Introduction

This report documents the nature of erosion and shoreline migration at the Barry property based on quantitative measurements and observations obtained through field inspection, aerial photography, satellite imagery, and review of the geologic literature. An additional section addressing volcanic hazards and risk was included at the request of the Property owners.

Field Inspection

John Lockwood and Jacob Smith visited the Barry property (hereafter referred to as "the Property") with Kevin and Monica Barry on June 5th, 2018, and again on August 15th and September 11th, 2018. A total of three and a half hours were spent making field observations, surveying with Brunton pocket transit and measuring tape, and obtaining site photography.

The field observations of observed water line on June 5th were taken as the tide rose from +0.9 to +.1.1 feet above the tidal datum (tidal datum for Hilo, Hilo Bay, and Kuhio Bay, HI - *http://tidesand currents.noaa.gov)*. The ocean was characterized by moderate swells (3-4 feet), which generated light surf (Figure 1). The subsequent visits were made at times of higher surf to observe the impact of larger waves. The September 11th visit coincided with the impact of 8-10' swells on the coastline cliff face fronting the Property.

Figure 1. View of coastline fronting the Property – view to south. The vegetation (naupaka) defines the shoreline ("highest reach of waves") fronting the Property, and is as close as 8' to the coastline cliff (Figure 2) at the Property's south boundary. Normal surf does not reach above the coastal cliff, but angular boulders attests to the fact that exceptionally large storms can dislodge cliff edge pahoehoe and place blocks short distances inland, and scour vegetation inland from the cliff face. The coastal bench of bare pahoehoe is as much as 30' wide at the north Property boundary.

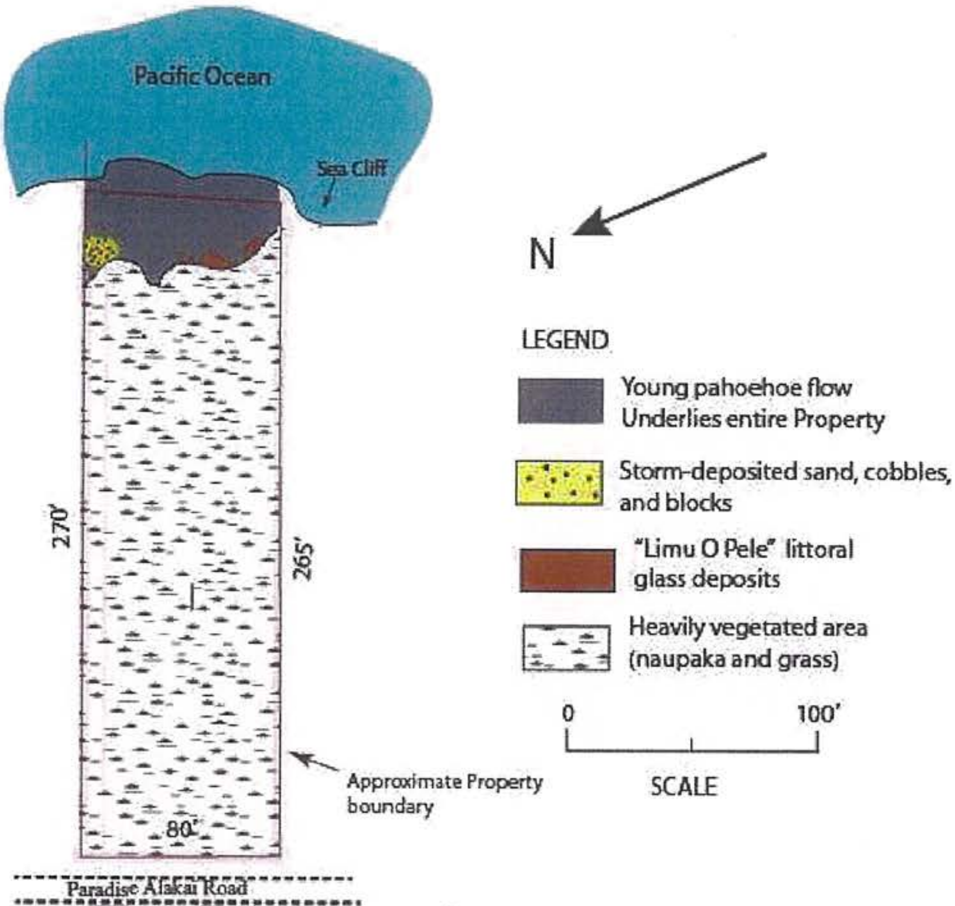

FIGURE 2. Location of Property relative to the coastline and geologic sketch map.

Geology

Lava Flow Nomenclature and Ages

According to Moore and Trusdell's (1991) geologic map of Kilauea's lower east rift zone, the lava flows underlying this area of Puna have estimated ages of 350-500 years before "present" (CE 1950), and belongs to their unit "f6a2". This unit mostly consists of dense pahoehoe lava over a wide area of Puna, extending from Kilauea Iki crater in Hawai'i Volcanoes National Park to the ocean, 20 miles away, where the flows form eight miles of the coastline (Wolfe and Morris, 1996 – their unit P4). The ages of these flows have recently been determined to be older than ages given by Moore and Trusdell, since they are everywhere overlain in Kilauea's summit region by a widespread pyroclastic ash deposit known as the "Keanakakoi Ash" (Swanson and others, 2012), which began to be deposited about 1500 CE. Recent radiocarbon dating and calibration by David Clague (MBARI, pers. communication, 2018) indicates that all of these flows (known as the 'Ai-la'āu flows – Holcomb, 1987, Clague and others, 1999) were emplaced before about 1470 CE, some as old as about 1300 CE. Because of the very young aspects of the upper lava flow at the Property (described below), I shall assign an age of about 550 years before today's date (2018 CE).

Erosion of the sea cliff fronting the Property reveals that these pahoehoe lobes overlie an older, massive, dense lava, along a sharp contact (Figure 3). This older flow could not be inspected because of dangerous surf conditions, and its origin is uncertain. It was probably erupted by an earlier phase of the same long-term ʻAi-laʻāu eruption that formed the overlying pahoehoe. The top of this underlying flow shows red oxidation (Figure 3) indicating some significant passage of time before emplacement of the overlying flow. Its age is not known, but I shall assume it erupted about 1350 CE (about 670 years ago) – one of the earliest ʻAi-la'āu flows.

Figure 3. Seacliff fronting the Property, showing the younger, overlying pahoehoe flow lobes that form the surface of the entire Property (above arrow) – view to northeast. The contact with the underlying dense, massive lava flow is marked by a red oxidized surface zone, which demonstrates substantial time elapsed between emplacement of the two flows.

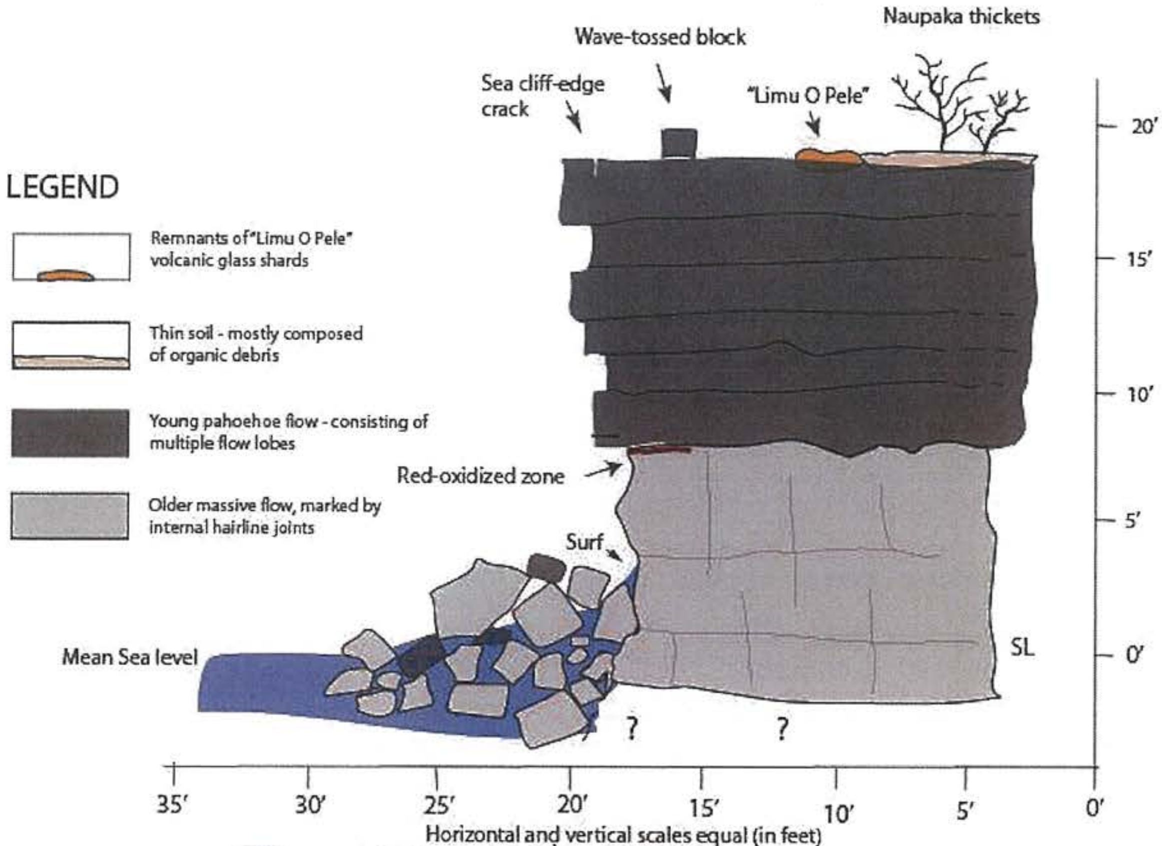

Figure 4. Geologic cross-section of typical coastal cliff fronting the Property - view to southwest.

Flow Lithology

The surface lava flow underlying the entire Property consists of multiple flow sheets of pahoehoe, all emplaced during the same eruption. These pahoehoe lava flows that form the surface of the entire Property (Figs. 1, 3) are dense, aphanitic (crystal-free) basalt typical of many of the ‘Ai-la‘āu flows that form Kaloli Point. The very fine-grained matrix "sparkles" with fine crystallites – probably consisting of plagioclase and clinopyroxene. Thick black glass marks some flow surfaces, especially inland of the naupaka-defined shoreline. Some of this glass is up to almost ½' in thickness – suggesting that it may have been quenched by either heavy rainfall or surf splashing.

Flow Internal Structures

The overlying pahoehoe flow consists of 5-8 individual flow sheets where exposed along the shoreline cliff (Figures 3, 4). Each one of these flow lobes erupted during the same eruption, but probably over an interval of only a few weeks or months. Individual flow lobes have black glassy surfaces at both tops and bottoms to half-inch thicknesses, but have nearly aphanitic (no large crystals) interiors where the lava cooled more slowly. A fine sparkly texture in the interiors reveal microlites of probable olivine and clinopyroxene. Abundant vesicles are rounded to sub-rounded throughout the lobes, attesting to the highly fluid nature of this pahoehoe when emplaced. The pahoehoe flow appears to be too thin to contain pyroducts ("lava tubes") beneath the Property, but about 100 yards to the south-southeast, where the flow is thicker, a probable pyroduct extending inland at the head of an embayment was noted.

Although the dense lava flow underlying the surface pahoehoe could not be inspected directly, it consists of a single thick, dense flow of unknown thickness. The sections exposed at the sea cliff consist of very dense, erosion resistant "blue rock" in the normal wave impact zone (Figure 3). Angular blocks of this unit at the foot of the sea cliff indicate the presence of very fine fracture joints that control block failure (following section).

Younger Deposits

The uppermost pahoehoe flow is overlain by three types of sedimentary deposits – coeval remnants of fragmental volcanic glass debris, scattered patches of cobbles, gravel and sand that have been deposited by exceptional storm wave activity, and a colluvial, organic rich soil found inland beneath vegetation.

Discontinuous deposits of volcanic glass fragments in deposits up to three inches in thickness are found in grass-covered pockets just makai of the naupaka-defined shoreline. These deposits consist of a unique material called "limu o Pele" (Mattox and Mangan, 1997), and were formed by the explosive interaction of seawater and fluid pahoehoe when the underlying flow entered the ocean 300-500 years ago. The rapid expansion of steam entering molten lava formed large "lava bubbles", which formed thin sheets of glass and fine particles as they exploded (Figure 5).

Figure 5. Bursting bubble of molten lava where seawater interacted explosively with fluid pahoehoe lava entering the sea along Kilauea's south coast during a 1990's eruption. Such explosions form the windborn fragmental debris uncommonly preserved on the Property as "limu O Pele". Photograph supplied by Tari Mattox, but photographer unknown.

The limu o Pele deposits consist of sedimentary remnants of pure volcanic glass that were once apparently widespread above the upper pahoehoe flow. They consist entirely of medium to coarse sand-size, glass fragments, and would have been scoured away by storm waves long ago if they were not protected by dense mats of an unidentified, presumably native grass whose rootlets permeate and stabilize the underlying loose glass fragments (Figures 6, 7). These deposits indicate that the original coastline when the underlying flows were emplaced could not have been too much farther seaward.

Scattered cobbles are widespread above the surface pahoehoe (note a few in Figure 6), and have accumulated to nearly a foot depth in one small area along the Property's northwest boundary (Figures 2, 8). These unconsolidated sediments are partially vegetated, and are only deposited or moved about by very infrequent storm waves that have over-topped the sea cliff in this area. On most of the vegetated areas of the Property, the pahoehoe flow is overlain by a discontinuous soil zone up to five inches thickness, consisting mostly of organic debris intermixed with very minor amounts fine silt- and clay-size mineral material, likely derived from the accumulation of windblown dust.

Figure 6. Limu O Pele deposit preserved 10' inland from cliff edge. These deposits, preserved by storm wave erosion by overlying grass mats, consist of sand-size volcanic glass fragments, and were formed by the explosive interaction of the underlying fluid lava with seawater. Their presence indicates that the original coastline when the underlying flows were emplaced could not have been too much farther seaward.

Figure 7. Limu O Pele deposit detail. Fragments consist entirely of fresh, brown volcanic glass fragments up to 1 mm diameter. Note the grass rootlets that permeate the deposit. Thinner glass films common in modern limu O Pele deposits have apparently been dissolved away, leaving only coarser fragments behind.

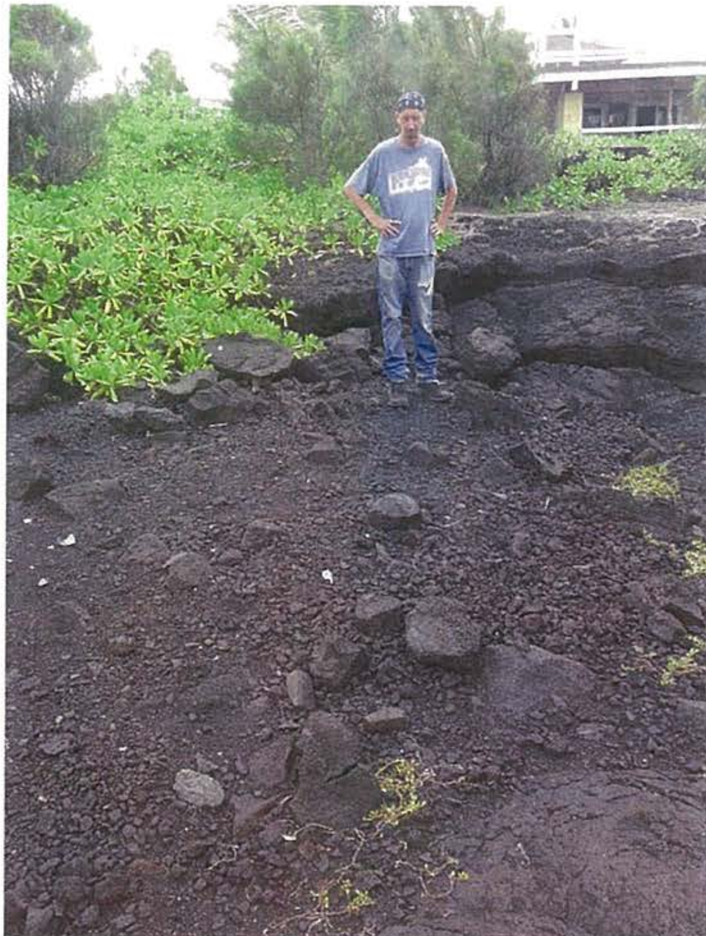

Figure 8. Small area of storm wave-deposited cobbles, gravel, and sand along the northwest-most boundary of the Property.

In summary, the two relatively young, prehistoric lava flows underlying the Property are of typical Kilauea compositions, and were erupted from Kilauea's summit area 500-700 years ago. They were not derived from Kilauea's recently active East Rift Zone, nor is the Property threatened by future eruptions from that rift. Sparse deposits of volcanic glassy debris found near the shoreline show that the original coastline was not located far offshore from its present position, and place limits on the amount of coastal erosion that has occurred since flow emplacement.

Shoreline Findings

The shoreline is legally defined in Hawai'i as "*the upper reaches of the wash of the waves, other than storm and seismic waves, at high tide during the season of the year in which the highest wash of the waves occurs, usually evidenced by the edge of vegetation growth, or the* *upper limit of debris left by the wash of the waves . . . .*" (HAR §13-5-2). In this case the shoreline has been assumed to be the edge of vegetation growth (Figures 1-3), which also coincides with the most mauka impact of storm waves. The vegetation-defined shoreline lies 8-30' back from the sea cliff makai of the Property boundary.

The vegetation inland from this shoreline is dense coastal naupaka (*Scaevola taccada)* with some minor young ironwood (*Casuarina equisetifolia*) scattered about. Ironwoods are fast-growing alien species that can block viewscapes and eliminate native vegetation – they should be uprooted and destroyed wherever found. The naupaka ("naupaka kahakai") grows everywhere on the Property inland from the shoreline, and is underlain by unconsolidated soil, which indicates no erosion is taking place mauka of the shoreline. Along the front of the Property there is no "debris line" that would mark the shoreline as along the sandy beaches on older islands such as Oahu and Kauai.

Over the very long-term (since the emplacement of the lava flow underlying the property about 550 years ago) coastal erosion has caused the shoreline to migrate mauka, but the present low erosion rate (discussed below) has limited this migration and it does not threaten the safety or integrity of the Property.

Erosion Processes

The sea cliff fronting the Property is resistant to erosion, and negligible erosion occurs during normal sea conditions. During times of major storms, however, the impact of waves can cause some mechanical and abrasional erosion, although even this is likely rare. Cracks near the edge of the sea cliff in several places (Figure 9) indicate where the cliff edge is unstable, and susceptible to failure when impacted by powerful storm waves. A few scattered blocks of angular pahoehoe up to two feet diameter were noted above the coastal plain and as much as ten feet inboard of the shoreline (Fig. 1). These were formed when powerful waves impacted the top of the sea cliff, injected high-pressure water into the contacts between flow lobes, and through the process of "hydraulic ramming" loosened blocks and moved them short distances inland.

Figure 9. Extension cracks present at the Property's coastal cliff edge. These cracks, which are common along this stretch of coastline, develop as stresses are relieved at the cliff face, and contribute to the susceptibility of this upper pahoehoe flow to rare storm waves that impact the cliff face and force sea water into the horizontal contacts between flow lobes.

The dense lava underlying the pahoehoe flows is highly resistant to wave impact forces, but also has internal joint fracture planes that can be exploited by the impact of particularly powerful waves. This type of mechanical erosion is rare, but can occur, as indicated by the presence of very large (up to five feet diameter) angular, subangular, and sub-rounded blocks found at the base of the sea cliff fronting the Property (Figures 3, 10).

These erosional processes are normal for the storm-wave exposed rocky coastlines of Puna, and are of no particular concern for this Property over the short-term (the next several decades).

Figure 10. Detailed view of eroded blocks at the base of the coastline cliff. Most of the blocks have slightly subrounded edges, indicating abrasion by surf action. The large block marked with an "X" is about three feet in diameter, with uniformly angular edges, and must have fallen within the past few years – long ago enough to be covered with marine algae. These large blocks serve to block and attenuate the force of impacting waves – forming protection from erosion.

Erosion Rate

A rigorously quantitative approximation of the shoreline erosion rate at the Property is not statistically feasible using the methods outlined by Hwang (2005) because of the relatively low rates of erosion and the inadequacy of available high-resolution aerial photography. Shoreline determinations must rely upon alternative indicators – primarily observation of active erosion of the coastal sea cliff makai of the shoreline – and factors such as freshly cut cliff faces or presence of angular erosional debris as discussed above. Shoreline erosion is, however, not a continuous process that can be characterized by simple "erosion rates". Mechanical erosion of the coastline is episodic, related to the uncommon impact of especially strong storm activity.

One perspective can be derived from estimates of the coastal erosion that has taken place since the emplacement of these lava flows. The uppermost pahoehoe flow has been eroded back since emplacement an estimated 550 years ago, but the distance eroded is not precisely quantifiable. The presence of littoral explosion-derived limu O Pele above the pahoehoe shelf suggests the original coastline was not far away. I assume that the coastline was 100' away at the time of flow emplacement (this estimate is based on observations of historical limu o Pele deposits associated with recent pahoehoe ocean entries associated with the Pu'u O'o eruption – Mattox and Mangan, 1997). Such an assumption would imply an overall erosion rate of 0.18 feet, or 2.2 inches/year over the past 550 years.

Careful inspection of available aerial photographs (Table 1) to measure coastline positions relative to internal fixed distances (between roads) provides another erosion rate. These photos indicate that slight erosion of the coastline (coastal sea-cliff) has occurred since the earliest 1954 photos, but migration of the shoreline (vegetation line) is not measureable. The large scale and limited resolution of the available aerial photographs makes precise analyses of fine-scale morphological changes of the shoreline or sea-cliff impossible, but a trend is apparent (Table 2).

Date	Agency	Flight Line	Frames
1954	USN-USGS	017	1755, 1756
1961	USGS	GS-VSJ 6	155, 56
1965	USDA	EKL-11CC	198, 199
1977	USGS	GS-VEEC 6	119, 120
2017	Google Earth	16 March, 2017 image	----

Table 1. Available aerial photography.

Differences in tidal level and surf conditions at the times individual photography was obtained also contributes to the lack of precision. It is thus doubtful that horizontal changes of less than 10 feet could be documented, although greater changes should be apparent, especially when the morphology of prominent coastal features change with time. So far as migration of the shoreline, there are no resources to evaluate the migration of the vegetation that defines the shoreline, but dead naupaka roots near the coastline suggests that this vegetative marker migrates with time in response to climatic as well as storm wave impacts.

Analyses of coastline migration yield erosion rates varying from 1.5-5.5 inches/year (Table 2) with an average erosion rate of the coastline cliff at 3.0 inches/year. This compares favorably with the less rigorous rate of 2.2 inches/year described above. Such rates are very low compared to the rapid rates of sandy beach shoreline erosion that can occur when impacted by severe storms on the older, low-lying islands of Maui, Oahu and Kauai (up to 20 feet in a single storm – Hwang, 2005).

Time interval	Road-→ Coastline Distance (ft)	Change since Aerial photo (ft)	Years elapsed	Indicated erosion (inches/year)
1954-→2017	286'	-12'	63	2.3"
1961-→2017	280'	-06'	56	1.3"
1965-→2017	299'	-24'	52	5.5"
2017	274'	----	----	
			Average erosion rate:	3.0"/year

Table 2. Coastal erosion estimates based on analyses of historical aerial photography between different photo sets. The differing erosion rates (Column 5) reflect measurement uncertainties related to low photograph resolution.

Effects of Subsidence and Sea Level Rise (SLR) on Shoreline

Hwang et al (2007) use a figure of .16 in/yr in their assessments of present-day SLR for Oahu, but an overall global rise in sea level of 3.3 feet by the end of the 21st century has been proposed by Fletcher (2010) and implies higher, increasing rates. SLR for any particular area depends heavily on local factors (water temperatures, ocean currents, salinity, etc.). Anderson and others (2015) predict a doubling of SLR rates for Hawai'i within 30 years.

Relative SLR, of course, is a result of the combined water rise and land subsidence. The Big Island of Hawai'i is sinking into the Earth's mantle because of the gravitational, isostaic load of it's growing volcanoes. A subsidence rate of 2-3 mm/year (0.08-0.12 inches/year) related to isostatic sinking has been determined by submersible studies of drowned reefs off west Hawai'i (Moore and Fornari, 1984), but that rate is higher for the Puna coastline, where volcanic loading activity is greater. Coastline subsidence can be accelerated by sudden events such as the 1975 Kalapana earthquake that caused land in Kapoho to drop 0.8 feet (based on Hawai'i Volcano Observatory (USGS) data in Hwang *et al.* 2007). Such *episodic* seismic induced subsistence is difficult to anticipate or measure over long periods of time. On the basis of InSAR (Synthetic Aperture Radar Interferometry) remote sensing data, Hwang et al (*ibid.*) state that the coastline at Kapoho may be subsiding at a *continuous* rate of between .31 – .67 in/yr. Rates of subsidence at the Property, 11 miles to the northwest of the East Rift Zone, are necessarily much lower as a result of their distance from Kilauea's active rift zone.

The combined effects of land subsidence and rising sea levels suggests an overall (relative) drop in the shoreline elevation relative to sea level of between 0.2 - 0.3 in/yr. The high cliff fronting the Property mitigates the impact of Sea Level Change, a major concern for low-lying coastlines elsewhere in the State. The durability and height of this cliff shows that SLR and land subsidence will not cause significant shoreline transgression in this area, although it will slowly increase the erosive action of storm waves over the next several decades and centuries.

General Coastal Zone Hazards and Risks

Hwang (2005) recommends that all hazards facing coastal areas should be considered when planning for land-use zoning in Hawai'i, and not just erosion. Fletcher *et al.* (2002) portray generalized hazards assessments for long areas of Hawai'i's coastlines, and rate the specific hazards for the area of Puna fronting the Property as shown in Column B of the following Table:

Hazard Type **A**	**Relative Threat (Risk)** **B**	**GCI-determined Relative Threat** **C**
Tsunami	High	Medium
Stream Flooding	Medium-high	Low
High Waves	Medium-high	Medium-High
Storms	High	Medium
Erosion	Medium-low	Medium-Low
Sea Level Change	Medium-high	Low
Volcanic/Seismic	High	Medium
Overall Hazard Assessment	Medium	Medium

Table 3. Natural hazards impacting the coastline fronting the Property (Columns A and B from Fletcher et al., 2002, p.150; Column C from this study).

The values assigned by Fletcher et al (Column B) are highly generalized for long stretches of Puna coastlines. The risk appraisals for the Property that we determined (Column C), differ in some regards from Fletcher et al.'s values (we indicate less risk) because our values are site-specific for the coast fronting the Property. The terms High,. Medium, and Low are subjective, however, and are only intended to convey relative risk as compared to other Hawaiian coastal areas reviewed by Fletcher in his State-wide Atlas.

Volcanic Hazards and Risks

Volcanic hazards are the natural phenomena that <u>could</u> pose a threat to property on or near volcanoes; *Volcanic risk* describes the statistical odds that a particular hazard <u>will</u> impact a particular area.

<u>Volcanic Hazards</u>

The volcanic hazards that could potentially impact the flanks of Kilauea volcano include the following:

a) Lava flow inundation
b) Explosive activity and ash deposition
c) Gas emissions
d) Volcano-related seismic activity

Only the first hazard (lava flow inundation) poses any potentail risk to the Property, and that risk is deemed to be relatively low. The Property is too far from the loci of potential future eruptions (either at the Kilauea summit or along its rift zones) to ever be impacted by significant ash fall. Future gas eruptions at the summit or East Rift Zone could impact the area with Sulphur aerosols during rare wind conditions, but gas levels will be at nuisance levels and of short duration. Major earthquakes will impact the Property in the future, but these will be caused by tectonic forces only indirectly related to Kilauea volcanic activity. Future structures on the Property should be built with strong foundations as mandated by present and future Hawai'i County building codes.

Volcanic Risk

The Property, although located on young lava flows from Kilauea volcano, is located in an area of relatively low volcanic risk. The Property is located entirely in Lava Hazard Zone 3 (Wright and others, 1992). Zone 3 is the same Lava Hazard Zone as Hilo.

The entire East Rift Zone of Kilauea (ERZ) is located in hazard Zones 1 or 2, because those areas are either within or downslope from potential ERZ eruptive vents. All of the recent 2018 tragic property losses on the lower ERZ were confined to Zones 1 and 2.

The Property is not subject to lava inundation from Kilauea's middle or lower East Rift Zone, as that eruptive zone is located ten miles to the south, and does not present any threat (Figure 11). As has been discussed above, the lavas underlying the Property were emplaced during the brief life of the 'Ai-la'āu shield, a satellite on the east margin of Kilauea caldera that erupted between about CE 1350 and 1470 (Holcomb, 1987). It would be unprecedented for another eruptive vent to open on this extinct marginal shield in this same area, and the high ground of the shield itself forms a high barrier to prevent any overflows from Kilauea volcano to the east.

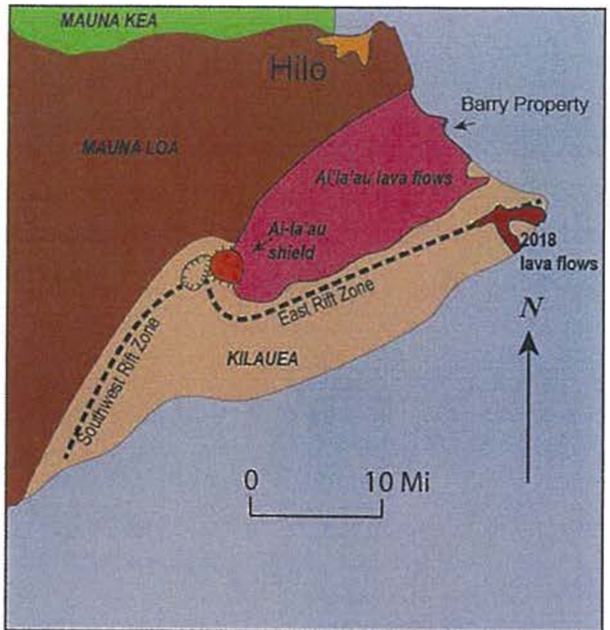

Figure 11. Relationship of the Property to Hawai'i volcanoes, to Kilauea's East Rift Zone, and to the destructive lava flows of 2018.

The risk of lava flow inundation is generally expressed in statistical terms – i.e. "*What are the odds that my Property could be buried by a future lava flow over certain future periods of time?*" This depends on determining a "recurrence interval" for previous lava flows in the area. Although the 'Ai-la'āu eruption probably involved near-continuous eruptive activity for 100 years or so, numerous individual separate lava flows were erupted, much like those that occurred during the 1983-2018 Kilauea eruptions on the middle ERZ. Only two of these 'Ai-la'āu flows have been identified beneath the Property, with estimated ages of about 1350 and 1470 CE, or about 669 and 549 years before the present date (2019). Assuming those ages are more or less correct, that shows two eruptions affecting the Property in 668 years, for a recurrence interval of one eruption every 334 years. If one then makes the assumption that past eruptions were, and future eruptions will be distributed randomly (stochastically) in time, then a simple Poisson Analysis could be used for statistical probabilities of future eruptions. The statistical probability (P) that a lava flow will occur over certain time periods in the future is derived from the following formula (discussed in Lockwood and Hazlett, 2010, pp.427-429):

$$P = 100\,(1 - e^{-t/T})$$

where t = probability evaluation window (yrs), and T = event recurrence interval (yrs). From this formula, the following probabilities that an eruption will occur in a particular time period can be derived (Table 4).

Future time interval (yrs.)	10	50	100	250	500	1000
Probability (%)	3%	14%	26%	53%	78%	95%

Table 4. Poisson probabilities that the Property could be impacted by a lava flow in future times.

The probabilities calculated in Table 4 are, however, far too high because they assume that the past history of lava flow inundation (2 flows in 668 years) will be typical of the future. In fact, this is not true, because deterministic (non-random) factors are involved; the ʻAi-laʻāu eruptions were geologically unique and eruptions are not likely to occur again in that area upslope of the Property for a very long time – likely thousands of years. Therefore, the statistical values given in Table 4 are the statistically highest possible probabilities of future lava flows impacting the Property, but in non-quantifiable fact, actual probabilities are much lower. With the passage of time, the "recurrence interval" for flows at the Property can only increase (assuming Pele doesn't figure out a way to visit) and the statistical probabilities for lava inundation will only decrease.

Summary

Our determination of natural hazards and risks facing the Property, as summarized in Table 3 – Column "C", is low to medium in comparison to other areas of the State, and less than the hazards estimated by Fletcher *et al.* (2002). We consider the Property to be suitable for residential development, in accordance with setback requirements to be determined by the Hawaiʻi County Planning Department.

The shoreline and sea cliff in front of the Property were mapped in order to assess the erodibility of underlying rocks and the dynamic nature of geologic and marine processes that contribute to erosion. The pahoehoe flow that defines the edge of the sea cliff is susceptible to slight, long-term erosion by storm or tsunami waves, and evidence of such erosion is documented by field photography. Historical aerial photos dating back to 1954 were compared to 2017 Google imagery in an attempt to establish an erosion rate for the area, and a rate of about 3.0 inches/year is suggested. A value of 2.2 inches/year was obtained from less precise estimates of lava flow age and distance to the original coastal lava entry point. Such rates are very low as compared to low-lying coastal areas on older islands where global Sea Level Rise and the vulnerability of sandy beaches can create serious long-term shoreline migration problems.

The slight erosion that does occur on this rocky coastline appears to be episodic, related to infrequent storm wave activity. Future inland migration of the shoreline will be impacted predominantly by such unpredictable and episodic storms, and could be accelerated by unforeseeable sudden subsistence due to seismic and tectonic events that are impacting shorelines closer to Kilauea's East Rift Zone. Over the very long term (centuries) coastal erosion and shoreline migration everywhere will be accelerated by global warming and rising sea levels.

The Property lies within Hawaiʻi island Lava Flow Hazard Zone 3 as determined by Wright and others (1992) – the same Hazard Zone as Hilo. The only volcanic hazard that could threaten this Property in the future is the potential for future lava flows from Kilauea volcano to inundate this area of the Puna coast. This risk of lava flow inundation is extremely low as compared to most areas of Kilauea, based not only on statistically calculated probabilities (Table 4), but also by the fact that this area is not threatened by future lava flows from Kilauea's active East Rift Zone. This part of the Puna coastline could only be threatened by Kilauea summit overflows, which are most unlikely given the high eastern walls of the summit caldera. The fact that Kilauea's summit magma chamber drained so completely in 2018, and is not likely to refill and overflow in any direction for a substantial period of time, gives further reason to disregard the potential for lava flow inundation.

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Appendix 3

General Botanical Survey and Vertebrate Fauna Assessment, Barry Property, Hawaiian Paradise Park, Island of Hawai'i

By Ron Terry, Ph.D
Geometrician Associates, LLC
May 2018

Introduction

This biological survey concerns a 0.51-acre property owned by the Barry Family Trust, identified by TMK (3) 1-5-059:059, as shown on Figure 1 (the "property").

The objectives of the botanical survey component of this survey were to 1) describe the vegetation; 2) list all species encountered; and 3) determine the likelihood of the presence of rare, threatened or endangered plant species, and to identify the locations of any such individuals found. The area was surveyed by Ron Terry on one day in May 2018. Plant species were identified in the field and, as necessary, collected and keyed out in the laboratory. Special attention was given to the possible presence of any federally (USFWS 2018) listed threatened or endangered plant species, although, with one exception discussed below, the habitat did not indicate a high potential for their presence.

The work also included a limited faunal survey of birds and introduced mammals, reptiles, or amphibians observed during the botanical survey. Also considered in this report is the general value of the habitat for native birds and the Hawaiian hoary bat. Not included in the survey were invertebrates or aquatic species or habitat, although it should be noted that the property is adjacent to the sea and that no streams, lakes or ponds are present.

Vegetation Type and Influences

The property is located on the flank of Kilauea, an active volcano, in the District of Puna, in the *ahupua'a* of Kea'au. The property receives an average of about 124 inches of rain annually, with a mean annual temperature of approximately 75 degrees Fahrenheit (Giambelluca et al 2014; UH Hilo-Geography 1998:57). The lava flows of this area are all derived from eruptive vents on Kilauea volcano's East Rift Zone, located as close as eight miles east of the project site. The specific lava flow that underlies the project site consists of pahoehoe erupted between 200 and 750 years (Moore and Trusdell 1991).

Soil in the area is classified as Opihikao highly decomposed plant material, 2 to 20 percent slopes. This is a very shallow, well-drained soil that formed in a thin mantle of organic material and small amounts of volcanic ash overlying pahoehoe lava (U.S. Soil Conservation Service 1973).

Prior to the use for agriculture, ranching, and lot subdivision, the natural vegetation of this part of the Puna shoreline (the site of a less than 400-year-old lava flow) was mostly coastal forest and strand vegetation, dominated by naupaka (*Scaevola taccada*), hala (*Pandanus tectorius*), 'ōhi'a (*Metrosideros polymorpha*), nanea (*Vigna marina*) and various ferns, sedges and grasses (Gagne and Cuddihy 1990). Some locations on the coastline also host a rare plant found only in the Hilo and Puna Districts: *Ischaemum byrone,* a State and federally listed endangered grass known to grow on pahoehoe close the edge of sea cliffs, where salt spray may limit other plants.

Aside from the road verge, the lava flow on the site does not appear to have been ripped by heavy equipment or otherwise disturbed, although the heavy vegetation makes that difficult to ascertain. Large ironwood (*Casuarina equisetifolia*) trees previously grew on the site and appear to have been felled, and this has provided a substrate for dense vine growth.

Environmental Setting: Flora

In terms of vegetation, the long, narrow rectangular property is divided into four basic zones, as illustrated in the photographs of Figure 2. The lava shelf zone consists of about 50 feet of nearly bare pahoehoe, with scattered, low clumps of akulikuli (*Sesuvium portulacastrum*) and mau'u 'aki'aki (*Fimbristylis cymosa*), two common indigenous herbs. Occasional surges from large waves during storms scour this zone and keep it largely vegetation free. The shoreline shrub zone just behind, heavily affected by constant sea spray and roughly 60 feet in depth, is dominated by the common indigenous shrub naupaka. Also present are ironwood, coconut palms, the indigenous sedge pycreus (*Cyperus polystachyos*), and various non-native grasses, vines, herbs and ferns.

No individuals of *Ischaemum byrone* were found. The extremely heavy sea spray in the makai edge of the lot might tend to discourage this grass, salt-tolerant though it is. Mauka of here the vegetation is so dense with naupaka and other plants that clusters of this grasses would not tend to thrive. No other rare, threatened or endangered plants are present. Although dominated by common native plants, with no rare species, the lava shelf zone and shoreline shrub zones represent native habitat with at least some conservation value.

The majority of the property – varying from about 180 to 200 feet in depth – contains the other two vegetation zones. The narrow road fringe is dominated by Guinea grass (*Megathyrsus maximus*) and a number of other weedy grasses, herbs and vines. The interior of the property is a secondary growth of almost entirely non-native grasses, shrubs, trees, herbs, vines and ferns. Prominent among them are lantana (*Lantana camara*), Guinea grass, red tower ginger (*Costus comosus*), sensitive plant (*Mimosa pudica*), sword fern (*Nephrolepis multiflora*), autograph tree (*Clusia rosea*), and maile pilau (*Paederia foetida*). A few native hala trees appear to be encroaching on the property from a neighbor's landscape. Seedlings of the highly invasive albizia tree (*Falcataria moluccana*) are emerging in various locations. There is little of value for biological conservation in the areas behind the shoreline shrub zone. A full list of plant species detected on the property is found in Table 1.

Table 1. Plant Species Observed on Barry Property

Scientific Name	Family	Common Name	Life Form	Status*
Ageratum houstonianum	Asteraceae	Ageratum	Herb	A
Allamanda cathartica	Apocynaceae	Allamanda	Vine	A
Canavalia cathartica	Fabaceae	Maunaloa	Vine	A
Casuarina equisetifolia	Casuarinaceae	Ironwood	Tree	A
Centella asiatica	Apiaceae	Asiatic Pennywort	Herb	A
Chamaecrista nictitans	Fabaceae	Partridge Pea	Herb	A
Clusia rosea	Clusiaceae	Autograph Tree	Tree	A
Cocos nucifera	Arecaceae	Coconut	Tree	PI
Costus comosus	Costaceae	Red Tower Ginger	Shrub	A
Crinum asiaticum	Amaryllidaceae	Spider Lily	Herb	A
Cyperus halpan	Cyperaceae	Cyperus	Sedge	A
Cyperus polystachyos	Cyperaceae	Pycreus	Herb	I
Desmodium triflorum	Fabaceae	Tick Clover	Herb	A
Digitaria ciliaris	Poaceae	Henry's Crabgrass	Herb	A
Digitaria insularis	Poaceae	Sour Grass	Herb	A
Dracaena marginata	Agavaceae	Money Tree	Tree	A
Emilia fosbergii	Asteraceae	Lilac Pualele	Herb	A
Euphorbia hirta	Euphorbiaceae	Garden Spurge	Herb	A
Falcataria moluccana	Fabaceae	Albizia	Tree	A
Fimbristylis cymosa	Cyperaceae	Mau'u 'Aki'aki	Herb	I
Ipomoea triloba	Convolvulaceae	Little Bell	Vine	A
Kyllinga brevifolia	Cyperaceae	Kyllinga	Herb	A
Macaranga tanarius	Euphorbiaceae	Macaranga	Shrub	A
Megathyrsus maximus	Poaceae	Guinea Grass	Grass	A
Mimosa pudica	Fabaceae	Sleeping Grass	Herb	A
Nephrolepis multiflora	Nephrolepidaceae	Sword Fern	Fern	A
Paederia scandens	Rubiaceae	Maile Pilau	Vine	A
Pandanus tectorius	Pandanaceae	Hala	Tree	I
Paspalum conjugatum	Poaceae	Hilo Grass	Herb	A
Phymatosorus grossus	Polypodiaceae	Maile Scented Fern	Fern	A
Scaevola taccada	Goodeniaceae	Beach Naupaka	Shrub	I
Schefflera actinophylla	Araliaceae	Octopus Tree	Tree	A
Sesuvium portulacastrum	Aizoaceae	Akulikuli	Herb	I

A=Alien E=Endemic I=Indigenous PI Polynesian Introd END=Federal and State Listed Endangered

Environmental Setting: Vertebrate Fauna

Very few birds were observed during the site visit, which took place in rainy, windy conditions at mid-day, during the summer season, a month after most migratory birds had already departed for the Arctic. At other times of the day or year, a variety of resident or migratory shorebirds could be present. These include the Pacific golden-plover or kolea (*Pluvialis fulva*), ruddy turnstone (*Arenaria interpres*), and wandering tattler (*Heteroscelus incanus*), which are often seen on the Puna coastline feeding on shoreline resources. They would be unlikely to make much use of most of the property, which is densely vegetated and offers no habitat for them. The seabird black noddy (*Anous minutus melanogenys*) was observed flying near the cliffs and over the nearshore waters, as it frequently does in cliffed coasts of the main Hawaiian Islands. It nests in crevices and caves in lava (especially pahoehoe) seacliffs; no black noddy nests were observed on the cliffs in front of the property, but openings in the rock might offer areas for nests.

Although no land birds were seen, during previous reconnaissance of shoreline properties in the Puna District, Geometrician Associates has noted a number of non-native land birds. These include common mynas (*Acridotheres tristis*), northern cardinals (*Cardinalis cardinalis*), spotted doves (*Streptopelia chinensis*), striped doves (*Geopilia striata*), Kalij pheasants (*Lophura leucomelanos*) Japanese white-eyes (*Zosterops japonicus*), and house finches (*Carpodacus mexicanus*), among other birds.

It is unlikely that many native forest birds would be expected to use the project site due to its low elevation, alien vegetation and lack of adequate forest resources. However, it is likely that Hawai'i 'amakihi (*Hemignathus virens*) are sometimes present, as some populations of this native honeycreeper appear to have adapted to the mosquito borne diseases of the Hawaiian lowlands.

As with all of East Hawai'i, several endangered native terrestrial vertebrates may be present in the general area and may overfly, roost, nest, or utilize resources of the property.

The endangered Hawaiian hawk (*Buteo solitarius*) is widespread, hunting throughout forested, agricultural and even residential areas of the island of Hawai'i. It nests in large trees and can be vulnerable during the summer nesting season. However, the property does not contain, nor is it near, large trees suitable for hawk nests, and therefore it would be very unlikely to be affected by activities on the property.

The Hawaiian petrel (*Pterodroma sandwichensis*), the Hawaiian sub-species of Newell's shearwater (*Puffinus newelli*), and the band-rumped storm-petrel (*Oceanodroma castro*) have been recorded over-flying various areas on the Island of Hawai'i between late April and the middle of December each year. The Hawaiian petrel and band-rumped storm-petrel are listed as endangered, and Newell's shearwater as threatened, under both federal and State of Hawai'i endangered species statutes. The petrels and shearwaters hunt over the ocean during the day and fly to higher elevations at night to roost and nest. The Hawaiian petrel and the band-rumped storm petrel are known to nest at elevations well above 5,000 feet on the Big Island, not within the project area. But during its breeding season from April through November, the Newell's shearwater burrows under ferns on forested mountain slopes. These burrows are used year after year and usually by the same pair of birds. Although capable of climbing shrubs and trees before taking flight, it needs an open downhill flight path through which it can become airborne. Although once abundant on all the main Hawaiian islands, most birds today are found in the steep terrain between 500 to 2,300 feet on Kaua'i (https://www.fws.gov/pacificislands/fauna/newellsshearwater.html). The primary cause of mortality in these species in Hawai'i is thought to be predation by alien mammalian species at the nesting colonies. Collision with man-made structures is another significant cause. Nocturnally flying seabirds, especially fledglings on their way to sea in the summer and fall, can become disoriented by exterior lighting. Disoriented seabirds may collide with manmade structures and, if not killed outright, become easy targets of predatory mammals. These listed seabirds would not directly utilize the property but could overfly it.

Only one native land mammal is present in the Hawaiian Islands, the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*). Found in all environments on the island of Hawai'i, this bat roosts in tall shrubs or trees and is vulnerable to disturbance during its roosting season of June 1 to September 15.

Aside from the Hawaiian hoary bat, all other mammals in the Paradise Park area are introduced species, including feral cats (*Felis catus*), feral pigs (*Sus scrofa*), small Indian mongooses (*Herpestes a. auropunctatus*) and various species of rats (*Rattus* spp.). None are of conservation concern and all are deleterious to native flora and fauna.

There are no native terrestrial reptiles or amphibians in Hawai'i. The only reptile observed on the property was an unidentified species of skink (Family: Scincidae). Various gecko species (Family: Gekkonidae) are also known to be present in the area. No other reptiles and amphibians were detected during the survey, but we have observed the highly invasive coqui frog (*Eleutherodactylus coqui*) in the area. It is likely that bufo toads (*Bufo marinus*) are occasionally present.

No invertebrate survey was undertaken as part of the survey, but rare native invertebrates tend to be associated with tracts of native vegetation and are not highly likely to be present. Although no lava tube openings were observed, if caves are present, native invertebrates including spiders and insects could be present, especially if the roots of native trees extend into the caves.

Impacts and Mitigation Measures: Vegetation

Most of the project site is dominated by alien vegetation, with the only native ecosystem on the property being the shoreline vegetation, where common native plants are present. Because of the location and nature of the project relative to sensitive vegetation and species, construction and use of the single-family dwelling and associated agricultural uses are not likely to cause adverse impacts to vegetation or habitat. It is our understanding that any development on the property will be set back outside the lava shelf and shoreline shrub zone, thus avoiding these resources, although some non-native species may be removed, appropriate native species may be planted and a narrow trail to the shoreline may be established, taking care to minimize harm to native species. As such, no adverse impact upon vegetation or endangered plant species should occur.

In order to avoid impacts to the endangered but regionally widespread terrestrial vertebrates listed above, we recommend that the landowner commit to certain standard conditions. Specifically, construction should refrain from activities that disturb or remove the vegetation between June 1 and September 15, when Hawaiian hoary bats may be sensitive to disturbance. The landowner should also shield any exterior lighting from shining upward, in conformance with Hawai'i County Code § 14 – 50 et seq., to minimize the potential for disorientation of seabirds.

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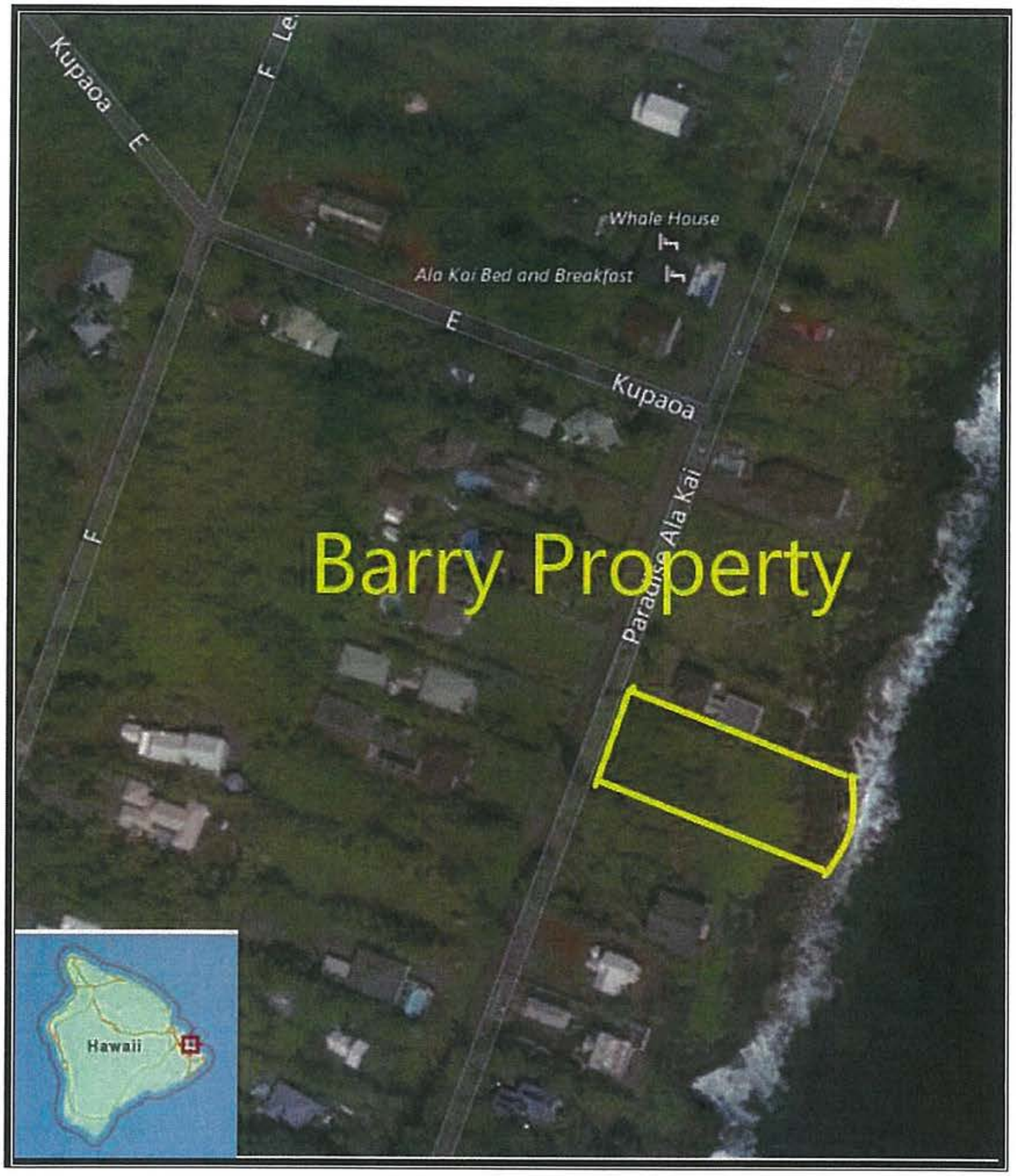
Figure 1. Property Map



Aerial Image Base Map © Digital Globe, HERE (from BING Maps)

Figure 2. Property Vegetation Photos

2a. Lava shelf zone (with shoreline shrub zone on right) ▲

▼ 2b. Shoreline shrub zone

Figure 2. Property Vegetation Photos

2c. Property interior zone ▲ ▼ 2d. Road fringe zone

Appendix 4

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June 10, 2018

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Subject: Archaeological Field Inspection of TMK: (3) 1-5-059:059, Kea'au Ahupua'a, Puna District, Island of Hawai'i.

Dear Susan:

At the request of Monica and Kevin Barry (landowners), in support of a district boundary amendment application being submitted to the State of Hawai'i Land Use Commission (LUC), ASM Affiliates (ASM) conducted an Archaeological Field Inspection of a 0.51-acre parcel (TMK: (3) 1-5-059:059) located in Hawaiian Paradise Park (HPP), Kea'au Ahupua'a, Puna District, Island of Hawai'i (Figures 1, 2, and 3). The landowner is seeking to reclassify the subject parcel from Conservation land to Agricultural land. According to the LUC's district boundary amendment, "On petitions to redistrict Conservation lands, the requirements of the EIS law (Chapter 343, HRS) must be met before the petition to reclassify Conservation land can be officially accepted as a proper filing and acted upon by the Commission." This Archaeological Field Inspection is intended to fulfill the Section 6E-42 requirements of Hawai'i Revised Statutes (HRS) Chapter 343, and was prepared according to Hawai'i Administrative Rules (HAR) 13§13-284 and 275. The purpose of the archaeological field inspection was to determine if any historic properties could potentially be impacted by the redistricting of the parcel from Conservation land to Agricultural Land.

Parcel 059, the subject parcel, is also identified as Lot 463 of Block 10 of the Hawaiian Paradise Park subdivision, which was created in 1959 when roughly 9,850 acres of coastal Kea'au Ahupua'a, and the neighboring *ahupua'a* of Waikahekahe Nui and Iki, were subdivided into nearly 8,900 parcels. The subject property is located along the eastern side of Kaloli Point *makai* of Paradise Ala Kai Street. It is bounded to the west by the paved roadway, to the north by a developed residential property, to the east by the Pacific Ocean, and to the south by an undeveloped residential parcel. The subject parcel is one of only a few conservation-zoned parcels remaining in HPP (Figure 4). Most of the neighboring parcels were converted from conservation to agriculturally-zoned land soon after the subdivision was created. The original owner of Parcel 059 could not be located at the time of the original district boundary amendment filing, so the subject parcel's zoning was never converted.

Description of Subject Property

The subject property is situated on a 200 to 750 year old lava flow that originated from Kīlauea Volcano (Sherrod et al. 2007). Soil within the general study area is classified as Opihikao highly decomposed plant material, consisting of a well-drained, thin organic soil overlying *pāheohoe* lava bedrock (Sato et al. 1973). This part of Hawai'i island has a mean annual rainfall of 124 inches (3,156.5 millimeters) and a mean annual temperature of 73° F (Juvik and Juvik 1998). Vegetation across the subject parcel is quite thick. The parcel is fronted at Paradise Ala Kai Street by a tall growth of grass (Figure 5). The grass transitions fairly quickly, however, to a dense, secondary growth of weeds, ferns, small trees, and vines that cover most of the *mauka* half of the property (Figure 6), and obscure a ground surface that is crisscrossed by relatively recently felled, large ironwood trees. Near the coastal margin of the property, the vegetation transitions to beach *naupaka* (*Scaevola sericea*) with some small ironwood trees (*Casuarina equisetifolia*) and coconut palms (*Cocos nucifera*) also growing (Figure 7). The parcel is fronted at the coast by a wave and windswept shelf of *pāhoehoe* bedrock and a low cliff (Figures 8 and 9).

Culture-Historical Background for Kea'au

The subject parcel is located within Kea'au Ahupua'a, a land unit of the District of Puna, one of six major districts on the island of Hawai'i. The *ahupua'a* of Kea'au is one of fifty traditional land divisions found in the *moku* (district) of Puna on the eastern shores of Hawai'i Island. The Hawaiian proverb "Puna, mai 'Oki'okiaho a Māwae" describes the extent of the district spanning from 'Oki'okiaho the southern boundary, to Māwae, the northern boundary. In the book, *Native Planters in Old Hawaii*, Handy and Handy (1991) describe Puna as an agriculturally fertile land that has repeatedly been devastated by lava flows. Writing during the 1930s, they relate that:

> The land division named Puna—one of the six chiefdoms of the island of Hawaii said to have been cut (*'oki*) by the son and successor of the island's first unifier, Umi-a-Liloa—lies between Hilo to the north and Ka'u to the south, and it projects sharply to the east as a great promontory into the Pacific. Kapoho is its most easterly point, at Cape Kumukahi. The uplands of Puna extend back toward the great central heights of Mauna Loa, and in the past its lands have been built, and devastated, and built again by that mountain's fires. In the long intervals, vegetation took hold, beginning with miniscule mosses and lichens, then ferns and hardier shrubs, until the uplands became green and forested and good earth and humus covered much of the lava-strewn terrain, making interior Puna a place of great beauty. . .
>
> ...One of the most interesting things about Puna is that Hawaiians believe, and their traditions imply that this was once Hawaii's richest agricultural region and that it is only in relatively recent time that volcanic eruption has destroyed much of its best land. Unquestionably lava flows in historic times have covered more good gardening land here than in any other district. But the present desolation was largely brought about by the gradual abandonment of their country by Hawaiians after sugar and ranching came in... (Handy and Handy 1991:539-542)

As suggested in the above passage, Puna was a region famed in legendary history for its associations with the goddess Pele and god Kāne (Maly 1998). Because of the relatively young geological history and persistent volcanic activity the region's association with Pele has been a strong one. However, the association with Kāne is perhaps more ancient. Kāne, ancestor to both chiefs and commoners, is the god of sunlight, fresh water, verdant growth, and forests (Pūku'i 1983). It is said that before Pele migrated to Hawai'i from Kahiki, there was "no place in the islands . . . more beautiful than Puna" (Pūku'i 1983:11). Contributing to that beauty were the groves of fragrant *hala* and forests of *'ōhi'a lehua* for which Puna was famous, and the inhabitants of Puna were likewise famous for their expertise and skill in *lauhala* weaving.

In Precontact and early Historic times the people of Puna lived primarily in small settlements along the coast with access to fresh water, where they subsisted on marine resources and agricultural products. According to McEldowney (1979), six coastal villages were traditionally present between Hilo and Cape Kumakahi (Kea'au or Hā'ena, Maku'u, Waiakahiula, Honolulu, Kahuwai, and Kula or Koa'e). The current study area is located between Hā'ena and Maku'u Villages. As described by McEldowney, each of the villages:

> ...seems to have comprised the same complex of huts, gardens, windbreaking shrubs, and utilized groves, although the form and overall size of each appear to differ. The major differences between this portion of the coast and Hilo occurred in the type of agriculture practiced and structural forms reflecting the uneven nature of the young terrain. Platforms and walls were built to include and abut outcrops, crevices were filled and paved for burials, and the large numbers of loose surface stones were arranged into terraces. To supplement the limited and often spotty deposits of soil, mounds were built of gathered soil, mulch, sorted sizes of stones, and in many circumstances, from burnt brush and

> surrounding the gardens. Although all major cultigens appear to have been present in these gardens, sweet potatoes, ti (*Cordyline terminalis*), *noni (Morinda citrifolia*), and gourds (*Lagenaria siceraria*) seem to have been more conspicuous. Breadfruit, pandanus, and mountain apple (*Eugenia malaccensis*) were the more significant components of the groves that grew in more disjunct patterns than those in Hilo Bay. (McEldowney 1979:17)

Ka Mo'olelo O Hi'iakaikapoliopele (The story of Hi'iakaikapoliopele), initially published in the Hawaiian language newspaper *Ka Na'i Aupuni* between the years 1905-1906 (Ho'oulumāhiehie 2006), tells a story of Pele and her siblings that takes place at Hā'ena not far from the current study area. The story relates that after settling on Hawai'i Island, Pele and her siblings ventured down to Hā'ena in Kea'au to bathe in the sea. While there, Pele was overcome with the desired to sleep. She informed her youngest sister, Hi'iaka not to allow any of their siblings to awaken her. Hi'iaka consented to her sister's commands. In her dream state, Pele followed the sound of a *pahu* (drum), which carried her spirit to the island of Kaua'i, where she saw and met a striking man named Lohi'au. The two met and fell madly in love, however, given that Pele was in her spirit form, she made it clear to Lohi'au that she must return to Hawai'i Island. Pele's long sleep was cause for concern and although tempted to awaken her sister, Hi'iaka held true to her sister's commands.

When she awoke, Pele called upon each of her sisters and made a proposition, asking which one of them would fetch her dream lover Lohi'au from Kaua'i. Knowing Pele's tempestuous temper, each feared possible repercussions and refused to go, except for her youngest sister, Hi'iaka. Pele demanded that Hi'iaka travel to Kaua'i to fetch Lohi'au, and sent her on her way with strict instructions; Hi'iaka was not to take him as her husband, she was not to touch him, and she was to take no longer than forty days on her journey. While Hi'iaka agreed to her sister's demands, she realized that in her absence, Pele would become incensed with a burning and vehement fury and destroy whatever she desired. So Hi'iaka set forth two stipulations of her own; her beloved *'ōhi'a lehua* grove in Puna was to be spared from destruction, and Pele was to protect her dear friend Hōpoe in her absence. In this version of the story, Hōpoe is described as a young girl from Kea'au who was skilled at riding the surf of Hā'ena, and who was the one who taught Hi'iaka the art of *hula*. Pele agreed to Hi'iaka's requests, and Hi'iaka departed on her journey to retrieve Pele's lover. In a sympathetic act, Pele bestowed supernatural powers upon Hi'iaka so that she would be protected against the dangers she would undoubtedly meet along the way.

Hi'iaka hadn't yet ventured very far on her journey when she realized that the volcano had begun to smoke thickly, trailing lava towards Hōpoe's home of Kea'au. It was not long before the smolder of smoke burst into a scorching fire. Despite being filled with a sense of dread, sensing that her sister had betrayed her promise, Hi'iaka continued her journey. At last, Hi'iaka found Lohi'au, unfortunately, all that remained of him was his lifeless corpse. Keenly aware that she could not return Lohi'au to her sister in such a state, Hi'iaka used her healing powers to return his wandering spirit back into his body.

By this time, because of the amount of time taken by Hi'iaka, Pele was furious. She shook the earth with great ferocity and heaved her lava in a torrent of devastation, annihilating Hi'iaka's *'ōhi'a lehua* forest, obliterating all of Puna, and finally consuming Hōpoe as she lingered by the sea. In her death, Hōpoe was transformed into a stone at the coast of Kea'au; a stone, carefully balanced alongside the sea, that would dance gracefully when touched by the soft breeze or the rumbling of the earth. Hi'iaka, her heart bitter with her sister's betrayal, brought Lohi'au back to Puna as she swore she would. There, enraged by her sister's spiteful acts, Hi'iaka fought a brutal battle with Pele. Fearing that the two sisters would destroy the entire island, the elder gods finally intervened and ended the battle.

A map prepared in 1930, and filed with Land Court Application 1053 (Figures 10), labels the coastal lands on the eastern side of Kaloli Point as "Hopoe," suggesting that the events of *Ka Mo'olelo O Hi'iakaikapoliopele* (Ho'oulumāhiehie 2006) may have occurred in the general vicinity of the subject parcel. The stone believed to be Hi'iaka's companion, Hōpoe, was moved by a *tsunami* in 1946 (Pukui et al. 1974:52), and no longer dances along the shore of Kea'au Ahupua'a.

In 1823, British missionary William Ellis and members of the American Board of Commissioners for Foreign Missions (ABCFM) toured the island of Hawai'i seeking out communities in which to establish church centers for the growing Calvinist mission. Ellis recorded observations made during this tour in a journal (Ellis 2004). Walking southwest to northeast along the southeastern shore of the District of Puna with his missionary companions Asa Thurston and Artemas Bishop, Ellis' writings present descriptions of residences and practices in the district, and provide the first written description of Kea'au (or Hā'ena) Village and its environs:

> ...The country was populous, but the houses stood singly, or in small clusters, generally on the plantations, which were scattered over the whole country. Grass and herbage were abundant, vegetation in many places luxuriant, and the soil, though shallow, was light and fertile.
>
> Soon after 5 P.M., we reached Kaau [Kea'au], the last village in the division of Puna. It was extensive and populous, abounding well with cultivated plantations of taro, sweet potatoes, and sugar-cane, and probably owes its fertility to a fine rapid stream, which, descending from the mountains, runs through it into the sea. (Ellis 2004:296)

When Ellis visited Puna, less than fifty years after the arrival of the first Europeans, the population of Hawai'i was already beginning to decline (Maly 1998). By the mid-nineteenth century, the ever-growing population of Westerners in the Hawaiian Islands forced socioeconomic and demographic changes that promoted the establishment of a Euro-American style of land ownership, and the *Māhele 'Āina* (Land Division) of 1848 became the vehicle for determining the ownership of native lands within the island kingdom. During the *Māhele*, native tenants of the lands could also claim, and acquire title to, *kuleana* parcels that they actively lived on or farmed. As a result of the *Māhele*, Kea'au Ahupua'a was awarded to William C. Lunalilo (the future, and first elected, monarch of the Hawaiian Islands) as *'āpana* (lot) 16 of LCAw. 8559B. Kea'au was one of sixty-five *ahupua'a* maintained by Lunalilo following the *Māhele*. In Puna, very few claims for *kuleana* were submitted. Maly (1998:37) notes that, with the exception of the islands of Kaho'olawe and Ni'ihau, no other land division of comparable size, had fewer claims for *kuleana* from native tenants than the district of Puna. Only two *kuleana* (LCAw. 2327 to Barenaba and LCAw. 8081 to Hewahewa) were awarded within Kea'au Ahupua'a, neither of which was in close proximity to the current study area (Maly 1999).

Although exposed to missionary presence since the 1820s, early pre-*Māhele* narratives portray Puna as a district still heavily rooted in tradition, being only marginally impacted by foreign influence. While earlier narratives describe the region as densely populated with settlement locales present at both coastal and inland settings, subsequent accounts reveal a sharp decline in the native population throughout the nineteenth century, with Hawaiians maintaining marginalized communities outside of the central population centers. Within a quarter of a century, Puna's population deteriorated by more than half from 4,800 in 1835 to 2,158 in 1860 (Anderson 1865), and continued decreasing to a mere 1,043 by 1878, reaching an unsurpassed low of 944 by 1884 (Thrum 1885 and 1886). Lifeways for the Hawaiian population still residing in Puna underwent drastic changes during the second half of the nineteenth century, as the traditional villages and subsistence activities were mostly abandoned.

By the beginning of the twentieth century, Puna was on the verge of major economic growth, spurred by the booming sugar and lumber industries. Increasing urbanization of Puna, and particularly Kea'au, were initially propelled by the sale of the *ahupua'a* to William Herbert (W.H.) Shipman, J. Eldarts, and Samuel Damon by the King Lunalilo Estate in 1882. Campbell and Ogburn (1992) relate that with land leased from Shipman, a small group of investors (B.F. Dillingham, Lorrin A. Thurston, Alfred W. Carter, Samuel M. Damon) created and developed the 'Ōla'a Sugar Company, which operated on lands *mauka* of the current study area between 1899 and 1984. The current study area was too rocky for the cultivation of sugarcane, and was used by the Shipman family as ranch/grazing land until the late 1950s, when it subdivided into the Hawaiian Paradise Park subdivision and sold in many small pieces to individual owners.

Prior Archaeological Studies

Records on file at DLNR-SHPD indicate that 22 parcels within the Hawaiian Paradise Park subdivision (totaling 22 acres) have been previously surveyed for archaeological sites. Twenty-one parcels were surveyed by Haun and Henry (2013a, 2013b, 2013c) and the twenty-second parcel was surveyed by Higelmire and Lash (2017). Each of these studies, conducted at locations inland of the current study area, reported negative findings with regards to the presence of archaeological sites and features.

A survey of coastal lands within Kea'au Ahupua'a, conducted by Lass (1997) along the route of the Old Government Road to the northwest of HPP, identified fifteen archaeological sites including the Old Government Road/Puna Trail (Site 50-10-36-21273), which once passed inland of the current study area (Figure 10), along with numerous rock walls, enclosures, rock piles, modified bedrock features, and several concrete structures (Sites 50-10-36-21259 to 21273) (Figure 11). These sites were interpreted as having been used for Precontact to early Historic Period habitation, burial, and agricultural purposes, Historic ranching purposes, and World War II-era coastal defense purposes. Although not previously recorded, it is likely that similar sites were once common along the coast of HPP as well, prior to the development of the subdivision roads and lots.

Field Inspection

On June 6, 2018, Matthew R. Clark, M.A., conducted an archaeological field inspection of the 0.51-acre subject parcel. Walking a meandering transect from east to west (from Paradise Ala Kai Street to the coast) across the 80-foot wide by 265-foot long study area, the surface of the parcel was examined for the presence of historic properties. Fallen trees and thick vegetation covering the *mauka* portion of the property limited ground visibility in that area, but the visibility improved in the *naupaka* covered area at the seaward end of the parcel, and was excellent on the coastal bedrock shelf fronting the property. No archaeological resources of any kind were observed on the surface of the subject parcel during the field inspection, and the likelihood of encountering subsurface resources is extremely remote given the exposed bedrock ground surface. Based on the negative findings of the field investigation, on behalf of our client, we are requesting that DLNR-SHPD issue a written determination of "no historic properties affected" in accordance with HAR 13§13-284-5(b)1, with respect to the proposed district boundary amendment.

Sincerely,

Matthew R. Clark, M.A.
Principal Archaeologist

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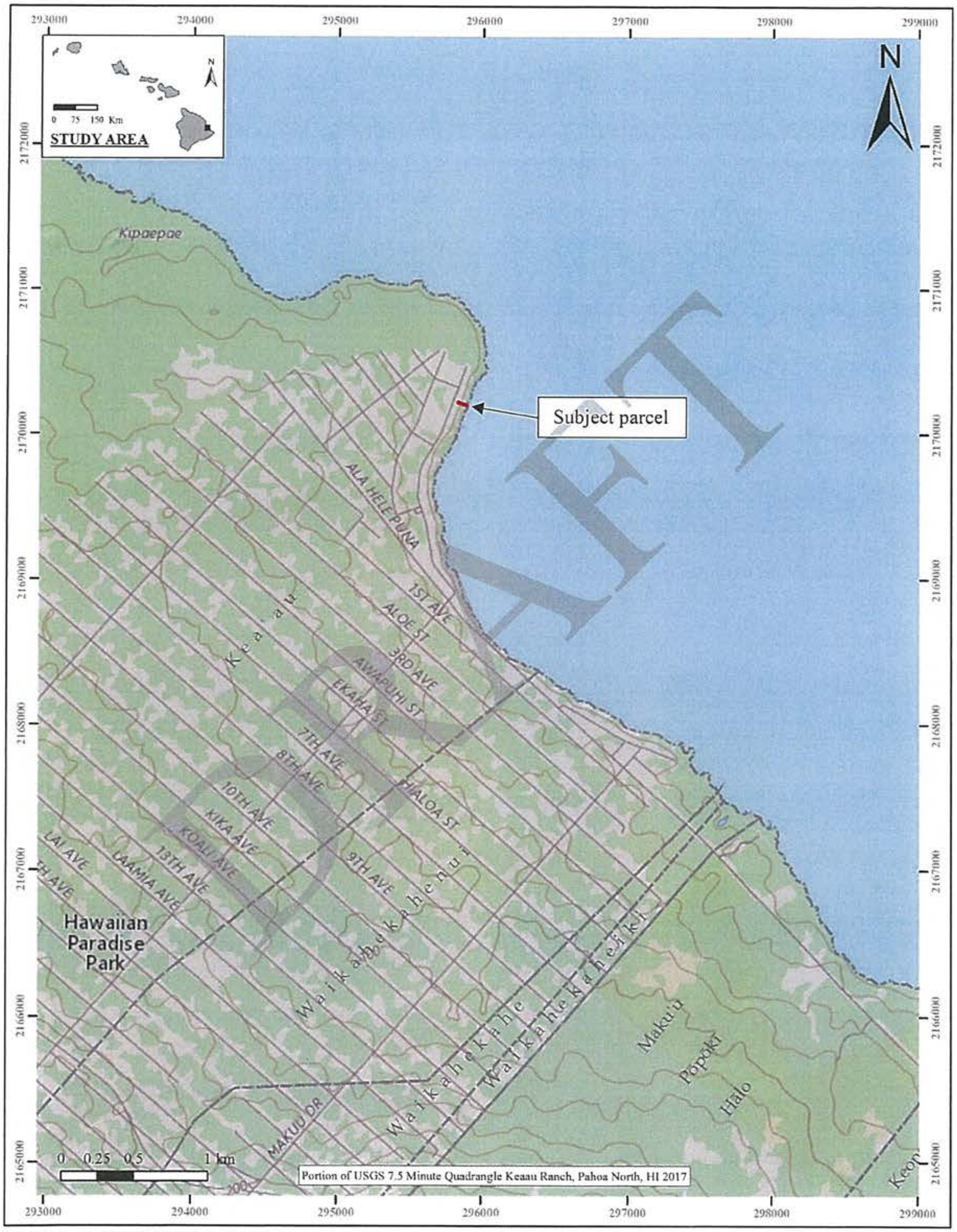

Figure 1. Subject parcel location.

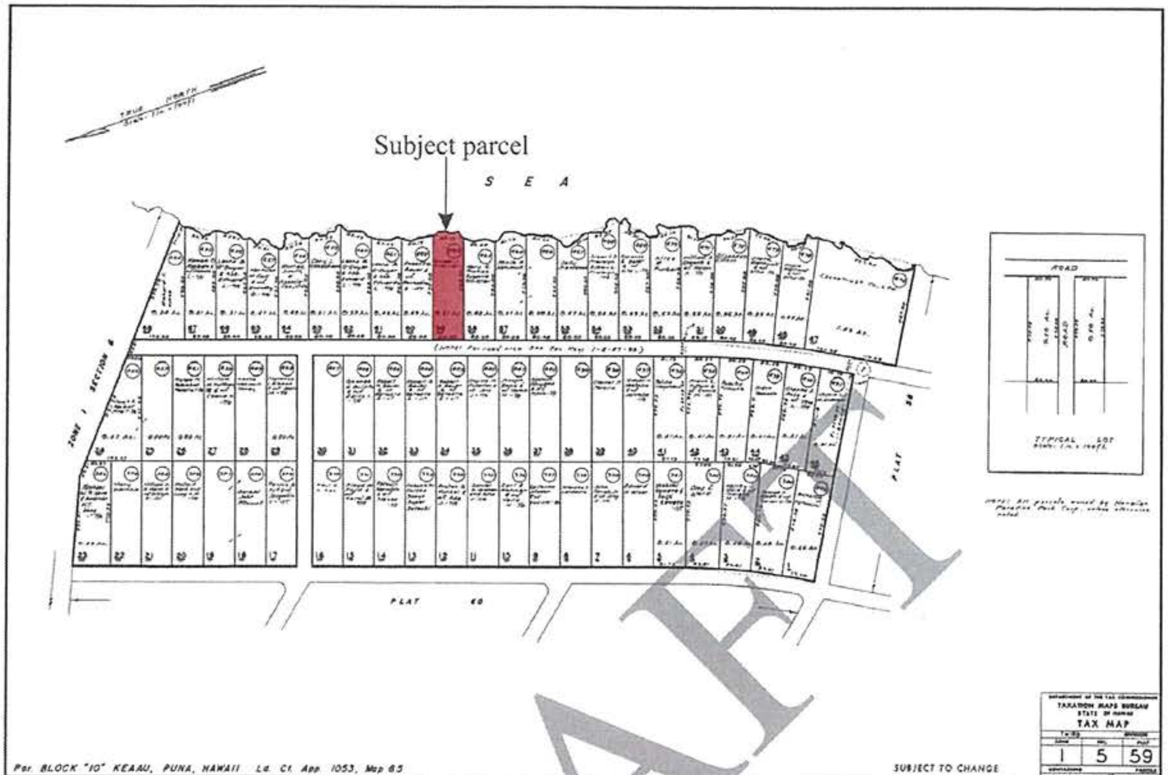

Figure 2. Tax Map Key (3) 1-5-059 with the subject parcel (059) indicated in red.

Figure 3. Aerial image showing the subject parcel (outlined in red).

Figure 4. Conservation-zoned lands in the vicinity of the subject parcel.

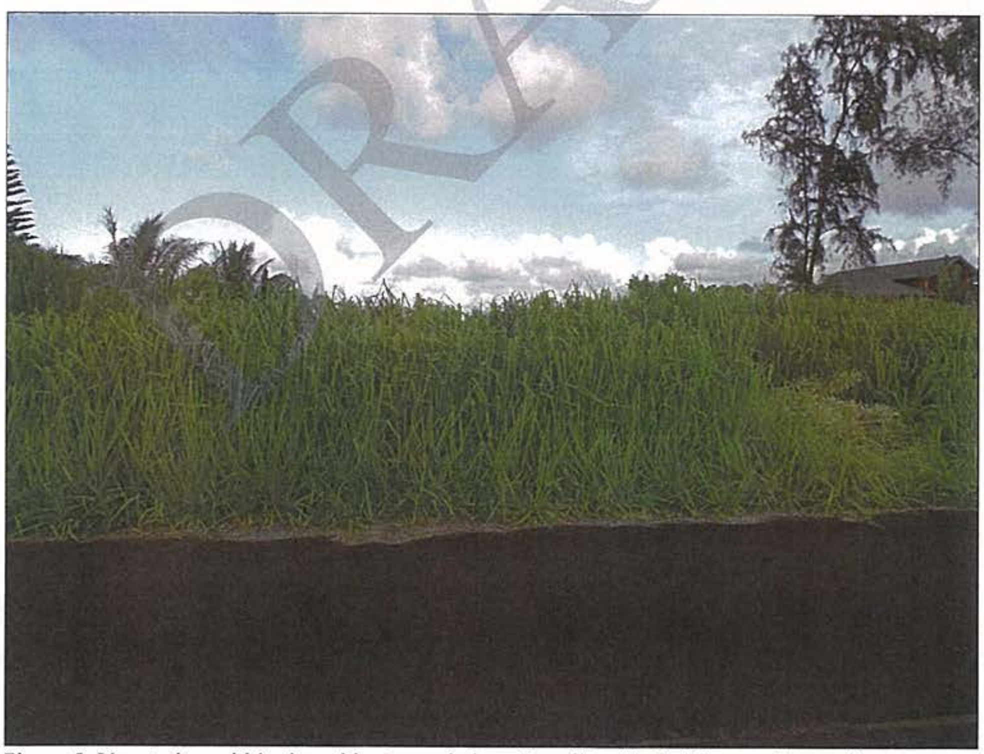

Figure 5. Vegetation within the subject parcel along Paradise Ala Kai Street, view to the east.

Figure 6. Vegetation within the *mauka* portion of the subject parcel, view to the east.

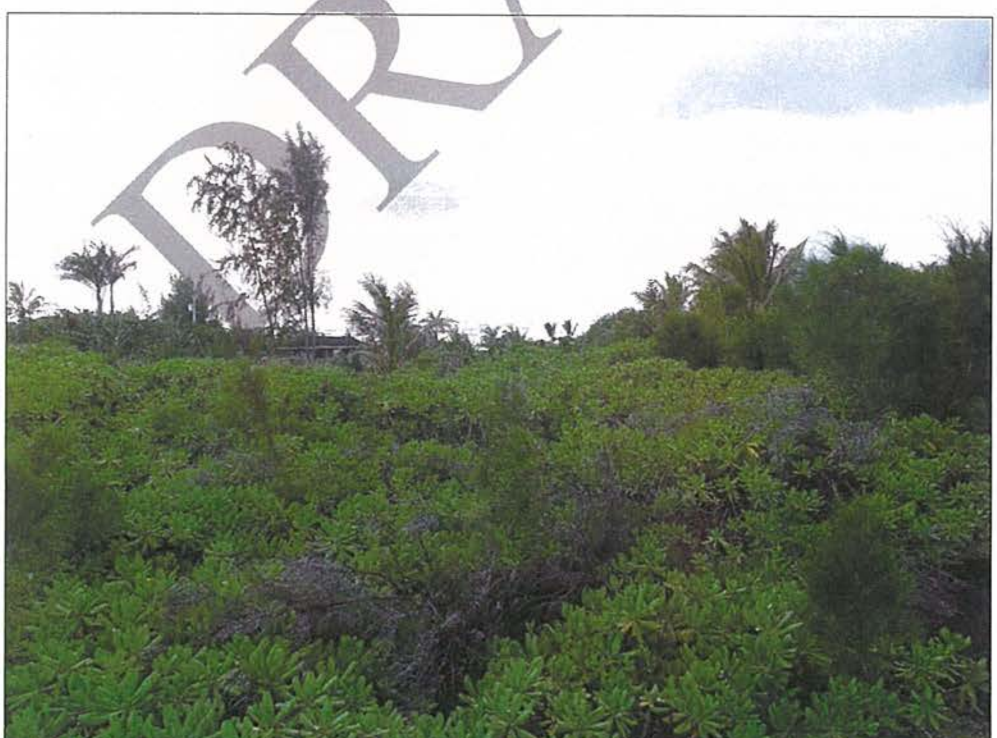

Figure 7. Vegetation within the *makai* portion of the subject parcel, view to the west.

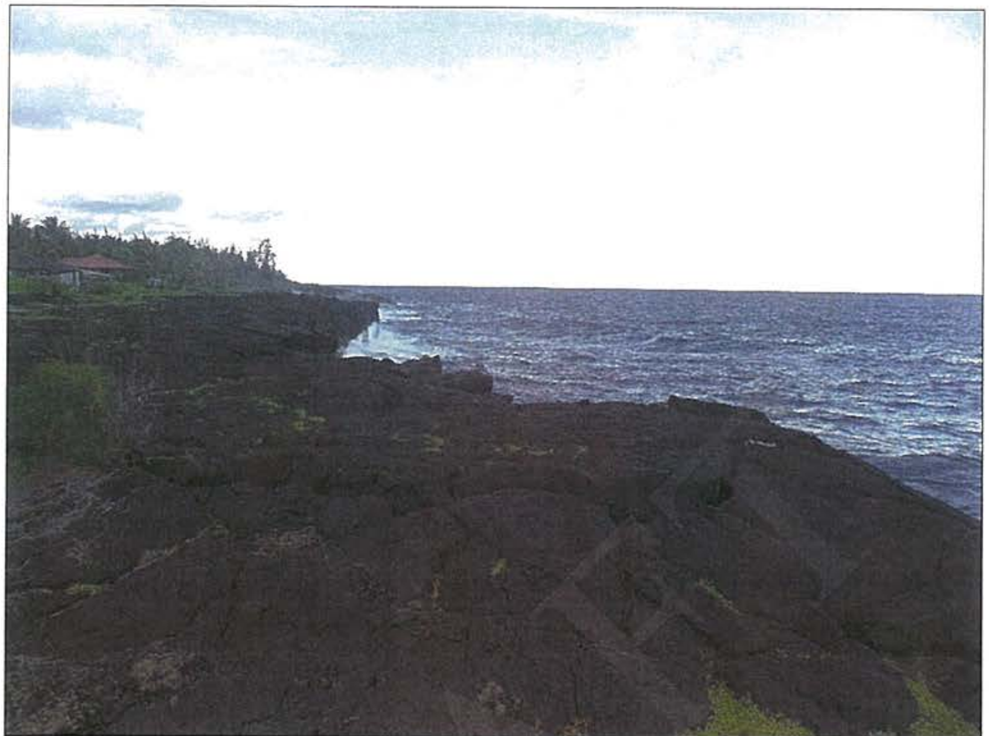
Figure 8. Bedrock shelf fronting the subject parcel at the coast, view to the north.


Figure 9. Bedrock shelf fronting the subject parcel at the coast, view to the south.

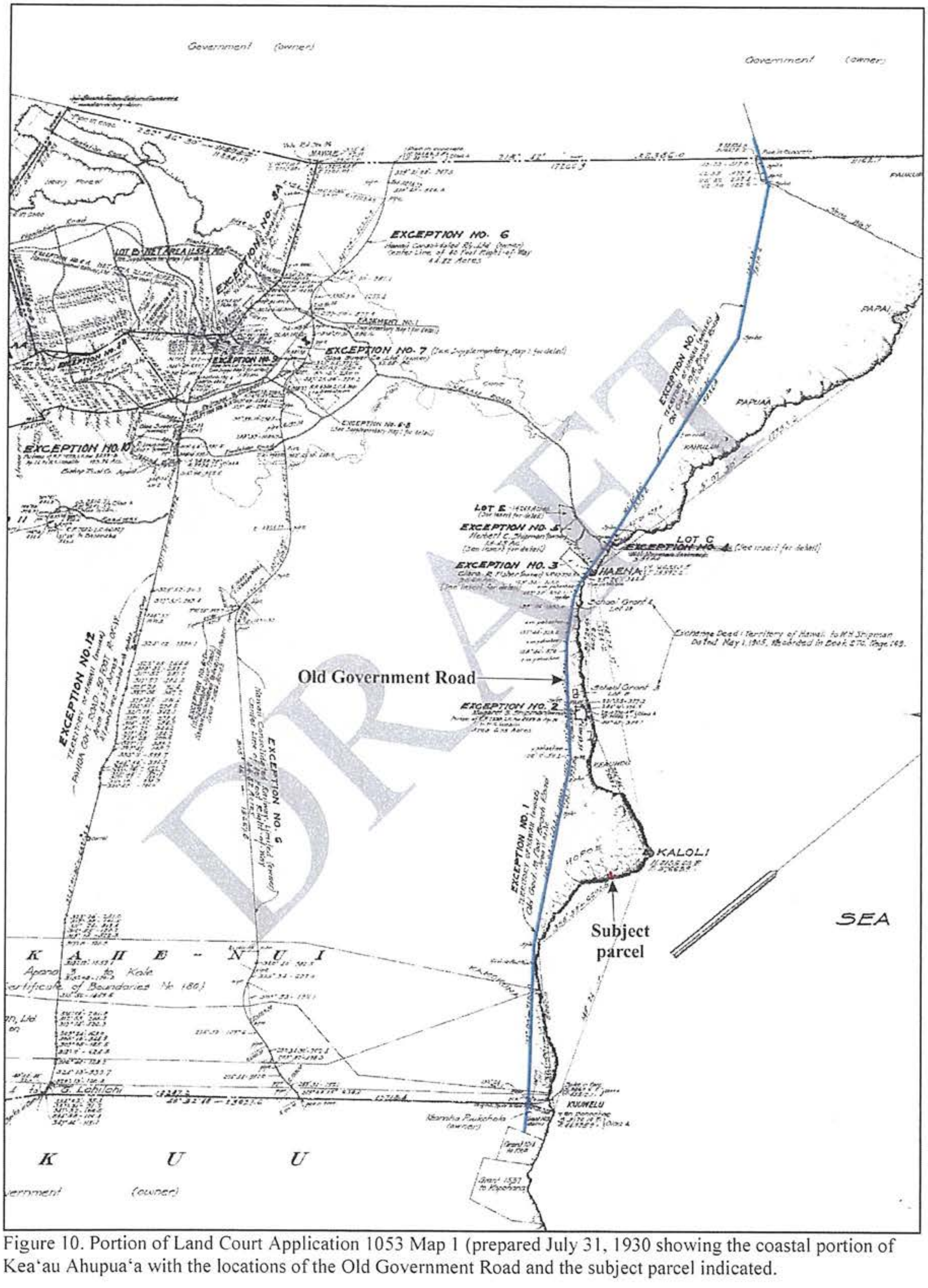

Figure 10. Portion of Land Court Application 1053 Map 1 (prepared July 31, 1930 showing the coastal portion of Kea'au Ahupua'a with the locations of the Old Government Road and the subject parcel indicated.

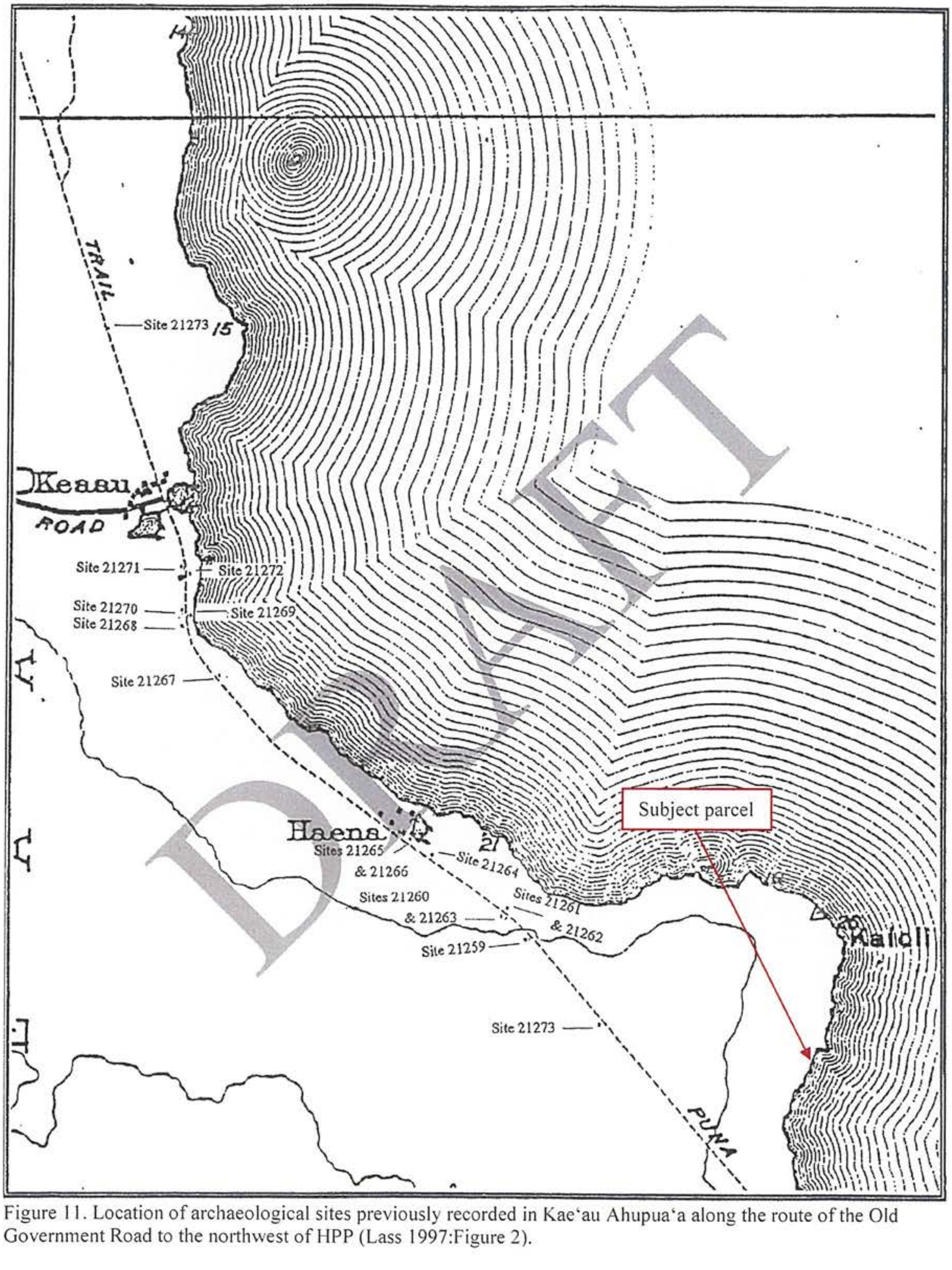

Figure 11. Location of archaeological sites previously recorded in Kae'au Ahupua'a along the route of the Old Government Road to the northwest of HPP (Lass 1997:Figure 2).

Appendix 5

ASM affiliates
Archaeology • History • Ethnography • Architectural History

Monica and Kevin Barry (landowners)
TMK: (3) 1-5-059:059

Ka Pa'akai Analysis

July 2018

Lokelani Brandt, M.A.
Robert B. Rechtman, Ph.D.
ASM Affiliates

At the request of Monica and Kevin Barry (landowners), in support of a district boundary amendment application being submitted to the State of Hawai'i Land Use Commission (LUC), ASM Affiliates (ASM) conducted a *Ka Pa'akai O Ka 'Aina* analysis of a 0.51-acre parcel (TMK: (3) 1-5-059:059) located in Hawaiian Paradise Park (HPP), Kea'au Ahupua'a, Puna District, Island of Hawai'i (Figures 1, 2, and 3). The landowner is seeking to reclassify the subject parcel from Conservation land to Agricultural land (Figure 4).

Article XII, Section 7 of the Hawai'i Constitution obligates the State and its agencies, such as the LUC, "to protect the reasonable exercise of customarily and traditionally exercised rights of native Hawaiians to the extent feasible when granting a petition for reclassification of district boundaries." (Ka Pa'akai O Ka 'Aina v Land Use Commission, 94 Hawai'i 31, 7 P.3d 1068 [2000]). Under Article XII, Section 7, the State shall protect all rights, customarily and traditionally exercised for subsistence, cultural and religious purposes and possessed by *ahupua'a* tenants who are descendants of native Hawaiians who inhabited the Hawaiian Islands prior to 1778, subject to the right of the State to regulate such rights. In the context of land use permitting, these issues are commonly addressed when the LUC is asked to approve a petition for the reclassification of district boundaries, as such an action most often initiates activities that precede initial intensive development.

In the September 11, 2000 Hawai'i Supreme Court landmark decision (Ka Pa'akai O Ka 'Aina v Land Use Commission), an analytical framework for addressing the preservation and protection of customary and traditional native practices specific to Hawaiian communities was created. The court decision established a three-part process relative to evaluating such potential impacts: first, to identify whether any valued cultural, historical, or natural resources are present; and identify the extent to which any traditional and customary native Hawaiian rights are exercised; second, to identify the extent to which those resources and rights will be affected or impaired by the proposed action; and third, to specify the feasible action, if any, to be taken by the regulatory body to reasonably protect native Hawaiian rights if they are found to exist.

In an effort to identify whether any valued cultural, historical, or natural resources are present within the proposed project area, and identify the extent to which any traditional and customary native Hawaiian rights are, or have been, exercised (the first part of the analytical process); historical archival information was investigated, and prior cultural studies that included consultation and oral-historical interviews were reviewed. A summary of this analysis is presented below.

Culture-Historical Background for Kea'au

The subject parcel is located within Kea'au Ahupua'a, a traditional land unit of the Puna District, which is one of six major districts on the island of Hawai'i. The *ahupua'a* of Kea'au is one of fifty traditional land divisions found in the *moku* (district) of Puna on the eastern shores of Hawai'i Island. The Hawaiian proverb "Puna, mai 'Oki'okiaho a Māwae" describes the extent of the district spanning from 'Oki'okiaho the southern boundary, to Māwae, the northern boundary. In the book, *Native Planters in Old Hawaii*, Handy and Handy (1991) described Puna as an agriculturally fertile land that has repeatedly been devastated by lava flows. Writing during the 1930s, they relate that:

> The land division named Puna—one of the six chiefdoms of the island of Hawaii said to have been cut ('oki) by the son and successor of the island's first unifier, Umi-a-Liloa—lies between Hilo to the north and Ka'u to the south, and it projects sharply to the east as a great promontory into the Pacific. Kapoho is its most easterly point, at Cape Kumukahi. The uplands of Puna extend back toward the great central heights of Mauna Loa, and in the past its lands have been built, and devastated, and built again by that mountain's fires. In the long intervals, vegetation took hold, beginning with miniscule mosses and lichens, then ferns and hardier shrubs, until the uplands became green and forested and good earth and humus covered much of the lava-strewn terrain, making interior Puna a place of great beauty. . .
>
> ...One of the most interesting things about Puna is that Hawaiians believe, and their traditions imply that this was once Hawaii's richest agricultural region and that it is only in relatively recent time that volcanic eruption has destroyed much of its best land. Unquestionably lava flows in historic times have covered more good gardening land here than in any other district. But the present desolation was largely brought about by the gradual abandonment of their country by Hawaiians after sugar and ranching came in... (Handy and Handy 1991:539-542)

As suggested in the above passage, Puna was a region famed in legendary history for its associations with the goddess Pele and god Kāne (Maly 1998). Because of the relatively young geological history and persistent volcanic activity, the region's association with Pele has been a strong one. However, the association with Kāne is perhaps more ancient. Kāne, ancestor to both chiefs and commoners, is the god of sunlight, fresh water, verdant growth, and forests (Pukui 1983). It is said that before Pele migrated to Hawai'i from Kahiki, there was "no place in the islands . . . more beautiful than Puna" (Pukui 1983:11). Contributing to that beauty were the groves of fragrant *hala* and forests of *'ōhi'a* lehua for which Puna was famous, and the inhabitants of Puna were likewise famous for their expertise and skill in *lauhala* weaving.

In Precontact and early Historic times the people of Puna lived primarily in small settlements along the coast with access to fresh water, where they subsisted on marine resources and agricultural products. According to McEldowney (1979), six coastal villages were traditionally present between Hilo and Cape Kumukahi (Kea'au or Hā'ena, Maku'u, Waiakahiula, Honolulu, Kahuwai, and Kula or Koa'e). The current study area is located between Hā'ena and Maku'u Villages. As described by McEldowney, each of the villages:

> ...seems to have comprised the same complex of huts, gardens, windbreaking shrubs, and utilized groves, although the form and overall size of each appear to differ. The major differences between this portion of the coast and Hilo occurred in the type of agriculture practiced and structural forms reflecting the uneven nature of the young terrain. Platforms and walls were built to include and abut outcrops, crevices were filled and paved for burials, and the large numbers of loose surface stones were arranged into terraces. To supplement the limited and often spotty deposits of soil, mounds were built of gathered soil, mulch, sorted sizes of stones, and in many circumstances, from burnt brush and surrounding the gardens. Although all major cultigens appear to have been present in these gardens, sweet potatoes, ti (*Cordyline terminalis*), *noni* (*Morinda citrifolia*), and gourds (*Lagenaria siceraria*) seem to have been more conspicuous. Breadfruit, pandanus, and mountain apple (*Eugenia malaccensis*) were the more significant components of the groves that grew in more disjunct patterns than those in Hilo Bay. (McEldowney 1979:17)

Ka Mo'olelo O Hi'iakaikapoliopele (The story of Hi'iakaikapoliopele), initially published in the Hawaiian language newspaper *Ka Na'i Aupuni* between the years 1905-1906 (Ho'oulumāhiehie 2006), tells a story of Pele and her siblings that takes place at Hā'ena, located to the northwest of subject parcel. The story relates that after settling on Hawai'i Island, Pele and her siblings ventured down to Hā'ena in Kea'au to bathe in the sea. While there, Pele was overcome with the desire to sleep. She informed her youngest sister, Hi'iaka not to allow any of their siblings to awaken her. Hi'iaka consented to her sister's commands. In her dream state, Pele followed the sound of a *pahu* (drum), which carried her spirit to the island of Kaua'i, where she met a striking man named Lohi'au. The two fell madly in love, but since Pele was in her spirit form, she made it clear to Lohi'au that she must return to Hawai'i Island. Pele's long sleep was cause for concern and although tempted to awaken her sister, Hi'iaka held true to her sister's commands and let her sleep.

When she awoke, Pele called upon each of her sisters and made a proposition, asking which one of them would fetch her dream lover Lohi'au from Kaua'i. Knowing Pele's tempestuous temper, each feared possible repercussions and refused to go, except for her youngest sister, Hi'iaka. Pele demanded that Hi'iaka travel to Kaua'i to fetch Lohi'au, and sent her on her way with strict instructions; Hi'iaka was not to take him as her husband, she was not to touch him, and she was to take no longer than forty days on her journey. While Hi'iaka agreed to her sister's demands, she realized that in her absence, Pele would become incensed with a burning and vehement fury and destroy whatever she desired. So Hi'iaka set forth two stipulations of her own; her beloved *'ōhi'a lehua* grove in Puna was to be spared from destruction, and Pele was to protect her dear friend Hōpoe in her absence. In this version of the story, Hōpoe is described as a young girl from Kea'au who was skilled at riding the surf of Hā'ena, and who was the one that taught Hi'iaka the art of *hula*. Pele agreed to Hi'iaka's requests, and Hi'iaka departed on her journey to retrieve Pele's lover. In a sympathetic act, Pele bestowed supernatural powers upon Hi'iaka so that she would be protected against the dangers she would undoubtedly meet along the way.

Hi'iaka hadn't ventured very far on her journey when she realized that the volcano had begun to smoke thickly, trailing lava towards Hōpoe's home of Kea'au. It was not long before the smolder of smoke burst into a scorching fire. Despite being filled with a sense of dread, sensing that her sister had betrayed her promise, Hi'iaka continued her journey. At last, Hi'iaka found Lohi'au, unfortunately, all that remained of him was his lifeless corpse. Keenly aware that she could not return Lohi'au to her sister in such a state, Hi'iaka used her healing powers to return his wandering spirit back into his body.

By this time, because of the amount of time taken by Hi'iaka, Pele was furious. She shook the earth with great ferocity and heaved her lava in a torrent of devastation, annihilating Hi'iaka's *'ōhi'a lehua* forest, obliterating all of Puna, and finally consuming Hōpoe as she lingered by the sea. In her death, Hōpoe was transformed into a stone at the coast of Kea'au; a stone, carefully balanced alongside the sea, that would dance gracefully when touched by the surf. Hi'iaka, her heart bitter with her sister's betrayal, brought Lohi'au back to Puna as she swore she would. There, enraged by her sister's spiteful acts, Hi'iaka fought a brutal battle with Pele. Fearing that the two sisters would destroy the entire island, the elder gods finally intervened and ended the battle.

A map prepared in 1930, and filed with Land Court Application 1053 (Figures 5), labels the coastal lands on the eastern side of Kaloli Point as "Hopoe," suggesting that the events of *Ka Mo'olelo O Hi'iakaikapoliopele* (Ho'oulumāhiehie 2006) may have occurred in the general vicinity of the subject parcel. Maly (1999:138) indicated that "Hōpoe embodied the *lehua* forest of Kea'au that extended across the flats that make up what is now called Kaloli Point." The stone believed to be Hi'iaka's companion, Hōpoe, was moved by a *tsunami* in 1946 (Maly 1999:134; Pukui et al. 1974:52), and no longer dances along the shore of Kea'au Ahupua'a.

In 1823, British missionary William Ellis and members of the American Board of Commissioners for Foreign Missions (ABCFM) toured the island of Hawai'i seeking out communities in which to establish church centers for the growing Calvinist mission. Ellis recorded observations made during this tour in a journal (Ellis 2004). Walking southwest to northeast along the southeastern shore of the District of Puna with his missionary companions Asa Thurston and Artemas Bishop, Ellis' writings present descriptions of residences and practices in the district, and provide the first written description of Kea'au (or Hā'ena) Village and its environs:

> …The country was populous, but the houses stood singly, or in small clusters, generally on the plantations, which were scattered over the whole country. Grass and herbage were abundant, vegetation in many places luxuriant, and the soil, though shallow, was light and fertile.
>
> Soon after 5 P.M., we reached Kaau [Kea'au], the last village in the division of Puna. It was extensive and populous, abounding well with cultivated plantations of taro, sweet potatoes, and sugar-cane, and probably owes its fertility to a fine rapid stream, which, descending from the mountains, runs through it into the sea. (Ellis 2004:296)

When Ellis visited Puna, less than fifty years after the arrival of the first Europeans, the population of Hawai'i was already beginning to decline (Maly 1998). By the mid-nineteenth century, the ever-growing population of Westerners in the Hawaiian Islands forced socioeconomic and demographic changes that promoted the establishment of a Euro-American style of land ownership, and the *Māhele 'Āina* (Land Division) of 1848 became the vehicle for determining the ownership of native lands within the island kingdom. During the *Māhele*, native tenants could also claim, and acquire title to, *kuleana* parcels that they actively lived on or farmed. As a result of the *Māhele*, Kea'au Ahupua'a was awarded to William C. Lunalilo (the future, and first elected, monarch of the Hawaiian Islands) as *'āpana* (parcel) 16 of Land Commission Award 8559B. Kea'au was one of sixty-five *ahupua'a* maintained by Lunalilo following the *Māhele*. In Puna, very few claims for *kuleana* were submitted. Maly (1998:37) notes that, with the exception of the islands of Kaho'olawe and Ni'ihau, no other land division of comparable size, had fewer claims for *kuleana* from native tenants than the district of Puna. Only two *kuleana* (LCAw. 2327 to Barenaba and LCAw. 8081 to Hewahewa) were awarded within Kea'au Ahupua'a, neither of which is in close proximity to the current study area (Maly 1999).

Although exposed to missionary presence since the 1820s, early pre-*Māhele* narratives portray Puna as a district still heavily rooted in tradition, being only marginally impacted by foreign influence. While earlier narratives describe the region as densely populated with settlement locales present at both coastal and inland settings, subsequent accounts reveal a sharp decline in the native population throughout the nineteenth century, with Hawaiians maintaining marginalized communities outside of the central population centers. During the middle part of the nineteenth century, Puna's population declined by more than half from 4,800 in 1835 to 2,158 in 1860 (Anderson 1865), and continued decreasing to a mere 1,043 by 1878, reaching an unsurpassed low of 944 by 1884 (Thrum 1885 and 1886). Lifeways for the Hawaiian population still residing in Puna underwent drastic changes during the second half of the nineteenth century, as the traditional villages and subsistence activities were mostly abandoned.

By the beginning of the twentieth century, Puna was on the verge of major economic growth, spurred by the booming sugar and lumber industries. Increasing urbanization of Puna, and particularly Kea'au, were initially propelled by the sale of the *ahupua'a* to William Herbert (W.H.) Shipman, J. Eldarts, and Samuel Damon by the King Lunalilo Estate in 1882. Campbell and Ogburn (1992) relate that with land leased from Shipman, a small group of investors (B.F. Dillingham, Lorrin A. Thurston, Alfred W. Carter, Samuel M. Damon) created and developed the 'Ōla'a Sugar Company, which operated on lands *mauka* of the current study area between 1899 and 1984. The current study area was too rocky for the cultivation of sugarcane, and was used by the Shipman family as ranch/grazing land until the late 1950s, when it subdivided into the Hawaiian Paradise Park subdivision and sold in many small pieces to individual owners.

Identification of Cultural, Historical or Natural Resources

Records on file at DLNR-SHPD indicate that twenty-two parcels within the Hawaiian Paradise Park subdivision (totaling 22 acres) have been previously surveyed for archaeological sites. Twenty-one parcels were surveyed by Haun and Henry (2013a, 2013b, 2013c) and the twenty-second parcel was surveyed by Higelmire and Lash (2017). Each of these studies, conducted at locations inland of the current study area, reported negative findings with regards to the presence of archaeological sites and features.

A survey of coastal lands within Kea'au Ahupua'a, conducted by Lass (1997) along the route of the Old Government Road to the northwest of HPP, identified fifteen archaeological sites including the Old Government Road/Puna Trail (Site 50-10-36-21273), which once passed inland of the current study area (Figure 10), along with numerous rock walls, enclosures, rock piles, modified bedrock features, and several concrete structures (Sites 50-10-36-21259 to 21273) (Figure 6). These sites were interpreted as having been used for Precontact to early Historic Period habitation, burial, and agricultural purposes, Historic ranching purposes, and World War II-era coastal defense purposes. Although not previously recorded, it is likely that similar sites were once common along the coast of HPP as well, prior to the development of the subdivision's roads and lots.

A field inspection of the subject parcel was conducted on June 6, 2018 by Matthew R. Clark, M.A. of ASM Affiliates. The field inspection revealed that no archaeological features are present on the surface of the parcel, and determined that the likelihood of encountering subsurface resources are extremely remote given the exposed bedrock ground surface (Clark 2018). Although no cultural or historical sites were identified during the archaeological survey, the current subject parcel is situated along the Kaloli Point coastline, which is still accessed for subsistence marine resource collection including but not limited to fishing and the collection of *'opihi* (*Cellana sp.*). An unpaved road located at the north end of Paradise Ala Kai Street provides pedestrian access to the coast where fishermen can walk south along the coastline. A portion of this unpaved road is accessible using a four-wheel drive vehicle.

Previous Ethnographic Studies

Kepā Maly in 1999 completed archival-historical research, consultation, and a limited site preservation plan for the Kea'au section of the Puna Trail-Old Government Road for *Nā Ala Hele*, the Hawai'i Statewide Trail and Access System. Maly's study identified traditions and practices associated with Kea'au Ahupua'a including travel along the Puna Trail and he identified significant features along the coastal landscape. The oral history component focused on recording the accounts of four individuals who utilized the trail and were knowledgeable about the coastal portion of Kea'au. Maly (1999) indicated that the Puna Trail evolved from the trail system known as the *ala loa*, which passed through the Puna District, and connected to the various districts on the island.

In 1998, Maly conducted an interview with John Ka'iewe Jr. who identified other old villages in the coastal section of Kea'au that were not noted by McEldowney (1979), namely Pākī and Keauhou, which are located between Kaloli Point and Hā'ena. Mr. Ka'iewe described the cultivating grounds for these villages being between the shore and the Old Government Road as well as on the *mauka* side of the road. Mr. Ka'iewe also described gathering marine resources in this area including *'opihi*, *wana*, and *limu*. Following World War II, Mr. Ka'iewe specified that access had become restricted on the Old Government Road and that "the section of the road from Kaloli to Hā'ena was opened up for military vehicles" (ibid.:133). The presence of burials along the coast between Kea'au to Maku'u were also noted by Mr. Ka'iewe.

Roy Shipman Blackshear, a descendant of William H. and Mary Shipman was also interviewed by Maly (1999). Mr. Blackshear described traveling along the Old Government Road and coastal lands of Kea'au. With respect to coastal sites, Mr. Blackshear described the fishpond and *kū'ula* (fishing shrines) stones at Kea'au Bay, a possible burial site on the *mauka* side of the Puna Trail near the Hōpoe vicinity, and old house sites and walls located along the portion of the trail extending from Hā'ena to Pākī and Keauhou. Mr. Blackshear also noted an old *heiau* and burial sites crossed by the Puna Trail in Waikahekahe Nui.

As part of this same study, Maly (1999) conducted an interview with a father and son, Albert Haa Sr. and Albert Haa Jr, who shared their experiences in traveling along the entire Kea'au shoreline for fishing. Mr. Haa described traveling along the shoreline trail from Hā'ena to Pākī instead of using the old Government Road. Mr. Haa also noted the presence of a large coastal cave, however, he did not specify its location.

Findings and Conclusions

In summary, the cultural-historical, archaeological, and ethnographic studies reviewed for this analysis revealed that the current subject parcel is located in the vicinity of Hōpoe; a place described in the epic account of *Pele and Hi'iaka*. From this account, we learn that Hōpoe was the name of Hi'iaka's companion and also the name of her beloved *'ōhi'a* grove, both of which were destroyed by her sister Pele. On a mythic level, this Hawaiian legendary account explains the major transformation of the Puna landscape through the interaction of gods and goddesses associated with the islands' volcanic and geological forces. Pukui and Elbert (1986:82) defined *hōpoe* as "fully developed, as a lehua flower." These description appear to describe the existence of a famed *'ōhi'a* grove that once thrived in this general area but was eventually consumed by Pele. It is interesting to note that the lava flow in the study area dates between 200 and 700 years old (Sherrod et al. 2007).

With respect to previously identified archaeological features, transportation related sites such as trails and historic roads are located to the west (*mauka*) of the current subject parcel. The oral histories also revealed that there was a less formal shoreline trail used when gathering marine resources. Located along these routes are several traditional settlements and village sites described by McEldowney (1979) and Maly (1999), including Keauhou, Pākī, and Hā'ena, which are located to the north of the subject parcel with additional village sites located to the south of the subject parcel. These coastal villages were established in areas with more favorable conditions for marine resources collection and also contained an environment to support traditional horticultural activities. As noted in the oral history interviews, these traditional agricultural sites are situated between the coast and Old Government Road. Burials were also noted by the several of the interviewees and being located near the villages and along the trails.

Although a variety of marine resources may be procured from the coast in the general vicinity of the subject parcel, the absence of cultivatable soil made this area a less favorable location for permanent settlement and traditional habitation. While the subject parcel location has not been identified as a traditional settlement or village site, other historic sites are known to exist in the general vicinity, one of which is the Puna Trail- Old Government Road, which is a marked trail currently managed by *Nā Ala Hele*.

It is our analysis, given the documented distance between the subject parcel and the previously identified natural, cultural, and historical resources, that the current proposed rezoning action will not adversely affect any of these valued resources. From a review of the oral traditions collected by Maly (1999), and through more recent observations, it is clear that the shoreline has been and continues to be accessed by local fishermen to procure a variety of marine resources. The collection of marine resources for subsistence purposes is a traditional and customary practice; and while such activity may be taking place in the vicinity of the current study parcel, it is our contention that the proposed rezoning action will not adversely affect this practice, nor will it impair access to the coast.

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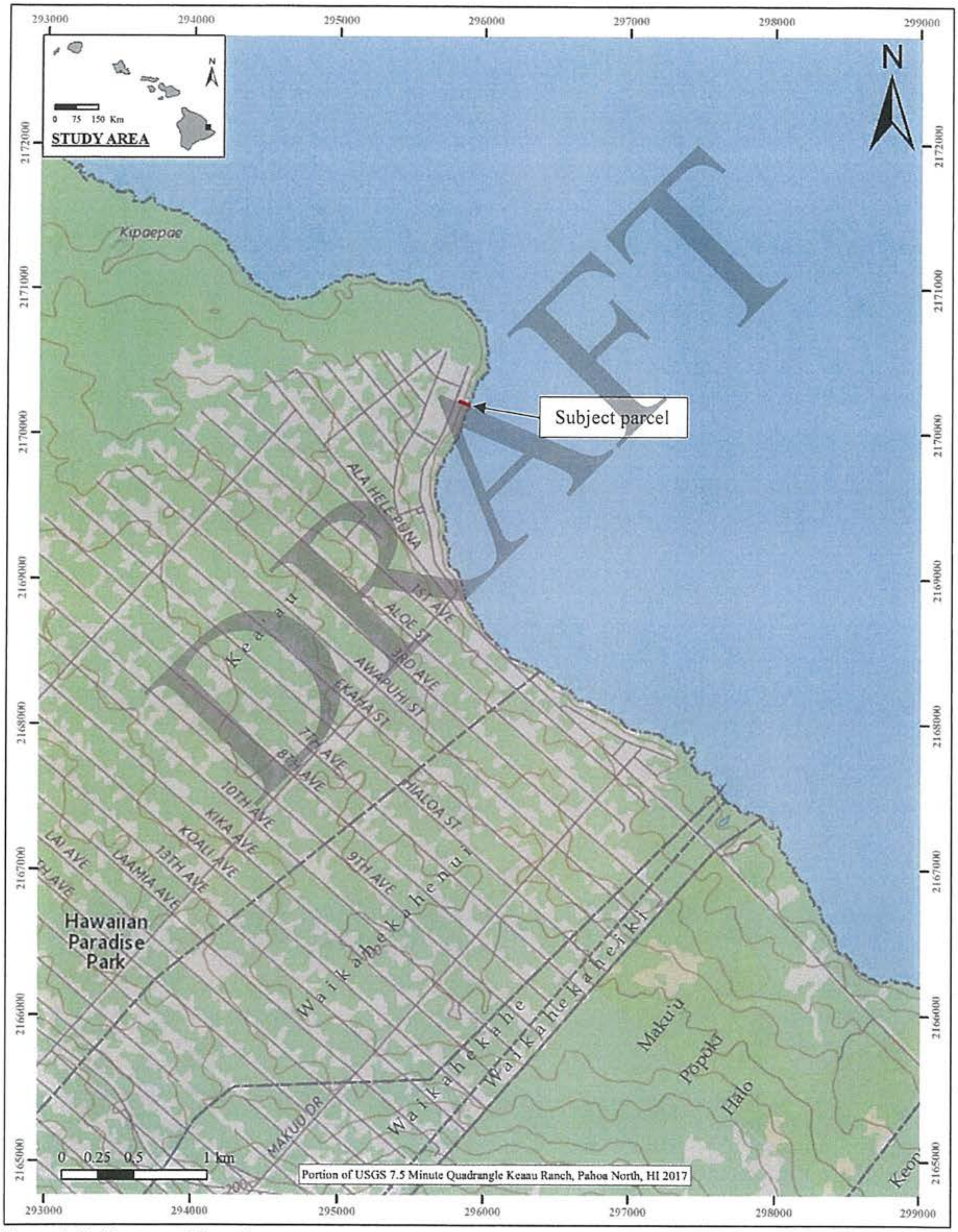

Figure 1. Subject parcel location.

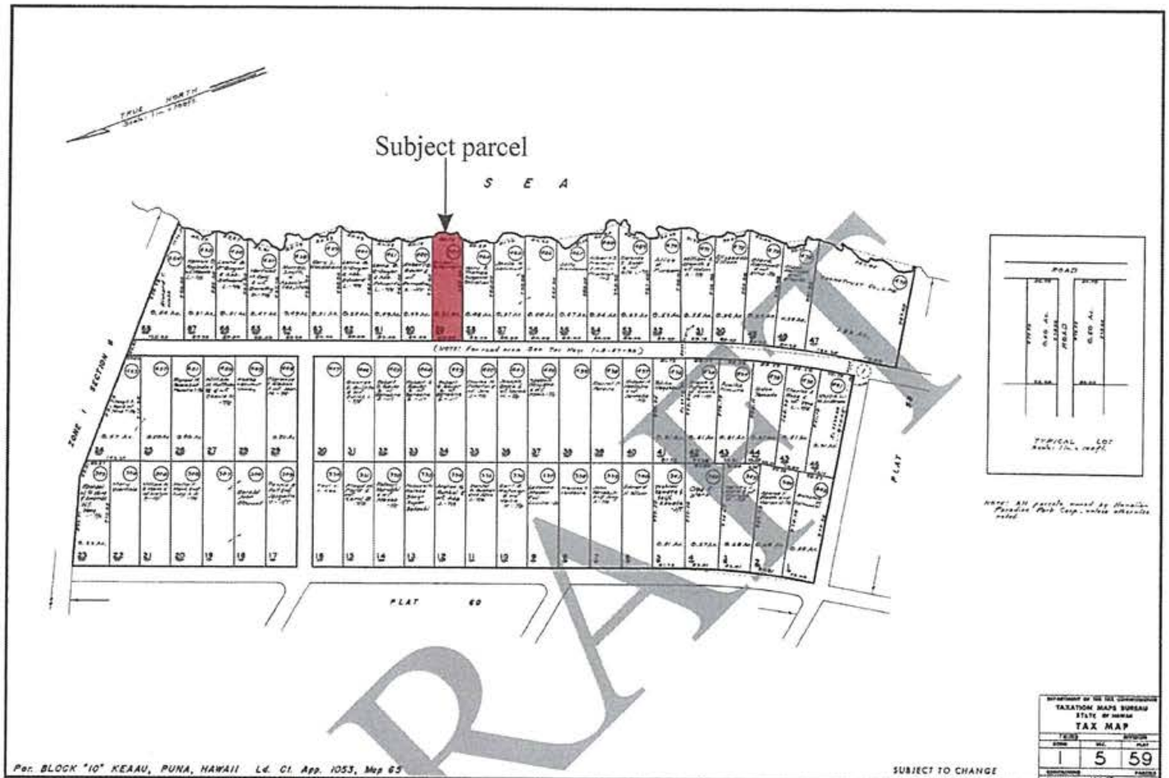

Figure 2. Tax Map Key (3) 1-5-059 with the subject parcel (059) indicated in red.

Figure 3. Aerial image showing the subject parcel (outlined in red).

Figure 4. Conservation-zoned lands in the vicinity of the subject parcel.

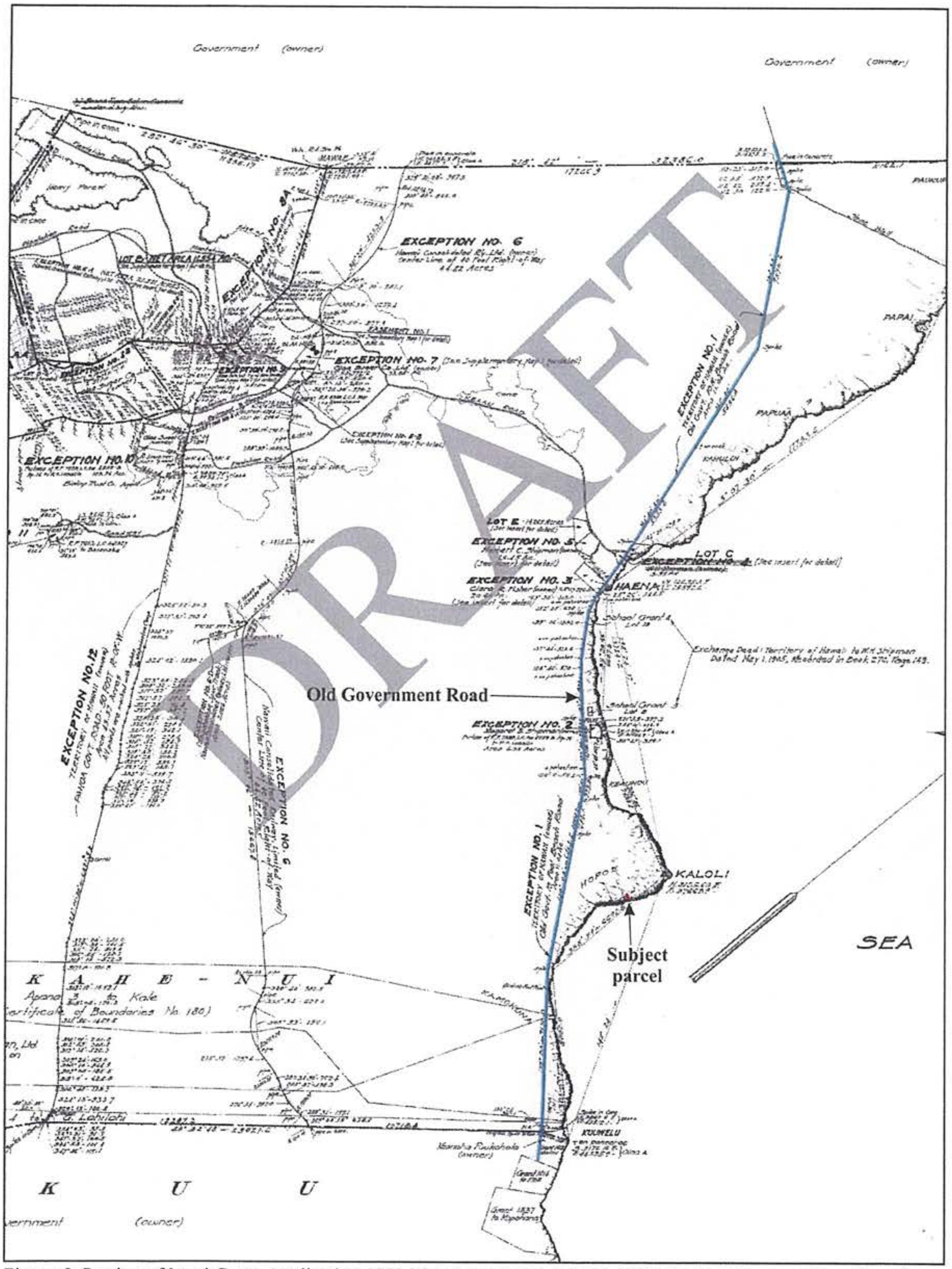

Figure 5. Portion of Land Court Application 1053 Map 1 (prepared July 31, 1930 showing the coastal portion of Kea'au Ahupua'a with the locations of the Old Government Road and the subject parcel indicated.

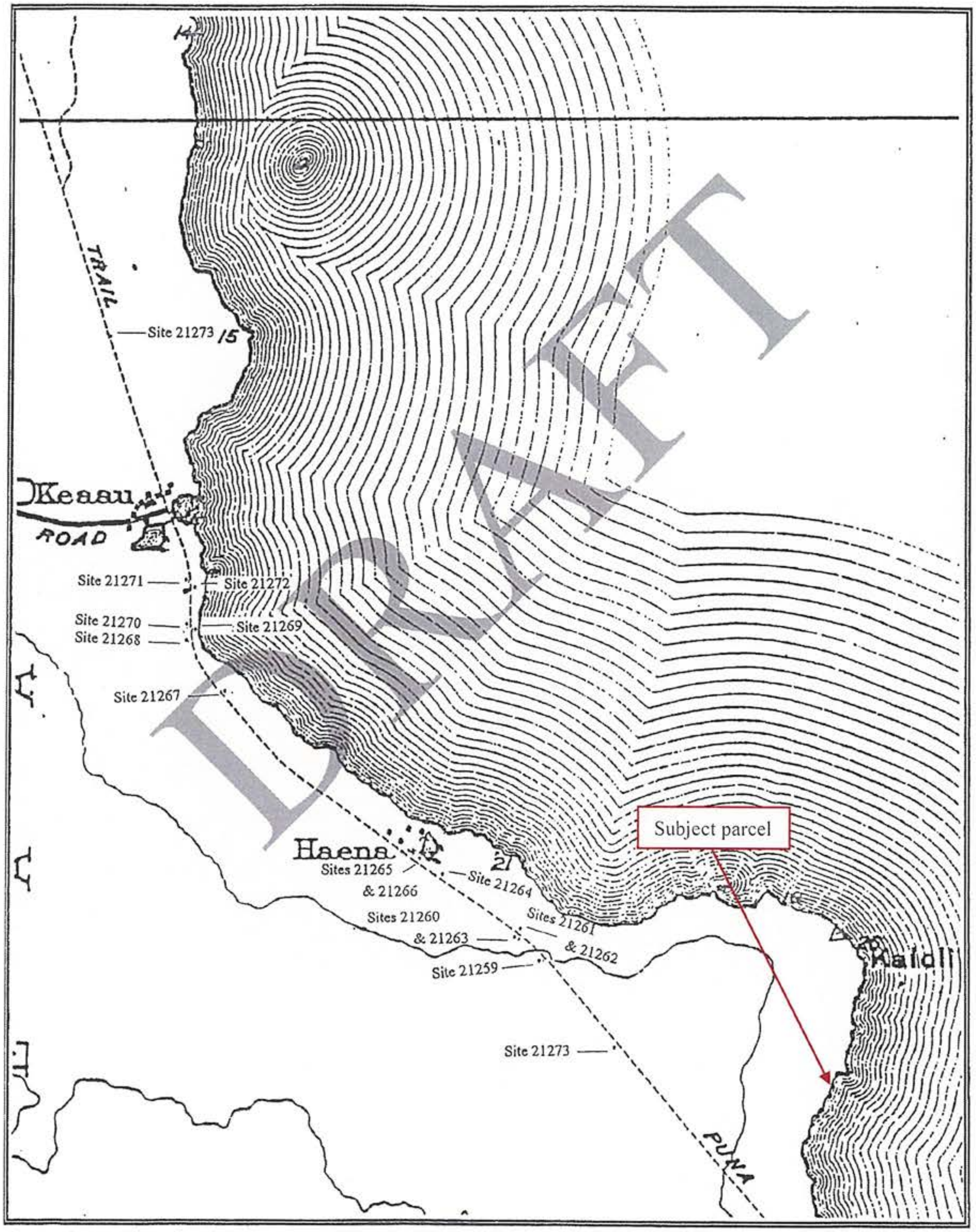

Figure 6. Location of archaeological sites previously recorded in Kae'au Ahupua'a along the route of the Old Government Road to the northwest of HPP (Lass 1997:Figure 2).

BEFORE THE LAND USE COMMISSION

OF THE STATE OF HAWAIʻI

In the Matter of the Petition of KEVIN M. BARRY AND MONICA S. BARRY, TRUSTEES OF THE BARRY FAMILY TRUST DATED NOVEMBER 15, 2006 To Amend the Land Use District Boundary of Certain Lands Situated at Keaʻau, Puna, County of Hawaiʻi, State of Hawaiʻi, Consisting of 0.51 Acres from the Conservation District to the Agricultural District, Tax Map Key No. (3) 1-5-059:059.	CERTIFICATE OF SERVICE

CERTIFICATE OF SERVICE

I hereby certify that due service of the within document was made by depositing the same with the United States Mail, postage prepaid, or by hand delivery, on July 26, 2019, addressed to:

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