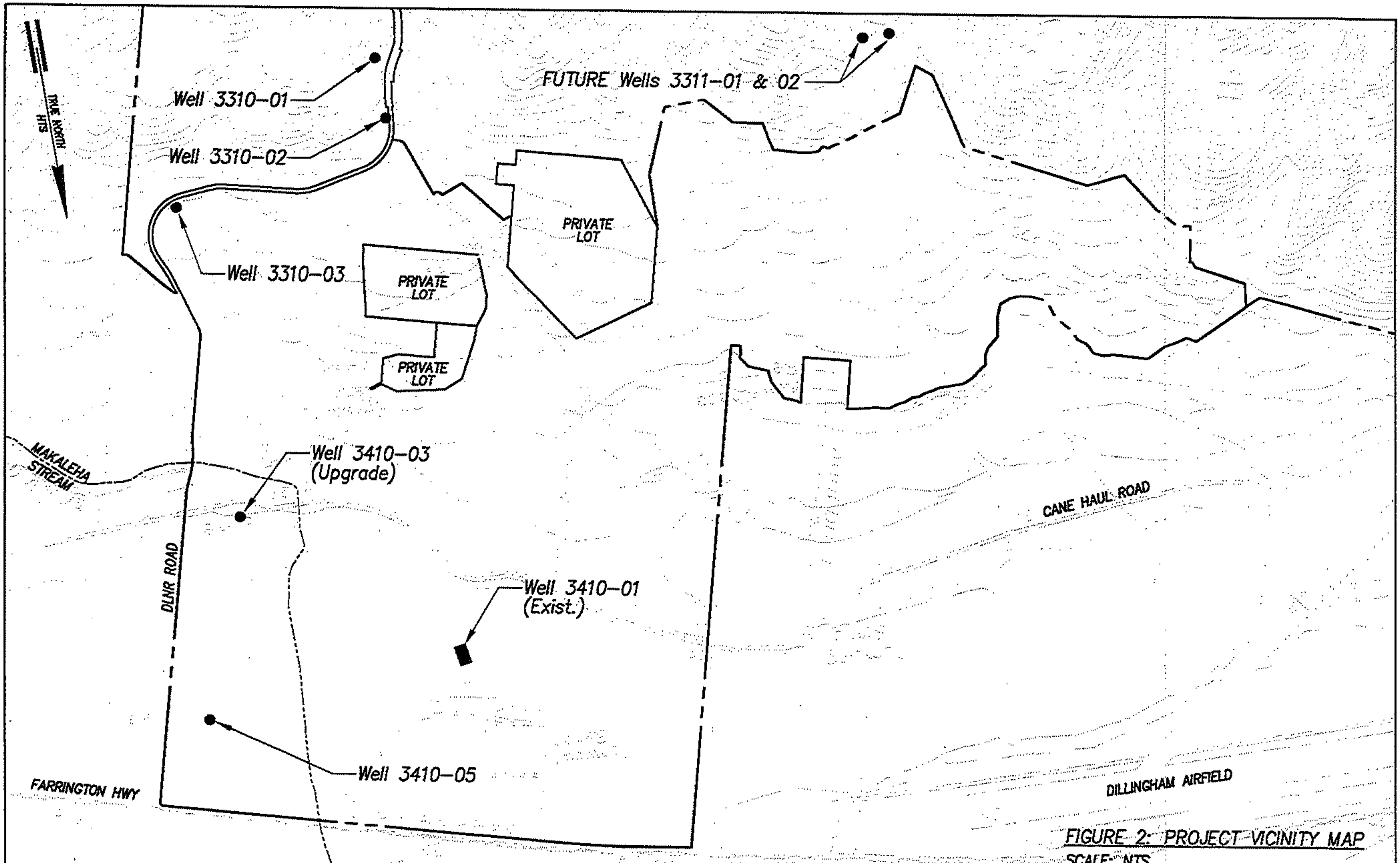
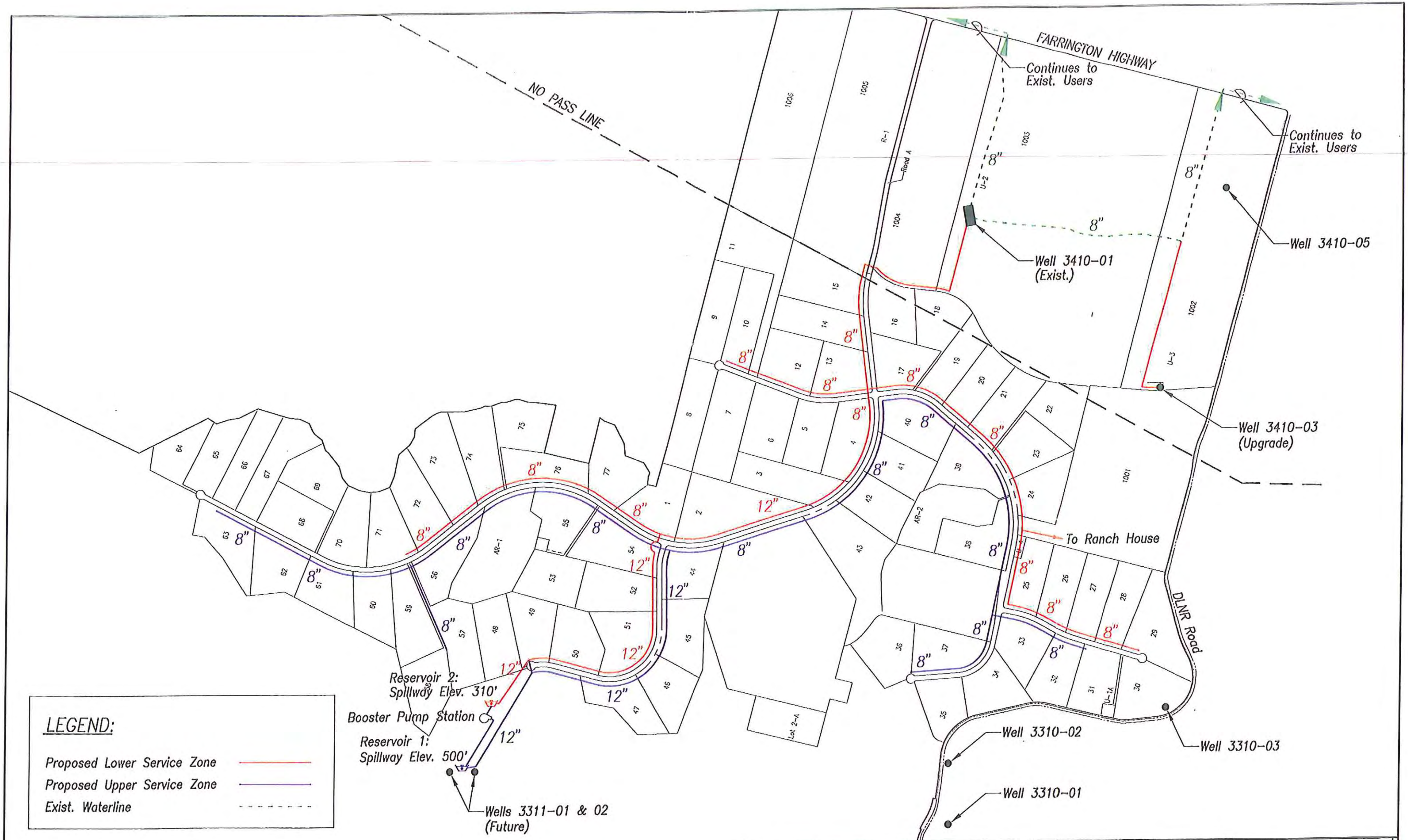


FIGURE 2: PROJECT VICINITY MAP
SCALE: NTS

Planning – Engineering – Environmental Services – Photogrammetry – Surveying – Construction Management
R. M. TOWILL CORPORATION
808 842 1133 2024 North King Street Suite 200 Honolulu Hawaii 96819-3470

Dillingham Ranch Agricultural Subdivision
TMK: (1)6-8-02:6 &
(1)6-8-03:5,6,15,19,20,30,31,33,35, &40

Figure 2



Planning – Engineering – Environmental Services – Photogrammetry – Surveying – Construction Management
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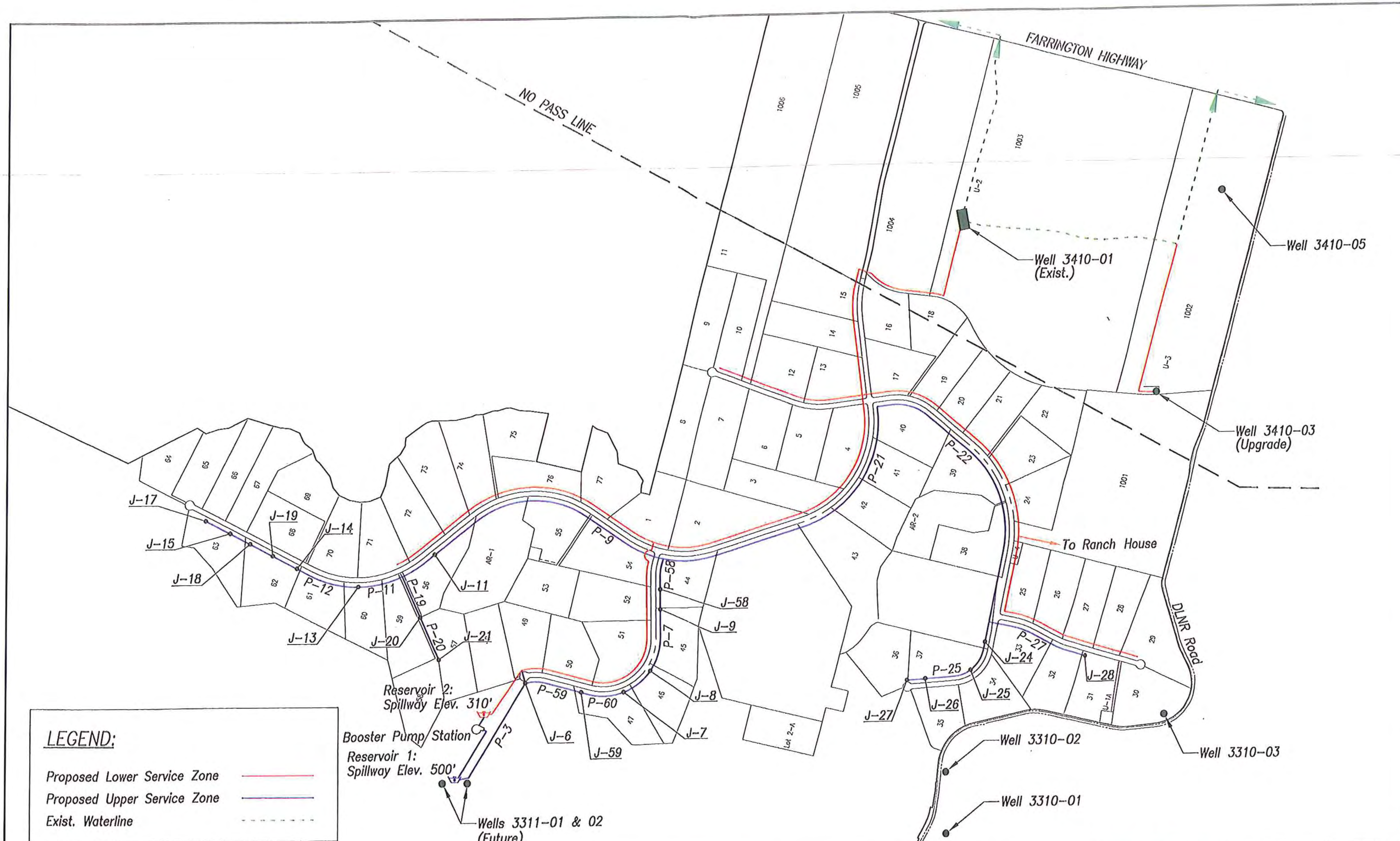
Dillingham Ranch Agricultural Subdivision Water Distribution System

Schematic of the Proposed Water System

Figure 3



Planning - Engineering - Environmental Services - Photogrammetry - Surveying - Construction Management

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North

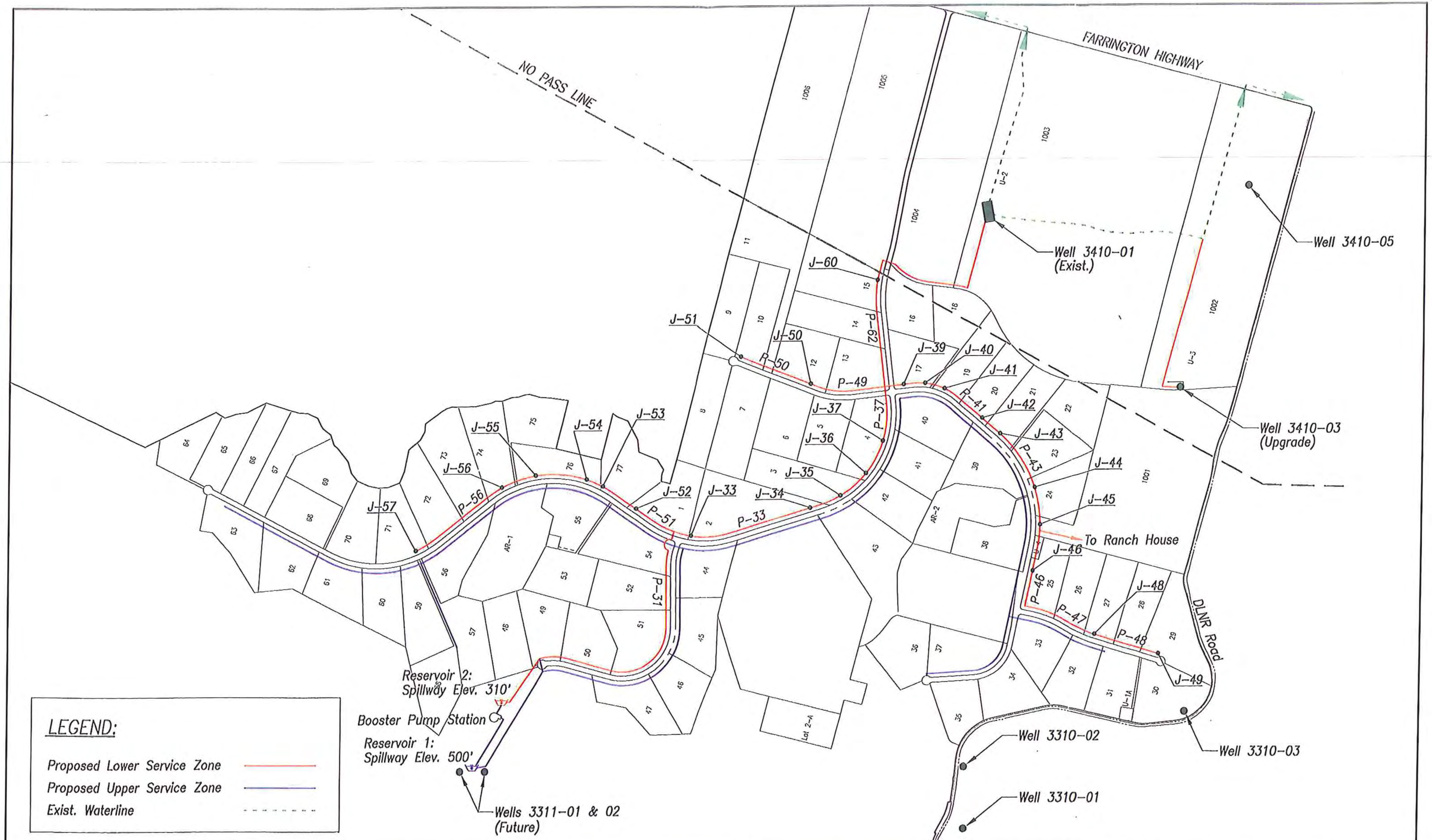
800' 400' 0 800' 1600'

SCALE: 1" = 800'

Dillingham Ranch Agricultural Subdivision Water Distribution System

Hydraulic Schematic of the Proposed Water System - 1
Upper Service Zone

Figure 4



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North

800' 400' 0 800' 1600'
SCALE: 1" = 800'

Dillingham Ranch Agricultural Subdivision Water Distribution System

Hydraulic Schematic of the Proposed Water System - 2
Lower Service Zone

Figure 5

APPENDICES

APPENDIX A

Distribution of Demands

Table A. Distribution of Demands

Node	Single Family Units	Flowrates for Design (GPD)					
		Average Day		Maximum Day		Peak Hour	
		Average Irrigation	Domestic Usage	Maximum Irrigation	Domestic Usage	Maximum Irrigation	Domestic Usage
Upper Service Zone- Supplied by Reservoir with Spillway El. = 500 ft.							
J-6	2	9,160	1,000	16,680	1,500	16,680	3,000
J-7	1	4,580	500	8,340	750	8,340	1,500
J-8	1	4,580	500	8,340	750	8,340	1,500
J-9	1	4,580	500	8,340	750	8,340	1,500
J-11	1	4,580	500	8,340	750	8,340	1,500
J-13	1	4,580	500	8,340	750	8,340	1,500
J-14	1	4,580	500	8,340	750	8,340	1,500
J-15	1	4,580	500	8,340	750	8,340	1,500
J-17	3	13,740	1,500	25,020	2,250	25,020	4,500
J-18	1	4,580	500	8,340	750	8,340	1,500
J-19	1	4,580	500	8,340	750	8,340	1,500
J-20	1	4,580	500	8,340	750	8,340	1,500
J-21	1	4,580	500	8,340	750	8,340	1,500
J-24	1	4,580	500	8,340	750	8,340	1,500
J-25	1	4,580	500	8,340	750	8,340	1,500
J-26	1	4,580	500	8,340	750	8,340	1,500
J-27	1	4,580	500	8,340	750	8,340	1,500
J-28	2	9,160	1,000	16,680	1,500	16,680	3,000
J-58	2	9,160	1,000	16,680	1,500	16,680	3,000
J-59	1	4,580	500	8,340	750	8,340	1,500
	Totals =	114,500	12,500	208,500	18,750	208,500	37,500
			127,000		227,250		246,000
Lower Service Zone- Supplied by Reservoir with Spillway El. = 310 ft.							
J-33	2	9,160	1,000	16,680	1,500	16,680	3,000
J-34	1	4,580	500	8,340	750	8,340	1,500
J-35	2	9,160	1,000	16,680	1,500	16,680	3,000
J-36	1	4,580	500	8,340	750	8,340	1,500
J-37	1	4,580	500	8,340	750	8,340	1,500
J-39	3	13,740	1,500	25,020	2,250	25,020	4,500
J-40	1	4,580	500	8,340	750	8,340	1,500
J-41	1	4,580	500	8,340	750	8,340	1,500
J-42	1	4,580	500	8,340	750	8,340	1,500
J-43	2	9,160	1,000	16,680	1,500	16,680	3,000
J-44	2	9,160	1,000	16,680	1,500	16,680	3,000
J-45	1	4,580	500	8,340	750	8,340	1,500
Ranch House			2,000		3,000		6,000
J-46	1	4,580	500	8,340	750	8,340	1,500
J-48	4	18,320	2,000	33,360	3,000	33,360	6,000
J-49	2	9,160	1,000	16,680	1,500	16,680	3,000
J-50	4	18,320	2,000	33,360	3,000	33,360	6,000
J-51	5	22,900	2,500	41,700	3,750	41,700	7,500
J-52	1	4,580	500	8,340	750	8,340	1,500
J-53	3	13,740	1,500	25,020	2,250	25,020	4,500
J-54	1	4,580	500	8,340	750	8,340	1,500
J-55	3	13,740	1,500	25,020	2,250	25,020	4,500
J-56	2	9,160	1,000	16,680	1,500	16,680	3,000
J-57	5	22,900	2,500	41,700	3,750	41,700	7,500
J-60	3	13,740	1,500	25,020	2,250	25,020	4,500
Exist. PWS-326			90,000		135,000		270,000
	Totals =	238,160	118,000	433,680	177,000	433,680	354,000
			356,160		610,680		787,680

(52 proposed single family units, in addition to exist. PWS-326 users and Ranch House)

APPENDIX B

WaterCAD Results:

Reservoir 1: Spillway El=500'

Reservoir 2: Spillway El=310'

Scenario: Base
Extended Period Analysis: 0.00 hr / 24.00
Junction Report

Label	Elevation (ft)	Type	Zone	Base Flow (gpd)	Pattern	Demand (Calculated) (gpd)	Calculated Hydraulic Grade (ft)	Pressure (psi)
J-5	400.00	Demand	Zone-Upper	0	Average Day	0	500.00	43.26
J-6	324.00	Demand	Zone-Upper	10,160	Average Day	10,160	499.99	76.14
J-7	328.00	Demand	Zone-Upper	5,080	Average Day	5,080	499.98	74.41
J-8	305.00	Demand	Zone-Upper	5,080	Average Day	5,080	499.98	84.36
J-9	229.00	Demand	Zone-Upper	5,080	Average Day	5,080	499.97	117.23
J-10	180.00	Demand	Zone-Upper	0	Average Day	0	499.96	138.43
J-11	171.00	Demand	Zone-Upper	5,080	Average Day	5,080	499.87	142.29
J-12	180.00	Demand	Zone-Upper	0	Average Day	0	499.86	138.39
J-13	207.00	Demand	Zone-Upper	5,080	Average Day	5,080	499.86	126.71
J-14	233.00	Demand	Zone-Upper	5,080	Average Day	5,080	499.85	115.45
J-15	207.00	Demand	Zone-Upper	5,080	Average Day	5,080	499.84	126.70
J-17	264.00	Demand	Zone-Upper	15,240	Average Day	15,240	499.84	102.04
J-18	199.00	Demand	Zone-Upper	5,080	Average Day	5,080	499.85	130.16
J-19	209.00	Demand	Zone-Upper	5,080	Average Day	5,080	499.85	125.84
J-20	261.00	Demand	Zone-Upper	5,080	Average Day	5,080	499.86	103.34
J-21	299.00	Demand	Zone-Upper	5,080	Average Day	5,080	499.86	86.90
J-22	45.00	Demand	Zone-Upper	0	Average Day	0	499.93	196.83
J-23	200.00	Demand	Zone-Upper	0	Average Day	0	499.90	129.75
J-24	235.00	Demand	Zone-Upper	5,080	Average Day	5,080	499.89	114.61
J-25	266.00	Demand	Zone-Upper	5,080	Average Day	5,080	499.89	101.19
J-26	282.00	Demand	Zone-Upper	5,080	Average Day	5,080	499.89	94.27
J-27	283.00	Demand	Zone-Upper	5,080	Average Day	5,080	499.89	93.84
J-28	137.00	Demand	Zone-Upper	10,160	Average Day	10,160	499.89	157.01
J-30	308.00	Demand	Zone-Lower	0	Average Day	0	309.96	0.85
J-31	306.00	Demand	Zone-Lower	0	Average Day	0	309.94	1.70
J-32	180.00	Demand	Zone-Lower	0	Average Day	0	309.75	56.14
J-33	153.00	Demand	Zone-Lower	10,160	Average Day	10,160	309.74	67.81
J-34	109.00	Demand	Zone-Lower	5,080	Average Day	5,080	309.64	86.81
J-35	102.00	Demand	Zone-Lower	10,160	Average Day	10,160	309.53	89.79
J-36	90.00	Demand	Zone-Lower	5,080	Average Day	5,080	309.37	94.91
J-37	79.00	Demand	Zone-Lower	5,080	Average Day	5,080	309.21	99.60
J-38	45.00	Demand	Zone-Lower	0	Average Day	0	308.86	114.16
J-39	52.00	Demand	Zone-Lower	15,240	Average Day	15,240	308.83	111.12
J-40	57.00	Demand	Zone-Lower	5,080	Average Day	5,080	308.81	108.95
J-41	58.00	Demand	Zone-Lower	5,080	Average Day	5,080	308.80	108.51
J-42	83.00	Demand	Zone-Lower	5,080	Average Day	5,080	308.78	97.69
J-43	87.00	Demand	Zone-Lower	10,160	Average Day	10,160	308.78	95.95
J-44	90.00	Demand	Zone-Lower	10,160	Average Day	10,160	308.76	94.65
J-45	110.00	Demand	Zone-Lower	7,080	Average Day	7,080	308.75	85.99
J-46	172.00	Demand	Zone-Lower	5,080	Average Day	5,080	308.74	59.16
J-47	200.00	Demand	Zone-Lower	0	Average Day	0	308.74	47.05
J-48	163.00	Demand	Zone-Lower	20,320	Average Day	20,320	308.73	63.05
J-49	116.00	Demand	Zone-Lower	10,160	Average Day	10,160	308.73	83.39
J-50	42.00	Demand	Zone-Lower	20,320	Average Day	20,320	308.85	115.45
J-51	28.00	Demand	Zone-Lower	25,400	Average Day	25,400	308.85	121.51
J-52	110.00	Demand	Zone-Lower	5,080	Average Day	5,080	309.72	86.41
J-53	119.00	Demand	Zone-Lower	15,240	Average Day	15,240	309.70	82.51
J-54	120.00	Demand	Zone-Lower	5,080	Average Day	5,080	309.70	82.07
J-55	135.00	Demand	Zone-Lower	15,240	Average Day	15,240	309.68	75.57
J-56	146.00	Demand	Zone-Lower	10,160	Average Day	10,160	309.67	70.81
J-57	181.00	Demand	Zone-Lower	25,400	Average Day	25,400	309.67	55.67
J-58	207.00	Demand	Zone-Upper	10,160	Average Day	10,160	499.96	126.75

Scenario: Base
Extended Period Analysis: 0.00 hr / 24.00
Junction Report

Label	Elevation (ft)	Type	Zone	Base Flow (gpd)	Pattern	Demand (Calculated) (gpd)	Calculated Hydraulic Grade (ft)	Pressure (psi)
J-59	328.00	Demand	Zone-Upper	5,080	Average Day	5,080	499.99	74.41
J-60	24.00	Demand	Zone-Lower	105,240	Average Day	105,240	308.79	123.21

Scenario: Base
Extended Period Analysis: 0.00 hr / 24.00
Pipe Report

Label	From Node	To Node	Length (ft)	Diameter (in)	Hazen-Williams C	Control Status	Discharge (gpd)	Pressure Pipe Headloss (ft)	Velocity (ft/s)
P-3	500-FT	J-5	96.00	12.0	150.0	Open	127,000	0.00	0.25
P-4	J-5	J-6	153.00	12.0	150.0	Open	127,000	0.00	0.25
P-6	J-7	J-8	284.00	12.0	150.0	Open	106,680	0.00	0.21
P-7	J-8	J-9	592.00	12.0	150.0	Open	101,600	0.01	0.20
P-9	J-10	J-11	2,593.00	8.0	150.0	Open	55,880	0.09	0.25
P-10	J-11	J-12	224.00	8.0	150.0	Open	50,800	0.01	0.23
P-11	J-12	J-13	288.00	8.0	150.0	Open	40,640	0.01	0.18
P-12	J-13	J-14	583.00	8.0	150.0	Open	35,560	0.01	0.16
P-17	J-18	J-15	159.00	8.0	150.0	Open	20,320	0.00	0.09
P-16	J-14	J-19	236.00	8.0	150.0	Open	30,480	0.00	0.14
P-18	J-19	J-18	289.00	8.0	150.0	Open	25,400	0.00	0.11
P-19	J-12	J-20	670.00	8.0	150.0	Open	10,160	0.00	0.05
P-20	J-20	J-21	320.00	8.0	150.0	Open	5,080	0.00	0.02
P-21	J-10	J-22	2,646.00	8.0	150.0	Open	30,480	0.03	0.14
P-22	J-22	J-23	3,055.00	8.0	150.0	Open	30,480	0.03	0.14
P-23	J-23	J-24	329.00	8.0	150.0	Open	20,320	0.00	0.09
P-24	J-24	J-25	367.00	8.0	150.0	Open	15,240	0.00	0.07
P-25	J-25	J-26	393.00	8.0	150.0	Open	10,160	0.00	0.05
P-26	J-26	J-27	52.00	8.0	150.0	Open	5,080	0.00	0.02
P-27	J-23	J-28	889.00	8.0	150.0	Open	10,160	0.00	0.05
P-29	310-FT	J-30	288.00	12.0	150.0	Open	356,160	0.04	0.70
P-30	J-30	J-31	122.00	12.0	150.0	Open	356,160	0.02	0.70
P-31	J-31	J-32	1,306.00	12.0	150.0	Open	356,160	0.19	0.70
P-32	J-32	J-33	133.00	12.0	150.0	Open	279,960	0.01	0.55
P-33	J-33	J-34	1,092.00	12.0	150.0	Open	269,800	0.10	0.53
P-34	J-34	J-35	175.00	8.0	150.0	Open	264,720	0.11	1.17
P-35	J-35	J-36	296.00	8.0	150.0	Open	254,560	0.17	1.13
P-36	J-36	J-37	281.00	8.0	150.0	Open	249,480	0.15	1.11
P-37	J-37	J-38	673.00	8.0	150.0	Open	244,400	0.35	1.08
P-38	J-38	J-39	323.00	8.0	150.0	Open	93,440	0.03	0.41
P-39	J-39	J-40	334.00	8.0	150.0	Open	78,200	0.02	0.35
P-40	J-40	J-41	104.00	8.0	150.0	Open	73,120	0.01	0.32
P-41	J-41	J-42	455.00	8.0	150.0	Open	68,040	0.02	0.30
P-42	J-42	J-43	157.00	8.0	150.0	Open	62,960	0.01	0.28
P-43	J-43	J-44	610.00	8.0	150.0	Open	52,800	0.02	0.23
P-44	J-44	J-45	294.00	8.0	150.0	Open	42,640	0.01	0.19
P-45	J-45	J-46	471.00	8.0	150.0	Open	35,560	0.01	0.16
P-46	J-46	J-47	336.00	8.0	150.0	Open	30,480	0.00	0.14
P-47	J-47	J-48	609.00	8.0	150.0	Open	30,480	0.01	0.14
P-48	J-48	J-49	653.00	8.0	150.0	Open	10,160	0.00	0.05
P-49	J-38	J-50	411.00	8.0	150.0	Open	45,720	0.01	0.20
P-50	J-50	J-51	580.00	8.0	150.0	Open	25,400	0.00	0.11
P-51	J-32	J-52	440.00	8.0	150.0	Open	76,200	0.03	0.34
P-52	J-52	J-53	420.00	8.0	150.0	Open	71,120	0.02	0.32
P-53	J-53	J-54	31.00	8.0	150.0	Open	55,880	0.00	0.25
P-54	J-54	J-55	747.00	8.0	150.0	Open	50,800	0.02	0.23
P-55	J-55	J-56	341.00	8.0	150.0	Open	35,560	0.01	0.16
P-56	J-56	J-57	761.00	8.0	150.0	Open	25,400	0.01	0.11
P-57	J-9	J-58	152.00	12.0	150.0	Open	96,520	0.00	0.19
P-58	J-58	J-10	540.00	12.0	150.0	Open	86,360	0.01	0.17
P-59	J-6	J-59	489.00	12.0	150.0	Open	116,840	0.01	0.23

Scenario: Base
Extended Period Analysis: 0.00 hr / 24.00
Pipe Report

Label	From Node	To Node	Length (ft)	Diameter (in)	Hazen-Williams C	Control Status	Discharge (gpd)	Pressure Pipe Headloss (ft)	Velocity (ft/s)
P-60	J-59	J-7	329.00	12.0	150.0	Open	111,760	0.01	0.22
P-62	J-38	J-60	644.00	8.0	150.0	Open	105,240	0.07	0.47
P-63	J-15	J-17	490.00	8.0	150.0	Open	15,240	0.00	0.07

Scenario: Base
Extended Period Analysis: 0.00 hr / 24.00
Reservoir Report

Label	Elevation (ft)	Zone	Inflow (gpd)	Calculated Hydraulic Grade (ft)
500-FT	500.00	Zone-Upper	-127,000	500.00
310-FT	310.00	Zone-Lower	-356,160	310.00

Scenario: Base
Extended Period Analysis: 0.00 hr / 24.00
Junction Report

Label	Elevation (ft)	Type	Zone	Base Flow (gpd)	Pattern	Demand (Calculated) (gpd)	Calculated Hydraulic Grade (ft)	Pressure (psi)
J-5	400.00	Demand	Zone-Upper	0	Max Day + F.F.	0	499.76	43.16
J-6	324.00	Demand	Zone-Upper	18,180	Max Day + F.F.	18,180	499.36	75.87
J-7	328.00	Demand	Zone-Upper	9,090	Max Day + F.F.	9,090	497.33	73.26
J-8	305.00	Demand	Zone-Upper	9,090	Max Day + F.F.	9,090	496.63	82.91
J-9	229.00	Demand	Zone-Upper	9,090	Max Day + F.F.	9,090	495.20	115.17
J-10	180.00	Demand	Zone-Upper	0	Max Day + F.F.	0	493.57	135.67
J-11	171.00	Demand	Zone-Upper	9,090	Max Day + F.F.	9,090	493.31	139.45
J-12	180.00	Demand	Zone-Upper	0	Max Day + F.F.	0	493.29	135.54
J-13	207.00	Demand	Zone-Upper	9,090	Max Day + F.F.	9,090	493.27	123.86
J-14	233.00	Demand	Zone-Upper	9,090	Max Day + F.F.	9,090	493.25	112.60
J-15	207.00	Demand	Zone-Upper	9,090	Max Day + F.F.	9,090	493.23	123.84
J-17	264.00	Demand	Zone-Upper	27,270	Max Day + F.F.	27,270	493.22	99.17
J-18	199.00	Demand	Zone-Upper	9,090	Max Day + F.F.	9,090	493.23	127.30
J-19	209.00	Demand	Zone-Upper	9,090	Max Day + F.F.	9,090	493.24	122.98
J-20	261.00	Demand	Zone-Upper	9,090	Max Day + F.F.	9,090	493.28	100.50
J-21	299.00	Demand	Zone-Upper	9,090	Max Day + F.F.	9,090	493.28	84.06
J-22	45.00	Demand	Zone-Upper	0	Max Day + F.F.	0	453.84	176.89
J-23	200.00	Demand	Zone-Upper	0	Max Day + F.F.	0	407.98	89.98
J-24	235.00	Demand	Zone-Upper	9,090	Max Day + F.F.	9,090	403.15	72.75
J-25	266.00	Demand	Zone-Upper	9,090	Max Day + F.F.	9,090	397.83	57.04
J-26	282.00	Demand	Zone-Upper	9,090	Max Day + F.F.	9,090	392.19	47.67
J-27	283.00	Demand	Zone-Upper	1,449,090	Composite	1,449,090	391.45	46.92
J-28	137.00	Demand	Zone-Upper	18,180	Max Day + F.F.	18,180	407.98	117.24
J-30	308.00	Demand	Zone-Lower	0	Max Day + F.F.	0	308.92	0.40
J-31	306.00	Demand	Zone-Lower	0	Max Day + F.F.	0	308.47	1.07
J-32	180.00	Demand	Zone-Lower	0	Max Day + F.F.	0	303.58	53.47
J-33	153.00	Demand	Zone-Lower	18,180	Max Day + F.F.	18,180	303.14	64.96
J-34	109.00	Demand	Zone-Lower	9,090	Max Day + F.F.	9,090	299.61	82.47
J-35	102.00	Demand	Zone-Lower	18,180	Max Day + F.F.	18,180	295.56	83.74
J-36	90.00	Demand	Zone-Lower	9,090	Max Day + F.F.	9,090	288.84	86.03
J-37	79.00	Demand	Zone-Lower	9,090	Max Day + F.F.	9,090	282.51	88.05
J-38	45.00	Demand	Zone-Lower	0	Max Day + F.F.	0	267.50	96.27
J-39	52.00	Demand	Zone-Lower	27,270	Max Day + F.F.	27,270	261.96	90.84
J-40	57.00	Demand	Zone-Lower	9,090	Max Day + F.F.	9,090	256.40	86.27
J-41	58.00	Demand	Zone-Lower	9,090	Max Day + F.F.	9,090	254.69	85.10
J-42	83.00	Demand	Zone-Lower	9,090	Max Day + F.F.	9,090	247.29	71.08
J-43	87.00	Demand	Zone-Lower	18,180	Max Day + F.F.	18,180	244.76	68.26
J-44	90.00	Demand	Zone-Lower	18,180	Max Day + F.F.	18,180	235.15	62.80
J-45	110.00	Demand	Zone-Lower	12,090	Max Day + F.F.	12,090	230.62	52.19
J-46	172.00	Demand	Zone-Lower	9,090	Max Day + F.F.	9,090	223.47	22.27
J-47	200.00	Demand	Zone-Lower	0	Max Day + F.F.	0	218.43	7.97
J-48	163.00	Demand	Zone-Lower	1,476,360	Composite	1,476,360	209.28	20.02
J-49	116.00	Demand	Zone-Lower	18,180	Max Day + F.F.	18,180	209.28	40.36
J-50	42.00	Demand	Zone-Lower	36,360	Max Day + F.F.	36,360	267.47	97.55
J-51	28.00	Demand	Zone-Lower	45,450	Max Day + F.F.	45,450	267.46	103.60
J-52	110.00	Demand	Zone-Lower	9,090	Max Day + F.F.	9,090	303.50	83.72
J-53	119.00	Demand	Zone-Lower	27,270	Max Day + F.F.	27,270	303.43	79.80
J-54	120.00	Demand	Zone-Lower	9,090	Max Day + F.F.	9,090	303.43	79.36
J-55	135.00	Demand	Zone-Lower	27,270	Max Day + F.F.	27,270	303.37	72.84
J-56	146.00	Demand	Zone-Lower	18,180	Max Day + F.F.	18,180	303.35	68.08
J-57	181.00	Demand	Zone-Lower	45,450	Max Day + F.F.	45,450	303.34	52.93
J-58	207.00	Demand	Zone-Upper	18,180	Max Day + F.F.	18,180	494.83	124.53

Scenario: Base
Extended Period Analysis: 0.00 hr / 24.00
Junction Report

Label	Elevation (ft)	Type	Zone	Base Flow (gpd)	Pattern	Demand (Calculated) (gpd)	Calculated Hydraulic Grade (ft)	Pressure (psi)
J-59	328.00	Demand	Zone-Upper	9,090	Max Day + F.F.	9,090	498.14	73.61
J-60	24.00	Demand	Zone-Lower	162,270	Max Day + F.F.	162,270	267.34	105.28

Scenario: Base
Extended Period Analysis: 0.00 hr / 24.00
Pipe Report

Label	From Node	To Node	Length (ft)	Diameter (in)	Hazen-Williams C	Control Status	Discharge (gpd)	Pressure Pipe Headloss (ft)	Velocity (ft/s)
P-3	500-FT	J-5	96.00	12.0	150.0	Open	1,667,250	0.24	3.28
P-4	J-5	J-6	153.00	12.0	150.0	Open	1,667,250	0.39	3.28
P-6	J-7	J-8	284.00	12.0	150.0	Open	1,630,890	0.70	3.21
P-7	J-8	J-9	592.00	12.0	150.0	Open	1,621,800	1.43	3.19
P-9	J-10	J-11	2,593.00	8.0	150.0	Open	99,990	0.26	0.44
P-10	J-11	J-12	224.00	8.0	150.0	Open	90,900	0.02	0.40
P-11	J-12	J-13	288.00	8.0	150.0	Open	72,720	0.02	0.32
P-12	J-13	J-14	583.00	8.0	150.0	Open	63,630	0.03	0.28
P-17	J-18	J-15	159.00	8.0	150.0	Open	36,360	0.00	0.16
P-16	J-14	J-19	236.00	8.0	150.0	Open	54,540	0.01	0.24
P-18	J-19	J-18	289.00	8.0	150.0	Open	45,450	0.01	0.20
P-19	J-12	J-20	670.00	8.0	150.0	Open	18,180	0.00	0.08
P-20	J-20	J-21	320.00	8.0	150.0	Open	9,090	0.00	0.04
P-21	J-10	J-22	2,646.00	8.0	150.0	Open	1,494,540	39.72	6.62
P-22	J-22	J-23	3,055.00	8.0	150.0	Open	1,494,540	45.86	6.62
P-23	J-23	J-24	329.00	8.0	150.0	Open	1,476,360	4.83	6.54
P-24	J-24	J-25	367.00	8.0	150.0	Open	1,467,270	5.32	6.50
P-25	J-25	J-26	393.00	8.0	150.0	Open	1,458,180	5.64	6.46
P-26	J-26	J-27	52.00	8.0	150.0	Open	1,449,090	0.74	6.42
P-27	J-23	J-28	889.00	8.0	150.0	Open	18,180	0.00	0.08
P-29	310-FT	J-30	288.00	12.0	150.0	Open	2,050,680	1.08	4.04
P-30	J-30	J-31	122.00	12.0	150.0	Open	2,050,680	0.46	4.04
P-31	J-31	J-32	1,306.00	12.0	150.0	Open	2,050,680	4.89	4.04
P-32	J-32	J-33	133.00	12.0	150.0	Open	1,914,330	0.44	3.77
P-33	J-33	J-34	1,092.00	12.0	150.0	Open	1,896,150	3.53	3.74
P-34	J-34	J-35	175.00	8.0	150.0	Open	1,887,060	4.05	8.36
P-35	J-35	J-36	296.00	8.0	150.0	Open	1,868,880	6.72	8.28
P-36	J-36	J-37	281.00	8.0	150.0	Open	1,859,790	6.32	8.24
P-37	J-37	J-38	673.00	8.0	150.0	Open	1,850,700	15.01	8.20
P-38	J-38	J-39	323.00	8.0	150.0	Open	1,606,620	5.54	7.12
P-39	J-39	J-40	334.00	8.0	150.0	Open	1,579,350	5.55	7.00
P-40	J-40	J-41	104.00	8.0	150.0	Open	1,570,260	1.71	6.96
P-41	J-41	J-42	455.00	8.0	150.0	Open	1,561,170	7.41	6.92
P-42	J-42	J-43	157.00	8.0	150.0	Open	1,552,080	2.53	6.88
P-43	J-43	J-44	610.00	8.0	150.0	Open	1,533,900	9.61	6.80
P-44	J-44	J-45	294.00	8.0	150.0	Open	1,515,720	4.53	6.72
P-45	J-45	J-46	471.00	8.0	150.0	Open	1,503,630	7.15	6.66
P-46	J-46	J-47	336.00	8.0	150.0	Open	1,494,540	5.04	6.62
P-47	J-47	J-48	609.00	8.0	150.0	Open	1,494,540	9.14	6.62
P-48	J-48	J-49	653.00	8.0	150.0	Open	18,180	0.00	0.08
P-49	J-38	J-50	411.00	8.0	150.0	Open	81,810	0.03	0.36
P-50	J-50	J-51	580.00	8.0	150.0	Open	45,450	0.01	0.20
P-51	J-32	J-52	440.00	8.0	150.0	Open	136,350	0.08	0.60
P-52	J-52	J-53	420.00	8.0	150.0	Open	127,260	0.07	0.56
P-53	J-53	J-54	31.00	8.0	150.0	Open	99,990	0.00	0.44
P-54	J-54	J-55	747.00	8.0	150.0	Open	90,900	0.06	0.40
P-55	J-55	J-56	341.00	8.0	150.0	Open	63,630	0.01	0.28
P-56	J-56	J-57	761.00	8.0	150.0	Open	45,450	0.02	0.20
P-57	J-9	J-58	152.00	12.0	150.0	Open	1,612,710	0.36	3.18
P-58	J-58	J-10	540.00	12.0	150.0	Open	1,594,530	1.27	3.14
P-59	J-6	J-59	489.00	12.0	150.0	Open	1,649,070	1.22	3.25

Scenario: Base
Extended Period Analysis: 0.00 hr / 24.00
Pipe Report

Label	From Node	To Node	Length (ft)	Diameter (in)	Hazen-Williams C	Control Status	Discharge (gpd)	Pressure Pipe Headloss (ft)	Velocity (ft/s)
P-60	J-59	J-7	329.00	12.0	150.0	Open	1,639,980	0.81	3.23
P-62	J-38	J-60	644.00	8.0	150.0	Open	162,270	0.16	0.72
P-63	J-15	J-17	490.00	8.0	150.0	Open	27,270	0.00	0.12

Scenario: Base
Extended Period Analysis: 0.00 hr / 24.00
Reservoir Report

Label	Elevation (ft)	Zone	Inflow (gpd)	Calculated Hydraulic Grade (ft)
500-FT	500.00	Zone-Upper	-1,667,250	500.00
310-FT	310.00	Zone-Lower	-2,050,680	310.00

Scenario: Base
Extended Period Analysis: 0.00 hr / 24.00
Junction Report

Label	Elevation (ft)	Type	Zone	Base Flow (gpd)	Pattern	Demand (Calculated) (gpd)	Calculated Hydraulic Grade (ft)	Pressure (psi)
J-5	400.00	Demand	Zone-Upper	0	Peak	0	499.99	43.26
J-6	324.00	Demand	Zone-Upper	19,680	Peak	19,680	499.98	76.14
J-7	328.00	Demand	Zone-Upper	9,840	Peak	9,840	499.93	74.39
J-8	305.00	Demand	Zone-Upper	9,840	Peak	9,840	499.92	84.33
J-9	229.00	Demand	Zone-Upper	9,840	Peak	9,840	499.89	117.20
J-10	180.00	Demand	Zone-Upper	0	Peak	0	499.86	138.39
J-11	171.00	Demand	Zone-Upper	9,840	Peak	9,840	499.56	142.15
J-12	180.00	Demand	Zone-Upper	0	Peak	0	499.54	138.25
J-13	207.00	Demand	Zone-Upper	9,840	Peak	9,840	499.52	128.56
J-14	233.00	Demand	Zone-Upper	9,840	Peak	9,840	499.49	115.30
J-15	207.00	Demand	Zone-Upper	9,840	Peak	9,840	499.47	126.54
J-17	264.00	Demand	Zone-Upper	29,520	Peak	29,520	499.47	101.87
J-18	199.00	Demand	Zone-Upper	9,840	Peak	9,840	499.47	130.00
J-19	209.00	Demand	Zone-Upper	9,840	Peak	9,840	499.48	125.68
J-20	261.00	Demand	Zone-Upper	9,840	Peak	9,840	499.54	103.20
J-21	299.00	Demand	Zone-Upper	9,840	Peak	9,840	499.53	86.76
J-22	45.00	Demand	Zone-Upper	0	Peak	0	499.76	196.75
J-23	200.00	Demand	Zone-Upper	0	Peak	0	499.65	129.64
J-24	235.00	Demand	Zone-Upper	9,840	Peak	9,840	499.64	114.50
J-25	266.00	Demand	Zone-Upper	9,840	Peak	9,840	499.64	101.08
J-26	282.00	Demand	Zone-Upper	9,840	Peak	9,840	499.63	94.16
J-27	283.00	Demand	Zone-Upper	9,840	Peak	9,840	499.63	93.73
J-28	137.00	Demand	Zone-Upper	19,680	Peak	19,680	499.64	156.90
J-30	308.00	Demand	Zone-Lower	0	Peak	0	309.82	0.79
J-31	306.00	Demand	Zone-Lower	0	Peak	0	309.74	1.62
J-32	180.00	Demand	Zone-Lower	0	Peak	0	308.91	55.77
J-33	153.00	Demand	Zone-Lower	19,680	Peak	19,680	308.85	67.43
J-34	109.00	Demand	Zone-Lower	9,840	Peak	9,840	308.40	86.27
J-35	102.00	Demand	Zone-Lower	19,680	Peak	19,680	307.90	89.08
J-36	90.00	Demand	Zone-Lower	9,840	Peak	9,840	307.11	93.93
J-37	79.00	Demand	Zone-Lower	9,840	Peak	9,840	306.37	98.37
J-38	45.00	Demand	Zone-Lower	0	Peak	0	304.67	112.35
J-39	52.00	Demand	Zone-Lower	29,520	Peak	29,520	304.57	109.28
J-40	57.00	Demand	Zone-Lower	9,840	Peak	9,840	304.50	107.08
J-41	58.00	Demand	Zone-Lower	9,840	Peak	9,840	304.48	106.64
J-42	83.00	Demand	Zone-Lower	9,840	Peak	9,840	304.40	95.79
J-43	87.00	Demand	Zone-Lower	19,680	Peak	19,680	304.36	94.05
J-44	90.00	Demand	Zone-Lower	19,680	Peak	19,680	304.31	92.72
J-45	110.00	Demand	Zone-Lower	15,840	Peak	15,840	304.29	84.06
J-46	172.00	Demand	Zone-Lower	9,840	Peak	9,840	304.26	57.22
J-47	200.00	Demand	Zone-Lower	0	Peak	0	304.25	45.10
J-48	163.00	Demand	Zone-Lower	39,360	Peak	39,360	304.23	61.10
J-49	116.00	Demand	Zone-Lower	19,680	Peak	19,680	304.23	81.44
J-50	42.00	Demand	Zone-Lower	39,360	Peak	39,360	304.64	113.63
J-51	28.00	Demand	Zone-Lower	49,200	Peak	49,200	304.62	119.68
J-52	110.00	Demand	Zone-Lower	9,840	Peak	9,840	308.82	86.02
J-53	119.00	Demand	Zone-Lower	29,520	Peak	29,520	308.74	82.09
J-54	120.00	Demand	Zone-Lower	9,840	Peak	9,840	308.74	81.66
J-55	135.00	Demand	Zone-Lower	29,520	Peak	29,520	308.67	75.14
J-56	146.00	Demand	Zone-Lower	19,680	Peak	19,680	308.65	70.37
J-57	181.00	Demand	Zone-Lower	49,200	Peak	49,200	308.63	55.22
J-58	207.00	Demand	Zone-Upper	19,680	Peak	19,680	499.86	126.72

Scenario: Base
Extended Period Analysis: 0.00 hr / 24.00
Junction Report

Label	Elevation (ft)	Type	Zone	Base Flow (gpd)	Pattern	Demand (Calculated) (gpd)	Calculated Hydraulic Grade (ft)	Pressure (psi)
J-59	328.00	Demand	Zone-Upper	9,840	Peak	9,840	499.95	74.39
J-60	24.00	Demand	Zone-Lower	299,520	Peak	299,520	304.18	121.22

Scenario: Base
Extended Period Analysis: 0.00 hr / 24.00
Pipe Report

Label	From Node	To Node	Length (ft)	Diameter (in)	Hazen-Williams C	Control Status	Discharge (gpd)	Pressure Pipe Headloss (ft)	Velocity (ft/s)
P-3	500-FT	J-5	96.00	12.0	150.0	Open	246,000	0.01	0.48
P-4	J-5	J-6	153.00	12.0	150.0	Open	246,000	0.01	0.48
P-6	J-7	J-8	284.00	12.0	150.0	Open	206,640	0.02	0.41
P-7	J-8	J-9	592.00	12.0	150.0	Open	196,800	0.03	0.39
P-9	J-10	J-11	2,593.00	8.0	150.0	Open	108,240	0.30	0.48
P-10	J-11	J-12	224.00	8.0	150.0	Open	98,400	0.02	0.44
P-11	J-12	J-13	288.00	8.0	150.0	Open	78,720	0.02	0.35
P-12	J-13	J-14	583.00	8.0	150.0	Open	68,880	0.03	0.31
P-17	J-18	J-15	159.00	8.0	150.0	Open	39,360	0.00	0.17
P-16	J-14	J-19	236.00	8.0	150.0	Open	59,040	0.01	0.26
P-18	J-19	J-18	289.00	8.0	150.0	Open	49,200	0.01	0.22
P-19	J-12	J-20	670.00	8.0	150.0	Open	19,680	0.00	0.09
P-20	J-20	J-21	320.00	8.0	150.0	Open	9,840	0.00	0.04
P-21	J-10	J-22	2,646.00	8.0	150.0	Open	59,040	0.10	0.26
P-22	J-22	J-23	3,055.00	8.0	150.0	Open	59,040	0.12	0.26
P-23	J-23	J-24	329.00	8.0	150.0	Open	39,360	0.01	0.17
P-24	J-24	J-25	367.00	8.0	150.0	Open	29,520	0.00	0.13
P-25	J-25	J-26	393.00	8.0	150.0	Open	19,680	0.00	0.09
P-26	J-26	J-27	52.00	8.0	150.0	Open	9,840	0.00	0.04
P-27	J-23	J-28	889.00	8.0	150.0	Open	19,680	0.00	0.09
P-29	310-FT	J-30	288.00	12.0	150.0	Open	787,680	0.18	1.55
P-30	J-30	J-31	122.00	12.0	150.0	Open	787,680	0.08	1.55
P-31	J-31	J-32	1,306.00	12.0	150.0	Open	787,680	0.83	1.55
P-32	J-32	J-33	133.00	12.0	150.0	Open	640,080	0.06	1.26
P-33	J-33	J-34	1,092.00	12.0	150.0	Open	620,400	0.45	1.22
P-34	J-34	J-35	175.00	8.0	150.0	Open	610,560	0.50	2.71
P-35	J-35	J-36	296.00	8.0	150.0	Open	590,880	0.80	2.62
P-36	J-36	J-37	281.00	8.0	150.0	Open	581,040	0.73	2.58
P-37	J-37	J-38	673.00	8.0	150.0	Open	571,200	1.70	2.53
P-38	J-38	J-39	323.00	8.0	150.0	Open	183,120	0.10	0.81
P-39	J-39	J-40	334.00	8.0	150.0	Open	153,600	0.07	0.68
P-40	J-40	J-41	104.00	8.0	150.0	Open	143,760	0.02	0.64
P-41	J-41	J-42	455.00	8.0	150.0	Open	133,920	0.08	0.59
P-42	J-42	J-43	157.00	8.0	150.0	Open	124,080	0.02	0.55
P-43	J-43	J-44	610.00	8.0	150.0	Open	104,400	0.07	0.46
P-44	J-44	J-45	294.00	8.0	150.0	Open	84,720	0.02	0.38
P-45	J-45	J-46	471.00	8.0	150.0	Open	68,880	0.02	0.31
P-46	J-46	J-47	336.00	8.0	150.0	Open	59,040	0.01	0.26
P-47	J-47	J-48	609.00	8.0	150.0	Open	59,040	0.02	0.26
P-48	J-48	J-49	653.00	8.0	150.0	Open	19,680	0.00	0.09
P-49	J-38	J-50	411.00	8.0	150.0	Open	88,560	0.03	0.39
P-50	J-50	J-51	580.00	8.0	150.0	Open	49,200	0.02	0.22
P-51	J-32	J-52	440.00	8.0	150.0	Open	147,600	0.09	0.65
P-52	J-52	J-53	420.00	8.0	150.0	Open	137,760	0.08	0.61
P-53	J-53	J-54	31.00	8.0	150.0	Open	108,240	0.00	0.48
P-54	J-54	J-55	747.00	8.0	150.0	Open	98,400	0.07	0.44
P-55	J-55	J-56	341.00	8.0	150.0	Open	68,880	0.02	0.31
P-56	J-56	J-57	761.00	8.0	150.0	Open	49,200	0.02	0.22
P-57	J-9	J-58	152.00	12.0	150.0	Open	186,960	0.01	0.37
P-58	J-58	J-10	540.00	12.0	150.0	Open	167,280	0.02	0.33
P-59	J-6	J-59	489.00	12.0	150.0	Open	226,320	0.03	0.45

Scenario: Base
Extended Period Analysis: 0.00 hr / 24.00
Pipe Report

Label	From Node	To Node	Length (ft)	Diameter (in)	Hazen-Williams C	Control Status	Discharge (gpd)	Pressure Pipe Headloss (ft)	Velocity (ft/s)
P-60	J-59	J-7	329.00	12.0	150.0	Open	216,480	0.02	0.43
P-62	J-38	J-60	644.00	8.0	150.0	Open	299,520	0.49	1.33
P-63	J-15	J-17	490.00	8.0	150.0	Open	29,520	0.01	0.13

Scenario: Base
Extended Period Analysis: 0.00 hr / 24.00
Reservoir Report

Label	Elevation (ft)	Zone	Inflow (gpd)	Calculated Hydraulic Grade (ft)
500-FT	500.00	Zone-Upper	-246,000	500.00
310-FT	310.00	Zone-Lower	-787,680	310.00